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Station

User's Guide for Computer Program TEMPER (X8305)

by Terry West, Federal Energy Regulatory Commission

WES

Prepared for Headquarters, U.S. Army Corps of Engineers

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Federal Energy Regulatory Commission
Atlanta Regional Office
3125 Presidential Parkway
Suite 300
Atlanta, GA 30340

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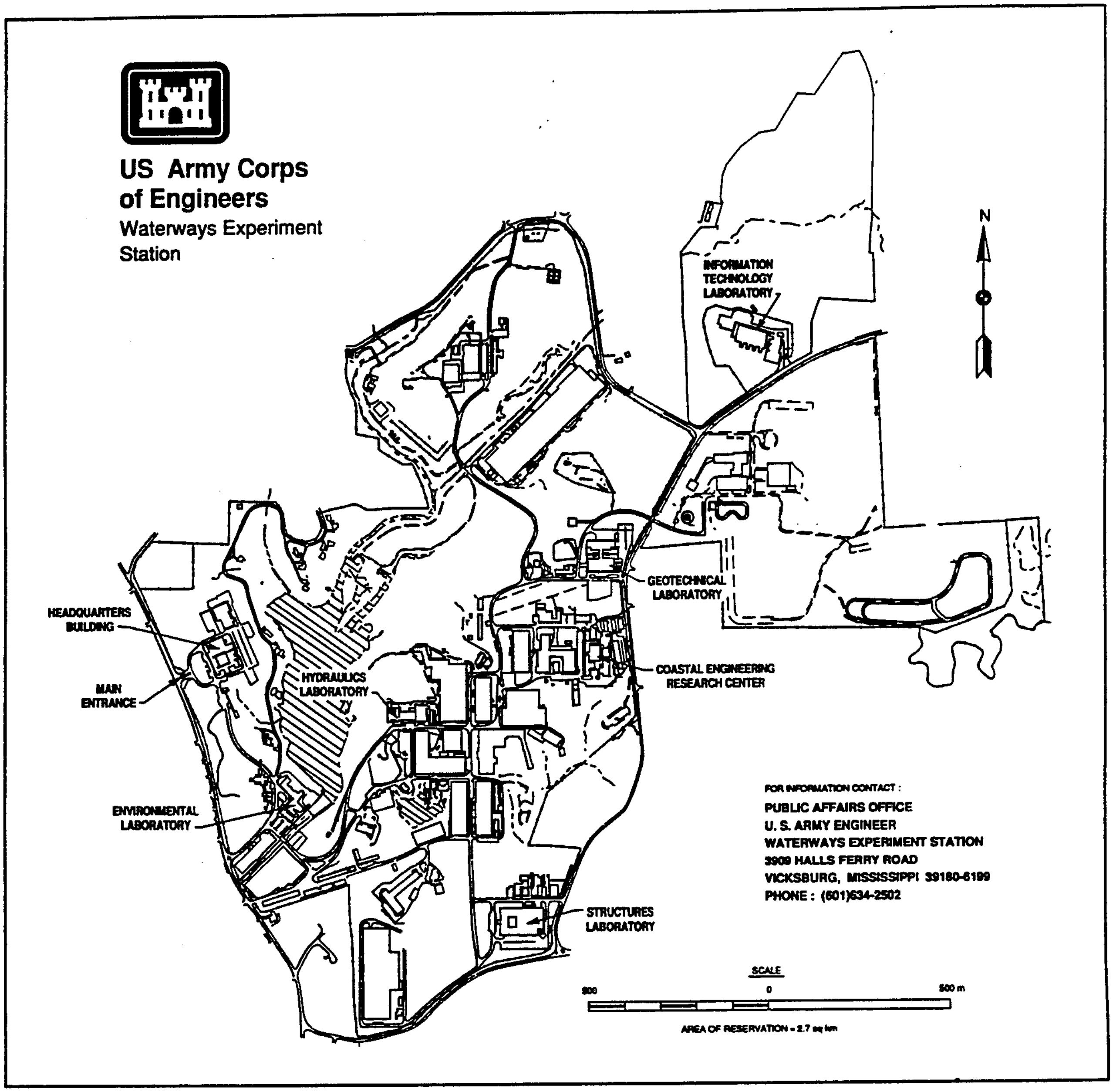

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Contents

Preface

This user's guide documents the computer program TEMPER (X8305). The program can be used to estimate the uniform and linear temperature distributions in arch dams. The program uses the theoretical methods described in "Control of Cracking in Mass Concrete Structures" by the U.S. Department of the Interior, Bureau of Reclamation. The user's guide discusses the limitations of the program, provides a description of the data required to run the program, describes the input and output files, and provides example files.

This user's guide was written by Mr. Terry W. West (formerly of the Jacksonville District) under the direction of the Computer-Aided Structural Engineering (CASE) Arch Dam task group. Task group members during the development of this user's guide were:

Mr. Byron J. Foster	CESAD-EN (Chairman)
Mr. G. Ray Navidi	CEMP-ET (formerly CEORH-ED)
Mr. William K. Wigner	CESAJ-END
Mr. Jerry L. Foster	CECW-ED
Mr. Donald R. Dressler	CECW-ED
Mr. H. Wayne Jones	CEWES-IM-DS (Task Group Coordinator)
Mr. David A. Dollar	Bureau of Reclamation
Mr. Larry K. Nuss	Bureau of Reclamation
Mr. Terry W. West	Federal Energy Regulatory Commission (formerly CESAJ-EN)

The work was accomplished under the general supervision of Dr. N. Radhakrishnan, Director, Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES), and under the direct supervision of Mr. H. Wayne Jones, Chief, Computer-Aided Engineering Division (CAED), ITL. The technical monitor for Headquarters, U.S. Army Corps of Engineers, was Mr. Jerry Foster.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
degrees Fahrenheit	5/9	degrees Celsius of kelvins[1]
feet	0.3048	meters
square feet	0.09290304	square meters

[1] To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

1 Introduction

Background

Computer program TEMPER (X8305) was developed to provide a fast and convenient way of predicting the temperature distributions in an arch dam. The output from TEMPER is designed to provide the temperature loads for use in other programs such as the Arch Dam Stress Analysis System (ADSAS) Program. To estimate the mean concrete temperatures, the TEMPER program uses the theoretical methods described in "Control of Cracking in Mass Concrete Structures" by the U.S. Department of the Interior, Bureau of Reclamation (BOR 1981). In addition, the formats for many of the summary tables produced by TEMPER are fashioned after similar computer programs developed by the BOR.

Limitations

The method of temperature prediction used in TEMPER is based on classical heat flow methods and should not be confused with more sophisticated methods which model transient heat flow. The method used by TEMPER involves determining the range of mean concrete temperatures that a slab of concrete will experience if it is exposed to varying temperatures on its two faces.

TEMPER assumes a linear distribution of temperatures between the upstream and downstream faces. This assumption is generally acceptable for relatively thin arch dams. Concrete dams with relatively thick sections will experience a somewhat different temperature distribution since the interior mass may not respond as quickly to changes in temperature at the faces. Therefore, for gravity dams and thick arch dams, the linear assumptions may not be appropriate, especially during the later phases of the design process.

In addition to the above method limitations, the program is limited to 26 elevations.

Units

The units used in TEMPER are feet and degrees Fahrenheit.

2 Required Data

TEMPER determines average temperature distributions within a dam based on the layout of the dam, the diffusivity of the concrete, and various site-specific conditions. The site conditions include air temperatures, reservoir water temperatures, and solar radiation.

Air Temperatures

Air temperature data needed include the average high and low temperatures for each month and the extreme high and low temperatures ever recorded at the site. If air temperature data for the damsite are not available, then data from the closest National Weather Service (NWS) weather station can be used. The program will adjust the temperature data to account for elevation and latitude differences.

Reservoir Water Temperatures

For existing dams, the average maximum and minimum reservoir water temperatures should be used. For new dams, the temperature can be estimated by performing a detailed thermal stratification study or can be estimated based on measured temperatures at nearby reservoirs. EM 1110-2-2201 (Headquarters, U.S. Army Corps of Engineers 1994) provides additional guidance on how reservoir temperatures can be estimated.

Concrete Diffusivity

Thermal diffusivity can be measured using CRD-C 37 (U.S. Army Engineer Waterways Experiment Station (1949). Since the aggregate has the greatest influence on thermal diffusivity, the tests should be performed using the aggregate proposed for new construction. If test results are not initially available, then typical values can be used. Diffusivity usually ranges between 0.20 and

0.60 ft^2/day.[1] Table 1 represents typical values based on severely different types of aggregate.

Table 1
Typical Diffusivity Values for Various Aggregates

Coarse Aggregate	Diffusivity, ft^2/hr
Quartzite	0.058
Limestone	0.051
Dolomite	0.050
Granite	0.043
Rhyolite	0.035
Basalt	0.032

Adapted from American Concrete Institute (ACI) 207.1R (ACI 1994).

Dam Layout

There are several variables needed for **each arch elevation** to be evaluated. These include the thickness of the dam, the slope of the surface from vertical, the angle between north and the normal to surface, and a terrain factor. The thickness of the dam is the average thickness of the dam from abutment to abutment. The slope and angle to north are needed for three cantilever sections: the crown cantilever and cantilevers near the quarter points of the crest. Figures 1 and 2 demonstrate how the slope and angle are determined. The terrain factor is usually the average value for the three cantilever sections. Figure 3 shows the procedure used to determine the terrain factor for each elevation.

[1] A table of factors for converting non-SI units of measurement to SI is presented on page v.

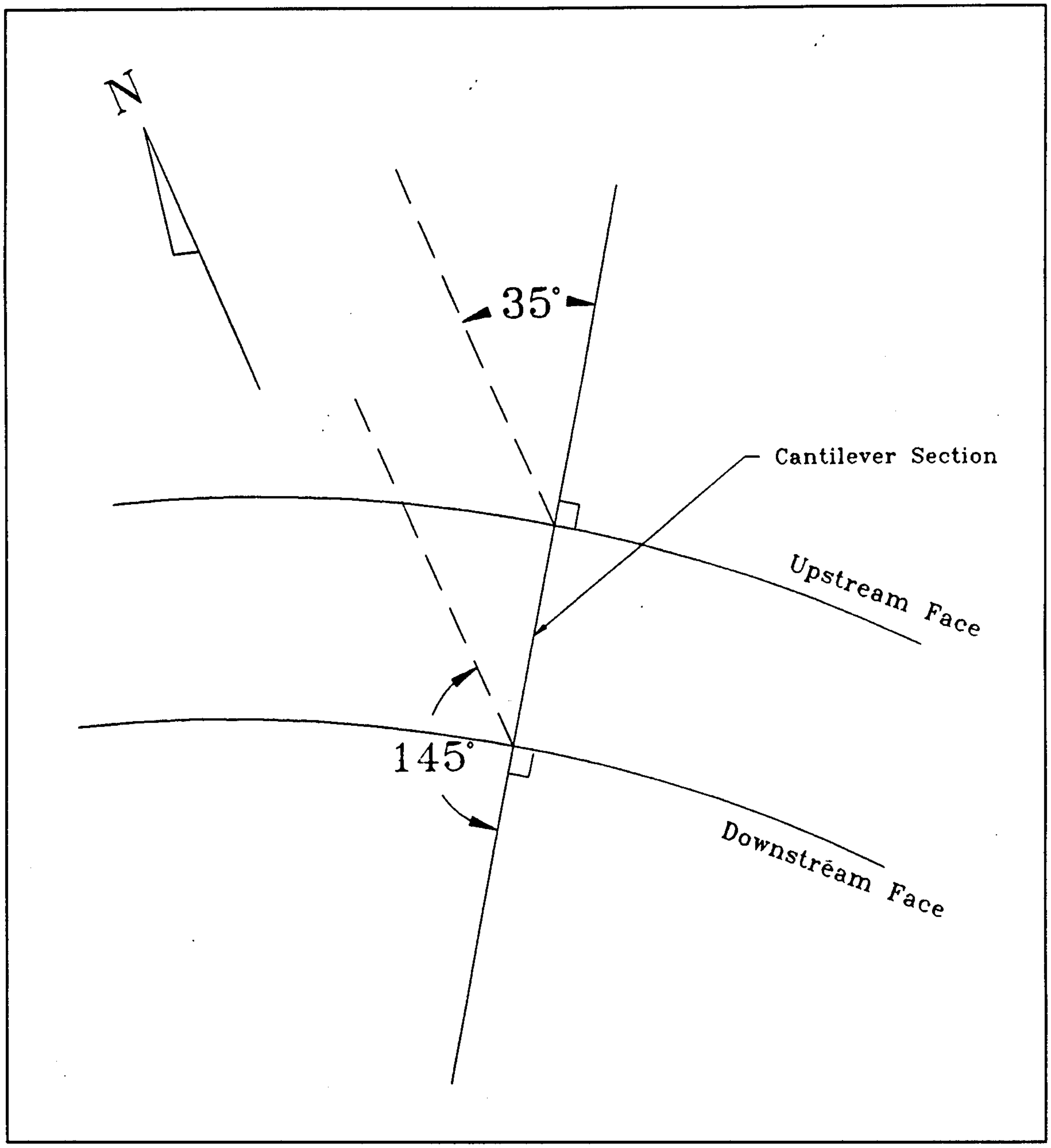

Figure 1. Measuring the angle between north and the normal to the surface

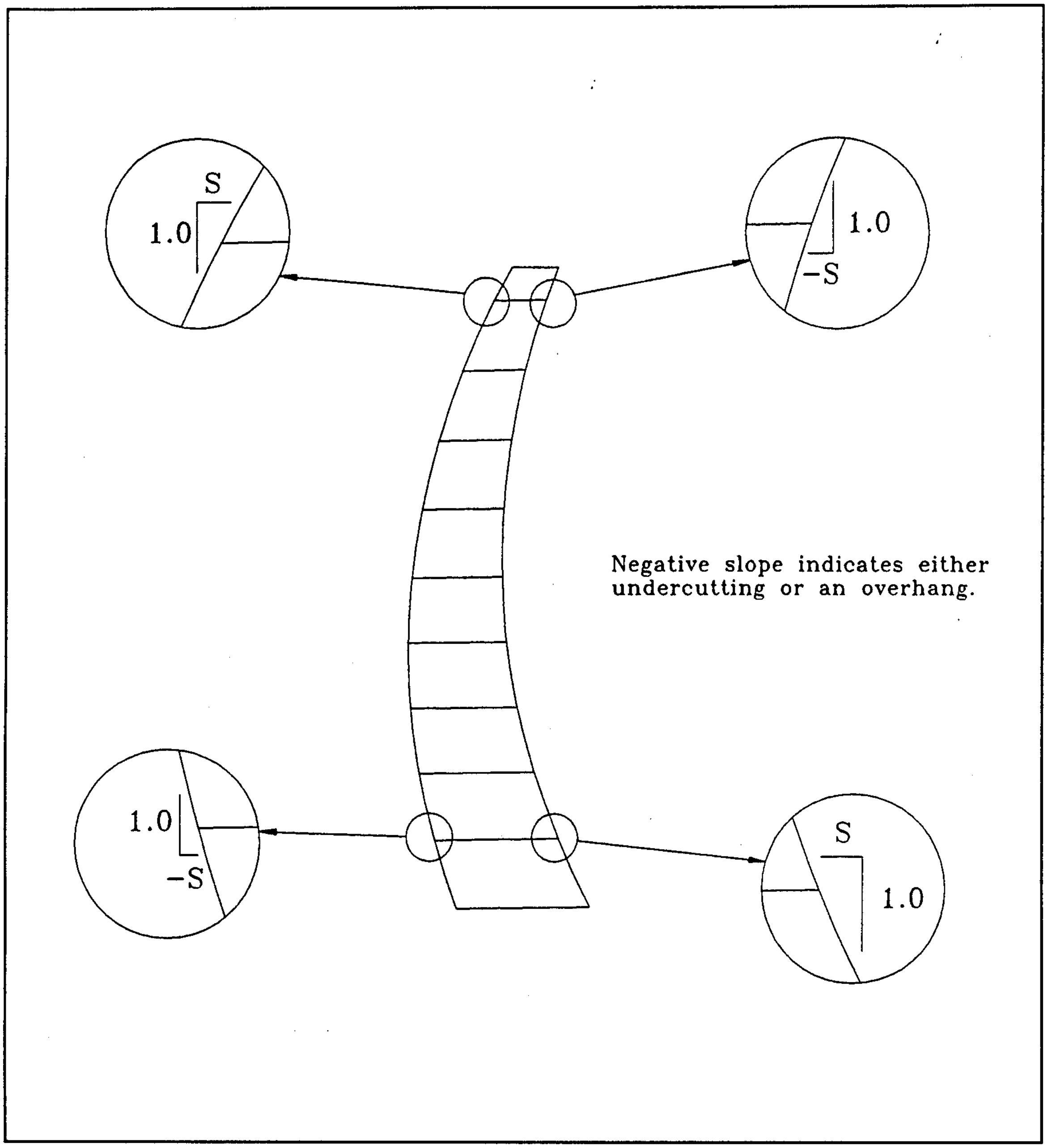

Figure 2. Determining slope of surface

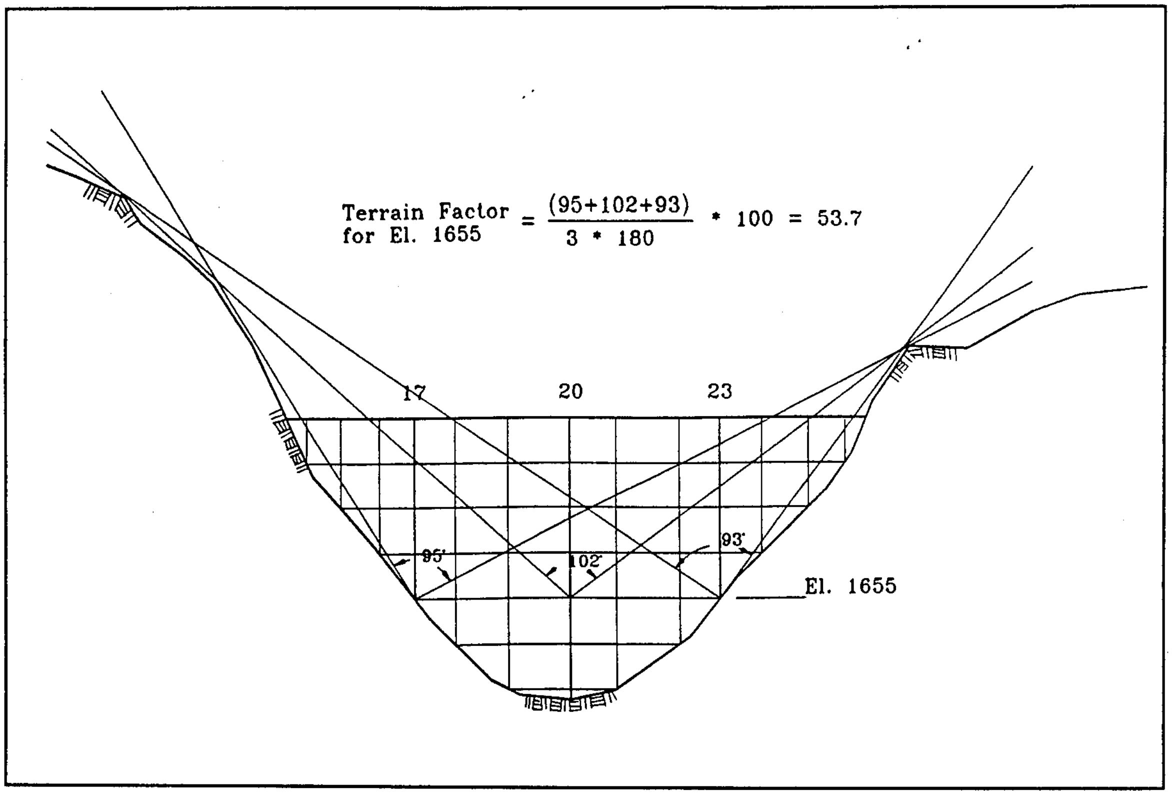

Figure 3. Procedure for determining terrain factors section taken east-west (looking north)

3 Input

TEMPER prompts the user for the names of the input and output files. Data in the input file should be input according to the following guide. All input is in free field (a comma or at least one blank should separate data items). An example input file is shown in Appendix A.

TITLE

TITLE - any alphanumeric information to identify the problem. (80 characters maximum)

DELEV, DLAT, TELEV, TLAT

DELEV - elevation of the damsite
DLAT - latitude of the damsite
TELEV - elevation of the town or weather station (source) for the air temperatures
TLAT - latitude of the town or weather station (source) for the air temperatures

TOWN

TOWN - name of the town or weather station where the air temperature was measured

STATE

STATE - name of the state where the town or weather station is located

TEMP(I,1), TEMP(I,2)

TEMP(I,1) - average low air temperature for the month (deg-F)
TEMP(I,2) - average high air temperature for the month (deg-F)

Note: Repeat this line of data 12 times, one line of data for each month, beginning with January.

TLOWBC, THIGHBC

TLOWBC - lowest recorded air temperature at the source
THIGHBC - highest recorded air temperature at the source

DIFF, NOELE

DIFF - concrete diffusivity (square feet per hour)
NOELE - number of elevations

ELE(I), THICK(I), WATER(I,1), WATER(I,2)

ELE(I) - elevation
THICK(I) - average concrete thickness for the elevation
WATER(I,1) - maximum water temperature at that elevation
WATER(I,2) - minimum water temperature at that elevation

Note: Repeat this line of data NOELE (number of elevations) times. If the normal water surface is below ELE(I), then enter zero for WATER(I,1). If WATER(I,1) is input as zero, then the effects of water are not included in the calculations at ELE(I).

C(I), AN(I,1), AN(I,2)

C(I) - cantilever number
AN(I,1) - upstream angle to north corresponding to the cantilever (see Figure 1)
AN(I,2) - downstream angle to north corresponding to the cantilever (see Figure 1)

Note: Repeat this line of data for each of the three cantilevers. Angles to north must be between 0 and 180 deg.

TFACT(I), (SLOPE(I,K),K=1,6)

TFACT(I) - terrain factor (see Figure 3)
SLOPE(I,K) - concrete slope from vertical (see Figure 2)

Note: Repeat this line of data NOELE (number of elevations) times. Slopes must be either -1.0 or be between -0.4 and 1.0. Negative slopes indicate either undercutting or overhanging (see Figure 2). If the base of the cantilever is below ELE(I), then enter -1.0 for SLOPE(I,K). If SLOPE(I,K) is input as -1.0, then the effects of solar radiation are not included in the calculations.

GROUT

GROUT - closure temperature (deg-F).

Note: Repeat this line for each grout temperature under consideration.

4 Output

Output is written to a file which can be viewed at the terminal or sent to a printer. The output includes a listing of the input data file; the ambient air temperatures for each month; the base ambient air temperatures; elevation and latitude corrections; amplitudes of air temperatures; concrete temperatures with air effects only, with air and reservoir effects, and with the effects of solar radiation; and the ADSAS temperatures for each month for usual conditions and mean conditions with air on both faces and with air on downstream face and water on upstream face.

The following calculations are used to produce the output file and are based primarily on the theoretical methods used in BOR (1981). Table numbers correspond to those in the example output file (Appendix A).

Mean Monthly Air Temperatures (Table 1 in Appendix A)

The mean monthly air temperature T is assumed to be the average of the minimum and maximum values from the input file, calculated for each month in degrees Fahrenheit as:

$$\frac{T = Temp(1) + Temp(2)}{2.0} \tag{1}$$

where

$Temp(1)$ = minimum ambient air temperature for the month

$Temp(2)$ = maximum ambient air temperature for the month

The mean annual base ambient air temperature is calculated by adding the T values for each month together and dividing by 12 (the number of months in a year).

Elevation and Latitude Corrections (Table 2 in Appendix A)

When air temperature data from a source away from the damsite is used, then a correction must be made to the data. The correction value is based on the difference between the elevation and latitude of the weather station and the damsite. The air temperatures are adjusted by 1 °F for each 250-ft change in elevation and for each 1.4-deg change in latitude.

$$Celev = \frac{Telev - Delev}{250.0} \tag{2}$$

$$Clat = \frac{Tlat - Dlat}{1.4} \tag{3}$$

$$Ctot = Celev + Clat \tag{4}$$

where

Celev = correction factor for elevation

Clat = correction factor for latitude

Telev = elevation of the town (source) for air temperatures

Delev = elevation of the damsite

Tlat = latitude of the town (source) for air temperatures

Dlat = latitude of the damsite

Ctot = total correction

Ctot from Equation 4 is added to the mean base ambient air temperatures at the source to obtain the corrected values for the damsite.

Amplitudes of Air Temperatures (Table 3 in Appendix A)

The amplitudes of air temperatures are calculated as shown below. The annual and daily amplitudes are assumed to be the same for mean and usual weather conditions.

Period	Mean Conditions		Usual Conditions	
	Above Mean	Below Mean	Above Mean	Below Mean
Yearly	*Amp* (1,1)	*Amp* (1,2)	*Amp* (1,3)	*Amp* (1,4)
7-Day	*Amp* (2,1)	*Amp* (2,2)	*Amp* (2,3)	*Amp* (2,4)
Daily	*Amp* (3,1)	*Amp* (3,2)	*Amp* (3,3)	*Amp* (3,4)

where

$$Amp(1,1) = Thmm - Tmean \tag{5}$$

$$Amp(1,2) = Tmean - Tlmm \tag{6}$$

$$Amp(2,1) = 0.0 \tag{7}$$

$$Amp(2,2) = 0.0 \tag{8}$$

$$Amp(3,1) = \frac{Tmindif}{2.0} \tag{9}$$

$$Amp(3,2) = Amp(3,1) \tag{10}$$

$$Amp(1,3) = Amp(1,1) \tag{11}$$

$$Amp(1,4) = Amp(1,2) \tag{12}$$

$$Amp(2,3) = Abs[(Amp(1,1) + Amp(3,1)] - \frac{Thigh + Thmmm}{2.0 - Tmean} \tag{13}$$

$$Amp(2,4) = Abs[(Amp(1,2) + Amp(3,1)] - \frac{Tmean - (Tlow + Tlmmm)}{2.0} \tag{14}$$

$$Amp(3,3) = Amp(3,1) \tag{15}$$

$$Amp(3,4) = Amp(3,1) \tag{16}$$

where

Thmm = Highest mean monthly air temperature recorded at the dam

Tmean = Mean annual base ambient air temperature recorded at the dam

Tlmm = Lowest mean monthly air temperature recorded at the dam

Tmindif = Minimum difference between the mean monthly maximum and the corresponding mean monthly minimum

Thigh = Highest maximum recorded air temperature at the dam

Thmmm = Highest mean monthly maximum recorded at the dam

Tlow = Lowest minimum recorded air temperature at the dam

Tlmmm = Lowest mean monthly minimum recorded at the dam

L1 Values (Table 4 in Appendix A)

As described in EM 1110-2-2201, a correction factor is needed to compute an "effective" slab thickness. This effective thickness is related to the actual thickness of the dam, the diffusivity of the concrete, and the air cycle being utilized--yearly, 7-day, or daily. Once the effective thickness is known, the ratios for each cycle can be obtained based on Figure 11 of BOR (1981). The effective slab thickness *L*1 for each air temperature cycle is obtained at each elevation as follows:

$$Annual\text{:}\quad L1 = \frac{Thick}{\sqrt{Diff * 8760.0}} \tag{17}$$

$$7\text{-}Day\text{:}\quad L1 = \frac{Thick}{\sqrt{Diff * 168.0}} \tag{18}$$

$$Daily\text{:}\quad L1 = \frac{Thick}{\sqrt{Diff * 24.0}} \tag{19}$$

where

Thick = thickness of the dam at that elevation

Diff = concrete diffusivity

Mean Concrete Temperatures with Air Effects Only (Table 5 of Appendix A)

For each value of $L1$ shown in Table 4 (in Appendix A), a ratio of the variation of mean concrete temperature to the variation of external temperature is obtained. The ratios R are based on Figure 11 of BOR (1981). The products of these ratios and their respective amplitudes from Equations 5-16 are algebraically added to and subtracted from the mean annual air temperature to obtain mean concrete temperatures for the condition of air on both faces.

For I = 1 to the number of elevations

Concrete temperatures, mean conditions:

$$\textit{Above mean: } Air(I,1) = Amp(1,1) * R(I,1) + Amp(2,1) * R(I,2) + Amp(3,1) * R(I,3) \quad (20)$$

$$\textit{Below mean: } Air(I,2) = Amp(1,2) * R(I,1) + Amp(2,1) * R(I,2) + Amp(3,2) * R(I,3) \quad (21)$$

$$\textit{Maximum: } Air(I,3) = Tmean + Air(I,1) \quad (22)$$

$$\textit{Minimum: } Air(I,4) = Tmean - Air(I,2) \quad (23)$$

Concrete temperatures, usual conditions:

$$\textit{Above mean: } Air(I,5) = Amp(1,3) * R(I,1) + Amp(2,3) * R(I,2) + Amp(3,3) * R(I,3) \quad (24)$$

$$\textit{Below mean: } Air(I,6) = Amp(1,4) * R(I,1) + Amp(2,4) * R(I,2) + Amp(3,4) * R(I,3) \quad (25)$$

$$\textit{Maximum: } Air(I,7) = Tmean + Air(I,5) \quad (26)$$

$$\textit{Minimum: } Air(I,8) = Tmean - Air(I,6) \quad (27)$$

Mean Concrete Temperatures with Air and Reservoir Effects Only (Table 6 in Appendix A)

Mean concrete temperatures which would result from a fictitious condition of water on both faces are then obtained, and the two conditions (air only and water only) are simply averaged together to obtain the condition of air on the downstream face and water on the upstream face.

For I = 1 to the number of elevations

Water temperatures:

$$\begin{aligned} Maximum &: Water(I,1) \\ Minimum &: Water(I,2) \\ Average &: Water(I,3) = \frac{Water(I,1) + Water(I,2)}{2.0} \end{aligned} \tag{28}$$

$$Amplitude : Water(I,4) = Water(I,1) - Water(I,3) \tag{29}$$

Concrete temperatures with water on both sides:

$$Amplitude : Water(I,5) = Water(I,4) * Yratio \tag{30}$$

$$Maximum : Water(I,6) = Water(I,3) + Water(I,5) \tag{31}$$

$$Minimum : Water(I,7) = Water(I,3) - Water(I,5) \tag{32}$$

where

Water (I,1) = maximum water temperature input to the data file

Water (I,2) = minimum water temperature input to the data file

Yratio = yearly ratio for a flat slab for each elevation

Concrete temperatures with air on downstream face and water on upstream face:

$$Mean\ maximum : Combo(I,1) = \frac{Air(I,3) + Water(I,6)}{2.0} \tag{33}$$

$$Mean\ minimum : Combo(I,2) = \frac{Air(I,4) + Water(I,7)}{2.0} \quad (34)$$

$$Usual\ maximum : Combo(I,3) = \frac{Air(I,7) + Water(I,6)}{2.0} \quad (35)$$

$$Usual\ minimum : Combo(I,4) = \frac{Air(I,8) + Water(I,7)}{2.0} \quad (36)$$

Effects from Solar Radiation (Table 7 in Appendix A)

The mean concrete temperatures obtained from air and water temperatures require adjustments due to the effect of solar radiation on the surface of the dam. Theoretical studies have been made which take into consideration varying slopes, orientation of the exposed faces, and latitudes. The results of these studies are presented in an unpublished BOR memorandum.[1] Figures 25-29 in BOR (1981) summarize the results and give values of the temperature increase. These curves are included in the program and used to determine the increase in temperature due to solar radiation *Tsolar*. These temperature rises are then corrected by the terrain factor *Tfact* which is input and is expressed as the ratio of actual exposure to the sun's rays to the theoretical exposure.

For each elevation I and K = 1 to 6

$$Asolar(I,K) = \frac{Tfact(I) * Tsolar(I,K)}{100.0} \quad (37)$$

where

Tfact (I) = terrain factor input in the data file

Tsolar (I,K) = temperature increase due to sun

The calculation in Equation 37 is made for the right side, the crown, and the left side cantilevers. Then the average temperature increases due to solar radiation are calculated for each elevation for the upstream (U.S.) face, the downstream (D.S.) face, the average of the upstream and downstream, and half of the downstream as:

[1] W. A. Trimble. (1954). "The average temperature rise of the surface of a concrete dam due to solar radiation," Bureau of Reclamation, unpublished, Denver, CO.

$$U.S.:\ Solar(I,1) = \frac{Asolar(I,1) + Asolar(I,3) + Asolar(I,5)}{N} \quad (38)$$

$$D.S.:\ Solar(I,2) = \frac{Asolar(I,2) + Asolar(I,4) + Asolar(I,6)}{N} \quad (39)$$

$$Avg.:\ Solar(I,3) = \frac{Solar(I,1) + Solar(I,2)}{2.0} \quad (40)$$

$$D.S./2:\ Solar(I,4) = \frac{Solar(I,2)}{2.0} \quad (41)$$

where N = number of *Asolar* (I)'s not equal to zero in the equation.

Mean Concrete Temperatures with Air, Reservoir, and Solar Radiation Effects Included (Table 8 in Appendix A)

The mean concrete temperatures that were calculated from Equations 22, 23, 26, and 27 for the conditions of air on both sides and air on the downstream face and water on the upstream face are increased by the *Solar* (I,K)'s from Equations 40 and 41 to produce the mean concrete temperatures with air, reservoir, and solar radiation effects included.

For I = 1 to the number of elevations

Mean concrete temperatures with air on both faces:

Mean conditions:

$$Maximum:\ Conc(I,1) = Air(I,3) + Solar(I,3) \quad (42)$$

$$Minimum:\ Conc(I,2) = Air(I,4) + Solar(I,3) \quad (43)$$

Usual conditions:

$$Maximum:\ Conc(I,3) = Air(I,7) + Solar(I,3) \quad (44)$$

$$Minimum:\ Conc(I,4) = Air(I,8) + Solar(I,3) \quad (45)$$

Mean concrete temperatures with air on downstream face and water on upstream face:

Mean conditions:

$$Maximum\text{: } Conc(I,5) = Combo(I,1) + Solar(I,N) \tag{46}$$

$$Minimum\text{: } Conc(I,6) = Combo(I,2) + Solar(I,N) \tag{47}$$

Usual conditions:

$$Maximum\text{: } Conc(I,7) = Combo(I,3) + Solar(I,N) \tag{48}$$

$$Minimum\text{: } Conc(I,8) = Combo(I,4) + Solar(I,N) \tag{49}$$

where $N = 4$
or $= 3$ if *Water* $(I,1) = 0.0$ in the data input.

Summary Tables for Temperature Loadings

The remaining tables in the TEMPER output file consist of a series of tables which convert the mean concrete temperatures into a format which can be used directly as temperature loads for the ADSAS computer program. A separate set of five tables is produced for each closure temperature specified by the user in the input file. The first set of tables (Tables 9-1 through 9-5) provides the ADSAS temperature loads for the first closure temperature in the data file. If there is a second closure temperature specified, then Tables 10-1 through 10-5 are printed. This procedure is continued for each closure temperature. The discussions below for Tables 9-1 through 9-5 are applicable to all the remaining tables.

ADSAS temperature for loadings (02) and (03) (Table 9-1 in Appendix A)

ADSAS uses uniform and linear temperature loads in the determination of stresses in an arch dam. Uniform temperature loads are called "02" in ADSAS terminology. The uniform temperature load is the difference between the computed mean concrete temperature and the assumed closure (grout) temperature.

The uniform ADSAS temperature for loading (02) with air on the downstream face and water on the upstream face is calculated for each elevation as:

For $I = 1$ to the number of elevations

Mean conditions:

$$Maximum: Adsas(I,2) = Conc(I,5) - Grout \quad (50)$$

$$Minimum: Adsas(I,3) = Conc(I,6) - Grout \quad (51)$$

Usual conditions:

$$Maximum: Adsas(I,4) = Conc(I,7) - Grout \quad (52)$$

$$Minimum: Adsas(I,5) = Conc(I,8) - Grout \quad (53)$$

where *Grout* = closure temperature.

The linear temperature loads are called "03" loads in ADSAS terminology. The linear temperature is the difference between the face temperatures in degrees Fahrenheit from the straight line approximation used to determine the uniform temperature loads (02).

The linear ADSAS temperature for loading (03) with air on the downstream face and water on the upstream face is calculated as:

For I = 1 to the number of elevations

If *Water* (I,6) is greater than zero:

Mean conditions:

$$Maximum: Adsas(I,6) = Conc(I,1) - Water(I,6) \quad (54)$$

$$Minimum: Adsas(I,7) = Conc(I,2) - Water(I,7) \quad (55)$$

Usual conditions:

$$Maximum: Adsas(I,8) = Conc(I,3) - Water(I,6) \quad (56)$$

$$Minimum: Adsas(I,9) = Conc(I,4) - Water(I,7) \quad (57)$$

If *Water* (I,6) is zero:

Mean conditions:

$$Maximum: Adsas(I,6) = Solar(I,2) - Solar(I,1) \quad (58)$$

$$Minimum: Adsas(I,7) = Solar(I,2) - Solar(I,1) \quad (59)$$

Usual conditions:

$$Maximum: Adsas(I,8) = Solar(I,2) - Solar(I,1) \tag{60}$$

$$Minimum: Adsas(I,9) = Solar(I,2) - Solar(I,1) \tag{61}$$

The uniform ADSAS temperature for loading (02) with air on both faces is calculated for each elevation as:

For I = 1 to the number of elevations

Mean conditions:

$$Maximum: Adsas(I,10) = Conc(I,1) - Grout \tag{62}$$

$$Minimum: Adsas(I,11) = Conc(I,2) - Grout \tag{63}$$

Usual conditions:

$$Maximum: Adsas(I,12) = Conc(I,3) - Grout \tag{64}$$

$$Minimum: Adsas(I,13) = Conc(I,4) - Grout \tag{65}$$

where *Grout* = closure temperature.

The linear ADSAS temperature for loading (03) with air on both faces is calculated as:

$$Adsas(I,14) = Solar(I,2) - Solar(I,1) \tag{66}$$

ADSAS temperature input by month (Tables 9-2 through 9-5 in Appendix A)

Tables 9-2 through 9-5 are included since loading combinations for arch dams are usually based on specified reservoir elevations and concurrent concrete temperatures (reference 4-1 in EM 1110-2-2201).

The ADSAS temperatures calculated by Equations 50-66 are used to calculate the temperatures for each month of the year. The program assumes the lowest concrete temperatures occur in February and the highest concrete temperatures occur in August.

Table 9-2. Usual conditions with air downstream face/water upstream face. This table is normally used in conjunction with the static usual (SU) loading conditions described in Chapter 4 of EM 1110-2-2201. The temperatures are calculated as:

For I = 1 to *Noele* (number of elevations) and J = 1 to 12 (number of months in a year)

$$\text{Uniform: } Tmontu(I,J) = Adsas(I,5) + [Adsas(I,4) - Adsas(I,5)] * \frac{6.0 - Rf(J)}{6.0} \quad (68)$$

$$\text{Linear: } Tmontl(I,J) = Adsas(I,9) + [Adsas(I,8) - Adsas(I,9)] * \frac{6.0 - Rf(J)}{6.0} \quad (69)$$

where $Rf(J)$ = factor for adjusting the temperature from high and low to monthly assuming August is the hottest month and February is the coldest month.

Table 9-3. Usual conditions with air on both faces. This table is not normally used, but can be used in the end of construction condition (SUN3) if a more severe temperature load than that shown in Table 9-5 is desired. The temperatures are calculated as:

For I = 1 to *Noele* (number of elevations) and J = 1 to 12 (number of months in a year)

$$\text{Uniform: } Tmontu(I,J) = Adsas(I,13) + [Adsas(I,12) - Adsas(I,13)] * \frac{6.0 - Rf(J)}{6.0} \quad (70)$$

$$\text{Linear: } Tmontl(I,J) = Adsas(I,14) \quad (71)$$

Table 9-4. Mean conditions with air downstream face/water upstream face. This table is normally used in conjunction with the static unusual (SUN), static extreme (SE), and each of the dynamic loading conditions, with the exception of the end of construction condition (SUN3). The temperatures are calculated as:

For I = 1 to *Noele* (number of elevations) and J = 1 to 12 (number of months in a year)

$$\textit{Uniform: } Tmontu(I,J) = Adsas(I,3) + [Adsas(I,2) - Adsas(I,3)] * \frac{6.0 - Rf(J)}{6.0} \quad (72)$$

$$\textit{Linear: } Tmontl(I,J) = Adsas(I,7) + [Adsas(I,6) - Adsas(I,7)] * \frac{6.0 - Rf(J)}{6.0} \quad (73)$$

Table 9-5. Mean conditions with air on both faces. This table is normally used in conjunction with the end of construction condition (SUN3). The temperatures are calculated as:

For $I = 1$ to *Noele* (number of elevations) and $J = 1$ to 12 (number of months in a year)

$$\textit{Uniform: } Tmontu(I,J) = Adsas(I,11) + [Adsas(I,10) - Adsas(I,11)] * \frac{6.0 - Rf(J)}{6.0} \quad (74)$$

$$\textit{Linear: } Tmontl(I,J) = Adsas(I,14) \quad (75)$$

Conclusions

Computer program TEMPER (X8305) provides a quick way of predicting the uniform and linear temperature distributions in an arch dam. These temperature distributions are for use in other programs such as the Arch Dam Stress Analysis System Program which is used to predict the behavior of arch dams. To estimate these concrete temperatures, the TEMPER program uses the theoretical methods described in "Control of Cracking in Mass Concrete Structures" by the U. S. Department of the Interior, Bureau of Reclamation (BOR 1981).

References

American Concrete Institute. (1994). "Mass concrete," ACI 207.1R-87, Detroit, MI.

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Headquarters, U.S. Army Corps of Engineers (1994). "Design of arch dams," EM 1110-2-2201, Washington, DC.

U.S. Army Engineer Waterways Experiment Station. (1949). "Method of test for thermal diffusivity of mass concrete," CRD-C 37, *Handbook for concrete and cement*, Vicksburg, MS.

Appendix A
Example Files

Example Data File

```
HAYSI PRELIMINARY W.S. EL. 1361
1255.0, 37.17, 2504.0, 37.76
BECKLEY
WEST VIRGINIA
22.50  36.70
25.60  41.20
31.70  53.40
38.60  56.50
52.90  75.70
58.80  78.80
62.00  83.30
61.60  83.90
55.20  72.80
36.80  60.00
36.90  55.80
29.80  45.30
-3.0  93.00
 .025  8
 1470.0  10.0   0.0   0.0
 1435.0  18.3   0.0   0.0
 1405.0  23.7   0.0   0.0
 1375.0  28.1   0.0   0.0
 1345.0  30.5  80.00 35.00
 1315.0  32.2  65.00 39.00
 1285.0  32.7  63.00 39.00
 1255.0  32.0  61.00 39.00
 17   9.0  171.0
 20  36.0  144.0
 23  58.5  121.5
 90.0   0.0   0.0    0.0   0.0   0.0   0.0
 88.9  .217 -.018   .393 -.193  .203 -.004
 87.2  .126  .042   .310 -.142  .112  .056
 84.2 -.006  .164   .177 -.054 -.020  .181
 81.1 -.112  .328   .052  .032 -.125  .351
 78.8 -.218  .385  -.071  .119 -.229  .405
 75.3  -1.0   0.0    0.0  .209  -1.0   0.0
 71.9  -1.0   0.0    0.0  .295  -1.0   0.0
45.0
50.0
```

Example Output File

```
************************************************************
*                                                          *
*   ECHO FROM DATA FILE                                    *
*                                                          *
************************************************************
CARD  1    HAYSI PRELIMINARY W.S. EL. 1361                                      CARD  1
CARD  2    1255.0, 37.17, 2504.0, 37.76                                         CARD  2
CARD  3    BECKLEY                                                              CARD  3
CARD  4    WEST VIRGINIA                                                        CARD  4
CARD  5    22.50  36.70                                                         CARD  5
CARD  6    25.60  41.20                                                         CARD  6
CARD  7    31.70  53.40                                                         CARD  7
CARD  8    38.60  56.50                                                         CARD  8
CARD  9    52.90  75.70                                                         CARD  9
CARD 10    58.80  78.80                                                         CARD 10
CARD 11    62.00  83.30                                                         CARD 11
CARD 12    61.60  83.90                                                         CARD 12
CARD 13    55.20  72.80                                                         CARD 13
CARD 14    36.80  60.00                                                         CARD 14
CARD 15    36.90  55.80                                                         CARD 15
CARD 16    29.80  45.30                                                         CARD 16
CARD 17    -3.0  93.00                                                          CARD 17
CARD 18    .025  8                                                              CARD 18
CARD 19    1470.0  10.0   0.0   0.0                                             CARD 19
CARD 20    1435.0  18.3   0.0   0.0                                             CARD 20
CARD 21    1405.0  23.7   0.0   0.0                                             CARD 21
CARD 22    1375.0  28.1   0.0   0.0                                             CARD 22
CARD 23    1345.0  30.5  80.00 35.00                                            CARD 23
CARD 24    1315.0  32.2  65.00 39.00                                            CARD 24
CARD 25    1285.0  32.7  63.00 39.00                                            CARD 25
CARD 26    1255.0  32.0  61.00 39.00                                            CARD 26
CARD 27    17   9.0  171.0                                                      CARD 27
CARD 28    20  36.0  144.0                                                      CARD 28
CARD 29    23  58.5  121.5                                                      CARD 29
CARD 30    90.0   0.0   0.0    0.0   0.0   0.0   0.0                            CARD 30
CARD 31    88.9  .217 -.018   .393 -.193  .203 -.004                            CARD 31
CARD 32    87.2  .126  .042   .310 -.142  .112  .056                            CARD 32
CARD 33    84.2 -.006  .164   .177 -.054 -.020  .181                            CARD 33
CARD 34    81.1 -.112  .328   .052  .032 -.125  .351                            CARD 34
CARD 35    78.8 -.218  .385  -.071  .119 -.229  .405                            CARD 35
CARD 36    75.3  -1.0   0.0    0.0  .209  -1.0   0.0                            CARD 36
CARD 37    71.9  -1.0   0.0    0.0  .295  -1.0   0.0                            CARD 37
CARD 38   45.0                                                                  CARD 38
CARD 39   50.0                                                                  CARD 39
```

PAGE 1 HAYSI PRELIMINARY W.S. EL. 1361

TABLE 1
MEAN MONTHLY AIR TEMPERATURES IN DEGREES FAHRENHEIT
MEASURED AT: TOWN - BECKLEY
STATE - WEST VIRGINIA
EL. 2504.00 LAT. 37.76N

MONTH	MIN	MEAN	MAX
JAN	22.50	29.60	36.70
FEB	25.60	33.40	41.20
MAR	31.70	42.55	53.40
APR	38.60	47.55	56.50
MAY	52.90	64.30	75.70
JUN	58.80	68.80	78.80
JUL	62.00	72.65	83.30
AUG	61.60	72.75	83.90
SEP	55.20	64.00	72.80
OCT	36.80	48.40	60.00
NOV	36.90	46.35	55.80
DEC	29.80	37.55	45.30

TABLE 2
BASE AMBIENT AIR TEMPERATURES IN DEGREES FAHRENHEIT
CORRECTED FOR ELEVATION AND LATITUDE

	SOURCE	CORRECTED
MEAN ANNUAL	52.32	57.74
HIGH MEAN MONTHLY	72.75	78.17
LOW MEAN MONTHLY	29.60	35.02
HIGHEST MEAN MONTHLY MAXIMUM	83.90	89.32
LOWEST MEAN MONTHLY MINIMUM	22.50	27.92
LOWEST MINIMUM	-3.00	2.42
HIGHEST MAXIMUM	93.00	98.42
LOWEST DIFFERENCE BETWEEN MEAN MONTHLY MAXIMUM AND MEAN MONTHLY MINIMUM	14.20	14.20

ELEVATION AND LATITUDE CORRECTION BETWEEN SITE AND SOURCE
SITE EL.1255.00 ; CORRECTION 5.00 (1 DEG / 250 FT)
SITE LAT. 37.17N; CORRECTION .42 (1 DEG / 1.4 LAT)
TOTAL CORRECTION = 5.42 DEGREES

PAGE 2 HAYSI PRELIMINARY W.S. EL. 1361

TABLE 3
AMPLITUDES OF AIR TEMPERATURES
(SEE TABLE II ON PAGE 19 OF BUREAU OF RECLAMATION
ENGINEERING MONOGRAPH NO. 34 FOR EQUATIONS)

PERIOD	MEAN CONDITIONS		USUAL CONDITIONS	
	ABOVE MEAN	BELOW MEAN	ABOVE MEAN	BELOW MEAN
YEARLY	20.425	22.725	20.425	22.725
7-DAY	.000	.000	8.600	12.750
DAILY	7.100	7.100	7.100	7.100

TABLE 4
L1 VALUES USED TO DETERMINE THE YEARLY, 7-DAY, AND DAILY RATIOS SHOWN IN TABLE 5
BASED ON A CONCRETE DIFFUSIVITY OF .025 SQ FT PER HOUR
(NOTE: RATIOS OBTAINED FROM FIGURE 11 OF BUREC EM 34)

	ELEV.	YEARLY L1 VALUE	7-DAY L1 VALUE	DAILY L1 VALUE
1	1470.0	.7	4.9	12.9
2	1435.0	1.2	8.9	23.6
3	1405.0	1.6	11.6	30.6
4	1375.0	1.9	13.7	36.3
5	1345.0	2.1	14.9	39.4
6	1315.0	2.2	15.7	41.6
7	1285.0	2.2	16.0	42.2
8	1255.0	2.2	15.6	41.3

PAGE 3 HAYSI PRELIMINARY W.S. EL. 1361

TABLE 5
CONCRETE TEMPERATURE BASED ON AIR EFFECTS ONLY
(NO RESERVOIR AND SOLAR RADIATION EFFECTS)

						AIR ON BOTH FACES ONLY MEAN CONDITIONS				AIR ON BOTH FACES ONLY USUAL CONDITIONS			
	ELEV.	THICK.	YEARLY RATIO	7-DAY RATIO	DAILY RATIO	ABOVE MEAN	BELOW MEAN	MAX	MIN	ABOVE MEAN	BELOW MEAN	MAX	MIN
1	1470.0	10.0	.956	.164	.062	19.96	22.16	77.70	35.58	21.37	24.25	79.11	33.49
2	1435.0	18.3	.737	.090	.034	15.30	17.00	73.04	40.74	16.07	18.14	73.81	39.60
3	1405.0	23.7	.560	.069	.026	11.63	12.92	69.37	44.82	12.23	13.80	69.97	43.94
4	1375.0	28.1	.435	.058	.022	9.03	10.03	66.78	47.71	9.54	10.78	67.28	46.96
5	1345.0	30.5	.388	.054	.020	8.07	8.97	65.81	48.78	8.53	9.65	66.28	48.09
6	1315.0	32.2	.368	.051	.019	7.65	8.49	65.39	49.25	8.08	9.14	65.83	48.60
7	1285.0	32.7	.362	.050	.019	7.53	8.36	65.27	49.38	7.96	9.00	65.70	48.74
8	1255.0	32.0	.370	.051	.019	7.69	8.54	65.44	49.20	8.13	9.20	65.88	48.54

TABLE 6
CONCRETE TEMPERATURE WITH AIR AND RESERVOIR EFFECTS
(NO SOLAR RADIATION EFFECTS)

		WATER TEMPERATURE				WATER ON BOTH SIDES			AIR ON D.S. FACE WATER ON U.S. FACE MEAN		AIR ON D.S. FACE WATER ON U.S. FACE USUAL	
	ELEV.	MAX	MIN	AVG	AMP	AMP	MAX	MIN	MAX	MIN	MAX	MIN
1	1470.0								77.7	35.6	79.1	33.5
2	1435.0								73.0	40.7	73.8	39.6
3	1405.0								69.4	44.8	70.0	43.9
4	1375.0								66.8	47.7	67.3	47.0
5	1345.0	80.00	35.00	57.50	22.50	8.73	66.23	48.77	66.0	48.8	66.3	48.4
6	1315.0	65.00	39.00	52.00	13.00	4.78	56.78	47.22	61.1	48.2	61.3	47.9
7	1285.0	63.00	39.00	51.00	12.00	4.34	55.34	46.66	60.3	48.0	60.5	47.7
8	1255.0	61.00	39.00	50.00	11.00	4.07	54.07	45.93	59.8	47.6	60.0	47.2

PAGE 4 HAYSI PRELIMINARY W.S. EL. 1361

TABLE 7
CALCULATE THE EFFECTS OF SOLAR RADIATION

CANTILEVER 17			UPSTREAM ANGLE TO NORTH = 9.0			DOWNSTREAM ANGLE TO NORTH = 171.0		
	ELEV.	TF	SLOPE	100%	ACTUAL	SLOPE	100%	ACTUAL
1	1470.0	90.0	.000	.9	.8	.000	7.3	6.6
2	1435.0	88.9	.217	1.2	1.1	-.018	7.2	6.4
3	1405.0	87.2	.126	1.1	.9	.042	7.7	6.7
4	1375.0	84.2	-.006	.9	.7	.164	8.8	7.4
5	1345.0	81.1	-.112	.8	.6	.328	10.1	8.2
6	1315.0	78.8	-.218	.7	.6	.385	10.4	8.2
7	1285.0	75.3						
8	1255.0	71.9						

CANTILEVER 20			UPSTREAM ANGLE TO NORTH = 36.0			DOWNSTREAM ANGLE TO NORTH = 144.0		
	ELEV.	TF	SLOPE	100%	ACTUAL	SLOPE	100%	ACTUAL
1	1470.0	90.0	.000	2.0	1.8	.000	7.3	6.5
2	1435.0	88.9	.393	3.2	2.8	-.193	5.8	5.1
3	1405.0	87.2	.310	2.9	2.5	-.142	6.2	5.4
4	1375.0	84.2	.177	2.4	2.1	-.054	6.8	5.8
5	1345.0	81.1	.052	2.1	1.7	.032	7.5	6.1
6	1315.0	78.8	-.071	1.8	1.5	.119	8.3	6.5
7	1285.0	75.3	.000	2.0	1.5	.209	9.0	6.8
8	1255.0	71.9	.000	2.0	1.4	.295	9.5	6.8

PAGE 5 HAYSI PRELIMINARY W.S. EL. 1361

TABLE 7 (continued)
CALCULATE THE EFFECTS OF SOLAR RADIATION

CANTILEVER 23			UPSTREAM ANGLE TO NORTH = 58.5			DOWNSTREAM ANGLE TO NORTH = 121.5		
	ELEV.	TF	SLOPE	100%	ACTUAL	SLOPE	100%	ACTUAL
1	1470.0	90.0	.000	3.5	3.2	.000	7.0	6.3
2	1435.0	88.9	.203	4.3	3.8	-.004	6.9	6.2
3	1405.0	87.2	.112	4.0	3.5	.056	7.3	6.4
4	1375.0	84.2	-.020	3.4	2.9	.181	8.2	6.9
5	1345.0	81.1	-.125	3.1	2.5	.351	9.1	7.4
6	1315.0	78.8	-.229	2.7	2.2	.405	9.4	7.4
7	1285.0	75.3						
8	1255.0	71.9						

SUMMARY OF SOLAR RADIATION EFFECTS

	ELEV.	U.S.	D.S.	AVG.	D.S./2
1	1470.0	1.9	6.5	4.2	3.2
2	1435.0	2.6	5.9	4.2	2.9
3	1405.0	2.3	6.2	4.2	3.1
4	1375.0	1.9	6.7	4.3	3.3
5	1345.0	1.6	7.2	4.4	3.6
6	1315.0	1.4	7.4	4.4	3.7
7	1285.0	1.5	6.8	4.1	3.4
8	1255.0	1.4	6.8	4.1	3.4

PAGE 6 HAYSI PRELIMINARY W.S. EL. 1361

TABLE 8
MEAN CONCRETE TEMPERATURES WITH AIR, RESERVOIR, AND SOLAR RADIATION EFFECTS INCLUDED

			AIR ON BOTH FACES				AIR ON D.S. FACE WATER ON U.S. FACE			
			MEAN		USUAL		MEAN		USUAL	
	ELEV.	THICK	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
1	1470.0	10.0	81.9	39.8	83.3	37.7	81.9	39.8	83.3	37.7
2	1435.0	18.3	77.3	45.0	78.0	43.8	77.3	45.0	78.0	43.8
3	1405.0	23.7	73.6	49.1	74.2	48.2	73.6	49.1	74.2	48.2
4	1375.0	28.1	71.1	52.0	71.6	51.3	71.1	52.0	71.6	51.3
5	1345.0	30.5	70.2	53.2	70.7	52.5	69.6	52.4	69.9	52.0
6	1315.0	32.2	69.8	53.6	70.2	53.0	64.8	51.9	65.0	51.6
7	1285.0	32.7	69.4	53.5	69.8	52.9	63.7	51.4	63.9	51.1
8	1255.0	32.0	69.6	53.3	70.0	52.7	63.2	51.0	63.4	50.7

PAGE 7
HAYSI PRELIMINARY W.S. EL. 1361

TABLE 9-1
ADSAS TEMPERATURE INPUT FOR (03) AND (02) LOADING - CLOSURE TEMPERATURE = 45.0 F

ELEV	UNIFORM TEMPERATURE LOADING (02) AIR DS FACE/WATER US FACE				LINEAR TEMPERATURE LOADING (03) AIR DS FACE/WATER US FACE				UNIFORM TEMPERATURE LOADING (02) EXPOSED TO AIR ON BOTH FACES				LINEAR TEMP LOADING EXPOSED TO AIR ON BOTH FACES
	MEAN COND		USUAL COND		MEAN COND		USUAL COND		MEAN COND		USUAL COND		
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	
1470.00	36.89	-5.23	38.30	-7.33	4.55	4.55	4.55	4.55	36.89	-5.23	38.30	-7.33	4.55
1435.00	32.28	-.02	33.05	-1.16	3.31	3.31	3.31	3.31	32.28	-.02	33.05	-1.16	3.31
1405.00	28.61	4.06	29.21	3.18	3.87	3.87	3.87	3.87	28.61	4.06	29.21	3.18	3.87
1375.00	26.07	7.00	26.57	6.26	4.80	4.80	4.80	4.80	26.07	7.00	26.57	6.26	4.80
1345.00	24.64	7.38	24.87	7.04	4.00	4.43	4.46	3.74	25.23	8.19	25.69	7.51	5.62
1315.00	19.77	6.92	19.99	6.60	12.99	6.41	13.42	5.76	24.77	8.63	25.20	7.98	5.98
1285.00	18.69	6.40	18.91	6.08	14.05	6.85	14.49	6.21	24.40	8.51	24.83	7.87	5.28
1255.00	18.17	5.98	18.39	5.65	15.49	7.39	15.93	6.74	24.56	8.32	25.00	7.67	5.41

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PAGE  8
 HAYSI PRELIMINARY W.S. EL. 1361

    **** WARNING ****
    THESE TABLES ASSUME THE LOWEST CONCRETE TEMPERATURES OCCUR IN FEBRUARY AND THE HIGHEST CONCRETE
     TEMPERATURES OCCUR IN AUGUST.  SOME ADJUSTMENTS MAY BE NECESSARY BASED UPON "SITE SPECIFIC" CONDITIONS.
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TABLE 9-2

ADSAS TEMPERATURE INPUT BY MONTH — USUAL CONDITIONS, AIR DS FACE / WATER US FACE — CLOSURE TEMPERATURE = 45.0 F

ELEV	JAN AVG AIR = 35.0 F UNIFORM	JAN LINEAR	FEB AVG AIR = 38.8 F UNIFORM	FEB LINEAR	MAR AVG AIR = 48.0 F UNIFORM	MAR LINEAR	APR AVG AIR = 53.0 F UNIFORM	APR LINEAR	MAY AVG AIR = 69.7 F UNIFORM	MAY LINEAR	JUN AVG AIR = 74.2 F UNIFORM	JUN LINEAR
1470.00	.28	4.55	-7.33	4.55	.28	4.55	7.88	4.55	15.49	4.55	23.09	4.55
1435.00	4.54	3.31	-1.16	3.31	4.54	3.31	10.24	3.31	15.94	3.31	21.64	3.31
1405.00	7.52	3.87	3.18	3.87	7.52	3.87	11.85	3.87	16.19	3.87	20.53	3.87
1375.00	9.65	4.80	6.26	4.80	9.65	4.80	13.03	4.80	16.42	4.80	19.80	4.80
1345.00	10.01	3.86	7.04	3.74	10.01	3.86	12.98	3.98	15.95	4.10	18.93	4.22
1315.00	8.83	7.04	6.60	5.76	8.83	7.04	11.06	8.31	13.29	9.59	15.52	10.87
1285.00	8.22	7.59	6.08	6.21	8.22	7.59	10.36	8.97	12.49	10.35	14.63	11.73
1255.00	7.77	8.27	5.65	6.74	7.77	8.27	9.90	9.80	12.02	11.33	14.14	12.87

TABLE 9-2

ADSAS TEMPERATURE INPUT BY MONTH — USUAL CONDITIONS, AIR DS FACE / WATER US FACE — CLOSURE TEMPERATURE = 45.0 F

ELEV	JUL AVG AIR = 78.1 F UNIFORM	JUL LINEAR	AUG AVG AIR = 78.2 F UNIFORM	AUG LINEAR	SEP AVG AIR = 69.4 F UNIFORM	SEP LINEAR	OCT AVG AIR = 53.8 F UNIFORM	OCT LINEAR	NOV AVG AIR = 51.8 F UNIFORM	NOV LINEAR	DEC AVG AIR = 43.0 F UNIFORM	DEC LINEAR
1470.00	30.69	4.55	38.30	4.55	30.69	4.55	23.09	4.55	15.49	4.55	7.88	4.55
1435.00	27.35	3.31	33.05	3.31	27.35	3.31	21.64	3.31	15.94	3.31	10.24	3.31
1405.00	24.87	3.87	29.21	3.87	24.87	3.87	20.53	3.87	16.19	3.87	11.85	3.87
1375.00	23.19	4.80	26.57	4.80	23.19	4.80	19.80	4.80	16.42	4.80	13.03	4.80
1345.00	21.90	4.34	24.87	4.46	21.90	4.34	18.93	4.22	15.95	4.10	12.98	3.98
1315.00	17.76	12.15	19.99	13.42	17.76	12.15	15.52	10.87	13.29	9.59	11.06	8.31
1285.00	16.77	13.11	18.91	14.49	16.77	13.11	14.63	11.73	12.49	10.35	10.36	8.97
1255.00	16.26	14.40	18.39	15.93	16.26	14.40	14.14	12.87	12.02	11.33	9.90	9.80

PAGE 9
HAYSI PRELIMINARY W.S. EL. 1361

**** WARNING ****
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TABLE 9-3

ADSAS TEMPERATURE INPUT BY MONTH USUAL CONDITIONS, AIR ON BOTH FACES CLOSURE TEMPERATURE = 45.00 F

ELEV	JAN AVG AIR = 35.0 F		FEB AVG AIR = 38.8 F		MAR AVG AIR = 48.0 F		APR AVG AIR = 53.0 F		MAY AVG AIR = 69.7 F		JUN AVG AIR = 74.2 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	.28	4.55	-7.33	4.55	.28	4.55	7.88	4.55	15.49	4.55	23.09	4.55
1435.00	4.54	3.31	-1.16	3.31	4.54	3.31	10.24	3.31	15.94	3.31	21.64	3.31
1405.00	7.52	3.87	3.18	3.87	7.52	3.87	11.85	3.87	16.19	3.87	20.53	3.87
1375.00	9.65	4.80	6.26	4.80	9.65	4.80	13.03	4.80	16.42	4.80	19.80	4.80
1345.00	10.54	5.62	7.51	5.62	10.54	5.62	13.57	5.62	16.60	5.62	19.63	5.62
1315.00	10.85	5.98	7.98	5.98	10.85	5.98	13.72	5.98	16.59	5.98	19.46	5.98
1285.00	10.70	5.28	7.87	5.28	10.70	5.28	13.52	5.28	16.35	5.28	19.18	5.28
1255.00	10.56	5.41	7.67	5.41	10.56	5.41	13.45	5.41	16.33	5.41	19.22	5.41

TABLE 9-3

ADSAS TEMPERATURE INPUT BY MONTH USUAL CONDITIONS, AIR ON BOTH FACES CLOSURE TEMPERATURE = 45.00 F

ELEV	JUL AVG AIR = 78.1 F		AUG AVG AIR = 78.2 F		SEP AVG AIR = 69.4 F		OCT AVG AIR = 53.8 F		NOV AVG AIR = 51.8 F		DEC AVG AIR = 43.0 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	30.69	4.55	38.30	4.55	30.69	4.55	23.09	4.55	15.49	4.55	7.88	4.55
1435.00	27.35	3.31	33.05	3.31	27.35	3.31	21.64	3.31	15.94	3.31	10.24	3.31
1405.00	24.87	3.87	29.21	3.87	24.87	3.87	20.53	3.87	16.19	3.87	11.85	3.87
1375.00	23.19	4.80	26.57	4.80	23.19	4.80	19.80	4.80	16.42	4.80	13.03	4.80
1345.00	22.66	5.62	25.69	5.62	22.66	5.62	19.63	5.62	16.60	5.62	13.57	5.62
1315.00	22.33	5.98	25.20	5.98	22.33	5.98	19.46	5.98	16.59	5.98	13.72	5.98
1285.00	22.00	5.28	24.83	5.28	22.00	5.28	19.18	5.28	16.35	5.28	13.52	5.28
1255.00	22.11	5.41	25.00	5.41	22.11	5.41	19.22	5.41	16.33	5.41	13.45	5.41

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PAGE 10
 HAYSI PRELIMINARY W.S. EL. 1361


    **** WARNING ****
    THESE TABLES ASSUME THE LOWEST CONCRETE TEMPERATURES OCCUR IN FEBRUARY AND THE HIGHEST CONCRETE
     TEMPERATURES OCCUR IN AUGUST.  SOME ADJUSTMENTS MAY BE NECESSARY BASED UPON "SITE SPECIFIC" CONDITIONS.


                                                         TABLE  9-4
 ADSAS TEMPERATURE INPUT BY MONTH      MEAN CONDITIONS, AIR DS FACE / WATER US FACE     CLOSURE TEMPERATURE =  45.0 F
 --------------------------------------------------------------------------------------------------------------------
        :       JAN       :       FEB       :       MAR       :       APR       :       MAY       :       JUN
        : AVG AIR = 35.0 F: AVG AIR = 38.8 F: AVG AIR = 48.0 F: AVG AIR = 53.0 F: AVG AIR = 69.7 F: AVG AIR = 74.2 F
  ELEV  :-----------------:-----------------:-----------------:-----------------:-----------------:-----------------
        :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR
 -------:--------:--------:--------:--------:--------:--------:--------:--------:--------:--------:--------:--------
 1470.00:   1.79 :   4.55 :  -5.23 :   4.55 :   1.79 :   4.55 :   8.81 :   4.55 :  15.83 :   4.55 :  22.85 :   4.55
 1435.00:   5.36 :   3.31 :   -.02 :   3.31 :   5.36 :   3.31 :  10.75 :   3.31 :  16.13 :   3.31 :  21.51 :   3.31
 1405.00:   8.15 :   3.87 :   4.06 :   3.87 :   8.15 :   3.87 :  12.24 :   3.87 :  16.34 :   3.87 :  20.43 :   3.87
 1375.00:  10.18 :   4.80 :   7.00 :   4.80 :  10.18 :   4.80 :  13.36 :   4.80 :  16.54 :   4.80 :  19.72 :   4.80
 1345.00:  10.26 :   4.35 :   7.38 :   4.43 :  10.26 :   4.35 :  13.13 :   4.28 :  16.01 :   4.21 :  18.89 :   4.14
 1315.00:   9.06 :   7.50 :   6.92 :   6.41 :   9.06 :   7.50 :  11.20 :   8.60 :  13.34 :   9.70 :  15.49 :  10.79
 1285.00:   8.45 :   8.05 :   6.40 :   6.85 :   8.45 :   8.05 :  10.50 :   9.25 :  12.55 :  10.45 :  14.60 :  11.65
 1255.00:   8.01 :   8.74 :   5.98 :   7.39 :   8.01 :   8.74 :  10.04 :  10.09 :  12.07 :  11.44 :  14.10 :  12.79


                                                         TABLE  9-4
 ADSAS TEMPERATURE INPUT BY MONTH      MEAN CONDITIONS, AIR DS FACE / WATER US FACE     CLOSURE TEMPERATURE =  45.0 F
 --------------------------------------------------------------------------------------------------------------------
        :       JUL       :       AUG       :       SEP       :       OCT       :       NOV       :       DEC
        : AVG AIR = 78.1 F: AVG AIR = 78.2 F: AVG AIR = 69.4 F: AVG AIR = 53.8 F: AVG AIR = 51.8 F: AVG AIR = 43.0 F
  ELEV  :-----------------:-----------------:-----------------:-----------------:-----------------:-----------------
        :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR :UNIFORM : LINEAR
 -------:--------:--------:--------:--------:--------:--------:--------:--------:--------:--------:--------:--------
 1470.00:  29.87 :   4.55 :  36.89 :   4.55 :  29.87 :   4.55 :  22.85 :   4.55 :  15.83 :   4.55 :   8.81 :   4.55
 1435.00:  26.90 :   3.31 :  32.28 :   3.31 :  26.90 :   3.31 :  21.51 :   3.31 :  16.13 :   3.31 :  10.75 :   3.31
 1405.00:  24.52 :   3.87 :  28.61 :   3.87 :  24.52 :   3.87 :  20.43 :   3.87 :  16.34 :   3.87 :  12.24 :   3.87
 1375.00:  22.89 :   4.80 :  26.07 :   4.80 :  22.89 :   4.80 :  19.72 :   4.80 :  16.54 :   4.80 :  13.36 :   4.80
 1345.00:  21.76 :   4.07 :  24.64 :   4.00 :  21.76 :   4.07 :  18.89 :   4.14 :  16.01 :   4.21 :  13.13 :   4.28
 1315.00:  17.63 :  11.89 :  19.77 :  12.99 :  17.63 :  11.89 :  15.49 :  10.79 :  13.34 :   9.70 :  11.20 :   8.60
 1285.00:  16.64 :  12.85 :  18.69 :  14.05 :  16.64 :  12.85 :  14.60 :  11.65 :  12.55 :  10.45 :  10.50 :   9.25
 1255.00:  16.13 :  14.14 :  18.17 :  15.49 :  16.13 :  14.14 :  14.10 :  12.79 :  12.07 :  11.44 :  10.04 :  10.09
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PAGE 11
HAYSI PRELIMINARY W.S. EL. 1361

**** WARNING ****
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TABLE 9-5

ADSAS TEMPERATURE INPUT BY MONTH MEAN CONDITIONS, AIR ON BOTH FACES CLOSURE TEMPERATURE = 45.00 F

ELEV	JAN AVG AIR = 35.0 F		FEB AVG AIR = 38.8 F		MAR AVG AIR = 48.0 F		APR AVG AIR = 53.0 F		MAY AVG AIR = 69.7 F		JUN AVG AIR = 74.2 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	1.79	4.55	-5.23	4.55	1.79	4.55	8.81	4.55	15.83	4.55	22.85	4.55
1435.00	5.36	3.31	-.02	3.31	5.36	3.31	10.75	3.31	16.13	3.31	21.51	3.31
1405.00	8.15	3.87	4.06	3.87	8.15	3.87	12.24	3.87	16.34	3.87	20.43	3.87
1375.00	10.18	4.80	7.00	4.80	10.18	4.80	13.36	4.80	16.54	4.80	19.72	4.80
1345.00	11.03	5.62	8.19	5.62	11.03	5.62	13.87	5.62	16.71	5.62	19.55	5.62
1315.00	11.32	5.98	8.63	5.98	11.32	5.98	14.01	5.98	16.70	5.98	19.39	5.98
1285.00	11.16	5.28	8.51	5.28	11.16	5.28	13.81	5.28	16.45	5.28	19.10	5.28
1255.00	11.03	5.41	8.32	5.41	11.03	5.41	13.73	5.41	16.44	5.41	19.15	5.41

TABLE 9-5

ADSAS TEMPERATURE INPUT BY MONTH MEAN CONDITIONS, AIR ON BOTH FACES CLOSURE TEMPERATURE = 45.00 F

ELEV	JUL AVG AIR = 78.1 F		AUG AVG AIR = 78.2 F		SEP AVG AIR = 69.4 F		OCT AVG AIR = 53.8 F		NOV AVG AIR = 51.8 F		DEC AVG AIR = 43.0 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	29.87	4.55	36.89	4.55	29.87	4.55	22.85	4.55	15.83	4.55	8.81	4.55
1435.00	26.90	3.31	32.28	3.31	26.90	3.31	21.51	3.31	16.13	3.31	10.75	3.31
1405.00	24.52	3.87	28.61	3.87	24.52	3.87	20.43	3.87	16.34	3.87	12.24	3.87
1375.00	22.89	4.80	26.07	4.80	22.89	4.80	19.72	4.80	16.54	4.80	13.36	4.80
1345.00	22.39	5.62	25.23	5.62	22.39	5.62	19.55	5.62	16.71	5.62	13.87	5.62
1315.00	22.08	5.98	24.77	5.98	22.08	5.98	19.39	5.98	16.70	5.98	14.01	5.98
1285.00	21.75	5.28	24.40	5.28	21.75	5.28	19.10	5.28	16.45	5.28	13.81	5.28
1255.00	21.85	5.41	24.56	5.41	21.85	5.41	19.15	5.41	16.44	5.41	13.73	5.41

PAGE 12
HAYSI PRELIMINARY W.S. EL. 1361

TABLE 10-1
ADSAS TEMPERATURE INPUT FOR (03) AND (02) LOADING - CLOSURE TEMPERATURE = 50.0 F

ELEV	UNIFORM TEMPERATURE LOADING (02) AIR DS FACE/WATER US FACE				LINEAR TEMPERATURE LOADING (03) AIR DS FACE/WATER US FACE				UNIFORM TEMPERATURE LOADING (02) EXPOSED TO AIR ON BOTH FACES				LINEAR TEMP LOADING EXPOSED TO AIR ON BOTH FACES
	MEAN COND		USUAL COND		MEAN COND		USUAL COND		MEAN COND		USUAL COND		
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	
1470.00	31.89	-10.23	33.30	-12.33	4.55	4.55	4.55	4.55	31.89	-10.23	33.30	-12.33	4.55
1435.00	27.28	-5.02	28.05	-6.16	3.31	3.31	3.31	3.31	27.28	-5.02	28.05	-6.16	3.31
1405.00	23.61	-.94	24.21	-1.82	3.87	3.87	3.87	3.87	23.61	-.94	24.21	-1.82	3.87
1375.00	21.07	2.00	21.57	1.26	4.80	4.80	4.80	4.80	21.07	2.00	21.57	1.26	4.80
1345.00	19.64	2.38	19.87	2.04	4.00	4.43	4.46	3.74	20.23	3.19	20.69	2.51	5.62
1315.00	14.77	1.92	14.99	1.60	12.99	6.41	13.42	5.76	19.77	3.63	20.20	2.98	5.98
1285.00	13.69	1.40	13.91	1.08	14.05	6.85	14.49	6.21	19.40	3.51	19.83	2.87	5.28
1255.00	13.17	.98	13.39	.65	15.49	7.39	15.93	6.74	19.56	3.32	20.00	2.67	5.41

PAGE 13
HAYSI PRELIMINARY W.S. EL. 1361

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TABLE 10-2

ADSAS TEMPERATURE INPUT BY MONTH USUAL CONDITIONS, AIR DS FACE / WATER US FACE CLOSURE TEMPERATURE = 50.0 F

ELEV	JAN AVG AIR = 35.0 F: UNIFORM	LINEAR	FEB AVG AIR = 38.8 F: UNIFORM	LINEAR	MAR AVG AIR = 48.0 F: UNIFORM	LINEAR	APR AVG AIR = 53.0 F: UNIFORM	LINEAR	MAY AVG AIR = 69.7 F: UNIFORM	LINEAR	JUN AVG AIR = 74.2 F: UNIFORM	LINEAR
1470.00	-4.72	4.55	-12.33	4.55	-4.72	4.55	2.88	4.55	10.49	4.55	18.09	4.55
1435.00	-.46	3.31	-6.16	3.31	-.46	3.31	5.24	3.31	10.94	3.31	16.64	3.31
1405.00	2.52	3.87	-1.82	3.87	2.52	3.87	6.85	3.87	11.19	3.87	15.53	3.87
1375.00	4.65	4.80	1.26	4.80	4.65	4.80	8.03	4.80	11.42	4.80	14.80	4.80
1345.00	5.01	3.86	2.04	3.74	5.01	3.86	7.98	3.98	10.95	4.10	13.93	4.22
1315.00	3.83	7.04	1.60	5.76	3.83	7.04	6.06	8.31	8.29	9.59	10.52	10.87
1285.00	3.22	7.59	1.08	6.21	3.22	7.59	5.36	8.97	7.49	10.35	9.63	11.73
1255.00	2.77	8.27	.65	6.74	2.77	8.27	4.90	9.80	7.02	11.33	9.14	12.87

TABLE 10-2

ADSAS TEMPERATURE INPUT BY MONTH USUAL CONDITIONS, AIR DS FACE / WATER US FACE CLOSURE TEMPERATURE = 50.0 F

ELEV	JUL AVG AIR = 78.1 F: UNIFORM	LINEAR	AUG AVG AIR = 78.2 F: UNIFORM	LINEAR	SEP AVG AIR = 69.4 F: UNIFORM	LINEAR	OCT AVG AIR = 53.8 F: UNIFORM	LINEAR	NOV AVG AIR = 51.8 F: UNIFORM	LINEAR	DEC AVG AIR = 43.0 F: UNIFORM	LINEAR
1470.00	25.69	4.55	33.30	4.55	25.69	4.55	18.09	4.55	10.49	4.55	2.88	4.55
1435.00	22.35	3.31	28.05	3.31	22.35	3.31	16.64	3.31	10.94	3.31	5.24	3.31
1405.00	19.87	3.87	24.21	3.87	19.87	3.87	15.53	3.87	11.19	3.87	6.85	3.87
1375.00	18.19	4.80	21.57	4.80	18.19	4.80	14.80	4.80	11.42	4.80	8.03	4.80
1345.00	16.90	4.34	19.87	4.46	16.90	4.34	13.93	4.22	10.95	4.10	7.98	3.98
1315.00	12.76	12.15	14.99	13.42	12.76	12.15	10.52	10.87	8.29	9.59	6.06	8.31
1285.00	11.77	13.11	13.91	14.49	11.77	13.11	9.63	11.73	7.49	10.35	5.36	8.97
1255.00	11.26	14.40	13.39	15.93	11.26	14.40	9.14	12.87	7.02	11.33	4.90	9.80

PAGE 14
HAYSI PRELIMINARY W.S. EL. 1361

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TABLE 10-3
ADSAS TEMPERATURE INPUT BY MONTH USUAL CONDITIONS, AIR ON BOTH FACES CLOSURE TEMPERATURE = 50.00 F

ELEV	JAN AVG AIR = 35.0 F		FEB AVG AIR = 38.8 F		MAR AVG AIR = 48.0 F		APR AVG AIR = 53.0 F		MAY AVG AIR = 69.7 F		JUN AVG AIR = 74.2 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	-4.72	4.55	-12.33	4.55	-4.72	4.55	2.88	4.55	10.49	4.55	18.09	4.55
1435.00	-.46	3.31	-6.16	3.31	-.46	3.31	5.24	3.31	10.94	3.31	16.64	3.31
1405.00	2.52	3.87	-1.82	3.87	2.52	3.87	6.85	3.87	11.19	3.87	15.53	3.87
1375.00	4.65	4.80	1.26	4.80	4.65	4.80	8.03	4.80	11.42	4.80	14.80	4.80
1345.00	5.54	5.62	2.51	5.62	5.54	5.62	8.57	5.62	11.60	5.62	14.63	5.62
1315.00	5.85	5.98	2.98	5.98	5.85	5.98	8.72	5.98	11.59	5.98	14.46	5.98
1285.00	5.70	5.28	2.87	5.28	5.70	5.28	8.52	5.28	11.35	5.28	14.18	5.28
1255.00	5.56	5.41	2.67	5.41	5.56	5.41	8.45	5.41	11.33	5.41	14.22	5.41

TABLE 10-3
ADSAS TEMPERATURE INPUT BY MONTH USUAL CONDITIONS, AIR ON BOTH FACES CLOSURE TEMPERATURE = 50.00 F

ELEV	JUL AVG AIR = 78.1 F		AUG AVG AIR = 78.2 F		SEP AVG AIR = 69.4 F		OCT AVG AIR = 53.8 F		NOV AVG AIR = 51.8 F		DEC AVG AIR = 43.0 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	25.69	4.55	33.30	4.55	25.69	4.55	18.09	4.55	10.49	4.55	2.88	4.55
1435.00	22.35	3.31	28.05	3.31	22.35	3.31	16.64	3.31	10.94	3.31	5.24	3.31
1405.00	19.87	3.87	24.21	3.87	19.87	3.87	15.53	3.87	11.19	3.87	6.85	3.87
1375.00	18.19	4.80	21.57	4.80	18.19	4.80	14.80	4.80	11.42	4.80	8.03	4.80
1345.00	17.66	5.62	20.69	5.62	17.66	5.62	14.63	5.62	11.60	5.62	8.57	5.62
1315.00	17.33	5.98	20.20	5.98	17.33	5.98	14.46	5.98	11.59	5.98	8.72	5.98
1285.00	17.00	5.28	19.83	5.28	17.00	5.28	14.18	5.28	11.35	5.28	8.52	5.28
1255.00	17.11	5.41	20.00	5.41	17.11	5.41	14.22	5.41	11.33	5.41	8.45	5.41

PAGE 15
HAYSI PRELIMINARY W.S. EL. 1361

**** WARNING ****
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TABLE 10-4

ADSAS TEMPERATURE INPUT BY MONTH   MEAN CONDITIONS, AIR DS FACE / WATER US FACE   CLOSURE TEMPERATURE = 50.0 F

ELEV	JAN AVG AIR = 35.0 F		FEB AVG AIR = 38.8 F		MAR AVG AIR = 48.0 F		APR AVG AIR = 53.0 F		MAY AVG AIR = 69.7 F		JUN AVG AIR = 74.2 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	-3.21	4.55	-10.23	4.55	-3.21	4.55	3.81	4.55	10.83	4.55	17.85	4.55
1435.00	.36	3.31	-5.02	3.31	.36	3.31	5.75	3.31	11.13	3.31	16.51	3.31
1405.00	3.15	3.87	-.94	3.87	3.15	3.87	7.24	3.87	11.34	3.87	15.43	3.87
1375.00	5.18	4.80	2.00	4.80	5.18	4.80	8.36	4.80	11.54	4.80	14.72	4.80
1345.00	5.26	4.35	2.38	4.43	5.26	4.35	8.13	4.28	11.01	4.21	13.89	4.14
1315.00	4.06	7.50	1.92	6.41	4.06	7.50	6.20	8.60	8.34	9.70	10.49	10.79
1285.00	3.45	8.05	1.40	6.85	3.45	8.05	5.50	9.25	7.55	10.45	9.60	11.65
1255.00	3.01	8.74	.98	7.39	3.01	8.74	5.04	10.09	7.07	11.44	9.10	12.79

TABLE 10-4

ADSAS TEMPERATURE INPUT BY MONTH   MEAN CONDITIONS, AIR DS FACE / WATER US FACE   CLOSURE TEMPERATURE = 50.0 F

ELEV	JUL AVG AIR = 78.1 F		AUG AVG AIR = 78.2 F		SEP AVG AIR = 69.4 F		OCT AVG AIR = 53.8 F		NOV AVG AIR = 51.8 F		DEC AVG AIR = 43.0 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	24.87	4.55	31.89	4.55	24.87	4.55	17.85	4.55	10.83	4.55	3.81	4.55
1435.00	21.90	3.31	27.28	3.31	21.90	3.31	16.51	3.31	11.13	3.31	5.75	3.31
1405.00	19.52	3.87	23.61	3.87	19.52	3.87	15.43	3.87	11.34	3.87	7.24	3.87
1375.00	17.89	4.80	21.07	4.80	17.89	4.80	14.72	4.80	11.54	4.80	8.36	4.80
1345.00	16.76	4.07	19.64	4.00	16.76	4.07	13.89	4.14	11.01	4.21	8.13	4.28
1315.00	12.63	11.89	14.77	12.99	12.63	11.89	10.49	10.79	8.34	9.70	6.20	8.60
1285.00	11.64	12.85	13.69	14.05	11.64	12.85	9.60	11.65	7.55	10.45	5.50	9.25
1255.00	11.13	14.14	13.17	15.49	11.13	14.14	9.10	12.79	7.07	11.44	5.04	10.09

PAGE 16
HAYSI PRELIMINARY W.S. EL. 1361

**** WARNING ****
THESE TABLES ASSUME THE LOWEST CONCRETE TEMPERATURES OCCUR IN FEBRUARY AND THE HIGHEST CONCRETE TEMPERATURES OCCUR IN AUGUST. SOME ADJUSTMENTS MAY BE NECESSARY BASED UPON "SITE SPECIFIC" CONDITIONS.

TABLE 10-5

ADSAS TEMPERATURE INPUT BY MONTH   MEAN CONDITIONS, AIR ON BOTH FACES   CLOSURE TEMPERATURE = 50.00 F

ELEV	JAN AVG AIR = 35.0 F		FEB AVG AIR = 38.8 F		MAR AVG AIR = 48.0 F		APR AVG AIR = 53.0 F		MAY AVG AIR = 69.7 F		JUN AVG AIR = 74.2 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	-3.21	4.55	-10.23	4.55	-3.21	4.55	3.81	4.55	10.83	4.55	17.85	4.55
1435.00	.36	3.31	-5.02	3.31	.36	3.31	5.75	3.31	11.13	3.31	16.51	3.31
1405.00	3.15	3.87	-.94	3.87	3.15	3.87	7.24	3.87	11.34	3.87	15.43	3.87
1375.00	5.18	4.80	2.00	4.80	5.18	4.80	8.36	4.80	11.54	4.80	14.72	4.80
1345.00	6.03	5.62	3.19	5.62	6.03	5.62	8.87	5.62	11.71	5.62	14.55	5.62
1315.00	6.32	5.98	3.63	5.98	6.32	5.98	9.01	5.98	11.70	5.98	14.39	5.98
1285.00	6.16	5.28	3.51	5.28	6.16	5.28	8.81	5.28	11.45	5.28	14.10	5.28
1255.00	6.03	5.41	3.32	5.41	6.03	5.41	8.73	5.41	11.44	5.41	14.15	5.41

TABLE 10-5

ADSAS TEMPERATURE INPUT BY MONTH   MEAN CONDITIONS, AIR ON BOTH FACES   CLOSURE TEMPERATURE = 50.00 F

ELEV	JUL AVG AIR = 78.1 F		AUG AVG AIR = 78.2 F		SEP AVG AIR = 69.4 F		OCT AVG AIR = 53.8 F		NOV AVG AIR = 51.8 F		DEC AVG AIR = 43.0 F	
	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR	UNIFORM	LINEAR
1470.00	24.87	4.55	31.89	4.55	24.87	4.55	17.85	4.55	10.83	4.55	3.81	4.55
1435.00	21.90	3.31	27.28	3.31	21.90	3.31	16.51	3.31	11.13	3.31	5.75	3.31
1405.00	19.52	3.87	23.61	3.87	19.52	3.87	15.43	3.87	11.34	3.87	7.24	3.87
1375.00	17.89	4.80	21.07	4.80	17.89	4.80	14.72	4.80	11.54	4.80	8.36	4.80
1345.00	17.39	5.62	20.23	5.62	17.39	5.62	14.55	5.62	11.71	5.62	8.87	5.62
1315.00	17.08	5.98	19.77	5.98	17.08	5.98	14.39	5.98	11.70	5.98	9.01	5.98
1285.00	16.75	5.28	19.40	5.28	16.75	5.28	14.10	5.28	11.45	5.28	8.81	5.28
1255.00	16.85	5.41	19.56	5.41	16.85	5.41	14.15	5.41	11.44	5.41	8.73	5.41

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This manual documents the computer program TEMPER (X8305) which estimates, using classical heat flow methods, the uniform and linear temperature distributions in arch dams. The program uses the theoretical methods described in "Control of Cracking in Mass Concrete Structures" by the U.S. Department of the Interior, Bureau of Reclamation.

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