



Arizona Nuclear Power Project

FOR INFO ONLY

DOCUMENT NUMBER

13 - MC - HA - A03

TITLE/DESCRIPTION

Transient temperature study for Aux. feed water "B"
Pump room.

Safety related Quality class "Q"

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INTERNAL CONTROL NO.

18601-183-CALC-004



CALCULATION COVER SHEET

SHEET 1

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

FILE NO.

PROJECT
QUALITY CLASS Q

DISCIPLINE MECH

COMPUTER
PROGRAMSCP
☒ YES ☐ NOPROGRAM NO.(S)
ME 204VERSION/RELEASE NO.
A1

RECORD OF ISSUES

NO.	DESCRIPTION	TOTAL NO. OF SHEETS	LAST SHEET NO.	ORIG	CKR	GL	GS	CHIEF	DATE
0	ORIGINAL ISSUE	51	51	PSS	G.W.M.	-	AB	-	APPR. 4-7-88 FILM
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INFORMATION ENTERED IN THIS SPACE:

- SHOW PROFESSIONAL ENGINEER STAMP, IF REQUIRED.
- ENTER REFERENCE TO INCLUSION OF CHECKER'S ALTERNATE CALCULATIONS, IF USED.
- PROVIDE ANY NOTES TO ASSIST CHECKING AND APPROVAL.

NOTICE

Utilization of these calculations by persons without access to pertinent factors, and without proper regard for their purpose could lead to erroneous conclusions. Bechtel cannot assume responsibility for the use of these calculations not under its direct control.



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 2

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
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Table of Contents

Page No.

I.	Purpose	4
II.	Design Criteria	5
III.	Study Assumptions	6
IV.	References	11
V.	Summary of Results	13
VI.	Room Heat-Up Computer Model	
A.	Model Description	14
B.	Required Input	16
C.	Assumptions	17
D.	Limitations	17
E.	Output	17
VII.	Study	
A.	Case A: Pump room with No HVAC	
1.	Heat Loads	
a.	Electric Motors Heat Load	18
b.	Lighting Heat Load	20
c.	Total Heat Loads	21
2.	AFW B Pump Room Surface Area & Volume	22
3.	Input Data	24
4.	Results	25
B.	Case B: With Normal HVAC	
1.	Heat Loads	26
2.	Input Data	26
3.	Results	27





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 3

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	4-1-88	G. W. M	4-1-88					

C. Case C: Verification of AFW B Pump Room Temperature

1. Heat Loads 28
2. Input Data 29
3. Results 29

D. Conclusion: With Normal HVAC 30

VIII. Figures:

1. Classification of Heat Loads 31
2. AFW B Pump Room with no HVAC 32
3. AFW B Pump Room with Normal HVAC 52

IX. Appendices:

1. Computer Runs For:
 - A. AFW B Pump Room with No HVAC 34
 - B. AFW B Pump Room with Normal HVAC 40
 - C. AFW B Pump Room with Normal HVAC (Alternate Run for Verification of Pump Room Temperature for Case B) 46



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 4

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
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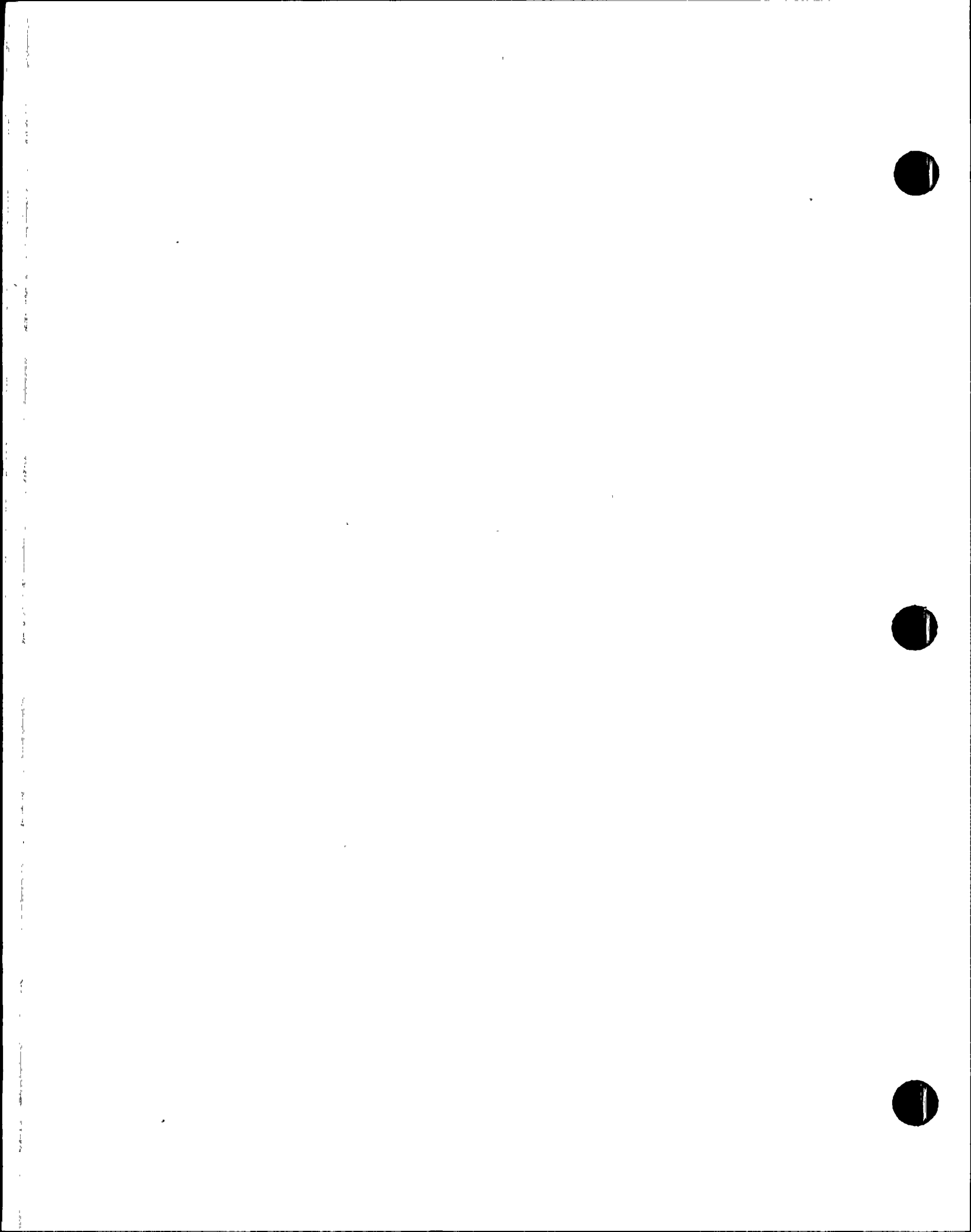
I. PURPOSE

The design basis for cooling the Auxiliary Feedwater (AFW) B Pump Room, when the pump is in operation, uses an Essential Air Cooling Unit (ACU) and the Essential Chilled Water System (ECWS) for cooling. In the event that either the ACU or ECWS fails when the pump runs, the room temperature will rise rapidly. The purpose of this study is to determine the transient air temperature for 24 hours in the motor driven AFW B pump room for the following two cases:

- A) AFW B pump operates at a design flow of 1010 gpm for 2 hours, and then operates at 500 gpm for 22 hours. Normal HVAC and essential HVAC are not available in this case.
- B) AFW B pump operates at design flow of 1010 gpm for 2 hours, and then operates at 500 gpm for 22 hours. Essential HVAC is not available. Normal HVAC is available in this case.

Standard room heat-up (RMHTUP) computer program, ME 204, version A1, is used to study the room ambient air heat-up by the equipment and other heat loads in the AFW B pump room.

The heat generated in the room is transferred to the room air, stored in the room enclosure concrete (heat sink) and transferred to the air outside the room. Initially, the transient temperature for the AFW B room air is studied for a time period of 24 hours without any HVAC. Secondly, the transient temperature for this room is studied for a time period of 24 hours, when normal HVAC is available.





CALCULATION SHEET

PROJECT ANPP JOB NO. 18601-183 CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM SHEET NO. 5

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II. DESIGN CRITERIA:

This is a study of the effect of certain equipment failures which are, strictly speaking, beyond the specific design basis for the affected systems. The results will be used as input to a probabilistic risk assessment evaluation done by others.

The system involved in this study are the Auxiliary Feedwater, Auxiliary Building HVAC (Normal and Essential), and Essential Chilled Water. Their design criteria are references 25, 26 and 27.



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 6

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
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III. STUDY ASSUMPTIONS:

1. AFW pump B operates at a design flow for 2 hours, and then operates at 500 gpm for 22 hours. For details, refer to Section I. of this study.
2. The initial temperature inside the AFW B pump room is 75°F. This is based on the assumption that normal HVAC is available before the time period of this study. Temperature of 75°F is the typical normal temperature in the AFW pump rooms and is based on the operating experience.
3. The initial temperature outside the AFW B pump room is 75°F. This is based on the assumption that normal HVAC is available before the time period of this study. The initial temperature of 75°F is the typical normal temperature in the close vicinity of the AFW pump rooms and is based on the operating experience.
4. Essential HVAC is not available during the time period of this study. In addition, normal HVAC is not available for Case A. These are the principal failures assumed at the onset of this study as discussed in Section I.
5. Initially, steady state temperature conditions exist in the AFW B pump room and outside the pump room.



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PROJECT ANPP

JOB NO. 18601-183

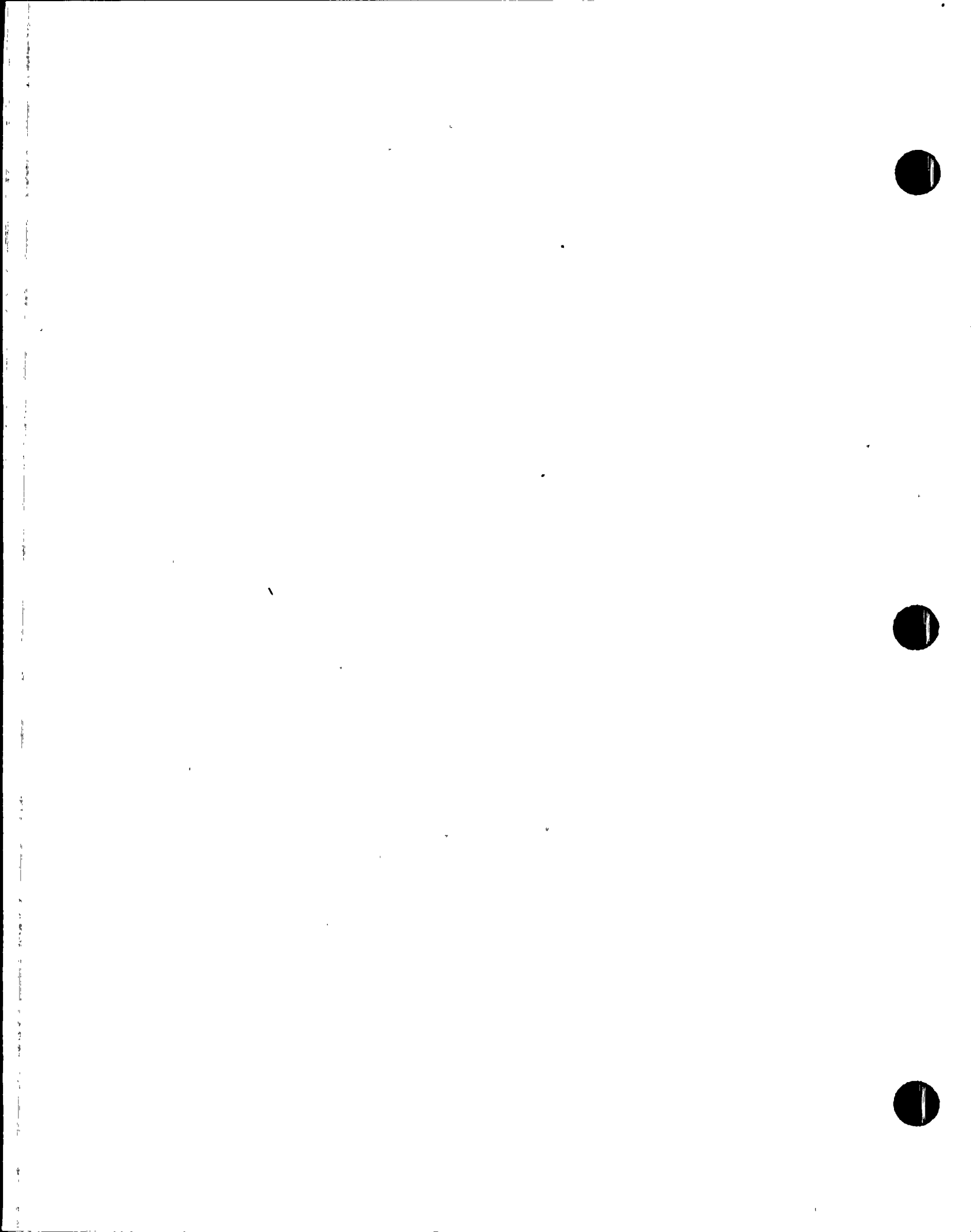
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SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 7

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6. The room is simplified as an enclosed space bounded by the same thickness of walls, ceiling and floor. All of the room walls actually are 3'-6" thick. In case of floor, no credit is taken for the thickness being more than the wall thickness of 3'-6". Due to the low heat load generated in 24 hours compared to the thermal capacity of the existing walls to absorb the heat, the additional floor thickness will not make any difference to the room ambient air temperature.
7. The walls, ceiling and floor are used as a heat sink. For details, refer to Section VI.C of this study.
8. The heat generated within the room is considered as being constant. This is due to the fact that more than 95% of the heat load, as shown in figure 1, is from the electric motors. For details refer to Sections VI.D and VII.A.1.c of this study.
9. No heat transfer is assumed to the room air from the AFW fluid piping or the AFW pump. This is due to the fact that when the AFW B pump is running, the room temperature and the AFW fluid temperature are approximately the same; the amount of the heat transferred is insignificant.





CALCULATION SHEET

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 8

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10. When a wall is shared by two rooms, which may be heated at the same time, half of the wall surface area will be considered as a heat transmission pathway for each room. AFW A and B pump rooms share a wall. Operation of only one AFW B or AFW A pump is required. This study uses a worst case scenario and assumes half of the wall as a heat sink for each room.

11. The dimensions of the AFW B pump rooms for all three units are essentially identical. In addition, the electric motors and pumps, equipment, lighting and piping sizes and lengths are virtually the same for all of these rooms. This study is performed for AFW B pump room for Unit 1 and is applicable to AFW B pump rooms for all three units.

12. Per assumption 4 above, the essential HVAC is not available during the time period of this study. For a conservative approach, ACU fan will be assumed running, without chilled water through the essential coils. The heat load due to this motor is minor as compared to the heat load from the AFW B pump motor. An efficiency of 82% for the ACU fan motor is assumed for calculation of room heat load. This is a typical motor efficiency for 5 hp motors as shown in reference 1, chapter 22, table 30, page 417.

13. The lighting load in the AFW B pump room is assumed to be 2 Watts/FT². This is a typical lighting load for industrial buildings as shown in the national electrical code 1987 handbook, reference 7.



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 9

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
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14. This study is performed for a time period of 24 hours. The computer model can provide details for a maximum of 720 steps (Refer Section VI.D). Therefore, each step or time increment is 2 minutes.

15. The room walls are required to be divided into a number of layers for computation of temperature distribution in the concrete walls by the computer model. The required input for the thickness of the first layer and the multiplication factor for thickness of other layers are selected as 0.01 ft (approx. 1/8") and 1.41 respectively. For details, see sections VI.A and B.

16. For calculation of heat removed from the pump room for the case of normal HVAC, the supply air temperature is assumed to be 62°F. Refer to references 23 and 4 for support of this temperature.

17. For calculation of heat removed from the pump room for the case of normal HVAC, the room average ambient temperature is assumed to be 125°F. For support of this average ambient temperature, see section VII.C, verification of average room ambient temperature.

18. Concrete has the following properties:

- A. Density 144 lbs/ft³ (Ref 6)
- B. Thermal conductivity 0.54 (Ref 6)
- C. Specific heat 0.2 btu/lb-°F (Ref 6)



CALCULATION SHEET

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 10

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19. The net pump room volume is required as input to the computer model. For calculation of net room volume, the volume of the HVAC equipment in the AFW B pump room is insignificant and is neglected.

20. Comparing references 9 and 10, the Auxiliary Feedwater fluid piping is virtually the same for the AFW A&B pump rooms. Therefore, for calculation of net room volume, the AFW B piping volume used is the same as that of fluid piping volume for AFW A pump given in Reference 28.



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 11

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IV. REFERENCES:

1. ASHRAE Handbook of Fundamentals, 1972.
2. Technical specification for thermal insulation materials and the application to piping and equipment, specification number 13-MM-301, Rev. 2.
3. Line designation list, 13-P-ZZG-014, Rev. 29.
4. Auxiliary building essential cooling system heat load calculation, calculation number 13-MC-HA-051, Rev. 1.
5. P & I diagram, Auxiliary Feedwater system, drawing number 13-M-AFP-001, Rev. 26.
6. Principles of heat transfer, third edition, Frank Kreith, Intext Educational Publishers. table A-2, Physical Properties of Some Nonmetals, page 635.
7. The National Electrical Code 1987 Handbook, fourth edition, General Lighting Loads by Occupancies, table 220-3(b), page 100.
8. NAVCO Piping "Datalog", National Valve and Manufacturing Company, Pittsburg, PA. Edition No. 10.
9. M.S.S.S. Isometric Motor Driven Pump, Drawing Number 13-P-AFF-133, Sheet 1, Rev. 18.
10. M.S.S.S. Isometric Turbine Driven Pump, Drawing Number 13-P-AFF-132, Sheet 1, Rev. 20.
11. Main Steam Support Structure, Floor Inserts and Penetrations, Drawing Number 13-C-ZCS-705, Rev. 19.
12. Main Steam Support Structure, Concrete Sections and Details, Drawing Number 13-C-ZCS-703, Rev. 7.
13. Equipment Location Containment Bldg. Drawing Number 13-P-ZCL-106, Rev. 4.
14. Auxiliary Feedwater Pump Outline, Log M021-3-10



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 12

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV.
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15. Motor Outline, Auxiliary Feedwater Pump AFB-P01, Log M021-58-6.
16. Auxiliary Feedwater Pump data sheet, log M021-102-1
17. Reliance Electric Co. drawing, log M721A-112-2
18. User's and Theoretical Manuals Verification Report, program RMHTUP-Room Heat Up, program number ME 204, version A1, Bechtel Power Corporation, San Francisco Power Division.
19. Final Safety Analysis Report, Palo Verde Nuclear Generating Station, Amendment 17.
20. Q-Motor Test for Auxiliary Feedwater Pump AFB-P01, Log M021-128-1.
21. Q-Motor Pump Test 1M-AFB-P01, log M021-114-1.
22. Auxiliary Building Normal Cooling System Heat Load Calculation, Calculation Number 13-MC-HA-001, Rev. 3.
23. Basic Flow Diagram, HVAC Auxiliary Building, Drawing Number 13-M-HAF-002, Rev. 2.
24. Unit 1-Auxiliary Building Final Air Balance, log M634-150-1.
25. Detailed Design Criteria, Part III, System HA, HVAC-Auxiliary Building, Rev. 8.
26. Detailed Design Criteria, Part III, System AF, Auxiliary Feedwater System, Rev. 4.
27. Detailed Design Criteria, Part III, System EC, Essential Chilled Water System, Rev. 3.
28. Transient Temperature Study for AFW A Pump Room, Calculation Number 13-MC-HA-A04, Rev. 0.



CALCULATION SHEET

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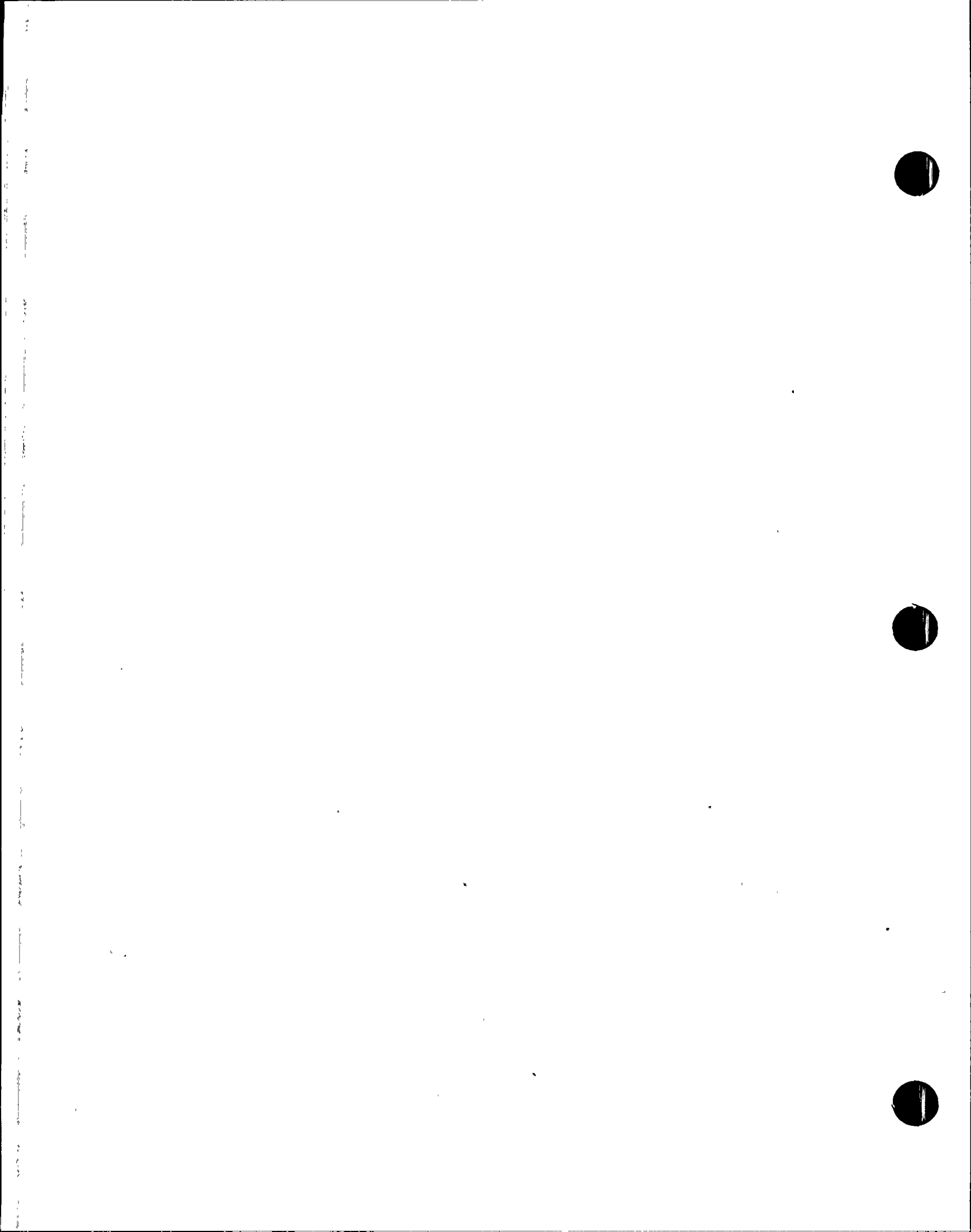
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V. SUMMARY OF RESULTS:

The transient temperature summary for the AFW B pump room air is shown below. For case A, the temperature values can be used directly.

For cases B and C, having normal HVAC lowers the temperature profile for the room air. It is apparent that the maximum difference between corresponding temperatures in Cases B and C is $< 1.5^{\circ}\text{F}$. As explained in Section VII.D, the average of the results for cases B and C is felt to better estimate the transient temperature profile when normal HVAC is operating.

<u>Time Period</u>	<u>No HVAC</u>		<u>with only Normal HVAC</u>		
	<u>CASE A</u>	<u>CASE B</u>	<u>CASE C</u>	<u>AVG B&C</u>	
	<u>Temp., $^{\circ}\text{F}$</u>	<u>Temp., $^{\circ}\text{F}$</u>	<u>Temp., $^{\circ}\text{F}$</u>	<u>Temp., $^{\circ}\text{F}$</u>	
0 min	75	75	75	75	
2 min	88.92	85.98	85.74	85.86	
4 min	96.91	92.35	91.99	92.17	
12 min	106.83	100.52	100.01	100.27	
36 min	111.85	104.58	103.99	104.29	
1 hr	114.67	106.82	106.18	106.50	
2 hr	119.70	110.80	110.08	110.44	
4 hr	126.72	116.35	115.51	115.93	
6 hr	132.08	120.58	119.65	120.12	
8 hr	136.60	124.14	123.14	123.64	
12 hr	144.16	130.11	128.97	129.54	
24 hr	161.25	143.58	142.15	142.87	





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 14

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
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VI. ROOM HEAT-UP COMPUTER MODEL

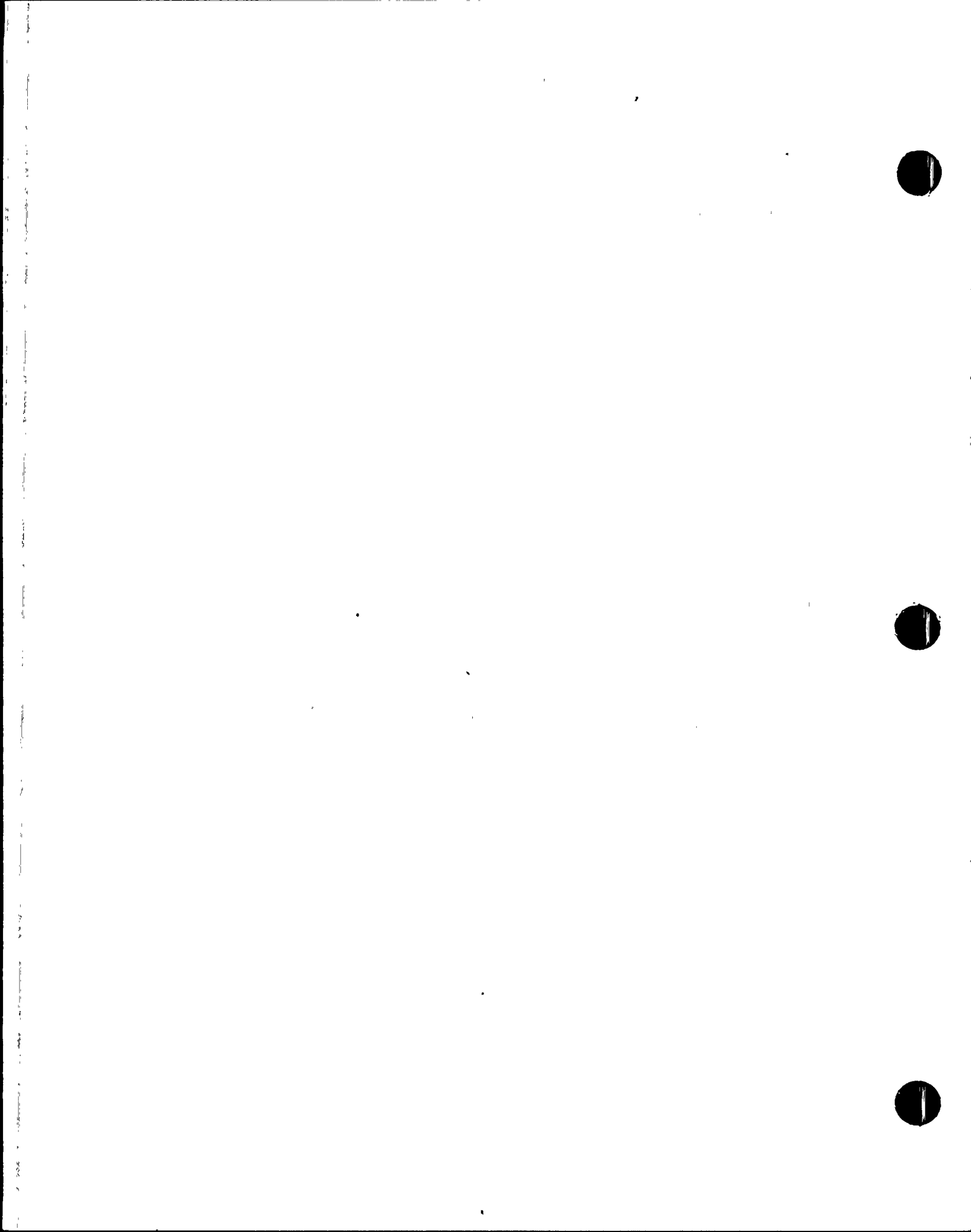
A. Model Description: (Ref 18)

The room heat-up computer program, RMHTUP, program number ME 204, version A1, can be used to study the room ambient air heat-up by the equipment heat or any other heat sources in the room.

The temperature of room ambient air increases with time, due to the heat released from the equipment and other sources. The heat generated within the room is transferred to the ambient room air, stored in the room enclosure (walls, ceiling, and floor) and transferred to the air outside the room.

The room walls are divided into a number of layers with incremental thicknesses for numerical computation by the computer program. In this study, the value of imaginary thickness of first layer of concrete wall is selected as 0.01 ft and the multiplication factor of imaginary thickness of other layers is taken as 1.41. In other words, the first concrete layer thickness is 0.01 ft (approx. 1/8"), the second layer thickness is 0.0141 ft (approx. 3/16"), third layer $0.01 \times (1.41)^2$ ft, etc.

The transient room temperature is determined from the heat balance equation, which balances the heat generated within the room and the heat transferred to the ambient room air, stored in the room enclosure and transferred to the outside air, as shown below:

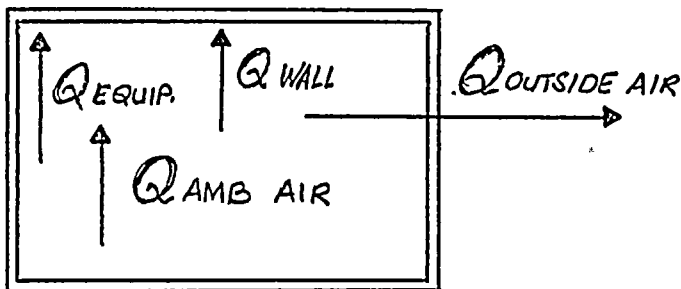




CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-NC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 15

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$$Q_{EQUIP} = Q_{AMB AIR} + Q_{WALL} + Q_{OUTSIDE AIR}$$

WHERE Q_{EQUIP} = Heat generated from equipment or any other source in the room, BTU/HR

$Q_{AMB AIR}$ = Heat transferred to the ambient room air, BTU/HR

Q_{WALL} = Heat stored in the room walls, ceiling and floor, BTU/HR

$Q_{OUTSIDE AIR}$ = Heat transferred to the outside air, BTU/HR

The room ambient temperature and the wall temperature distribution are calculated at fixed time intervals. In addition, total heat stored in the ambient air and in the concrete walls and heat transferred to the outside air are provided for each time interval.



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 16

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDIC.
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B. Input Required for Computer Model:

The following information is required as input for transient temperature study in the AFW B pump room:

1. Initial room ambient temperature, degrees F
2. Initial outside ambient temperature, degrees F
3. Equipment and other heat generated in the room, BTU/HR
4. Net room surface area, ft^2
5. Net room volume, ft^3
6. Thickness of room enclosure, ft
7. Density of room enclosure material, lbs/ft^3
8. Thermal conductivity of room enclosure material, BTU/HR-ft-F
9. Specific heat of room enclosure material, BTU/lb-F
10. One period of time increment for calculation, min
11. Imaginary thickness of first layer of room enclosure, ft
12. Multiplication factor of imaginary thickness of other layers





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 17

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
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C. Assumptions for the Computer Model

1. The room is simplified as an enclosed space bounded by the same thickness of walls, ceiling, and floors.
2. The gross room volume is corrected for the volume occupied by piping and equipment.
3. The gross room surface area of the room enclosure is corrected for the area occupied by equipment.
4. The enclosure walls, ceiling and floor are taken as a heat sink.

D. Computer Model Limitations

1. The room enclosure walls, ceiling and floor must be considered as having the same thickness and of the homogenous material.
2. The air temperatures outside the room must be considered as being the same and remaining constant.
3. The heat generated within the room must be considered as being constant. No heat generated outside the room can be considered.
4. The program is limited to 720 time period calculations.

E. Computer Model Output

The following information is provided in the computer model output:

TAF = Final room air temperature at each period, °F

QAT = Heat stored in the ambient air, BTU

QST = Total heat stored in the concrete, BTU

QOT = Heat transferred to the outside air, BTU



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 18

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
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VII. STUDY:

This study is performed for the following two cases:

- A. AFW pump B operates at the design flow for 2 hours, and then operates at 500 gpm for 22 hours. Normal HVAC is not available.
- B. AFW pump B operates at the design flow for 2 hours, and then operates at 500 gpm for 22 hours. Normal HVAC is available.

Essential HVAC is not available for either of the above cases.

VII.A

CASE A

AFW PUMP B OPERATES AT THE DESIGN FLOW FOR 2 HOURS, AND THEN OPERATES AT 500 gpm FOR 22 HOURS. NORMAL HVAC IS NOT AVAILABLE.

1. Heat Loads:

a. Electric Motors Heat Load:

This heat load consists of the heat generated by the AFW B pump motor and ACU fan motor.

1. AFW B Pump Electrical Motor Heat Load:

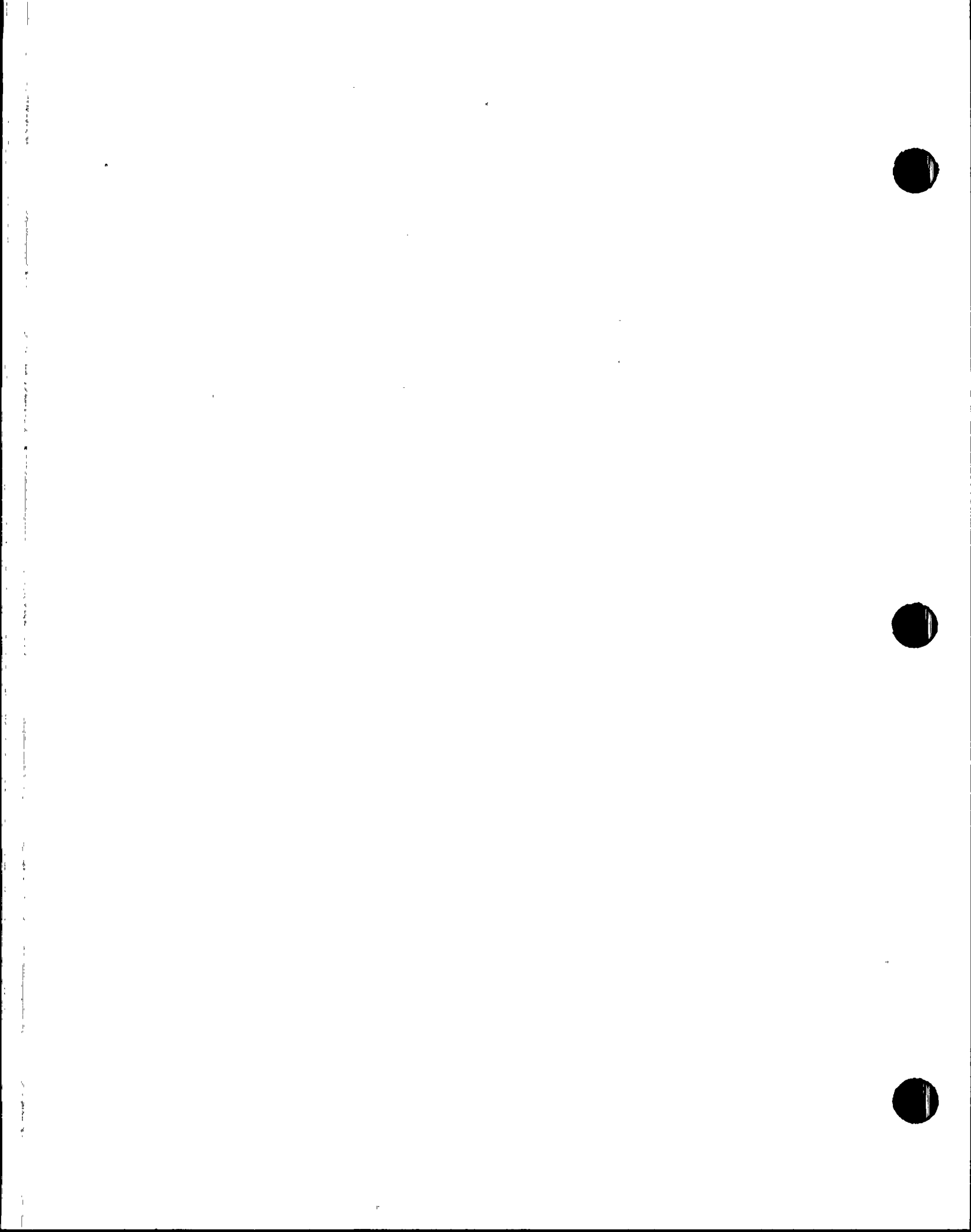
AFW B Pump design flow = 1010 gpm (REF 16)

Pump design flow BHP = 1066 hp (REF 16)

Motor efficiency at full load = 95.0% (REF 20)

BHP for flow of 500 gpm = 750 hp (REF 21)

Motor efficiency at 3/4 load = 95.1 (REF 20)





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 19

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	4-1-88	G.W.M	4-1-88					

AFW pump B operates at design flow for 2 hours and at 500 gpm for 22 hours. (Refer Section I).

$$\begin{aligned}\text{Therefore, average BHP} &= \frac{(2 \times 1066) + (22 \times 750)}{24} \text{ hp} \\ &= 776.33 \text{ hp}\end{aligned}$$

$$\begin{aligned}\text{Average motor efficiency,} &= \frac{(2 \times 95) + (22 \times 95.1)}{24} \\ &= 95.09\%\end{aligned}$$

The pump and the motor are inside the AFW B pump room. The fluid is pumped to outside of the room.

$$\text{Motor heat load} = \text{BHP} \times 2545 \times \frac{(1 - \eta)}{\eta}$$

$$\begin{aligned}&(\text{REF 1, note C, table 30, chap 22, page 417}) \\ &= 776.33 \times 2545 \times \frac{(1 - 0.9509)}{0.9509} \text{ BTU/HR} \\ &= 102,019 \text{ BTU/HR}\end{aligned}$$

ii. ACU Fan Motor Heat Load:

The essential ACU fan may be running without essential chilled water thru the essential cooling coils (See Assumption 12)

ACU nameplate fan h.p. = 5 h.p. (REF 17)

Motor efficiency = 82% (See Assumption 12)

The motor and the driver are both in the AFW B room and the air stays inside the room (i.e. all the fan motor energy stays inside the room).



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 20

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	4-1-88	G.W.M	4-1-88						

From ref 1, chap 22, table 30, page 417,

Heat gain from fan motor

$$= \frac{\text{hp} \times 2545}{\% \text{ eff}}$$

$$= \frac{5 \times 2545}{0.82}$$

$$= 15,518 \text{ BTU/HR}$$

$$\begin{aligned} \text{Total motor heat load} &= 102,019 + 15,518 \\ &= 117,537 \text{ BTU/HR} \end{aligned}$$

b. Lighting Heat Loads:

The heat load is due to the lighting in the AFW B pump room.

$$\begin{aligned} \text{AFW B pump room area} &= (35'-0") \times (18'-3") \\ &\quad (\text{Ref 11}) \\ &= 35.0 \times 18.25 \text{ FT}^2 \\ &= 638.75 \text{ FT}^2 \end{aligned}$$

Typical lighting load for industrial buildings =
2 watts/FT² [Refer Assumption 13]

$$\begin{aligned} \text{Room lighting load} &= (\text{Room area, ft}^2) \times (2 \text{ watts/ft}^2) \times \\ &\quad 3.41 \text{ BTU/HR-watt} \end{aligned}$$

$$\begin{aligned} &= 638.75 \times 2 \times 3.41 \text{ BTU/HR} \\ &= 4356 \text{ BTU/HR} \end{aligned}$$



CALCULATION SHEET

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 21

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PJH	4-1-88	G.W.M	4-1-88					

REV.
INDIC.
CATCH

c. Total Heat Loads:

No heat transfer is assumed to the room air from the AFW fluid piping or the AFW B pump casing (Refer Assumption. 9).

The following is the sum of the heat loads in the AFW B pump room:

AFW B pump and ACU fan

electric motors heat load = 117,537 BTU/HR [See Sec. VII.A.1.a]

Lighting heat load = 4,356 BTU/HR [See Sec. VII.A.1.b]

Total AFW B pump room

Heat Load = 121,893 BTU/HR



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 22

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PLH	4-1-88	G. W. M.	4-1-88						

2. AFW B Pump Room Surface Area & Volume:

a. AFW B Pump Room Surface Area:

AFW-B pump room dimensions are, L X W X H =

35'-0" X 18'-3" X 15'-6" (REF 11 & 12)

AFW A pump room has a common wall with AFW B pump room (REF 13)

The surface area of the shared wall will be considered 50% for AFW B pump room, resulting in half of the wall as a heat sink for this room (Refer to Assumption 10).

The dimension of the common wall are

(35'-0") x (15'-6") (REF 11 and 12)

Therefore, the surface area for heat transfer is as follows:

Wall surface area =

$$2 \times (18'-3" \times 15'-6") + (35'-0" \times 15'-6") + (35'-0" \times 15'-6") = 1379.5 \text{ ft}^2$$

2

Ceiling surface area = 35'-0" X 18'-3" = 638.75 ft²

Floor surface area = 35'-0" X 18'-3" = 638.75 ft²

Total surface area

$$= 1379.5 + 638.75 + 638.75 = 2657 \text{ ft}^2$$

Floor area occupied by the AFW B pump and motor set =

$$\frac{166}{12} \times \frac{47}{12} \text{ ft}^2 = 54.18 \text{ ft}^2$$

[For dimensions, see REF 14]

Net surface area for heat transmission =

$$2657 - 54.18 = 2602.82 \text{ ft}^2, \text{ say } 2603 \text{ ft}^2$$



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 23

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
10	PH	4-1-88	G.W.M	4-1-88					

b. AFW B Pump Room Volume: (Ref 14 and 15)

$$\text{Pump volume} = \frac{\pi}{4} \times \left(\frac{28}{12}\right)^2 \times \frac{60}{12} + \frac{\pi}{4} \times \left(\frac{10}{12}\right)^2 \times \frac{10}{12}$$
$$= 21.83 \text{ ft}^3$$

$$\text{Coupling volume} = \frac{\pi}{4} \times \left(\frac{10}{12}\right)^2 \times \frac{25}{12} = 1.14 \text{ ft}^3$$

$$\text{Base plate volume} = \frac{166}{12} \times \frac{6}{12} \times \frac{47}{12} = 27.09 \text{ ft}^3$$

$$\text{Motor volume} = \frac{\pi}{4} \times \left(\frac{36}{12}\right)^2 \times \frac{60}{12} + \frac{2}{12} \times \frac{34}{12} \times \frac{60}{12}$$
$$= 37.70 \text{ ft}^3$$

Estimated pump and motor set volume =

$$21.83 + 1.14 + 27.09 + 37.70 \text{ ft}^3 = 87.76 \text{ ft}^3$$

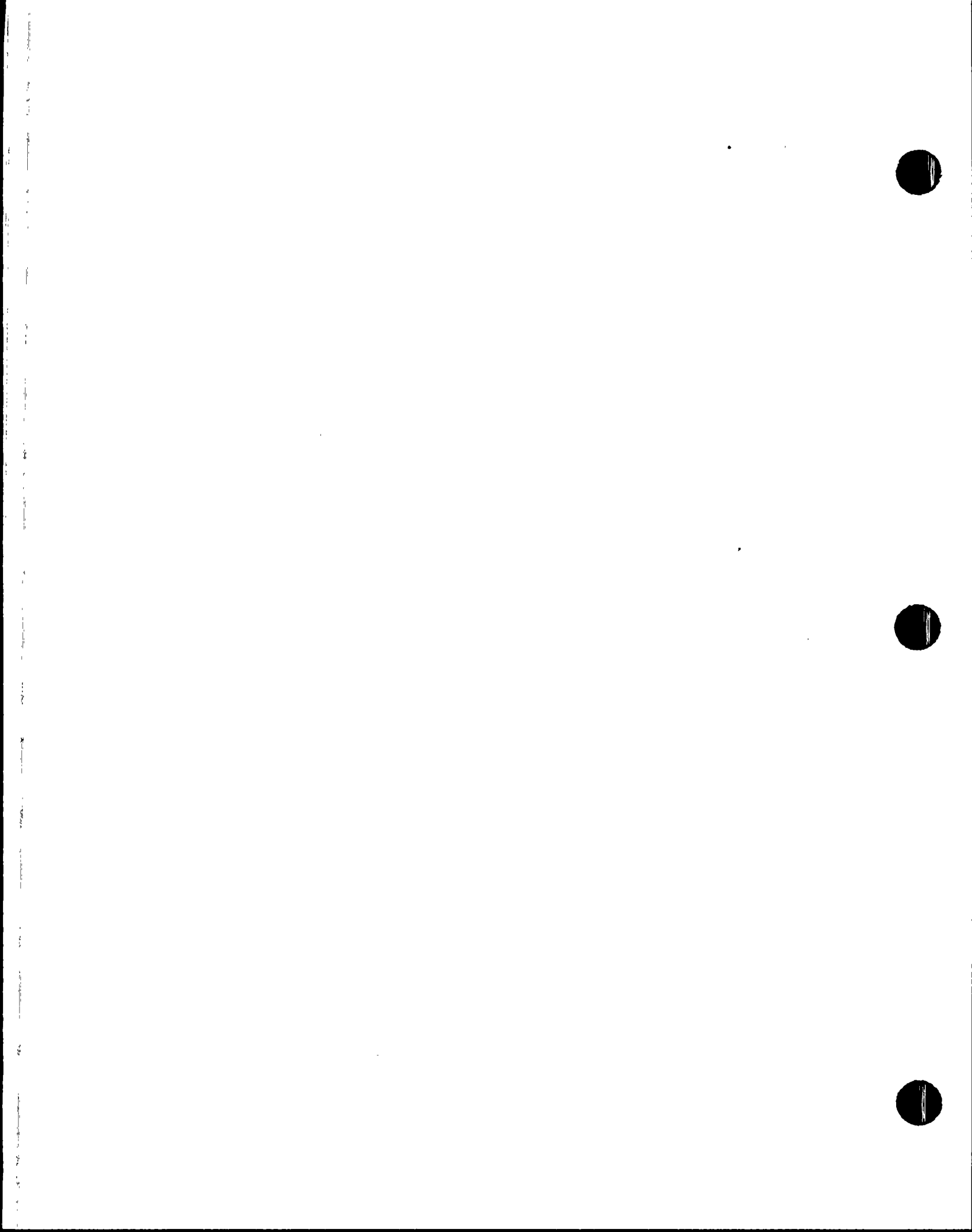
Piping Volume in the pump room = 132.45 ft^3

(From REF 28 per Assumption 20)

$$\text{AFW B pump room volume} = (35'-0") \times (18'-3") \times (15'-6")$$
$$= 9901 \text{ ft}^3 \quad (\text{Ref 11 \& 12})$$

Volume for the HVAC equipment and the ECWS piping is insignificant and is neglected. [Assumption 19]

$$\text{Net AFW B pump room volume} = 9901 - 87.76 - 132.45$$
$$= 9680.79 \text{ ft}^3, \text{ say } 9681 \text{ ft}^3$$





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 24

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	4-1-88	G.W.M	4-1-88					

3. Input Data: CASE A

The following input data for the computer model is used:

1. Initial room ambient temp. = 75°F [Assumption 2]
2. Initial outside ambient temp. = 75°F [Assumption 3]
3. Equipment and other heat generated in the room = 121,893 BTU/HR [See Section VII.A.1.c]
4. Net room surface area = 2603 FT^2 [See Section VII.A.2]
5. Net room volume = 9681 FT^3 [See Section VII.A.2]
6. Thickness of room enclosure = 3.5 FT [Ref 11 and 12]
7. Density of room enclosure material = 144 LBS/FT^3 [Ref 6]
8. Thermal conductivity of room enclosure material = $0.54\text{ BTU/HR-FT-}^{\circ}\text{F}$ [Ref 6]
9. Specific heat of room enclosure material = $0.2\text{ BTU/LB-}^{\circ}\text{F}$ [Ref 6]
10. One period of increment for calculation = 2 min [Assumption 14]
11. Imaginary thickness of first layer of concrete enclosure = 0.01 FT [Assumption 15]
12. Multiplication factor of imaginary thickness of other layers = 1.41 [Assumption 15]



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 25

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PLV	4-1-88	G.W.M	4-1-88					

4. Results: CASE A

The transient temperature for the AFW B pump room air obtained from the computer output, is shown in Figure 2. The transient temperature output, Appendix A, shows that without any HVAC, the calculated temperature in the pump room will be as follows:

<u>Time Period</u>	<u>Temperature^{°F}</u>
0 min	75
2 min	88.92
4 min	96.91
12 min	106.83
36 min	111.85
1 hr	114.67
2 hr	119.70
4 hr	126.72
6 hr	132.08
8 hr	136.60
12 hr	144.16
24 hr	161.25



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 26

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	4-1-88	G.W.M	4-1-88						

VII.B

CASE B

AFW PUMP B OPERATES AT DESIGN FLOW FOR 2 HOURS, AND THEN
OPERATES AT 500 gpm FOR 22 HOURS. NORMAL HVAC IS AVAILABLE.

1. Net Heat Load: CASE B

Normal HVAC design supply flow in AFW B pump room = 400 cfm
[Ref 23 & 24]

Normal HVAC air balance supply flow in AFW B pump room =
396 cfm [Ref 24, Page 15]

Supply air temperature = 62°F [Refer Assumption 16]

Assume average room ambient temperature = 125°F (See
assumption 17)

Using normal HVAC air balance supply flow,

Heat removed, qs = 1.08 X 396 X (125-62) BTU/HR
= 26,944 BTU/HR

Total Heat Load in AFW B pump room = 121,893 BTU [Refer
Sec. VII.A.1.c]

Net heat load in AFW B pump room = 121,893 - 26,944
= 94,949 BTU/HR

2. Input Data: CASE B

All input is the same as CASE A except item #3, Room heat
load, which is 94,949 BTU/HR.





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 27

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
1	PJ	4-1-88	G.W.M	4-1-88	1				
2					2				

REV. INDICATOR

3. RESULTS: CASE B

The transient temperature for the AFW B room air, obtained from the computer output, is shown in Figure 3. The transient temperature output, Appendix B, shows that with only normal HVAC, the calculated temperatures in the pump room will be as follows:

<u>Time Period</u>	<u>Temp. °F</u>
0 min	75
2 min	85.98
4 min	92.35
12 min	100.52
36 min	104.58
1 hr	106.82
2 hr	110.80
4 hr	116.35
6 hr	120.58
8 hr	124.14
12 hr	130.11
24 hr	143.58





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 28

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	4-1-88	G. W. M	4-1-88					

VII.C CASE C: VERIFICATION OF THE AFW B PUMP ROOM TEMPERATURE:

AFW PUMP B OPERATES AT THE DESIGN FLOW FOR 2 HOURS, AND THEN OPERATES AT 500 gpm FOR 22 HOURS. NORMAL HVAC IS AVAILABLE.

Average room temperature was assumed to be 125°F for Case B. The computer output for the CASE B (Appendix B) shows that the room temperature is 130°F after 12 hours. It is apparent that the average heat removed by the Normal HVAC is slightly under estimated and that the final temperature may be slightly over estimated. To establish a lower limit, the Normal HVAC effect was recalculated for 130°F.

1. Net Heat Load: CASE C

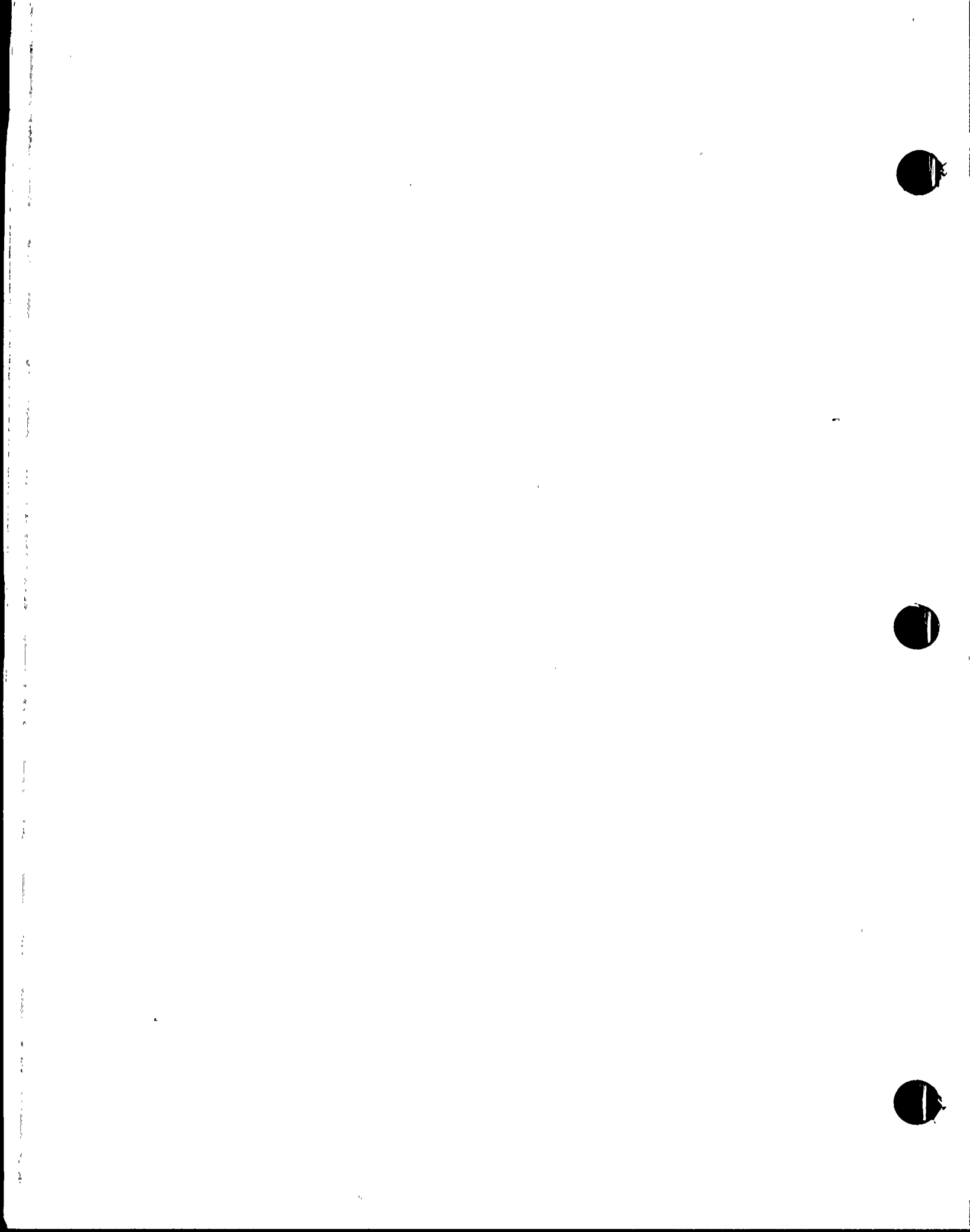
Using the methodology used in Case B, the heat removed by Normal HVAC and the net heat load in the pump room are recalculated, due to the temperature difference, with room temperature 130°F and supply air temperature 62°F (same as before).

Using normal HVAC air balance supply flow,

Heat removed, $q_s = 1.08 \times 396 \times (130 - 62) \text{ BTU/HR} = 29,082 \text{ BTU/HR}$

Total Heat Load in AFW B pump room = 121,893 BTU/HR [Refer Sec. VII.A.1.c]

Net heat load in AFW B pump room = 121,893 - 29,082 = 92,811 BTU/HR





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 29

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
△	PJH	4-1-88	G.W.M	4-1-88	△				
△					△				

2. Input Data: CASE C

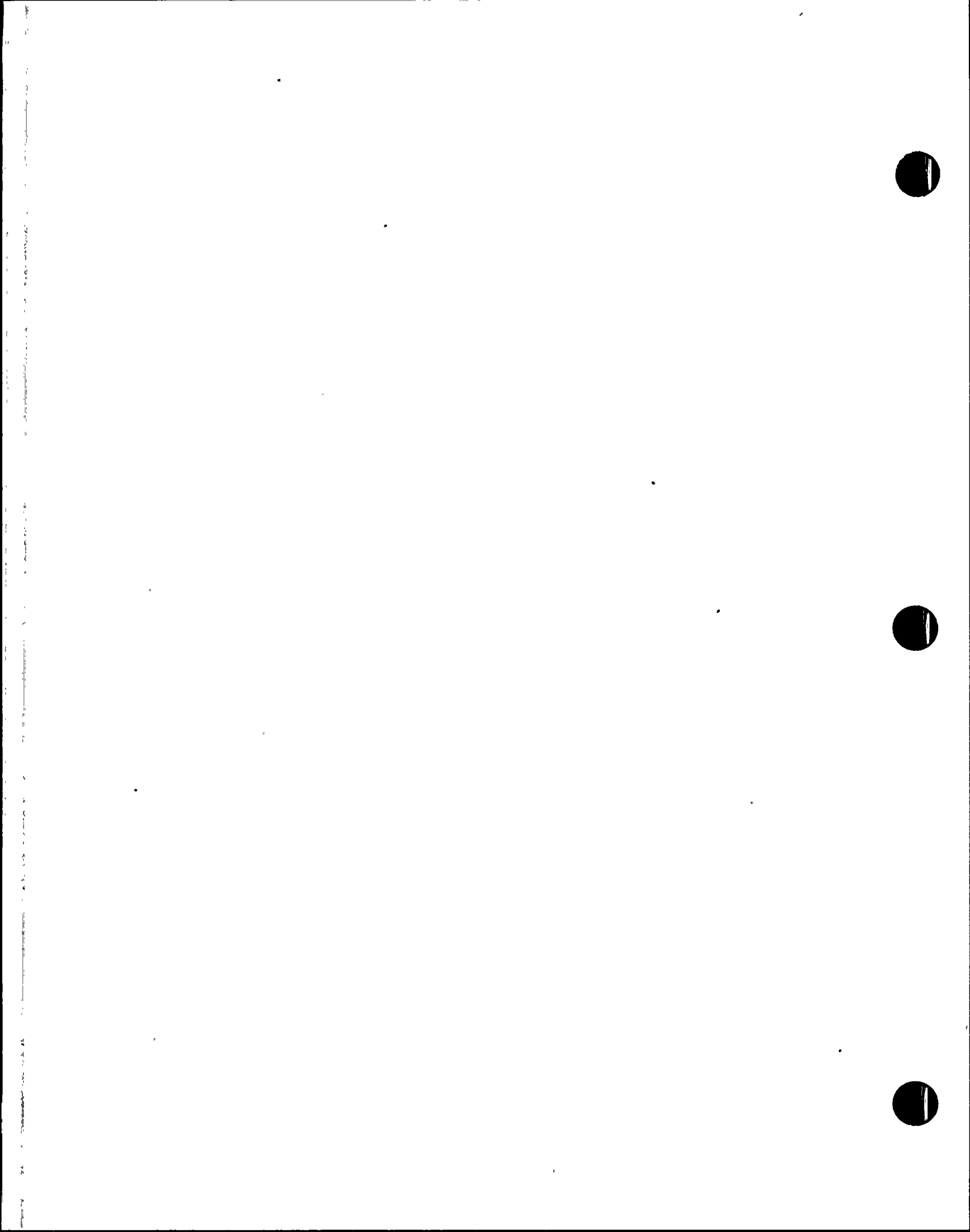
All input data for CASE C is the same as for CASE A except for item #3, Room heat load, which is 92,811 BTU/HR.

3. Results: CASE C

Using this heat load, computer model is again run. The result of this computer run, Appendix C, is plotted on Figure 3. It indicates that the temperature after 12 hours is 129°F and the 24 hour temperature is 142°F

The transient temperature for the AFW B pump room air, obtained from the computer output, is shown in Figure 3. The transient temperature output, Appendix C, shows that, with Normal HVAC, the calculated temperature in the pump room will be as follows.

<u>Time Period</u>	<u>Temp. °F</u>
0 min	75
2 min	85.74
4 min	91.99
12 min	100.01
36 min	103.99
1 hr	106.18
2 hr	110.08
4 hr	115.51
6 hr	119.65
8 hr	123.14
12 hr	128.97
24 hr	142.15





CALCULATION SHEET

PROJECT ANPP JOB NO. 18601-183 CALC. NO. 13-MC-HA-A03
SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM SHEET NO. 30

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
△	KW	4-1-88	G.W.M	4-1-88	△					↓
△					△					

VII.D CONCLUSIONS: Room cooling with only Normal HVAC:

Reviewing the results for CASE B, it is concluded that the temperature at each step beyond eight to twelve hours is slightly overestimated because the heat removed by the normal HVAC is slightly overestimated. Similarly for CASE C, the temperature in this time interval is slightly underestimated due to the slight overestimation of the heat removed by the normal HVAC. The effect is small as is apparent from the small differences between corresponding temperatures.

In evaluating these results, it is concluded that the average of the calculated transient room temperatures for CASES B and C is a better approximation of the expected results. The average of the results of CASES B and C follows:

With only Normal HVAC

	CASE B	CASE C	AVG B&C
<u>Time Period</u>	<u>Temp. °F</u>	<u>Temp. °F</u>	<u>Temp. °F</u>
0 min	75	75	75
2 min	85.98	85.74	85.86
4 min	92.35	91.99	92.17
12 min	100.52	100.01	100.27
36 min	104.58	103.99	104.29
1 hr	106.82	106.18	106.50
2 hr	110.80	110.08	110.44
4 hr	116.35	115.51	115.93
6 hr	120.58	119.65	120.12
8 hr	124.14	123.14	123.64
12 hr	130.11	128.97	129.54
24 hr	143.58	142.15	142.87



CALCULATION SHEET

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-NC-HA-A03

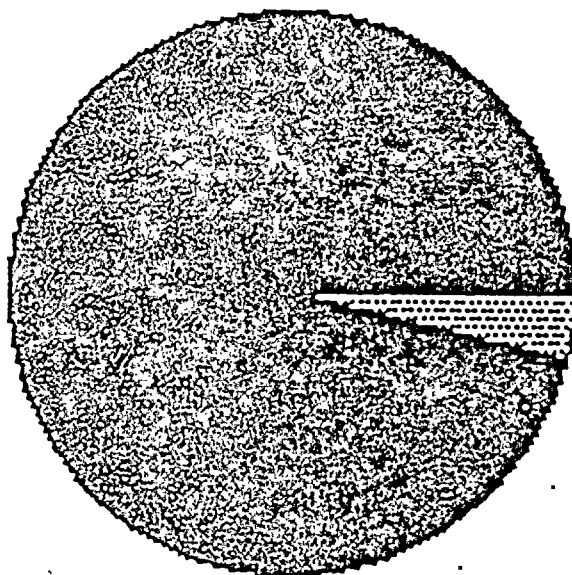
SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 31

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
10	PSS	4-1-88	G.W.M	4-1-88					

CLASSIFICATION OF HEAT LOADS

AFW B PUMP RM HEATUP

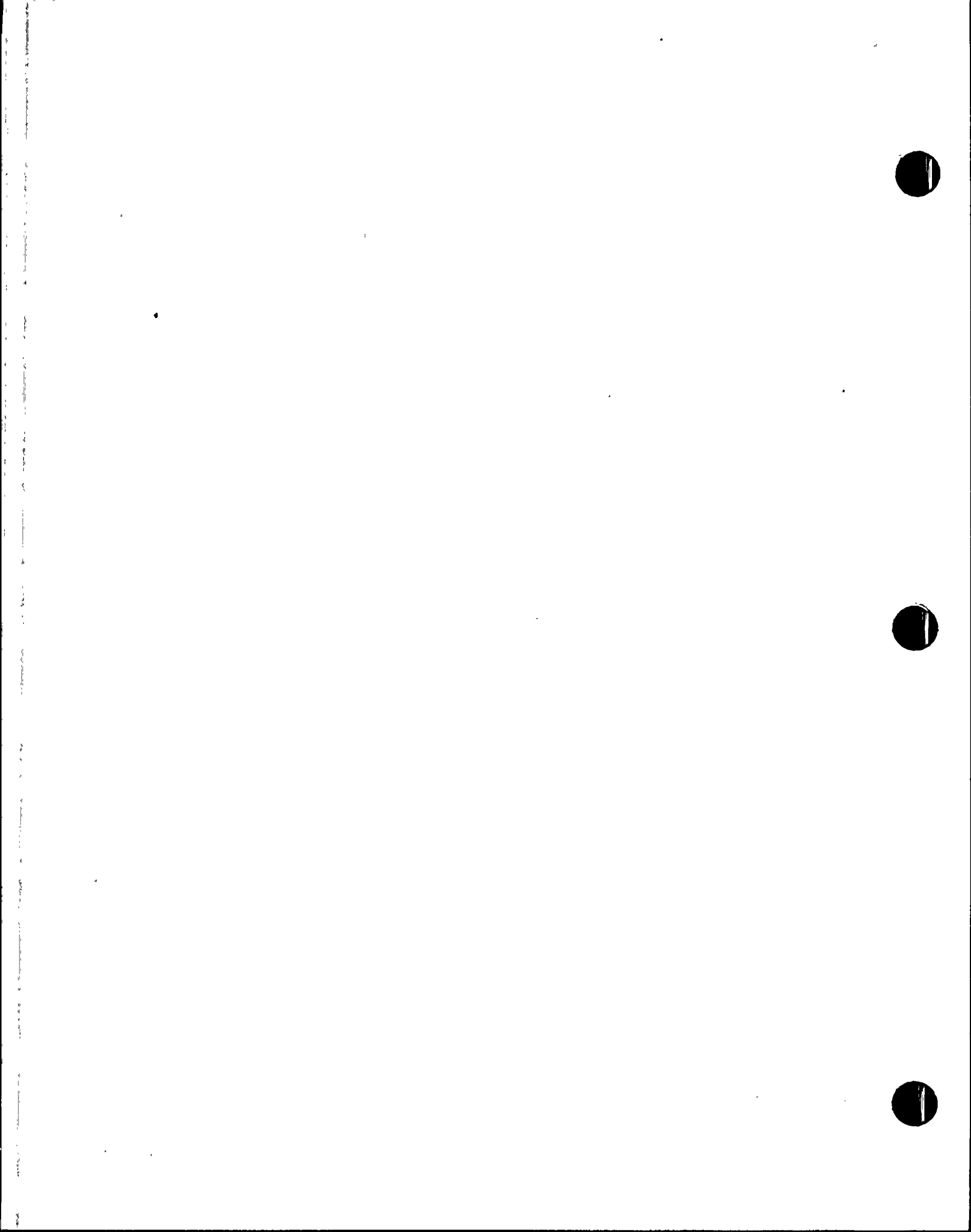


96.43%
ELECTRIC MOTORS

3.57%
ROOM LIGHTING

TOTAL HEAT LOAD BTU/HR
121.9 THOUSAND

FIGURE 1





CALCULATION SHEET

PROJECT ANPP JOB NO. 18601-183 CALC. NO. 13-MC-HA-AQ3

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMPROOM SHEET NO. 32

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
1	PSS	4-1-88	G. W. M.	4-1-88	1					
2					2					

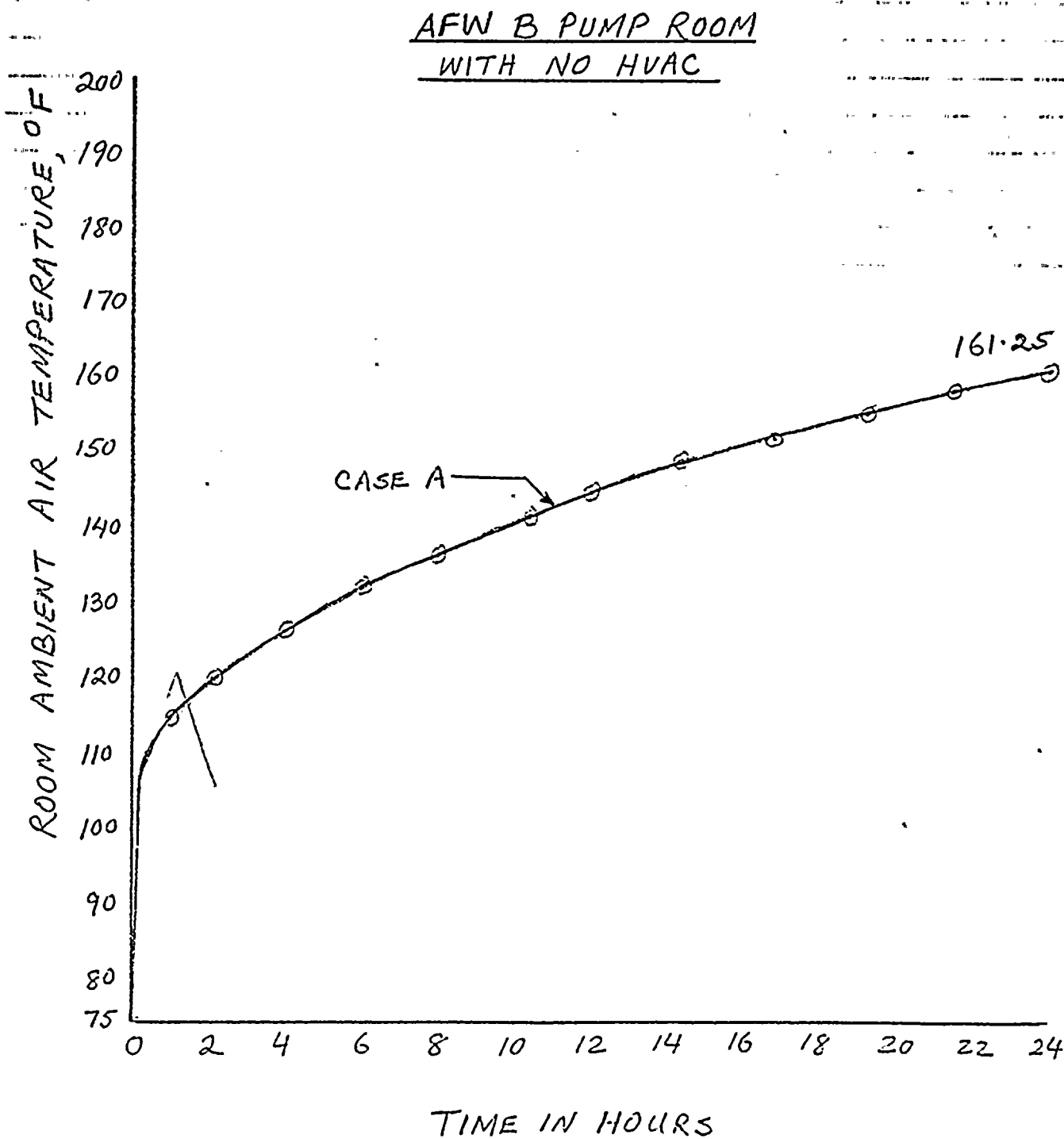
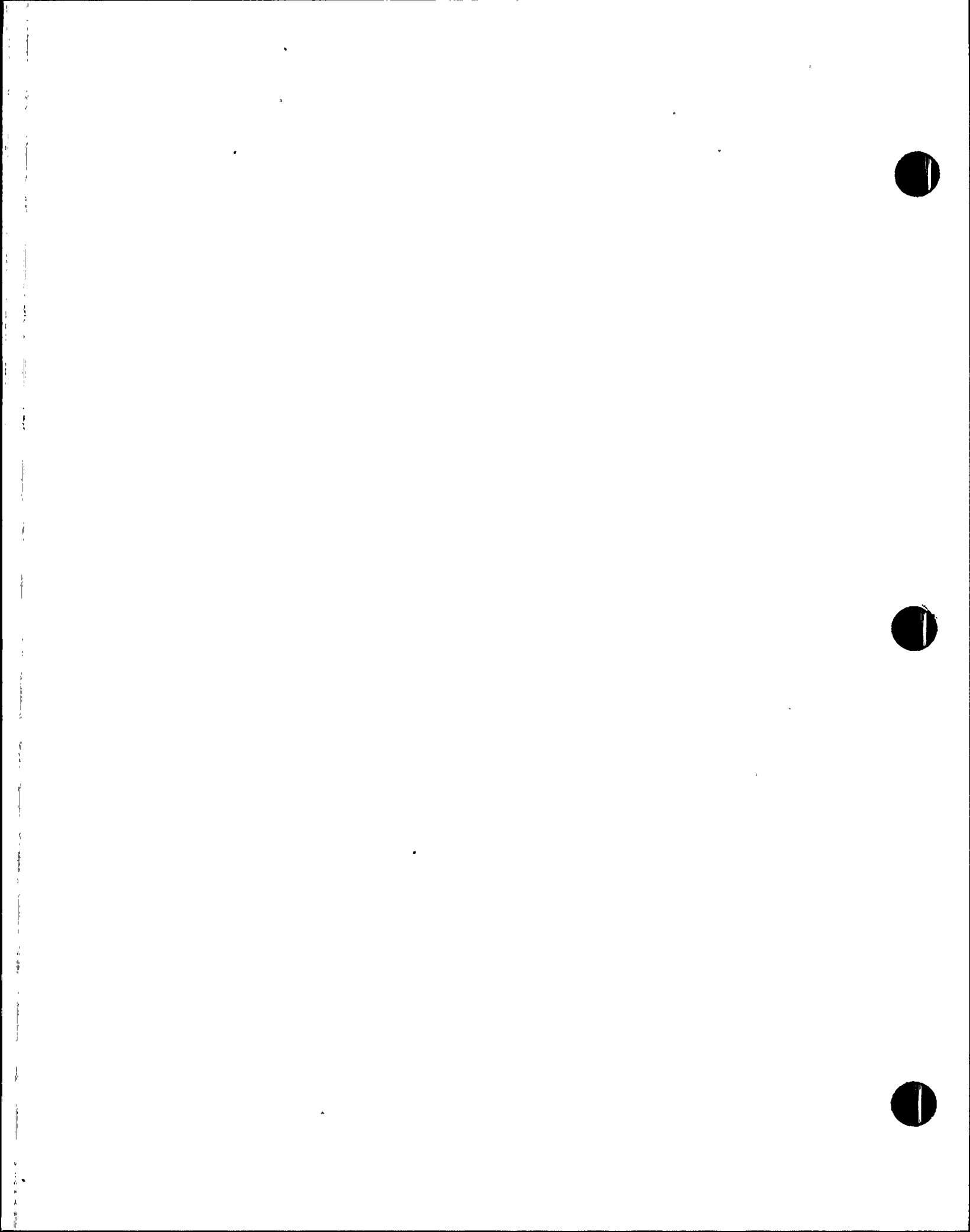


FIGURE 2





CALCULATION SHEET

PROJECT ANPP

JOB NO. _____

CALC. NO. 13-MC-HA-A0

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 33

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
△ O	PSS	4-1-88	G. W. M	4-1-88	△				
△					△				

REV. INDICATOR
↓

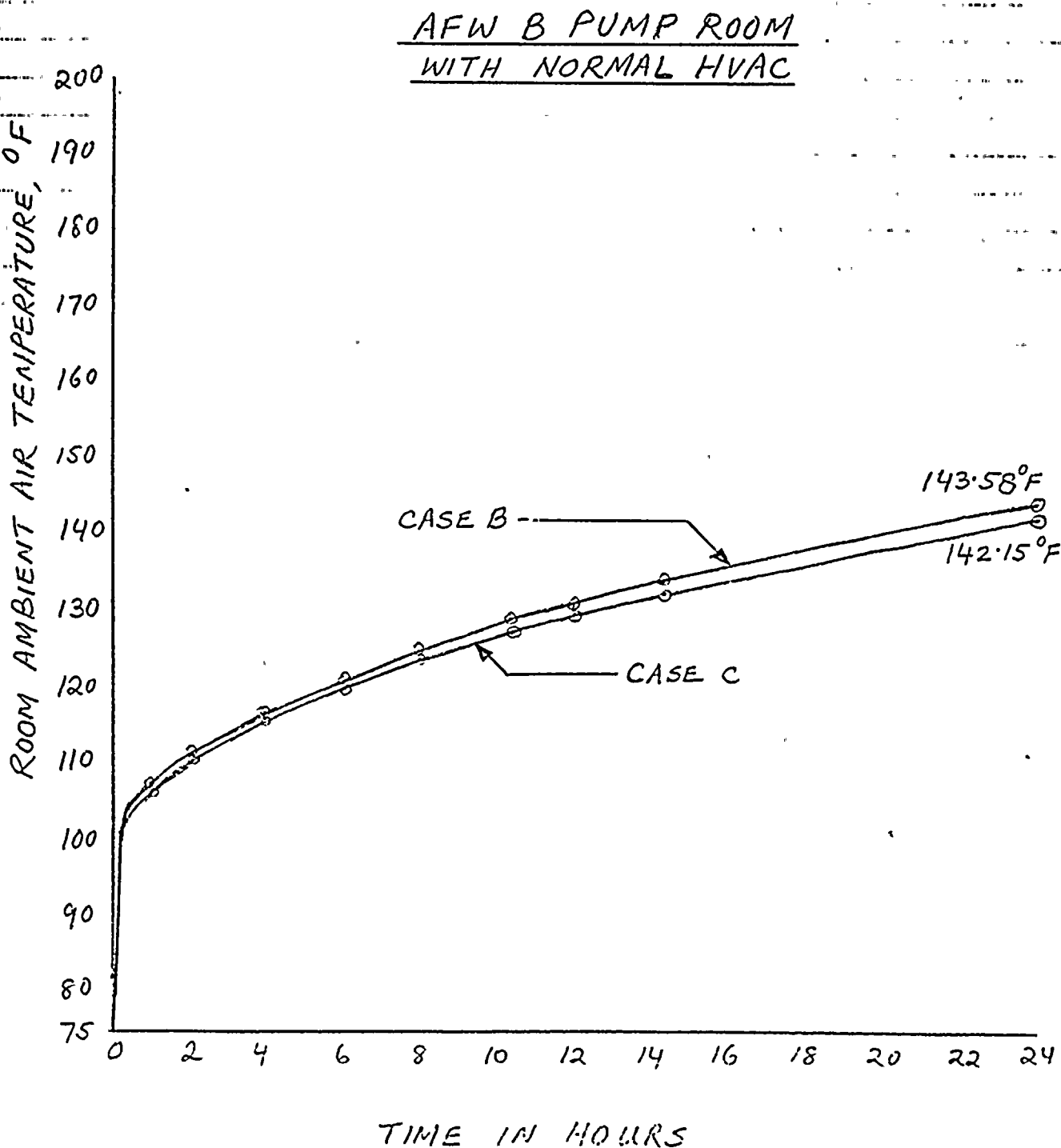
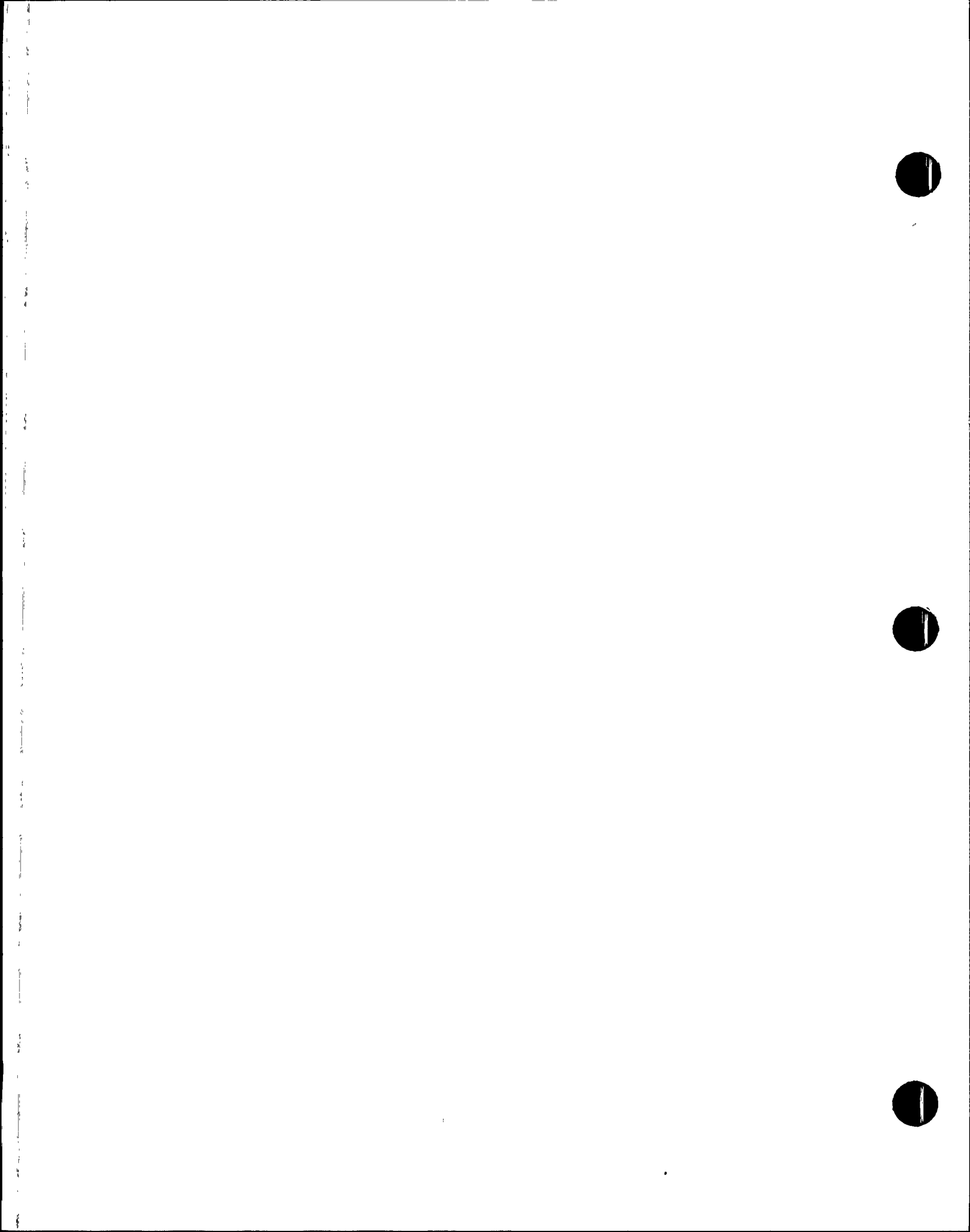


FIGURE 3





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 34

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
10	PSS	4-1-88	G.W.M	4-1-88					

APPENDIX A

- INITIAL INTERNAL ROOM AMBIENT TEMPERATURE, DEG. F=?
>75
INITIAL ADJACENT ROOM AMBIENT TEMPERATURE, DEG. F=?
>75
EQUIPMENT HEAT GENERATED IN THE INTERNAL ROOM, BTU/HR=?
>121893
NET INTERNAL ROOM SURFACE AREA, SQ. FT.=?
>2603
NET INTERNAL ROOM VOLUME, CU.FT.=?
>9681
THICKNESS OF ROOM ENCLOSURE, FT.=?
>3.5
DENSITY OF ROOM ENCLOSURE MATERIAL, LBS/CU.FT.=?
>144
THERMAL CONDUCTIVITY OF ROOM ENCLOSURE MATERIAL, BTU/HR-FT-F=?
>.54
SPECIFIC HEAT OF ROOM ENCLOSURE MATERIAL, BTU/LB-F=?
>.2
ONE PERIOD OF TIME INCREMENT FOR CALCULATION, MIN.=?
>2
IMAGINARY THICKNESS OF FIRST LAYER OF ROOM ENCLOSURE, FT.=?
>.01
MULTIPLICATION FACTOR OF IMAGINARY THICKNESS OF OTHER LAYERS=?
>1.41

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M=NUMBER OF IMAGINARY LAYER= 15

DX1,DX2,DX3,-----DX(M)
1.00000-02 1.41000-02 1.98810-02 2.80322-02 3.95254-02 5.57308-02
7.85805-02 .11080 .15623 .22028 .31059 .43794
.61749 .87066 .53017

2 MIN

1 PERIOD QAT= 2405. OST= 1658. OOT= 0. HCI=1.4538 HCO= .0000
TAF= 88.92
T1,T2,T3,-----T(H+1)
75.779 75.530 75.312 75.152 75.057 75.016
75.003 75.000 75.000 75.000 75.000 75.000
75.000 75.000 75.000 75.000

2 PERIOD QAT= 3749. OST= 4377. OOT= 0. HCI=1.5511 HCO= .0000
TAF= 96.91
T1,T2,T3,-----T(H+1)
76.700 76.251 75.812 75.443 75.192 75.061



CALCULATION SHEET

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 35

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	4-1-88	G.W.M	4-1-88						

75.013 75.002 75.000 75.000 75.000 75.000
75.000 75.000 75.000 75.000

3 PERIOD QAT= 4502. OST= 7687. OOT= 0. HCI=1.5974 HCO= .0000
TAF= 101.44

T1,T2,T3,-----T(H+1)

77.565 76.987 76.379 75.819 75.392 75.140
75.034 75.005 75.000 75.000 75.000 75.000
75.000 75.000 75.000 75.000

6 PERIOD QAT= 5387. OST= 18991. OOT= 0. HCI=1.6441 HCO= .0000
TAF= 106.83

T1,T2,T3,-----T(H+1)

79.603 78.867 78.000 77.071 76.206 75.551
75.179 75.037 75.004 75.000 75.000 75.000
75.000 75.000 75.000 75.000

12 PERIOD QAT= 5899. OST= 42856. OOT= 0. HCI=1.6645 HCO= .0000
TAF= 109.98

T1,T2,T3,-----T(H+1)

82.265 81.471 80.465 79.265 77.956 76.717
75.768 75.237 75.044 75.004 75.000 75.000
75.000 75.000 75.000 75.000

18 PERIOD QAT= 6201. OST= 66931. OOT= 0. HCI=1.6748 HCO= .0000
TAF= 111.85

T1,T2,T3,-----T(H+1)

84.197 83.387 82.335 81.030 79.515 77.937
76.547 75.597 75.148 75.020 75.001 75.000
75.000 75.000 75.000 75.000

24 PERIOD QAT= 6445. OST= 91064. OOT= 0. HCI=1.6831 HCO= .0000
TAF= 113.36

T1,T2,T3,-----T(H+1)

85.795 84.976 83.900 82.534 80.897 79.099
77.382 76.059 75.318 75.055 75.005 75.000
75.000 75.000 75.000 75.000

30 PERIOD QAT= 6656. OST= 115231. OOT= 0. HCI=1.6903 HCO= .0000
TAF= 114.67

T1,T2,T3,-----T(H+1)

87.190 86.365 85.272 83.867 82.146 80.191
78.223 76.579 75.545 75.114 75.012 75.001
75.000 75.000 75.000 75.000

36 PERIOD QAT= 6845. OST= 139419. OOT= 0. HCI=1.6968 HCO= .0000
TAF= 115.84

T1,T2,T3,-----T(H+1)

88.444 87.615 86.510 85.077 83.293 81.220
79.051 77.132 75.816 75.197 75.025 75.002
75.000 75.000 75.000 75.000

42 PERIOD QAT= 7016. OST= 163625. OOT= 0. HCI=1.7027 HCO= .0000
TAF= 116.91

T1,T2,T3,-----T(H+1)

89.593 88.761 87.647 86.191 84.360 82.192
79.859 77.702 76.122 75.303 75.045 75.003
75.000 75.000 75.000 75.000



CALCULATION SHEET

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 36

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDI.
0	PSS	4-1-88	G.W.M	4-1-88						

2 HR

48 PERIOD QAT= 7175. OST= 187843. OOT= 0. HCI=1.7081 HCO= .0000
TAF= 117.90
T1,T2,T3,-----T(H+1)
90.659 89.825 88.703 87.230 85.360 83.115
80.645 78.281 76.453 75.431 75.073 75.006
75.000 75.000 75.000 75.000

60 PERIOD QAT= 7464. OST= 236309. OOT= 0. HCI=1.7182 HCO= .0000
TAF= 119.70
T1,T2,T3,-----T(H+1)
92.602 91.764 90.632 89.131 87.202 84.838
82.150 79.440 77.172 75.744 75.152 75.016
75.001 75.000 75.000 75.000

72 PERIOD QAT= 7722. OST= 284804. OOT= 0. HCI=1.7272 HCO= .0000
TAF= 121.33
T1,T2,T3,-----T(H+1)
94.354 93.514 92.373 90.853 88.880 86.426
83.572 80.584 77.936 76.119 75.266 75.033
75.002 75.000 75.000 75.000

84 PERIOD QAT= 7959. OST= 333321. OOT= 0. HCI=1.7356 HCO= .0000
TAF= 122.82
T1,T2,T3,-----T(H+1)
95.963 95.120 93.974 92.438 90.431 87.907
84.919 81.703 78.726 76.542 75.413 75.060
75.004 75.000 75.000 75.000

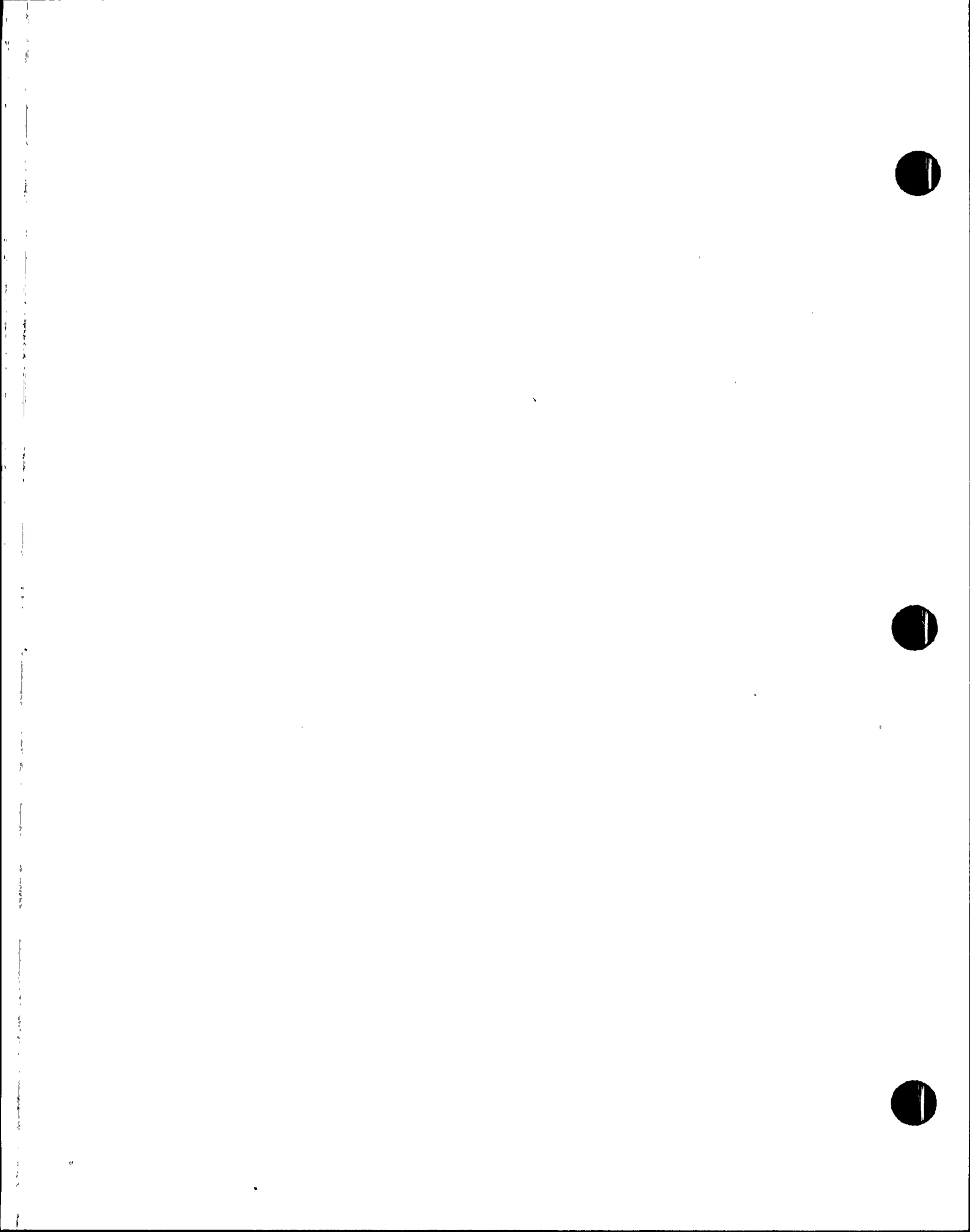
96 PERIOD QAT= 8179. OST= 381856. OOT= 0. HCI=1.7434 HCO= .0000
TAF= 124.20
T1,T2,T3,-----T(H+1)
97.458 96.614 95.462 93.914 91.880 89.299
86.201 82.793 79.527 77.002 75.590 75.098
75.008 75.000 75.000 75.000

108 PERIOD QAT= 8384. OST= 430405. OOT= 0. HCI=1.7508 HCO= .0000
TAF= 125.50
T1,T2,T3,-----T(H+1)
98.861 98.016 96.860 95.301 93.244 90.617
87.426 83.854 80.333 77.490 75.795 75.147
75.013 75.000 75.000 75.000

4 HR

120 PERIOD QAT= 8577. OST= 478965. OOT= 0. HCI=1.7577 HCO= .9447
TAF= 126.72
T1,T2,T3,-----T(H+1)
100.19 99.340 98.181 96.614 94.538 91.870
88.601 84.885 81.137 77.999 76.024 75.208
75.021 75.001 75.000 75.000

132 PERIOD QAT= 8761. OST= 527536. OOT= 0. HCI=1.7644 HCO= .9458
TAF= 127.89
T1,T2,T3,-----T(H+1)
101.45 100.60 99.437 97.863 95.770 93.068
89.730 85.889 81.936 78.524 76.275 75.281
75.032 75.001 75.000 75.000





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 37

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
△	PSS	4-1-88	G.W.M.	4-1-88	△				
△					△				

144 PERIOD QAT= 8936. OST= 576115. OOT= 0. HCI=1.7708 HCO= .9478
TAF= 129.00
T1,T2,T3,-----T(H+1)
102.65 101.80 100.64 99.057 96.950 94.217
90.819 86.866 82.729 79.062 76.545 75.365
75.045 75.002 75.000 75.000

156 PERIOD QAT= 9103. OST= 624701. OOT= 0. HCI=1.7769 HCO= .9495
TAF= 130.07
T1,T2,T3,-----T(H+1)
103.81 102.96 101.79 100.20 98.082 95.322
91.871 87.818 83.514 79.608 76.832 75.462
75.062 75.004 75.000 75.000

168 PERIOD QAT= 9264. OST= 673294. OOT= 0. HCI=1.7829 HCO= .9512
TAF= 131.10
T1,T2,T3,-----T(H+1)
104.92 104.07 102.90 101.30 99.173 96.389
92.890 88.747 84.289 80.161 77.134 75.569
75.082 75.005 75.000 75.000

6 HR 180 PERIOD QAT= 9419. OST= 721894. OOT= 0. HCI=1.7886 HCO= .9529
TAF= 132.08
T1,T2,T3,-----T(H+1)
105.99 105.14 103.96 102.37 100.23 97.421
93.879 89.654 85.055 80.719 77.449 75.687
75.106 75.008 75.000 75.000

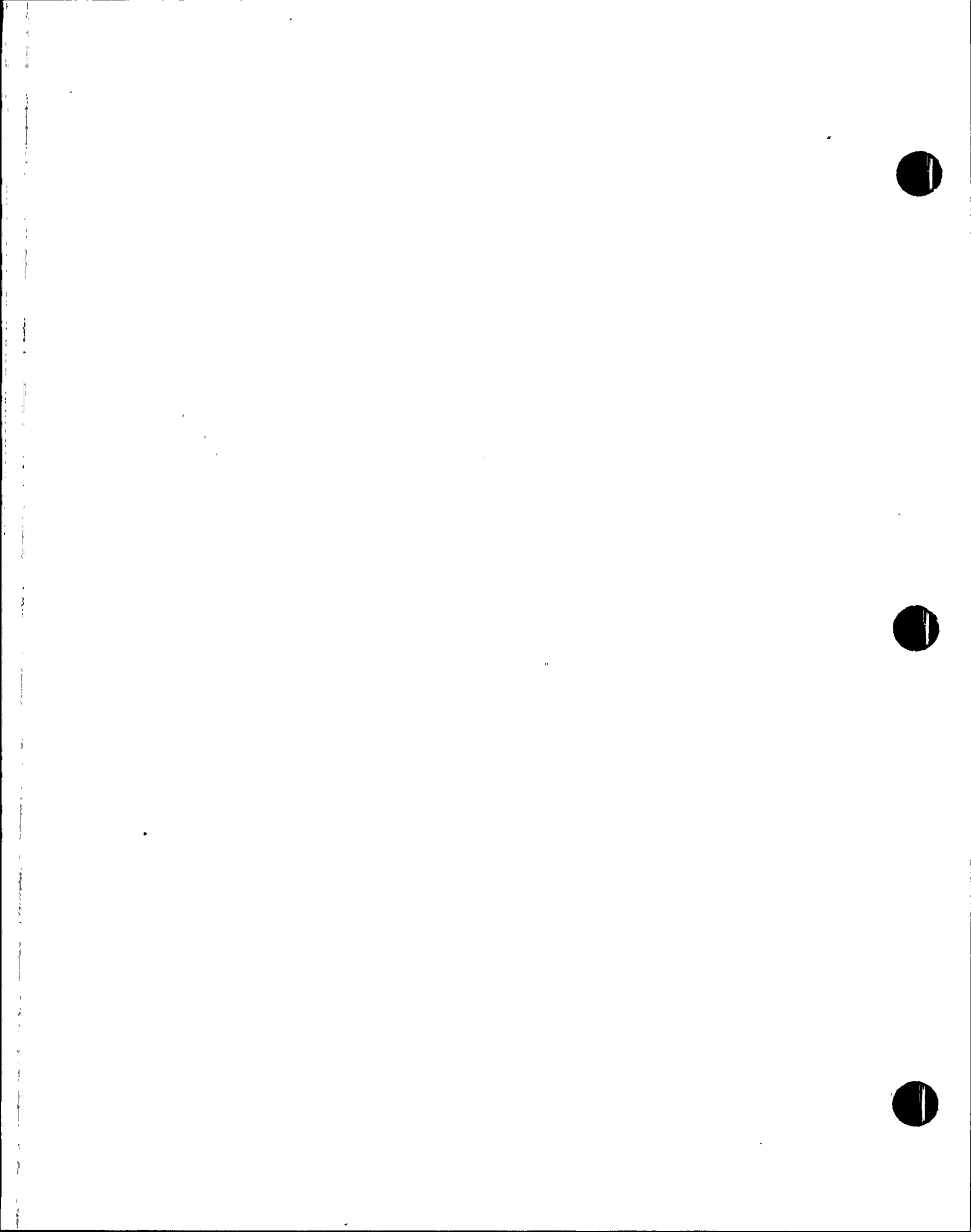
192 PERIOD QAT= 9568. OST= 770498. OOT= 0. HCI=1.7942 HCO= .9546
TAF= 133.04
T1,T2,T3,-----T(H+1)
107.02 106.17 105.00 103.40 101.25 98.422
94.839 90.540 85.811 81.279 77.775 75.816
75.134 75.010 75.000 75.000

204 PERIOD QAT= 9713. OST= 819107. OOT= 1. HCI=1.7996 HCO= .9564
TAF= 133.97
T1,T2,T3,-----T(H+1)
108.02 107.17 106.00 104.39 102.24 99.393
95.775 91.407 86.557 81.841 78.111 75.954
75.166 75.014 75.001 75.000

216 PERIOD QAT= 9853. OST= 867721. OOT= 1. HCI=1.8049 HCO= .9582
TAF= 134.87
T1,T2,T3,-----T(H+1)
109.00 108.15 106.97 105.36 103.20 100.34
96.686 92.255 87.294 82.404 78.455 76.101
75.203 75.018 75.001 75.001

228 PERIOD QAT= 9989. OST= 916339. OOT= 2. HCI=1.8101 HCO= .9600
TAF= 135.74
T1,T2,T3,-----T(H+1)
109.94 109.09 107.92 106.31 104.13 101.26
97.576 93.086 88.020 82.966 78.808 76.257
75.243 75.023 75.001 75.001

8 HR 240 PERIOD QAT= 10121. OST= 964960. OOT= 3. HCI=1.8151 HCO= .9619
TAF= 136.60





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 38

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
10	PSS	4-1-88	G.W.M	4-1-88						

T1,T2,T3,-----T(M+1)

110.87	110.01	108.84	107.22	105.04	102.15
98.445	93.901	88.737	83.527	79.166	76.421
75.288	75.029	75.002	75.001		

264 PERIOD QAT= 10376. QST= 1062211. QOT= 5. HCI=1.8249 HCO= .9657

TAF= 138.24

T1,T2,T3,-----T(M+1)

112.64	111.79	110.61	108.99	106.80	103.89
100.13	95.484	90.142	84.646	79.901	76.771
75.389	75.043	75.003	75.002		

288 PERIOD QAT= 10618. QST= 1159470. QOT= 9. HCI=1.8343 HCO= .9697

TAF= 139.81

T1,T2,T3,-----T(M+1)

114.34	113.49	112.31	110.68	108.48	105.55
101.74	97.012	91.511	85.755	80.652	77.149
75.508	75.061	75.005	75.003		

312 PERIOD QAT= 10850. QST= 1256738. QOT= 16. HCI=1.8433 HCO= .9738

TAF= 141.31

T1,T2,T3,-----T(M+1)

115.97	115.12	113.93	112.30	110.09	107.14
103.30	98.489	92.847	86.854	81.417	77.550
75.643	75.084	75.008	75.004		

336 PERIOD QAT= 11073. QST= 1354012. QOT= 26. HCI=1.8521 HCO= .9779

TAF= 142.76

T1,T2,T3,-----T(M+1)

117.54	116.68	115.50	113.87	111.65	108.68
104.80	99.920	94.150	87.940	82.191	77.973
75.793	75.112	75.011	75.006		

12 HR 360 PERIOD QAT= 11288. QST= 1451290. QOT= 40. HCI=1.8606 HCO= .9822

TAF= 144.16

T1,T2,T3,-----T(M+1)

119.05	118.19	117.01	115.37	113.15	110.16
106.25	101.31	95.423	89.014	82.972	78.413
75.959	75.145	75.016	75.008		

432 PERIOD QAT= 11889. QST= 1743131. QOT= 119. HCI=1.8848 HCO= .9951

TAF= 148.10

T1,T2,T3,-----T(M+1)

123.30	122.44	121.25	119.61	117.37	114.34
110.35	105.26	99.076	92.155	85.334	79.824
76.540	75.276	75.036	75.018		

504 PERIOD QAT= 12438. QST= 2034935. QOT= 285. HCI=1.9073 HCO=1.0082

TAF= 151.72

T1,T2,T3,-----T(M+1)

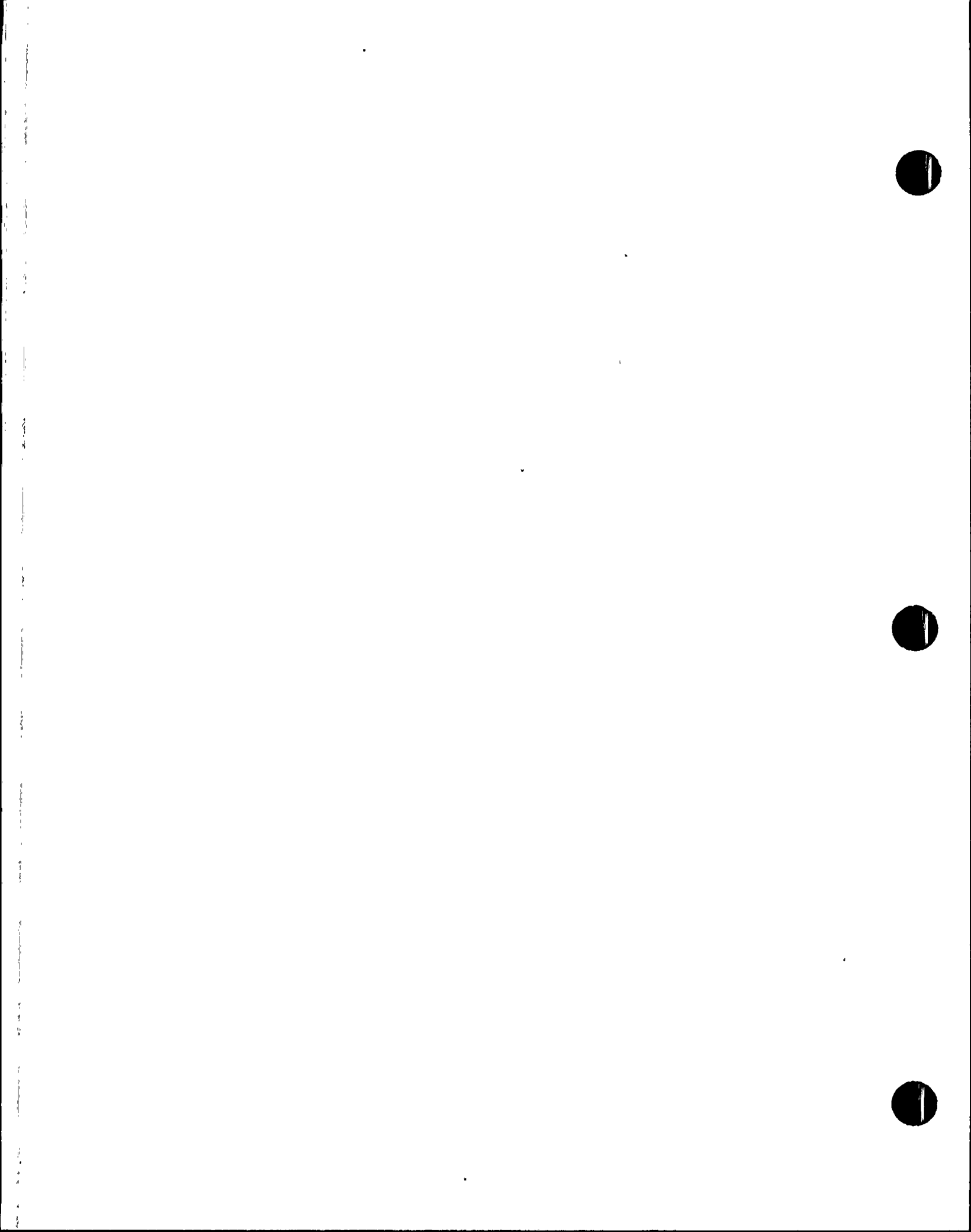
127.21	126.35	125.16	123.51	121.25	118.20
114.15	108.93	102.51	95.175	87.697	81.333
77.231	75.458	75.071	75.036		

576 PERIOD QAT= 12947. QST= 2326636. QOT= 590. HCI=1.9286 HCO=1.0213

TAF= 155.09

T1,T2,T3,-----T(M+1)

130.85	129.99	128.79	127.14	124.87	121.79
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CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 39

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	4-1-88	G.W.M	4-1-88					

REV.
INDICATOR

117.69 112.37 105.77 98.081 90.039 82.908
78.013 75.692 75.123 75.061

648 PERIOD QAT= 13423. OST= 2618169. OOT= 1094. HCI=1.9488 HCO=1.0342

TAF= 158.25

T1, T2, T3, -----T(H+1)

134.26 133.40 132.21 130.55 128.27 125.17
121.03 115.63 108.86 100.88 92.349 84.526
78.870 75.978 75.194 75.096

24 HR 720 PERIOD QAT= 13871. OST= 2909462. OOT= 1863. HCI=1.9682 HCO=1.0468

TAF= 161.25

T1, T2, T3, -----T(H+1)

137.49 136.63 135.44 133.78 131.49 128.37
124.20 118.73 111.82 103.58 94.621 86.170
79.789 76.312 75.287 75.141





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 40

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDIC.
0	PSS	4-1-88	G.W.M	4-1-88	1					
1					2					

APPENDIX B

- INITIAL INTERNAL ROOM AMBIENT TEMPERATURE, DEG. F=?
>75
INITIAL ADJACENT ROOM AMBIENT TEMPERATURE, DEG. F=?
>75
EQUIPMENT HEAT GENERATED IN THE INTERNAL ROOM, BTU/KR=?
>94949
NET INTERNAL ROOM SURFACE AREA, SQ. FT.=?
>2603
NET INTERNAL ROOM VOLUME, CU.FT.=?
>9681
THICKNESS OF ROOM ENCLOSURE, FT.=?
>345
DENSITY OF ROOM ENCLOSURE MATERIAL, LBS/CU.FT.=?
>144
THERMAL CONDUCTIVITY OF ROOM ENCLOSURE MATERIAL, BTU/KR-FT-F=?
>.54
SPECIFIC HEAT OF ROOM ENCLOSURE MATERIAL, BTU/LB-F=?
>.2
ONE PERIOD OF TIME INCREMENT FOR CALCULATION, MIN.=?
>2
IMAGINARY THICKNESS OF FIRST LAYER OF ROOM ENCLOSURE, FT.=?
>.01
MULTIPLICATION FACTOR OF IMAGINARY THICKNESS OF OTHER LAYERS=?
>1.41

.....
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.....

N=NUMBER OF IMAGINARY LAYER= 19

DX1,DX2,DX3,.....DX(N)
1.00000-02 1.41000-02 1.96810-02 2.80322-02 3.95254-02 5.57308-02
7.85805-02 .11080 .15623 .22028 .31059 .43794
.61749 .87066 1.2276 1.7310 2.4407 3.4413
2.1896

2 MIN

1 PERIOD QAT= 1896. OST= 1269. OOT= 0. NCI=1.4095 NCO= .0000
TAF= 85.98
T1,T2,T3,.....T(N+1)
75.596 75.405 75.239 75.116 75.044 75.012
75.002 75.000 75.000 75.000 75.000 75.000
75.000 75.000 75.000 75.000 75.000 75.000
75.000 75.000





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 41

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
△	PSS	4-1-88	G. W M	4-1-88	△				
△					△				

REV.
INDI-
4

2 PERIOD QAT= 2975. QST= 3353. QOT= 0. HCI=1.4971 HCO= .0000

TAF= 92.35

11,12,13,-----T(M+1)

76.303	75.959	75.622	75.340	75.147	75.047
75.010	75.001	75.000	75.000	75.000	75.000
75.000	75.000	75.000	75.000	75.000	75.000
75.000	75.000				

3 PERIOD QAT= 3593. QST= 5899. QOT= 0. HCI=1.5391 HCO= .0000

TAF= 96.05

11,12,13,-----T(M+1)

76.971	76.526	76.059	75.629	75.301	75.107
75.026	75.004	75.000	75.000	75.000	75.000
75.000	75.000	75.000	75.000	75.000	75.000
75.000	75.000				

6 PERIOD QAT= 4335. QST= 14649. QOT= 0. HCI=1.5817 HCO= .0000

TAF= 100.52

11,12,13,-----T(M+1)

78.558	77.988	77.317	76.598	75.930	75.424
75.138	75.028	75.003	75.000	75.000	75.000
75.000	75.000	75.000	75.000	75.000	75.000
75.000	75.000				

12 PERIOD QAT= 4759. QST= 33210. QOT= 0. HCI=1.5991 HCO= .0000

TAF= 103.10

11,12,13,-----T(M+1)

80.641	80.023	79.241	78.308	77.291	76.329
75.594	75.183	75.034	75.003	75.000	75.000
75.000	75.000	75.000	75.000	75.000	75.000
75.000	75.000				

18 PERIOD QAT= 5003. QST= 51951. QOT= 0. HCI=1.6073 HCO= .0000

TAF= 104.58

11,12,13,-----T(M+1)

82.150	81.519	80.700	79.684	78.506	77.279
76.200	75.462	75.114	75.016	75.001	75.000
75.000	75.000	75.000	75.000	75.000	75.000
75.000	75.000				

24 PERIOD QAT= 5199. QST= 70741. QOT= 0. HCI=1.6138 HCO= .0000

TAF= 105.78

11,12,13,-----T(M+1)

83.396	82.759	81.920	80.858	79.583	78.184
76.849	75.821	75.246	75.043	75.004	75.000
75.000	75.000	75.000	75.000	75.000	75.000
75.000	75.000				

1 HR 30 PERIOD QAT= 5368. QST= 89556. QOT= 0. HCI=1.6194 HCO= .0000

TAF= 106.82

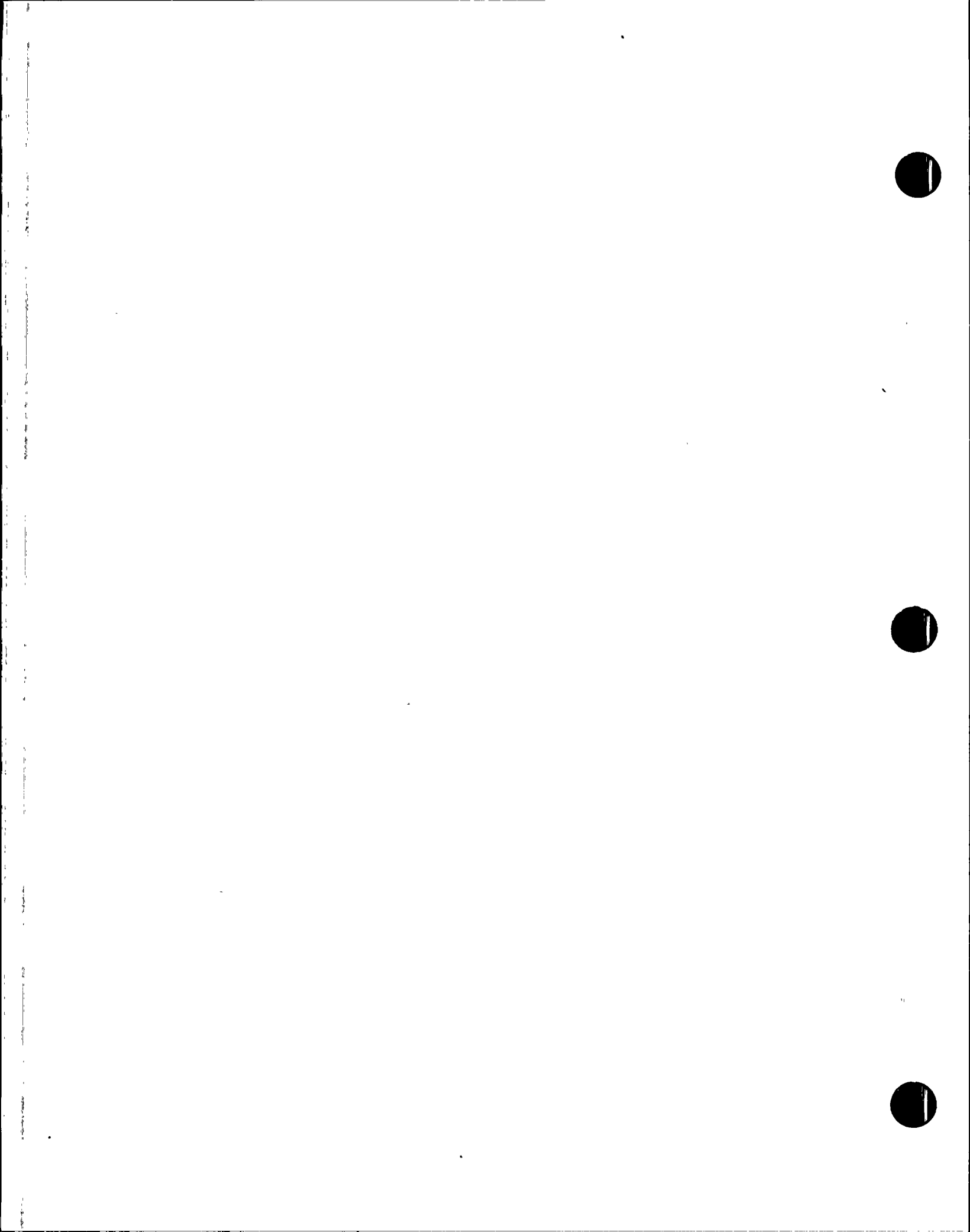
11,12,13,-----T(M+1)

84.484	83.842	82.991	81.897	80.557	79.036
77.504	76.226	75.423	75.088	75.010	75.000
75.000	75.000	75.000	75.000	75.000	75.000
75.000	75.000				

36 PERIOD QAT= 5519. QST= 108390. QOT= 0. HCI=1.6244 HCO= .0000

TAF= 107.75

11,12,13,-----T(M+1)





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 42

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
1	PSS		G.W.M	4-1-88	1				
2					2				

REV.
INDI-
CATOR

85.461 84.816 83.956 82.839 81.451 79.837
78.149 76.657 75.634 75.153 75.020 75.001
75.000 75.000 75.000 75.000 75.000 75.000
75.000 75.000

42 PERIOD GAT= 5657. OST= 127236. OOT= 0. HCI=1.6290 HCO= .0000

IAF= 108.59

11,12,13,-----I(M+1)

86.357 85.709 84.841 83.708 82.282 80.594
78.779 77.101 75.871 75.235 75.035 75.002
75.000 75.000 75.000 75.000 75.000 75.000
75.000 75.000

48 PERIOD GAT= 5785. OST= 146094. OOT= 0. HCI=1.6332 HCO= .0000

IAF= 109.38

11,12,13,-----I(M+1)

87.188 86.538 85.665 84.517 83.061 81.313
79.391 77.551 76.130 75.335 75.056 75.005
75.000 75.000 75.000 75.000 75.000 75.000
75.000 75.000

2HR 60 PERIOD GAT= 6016. OST= 183833. OOT= 0. HCI=1.6410 HCO= .0000

IAF= 110.80

11,12,13,-----I(M+1)

88.702 88.050 87.168 85.999 84.497 82.656
80.564 78.454 76.689 75.578 75.118 75.012
75.001 75.000 75.000 75.000 75.000 75.000
75.000 75.000

72 PERIOD GAT= 6224. OST= 221593. OOT= 0. HCI=1.6479 HCO= .0000

IAF= 112.09

11,12,13,-----I(M+1)

90.068 89.413 88.525 87.341 85.804 83.894
81.671 79.345 77.284 75.870 75.207 75.026
75.002 75.000 75.000 75.000 75.000 75.000
75.000 75.000

84 PERIOD GAT= 6414. OST= 259372. OOT= 0. HCI=1.6544 HCO= .0000

IAF= 113.26

11,12,13,-----I(M+1)

91.321 90.665 89.772 88.575 87.013 85.047
82.721 80.216 77.899 76.199 75.321 75.047
75.003 75.000 75.000 75.000 75.000 75.000
75.000 75.000

96 PERIOD GAT= 6590. OST= 297166. OOT= 0. HCI=1.6604 HCO= .0000

IAF= 114.36

11,12,13,-----I(M+1)

92.486 91.829 90.931 89.726 88.141 86.132
83.719 81.046 78.523 76.557 75.459 75.076
75.006 75.000 75.000 75.000 75.000 75.000
75.000 75.000

108 PERIOD GAT= 6755. OST= 334971. OOT= 0. HCI=1.6660 HCO= .0000

IAF= 115.38

11,12,13,-----I(M+1)

93.579 92.921 92.020 90.806 89.205 87.158
84.674 81.892 79.150 76.937 75.618 75.114
75.010 75.000 75.000 75.000 75.000 75.000



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 43

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
1	PSS	4-1-88	G. W. M	4-1-88						

4HR 120 PERIOD QAT= 6911. OST= 372786. OOT= 0. HCI=1.6713 HCO= .0000
IAF= 116.35

11,12,13,-----T(M+1)

94.612	93.953	93.050	91.829	90.212	88.134
85.589	82.695	79.777	77.334	75.797	75.162
75.017	75.001	75.000	75.000	75.000	75.000
75.000	75.000				

132 PERIOD QAT= 7058. OST= 410608. OOT= 0. HCI=1.6764 HCO= .0000
IAF= 117.27

11,12,13,-----T(M+1)

95.594	94.934	94.029	92.802	91.172	89.068
86.468	83.477	80.399	77.743	75.992	75.218
75.025	75.001	75.000	75.000	75.000	75.000
75.000	75.000				

144 PERIOD QAT= 7199. OST= 448437. OOT= 0. HCI=1.6813 HCO= .0000
IAF= 118.15

11,12,13,-----T(M+1)

96.532	95.871	94.964	93.732	92.091	89.963
87.316	84.238	81.017	78.162	76.202	75.284
75.035	75.002	75.000	75.000	75.000	75.000
75.000	75.000				

156 PERIOD QAT= 7333. OST= 486273. OOT= 0. HCI=1.6860 HCO= .0000
IAF= 118.99

11,12,13,-----T(M+1)

97.431	96.769	95.860	94.625	92.974	90.824
88.136	84.980	81.628	78.587	76.426	75.359
75.048	75.003	75.000	75.000	75.000	75.000
75.000	75.000				

168 PERIOD QAT= 7463. OST= 524114. OOT= 0. HCI=1.6905 HCO= .0000
IAF= 119.80

11,12,13,-----T(M+1)

98.295	97.634	96.723	95.483	93.823	91.655
88.930	85.704	82.232	79.018	76.661	75.443
75.064	75.004	75.000	75.000	75.000	75.000
75.000	75.000				

5HR 180 PERIOD QAT= 7587. OST= 561959. OOT= 0. HCI=1.6949 HCO= .0000
IAF= 120.58

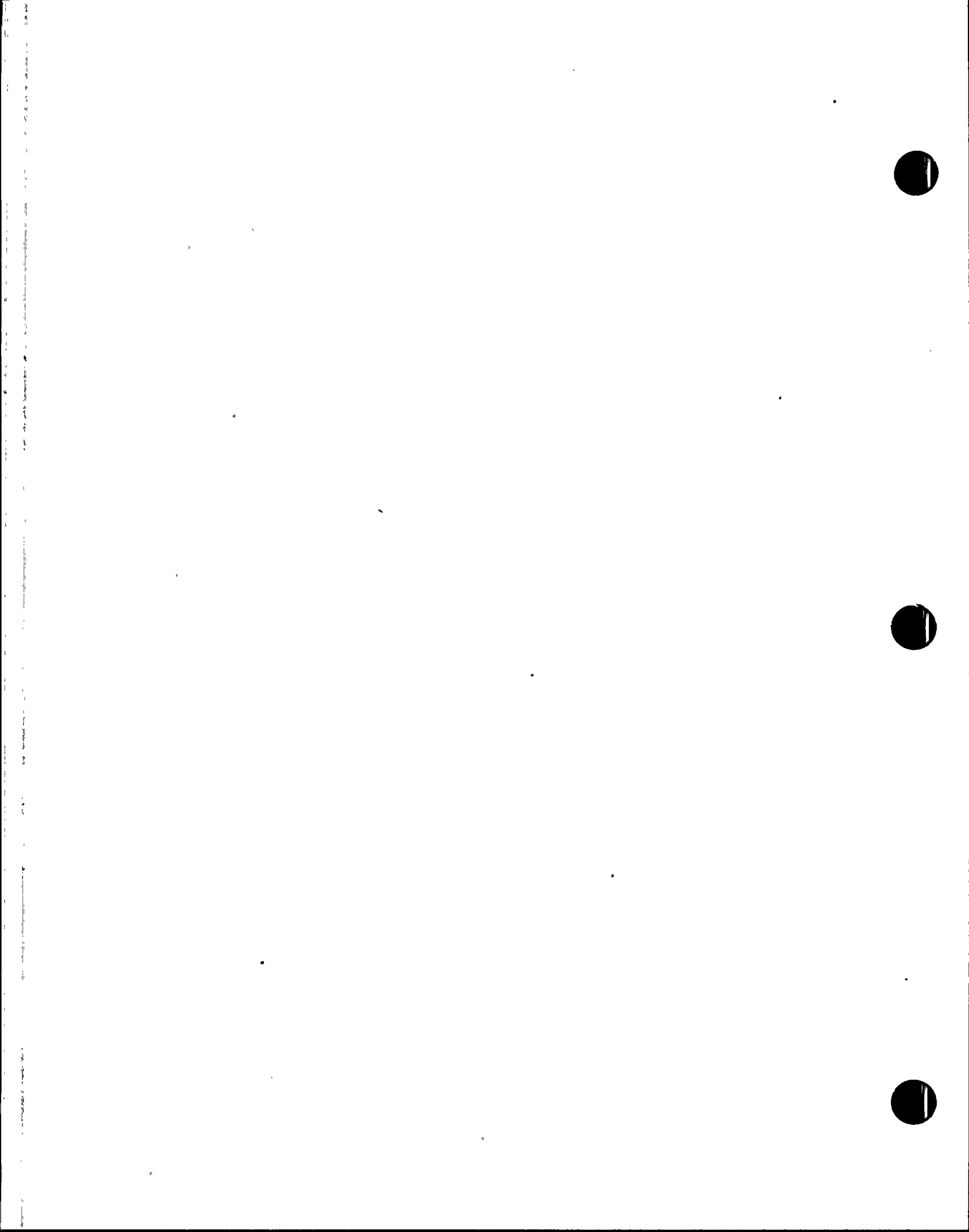
11,12,13,-----T(M+1)

99.130	98.467	97.555	96.312	94.644	92.459
89.700	86.410	82.829	79.452	76.906	75.535
75.083	75.006	75.000	75.000	75.000	75.000
75.000	75.000				

192 PERIOD QAT= 7707. OST= 599808. OOT= 0. HCI=1.6992 HCO= .0000
IAF= 121.34

11,12,13,-----T(M+1)

99.936	99.273	98.360	97.113	95.438	93.238
90.449	87.100	83.417	79.888	77.160	75.635
75.105	75.008	75.000	75.000	75.000	75.000
75.000	75.000				





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 44

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
10	PSS		G.W.M	4-1-88					

REV.
INDI-
CATED

204 PERIOD QAT= 7824. OSI= 637661. OOT= 0. HCI=1.7033 HCO= .0000
IAF= 122.07
11,12,13,-----I(M+1)
100.72 100.05 99.140 97.890 96.209 93.995
91.177 87.775 83.999 80.326 77.421 75.742
75.129 75.011 75.000 75.000 75.000 75.000
75.000 75.000

216 PERIOD QAT= 7937. OSI= 675517. OOT= 0. HCI=1.7073 HCO= .0000
IAF= 122.78
11,12,13,-----I(M+1)
101.48 100.81 99.897 98.645 96.958 94.731
91.887 88.436 84.572 80.764 77.690 75.857
75.158 75.014 75.001 75.000 75.000 75.000
75.000 75.000

228 PERIOD QAT= 8046. OSI= 713376. OOT= 0. HCI=1.7112 HCO= .0000
IAF= 123.47
11,12,13,-----I(M+1)
102.21 101.55 100.63 99.379 97.686 95.448
92.580 89.083 85.138 81.202 77.964 75.978
75.189 75.018 75.001 75.000 75.000 75.000
75.000 75.000

240 PERIOD QAT= 8153. OSI= 751237. OOT= 0. HCI=1.7150 HCO= .0000
IAF= 124.14
11,12,13,-----I(M+1)
102.93 102.27 101.35 100.09 98.396 96.147
93.257 89.718 85.696 81.639 78.244 76.106
75.224 75.022 75.001 75.000 75.000 75.000
75.000 75.000

264 PERIOD QAT= 8358. OSI= 826971. OOT= 0. HCI=1.7224 HCO= .0000
IAF= 125.44
11,12,13,-----I(M+1)
104.32 103.65 102.73 101.47 99.765 97.496
94.567 90.951 86.791 82.510 78.815 76.379
75.303 75.034 75.002 75.000 75.000 74.999
75.000 75.000

288 PERIOD QAT= 8553. OSI= 902715. OOT= 0. HCI=1.7295 HCO= .0000
IAF= 126.68
11,12,13,-----I(M+1)
105.64 104.97 104.05 102.79 101.07 98.789
95.825 92.141 87.858 83.375 79.401 76.673
75.395 75.048 75.003 75.000 75.000 74.999
75.000 75.000

312 PERIOD QAT= 8740. OSI= 978466. OOT= 0. HCI=1.7364 HCO= .0000
IAF= 127.86
11,12,13,-----I(M+1)
106.91 106.24 105.32 104.05 102.33 100.03
97.036 93.292 88.898 84.230 79.996 76.986
75.500 75.067 75.004 75.000 75.000 74.999
75.000 75.000

336 PERIOD QAT= 8920. OSI= 1054223. OOT= 0. HCI=1.7430 HCO= .0000
IAF= 129.01
11,12,13,-----I(M+1)





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 45

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
1	PSS	4-1-88	G. W. M	4-1-88	1					
2					2					

108.13 107.46 106.54 105.27 103.54 101.23
98.205 94.407 89.913 85.077 80.599 77.315
75.617 75.089 75.006 75.000 75.000 74.999
75.000 75.000

12 HR 360 PERIOD QAT= 9093. GST= 1129985. QOT= 0. HCI=1.7494 HCO= .0000
TAF= 130.11

T1, T2, T3, T(M+1)

109.30 108.64 107.71 106.44 104.71 102.38
99.336 95.489 90.904 85.913 81.207 77.658
75.745 75.115 75.008 75.000 75.000 74.999
75.000 75.000

432 PERIOD QAT= 9578. GST= 1357333. QOT= 0. HCI=1.7675 HCO= .0000
TAF= 133.21

T1, T2, T3, T(M+1)

112.62 111.95 111.02 109.74 108.00 105.64
102.53 98.565 93.750 88.360 83.047 78.756
76.197 75.220 75.020 75.000 75.000 74.999
75.000 75.000

504 PERIOD QAT= 10022. GST= 1584729. QOT= 0. HCI=1.7844 HCO= .0000
TAF= 136.07

T1, T2, T3, T(M+1)

115.66 114.99 114.07 112.78 111.02 108.64
105.49 101.42 96.427 90.712 84.888 79.932
76.734 75.366 75.039 75.001 75.000 74.999
75.000 75.000

576 PERIOD QAT= 10434. GST= 1812156. QOT= 0. HCI=1.8003 HCO= .0000
TAF= 138.72

T1, T2, T3, T(M+1)

118.50 117.83 116.90 115.61 113.84 111.44
108.25 104.11 98.961 92.976 86.712 81.158
77.343 75.553 75.068 75.003 75.000 74.999
75.000 75.000

648 PERIOD QAT= 10819. GST= 2039602. QOT= 0. HCI=1.8154 HCO= .0000
TAF= 141.22

T1, T2, T3, T(M+1)

121.16 120.49 119.56 118.27 116.49 114.08
110.85 106.64 101.37 95.157 88.511 82.417
78.010 75.781 75.108 75.006 75.000 74.999
75.000 75.000

24 HR 720 PERIOD QAT= 11182. GST= 2267060. QOT= 0. HCI=1.8298 HCO= .0000
TAF= 143.58

T1, T2, T3, T(M+1)

123.67 123.00 122.07 120.78 119.00 116.57
113.32 109.06 103.68 97.262 90.281 83.697
78.727 76.046 75.161 75.011 75.000 74.999
75.000 75.000





CALCULATION SHEET

PROJECT ANPP

JOB NO. 18601-183

CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM

SHEET NO. 46

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	4-1-88	G.W.M	4-1-88					

REV.
INDI.

APPENDIX C.

- INITIAL INTERNAL ROOM AMBIENT TEMPERATURE, DEG. F=?
- >75 INITIAL ADJACENT ROOM AMBIENT TEMPERATURE, DEG. F=?
- >75 EQUIPMENT HEAT GENERATED IN THE INTERNAL ROOM, BTU/HR=?
- >92811 NET INTERNAL ROOM SURFACE AREA, SQ. FT.=?
- >2603 NET INTERNAL ROOM VOLUME, CU.FT.=?
- >9681 THICKNESS OF ROOM ENCLOSURE, FT.=?
- >3.5 DENSITY OF ROOM ENCLOSURE MATERIAL, LBS/CU.FT.=?
- >144 THERMAL CONDUCTIVITY OF ROOM ENCLOSURE MATERIAL, BTU/HR-FT-F=?
- >.54 SPECIFIC HEAT OF ROOM ENCLOSURE MATERIAL, BTU/LB-F=?
- >.2 ONE PERIOD OF TIME INCREMENT FOR CALCULATION, MIN.=?
- >2 IMAGINARY THICKNESS OF FIRST LAYER OF ROOM ENCLOSURE, FT.=?
- >.01 MULTIPLICATION FACTOR OF IMAGINARY THICKNESS OF OTHER LAYERS=?
- >1.41

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NUMBER OF IMAGINARY LAYER= 15

DX1,DX2,DX3,-----DX(M)
1.00000-02 1.41000-02 1.98810-02 2.80322-02 3.95254-02 5.57308-02
7.85805-02 .11080 .15623 .22028 .31059 .43794
.61749 .87066 .53017

1 PERIOD QAT= 1855. QST= 1239. QOT= 0. MCI=1.4057 MCO= .0000
TAF= 85.74

T1,T2,T3,-----T(M+1)
75.582 75.396 75.233 75.113 75.043 75.012
75.002 75.000 75.000 75.000 75.000 75.000
75.000 75.000 75.000 75.000

2 PERIOD QAT= 2913. QST= 3274. QOT= 0. MCI=1.4925 MCO= .0000
TAF= 91.99

T1,T2,T3,-----T(M+1)
76.272 75.936 75.607 75.332 75.143 75.045



CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 47

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
1	PSS	4-1-88	G.W.M	4-1-88	1				
2					2				

REV.
INDI-
CATED

75.010 75.001 75.000 75.000 75.000 75.000
75.000 75.000 75.000 75.000

3 PERIOD QAT= 3520. OST= 5761. OOT= 0. HCI=1.5339 HCO= .0000
TAF= 95.61

11,12,13,-----T(M+1)

76.924 76.490 76.033 75.614 75.294 75.105
75.025 75.004 75.000 75.000 75.000 75.000
75.000 75.000 75.000 75.000

6 PERIOD QAT= 4250. OST= 14311. OOT= 0. HCI=1.5763 HCO= .0000
TAF= 100.01

11,12,13,-----T(M+1)

78.476 77.918 77.263 76.561 75.908 75.414
75.135 75.028 75.003 75.000 75.000 75.000
75.000 75.000 75.000 75.000

12 PERIOD QAT= 4666. OST= 32456. OOT= 0. HCI=1.5935 HCO= .0000
TAF= 102.54

11,12,13,-----T(M+1)

80.513 79.908 79.144 78.232 77.238 76.298
75.580 75.179 75.033 75.003 75.000 75.000
75.000 75.000 75.000 75.000

18 PERIOD QAT= 4905. OST= 50778. OOT= 0. HCI=1.6015 HCO= .0000
TAF= 103.99

11,12,13,-----T(M+1)

81.988 81.371 80.571 79.578 78.426 77.227
76.172 75.452 75.112 75.015 75.001 75.000
75.000 75.000 75.000 75.000

24 PERIOD QAT= 5097. OST= 69147. OOT= 0. HCI=1.6079 HCO= .0000
TAF= 105.17

11,12,13,-----T(M+1)

83.206 82.583 81.764 80.725 79.479 78.112
76.807 75.803 75.241 75.042 75.004 75.000
75.000 75.000 75.000 75.000

30 PERIOD QAT= 5263. OST= 87542. OOT= 0. HCI=1.6134 HCO= .0000
TAF= 106.18

11,12,13,-----T(M+1)

84.269 83.642 82.810 81.741 80.431 78.944
77.447 76.198 75.413 75.086 75.009 75.000
75.000 75.000 75.000 75.000

36 PERIOD QAT= 5411. OST= 105955. OOT= 0. HCI=1.6183 HCO= .0000
TAF= 107.09

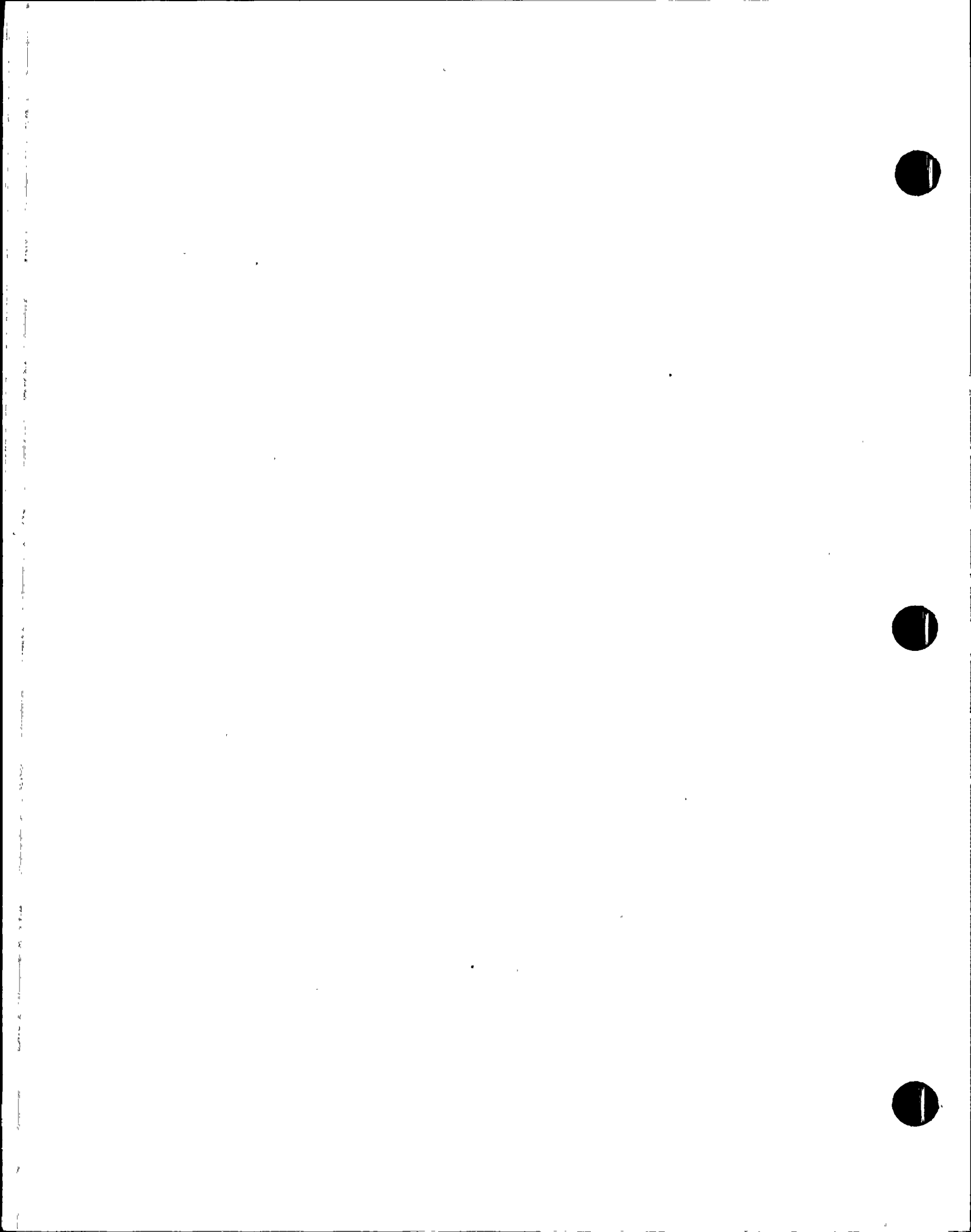
11,12,13,-----T(M+1)

85.225 84.594 83.753 82.662 81.305 79.727
78.078 76.619 75.619 75.149 75.019 75.001
75.000 75.000 75.000 75.000

42 PERIOD QAT= 5546. OST= 124380. OOT= 0. HCI=1.6228 HCO= .0000
TAF= 107.92

11,12,13,-----T(M+1)

86.100 85.467 84.619 83.511 82.117 80.468
78.693 77.053 75.852 75.230 75.034 75.002
75.000 75.000 75.000 75.000





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 48

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDIC.
1	PSS	4-1-88	4-1-88	4-1-88	1					
2					2					

48 PERIOD QAT= 5671. QST= 142816. QOT= 0. HCl=1.6269 HCO= .0000
TAF= 108.69

11,12,13,-----T(M+1)

86.913	86.278	85.424	84.302	82.879	81.171
79.292	77.493	76.104	75.327	75.055	75.005
75.000	75.000	75.000	75.000		

2HR 60 PERIOD QAT= 5898. QST= 179711. QOT= 0. HCl=1.6345 HCO= .0000
TAF= 110.08

11,12,13,-----T(M+1)

88.393	87.755	86.893	85.751	84.282	82.483
80.438	78.375	76.650	75.565	75.116	75.012
75.001	75.000	75.000	75.000		

72 PERIOD QAT= 6102. QST= 216629. QOT= 0. HCl=1.6413 HCO= .0000
TAF= 111.34

11,12,13,-----T(M+1)

89.728	89.088	88.220	87.062	85.560	83.693
81.520	79.247	77.232	75.850	75.202	75.025
75.001	75.000	75.000	75.000		

84 PERIOD QAT= 6288. QST= 253564. QOT= 0. HCl=1.6476 HCO= .0000
TAF= 112.49

11,12,13,-----T(M+1)

90.953	90.311	89.438	88.269	86.741	84.821
82.546	80.099	77.833	76.172	75.314	75.046
75.003	75.000	75.000	75.000		

96 PERIOD QAT= 6460. QST= 290513. QOT= 0. HCl=1.6534 HCO= .0000
TAF= 113.56

11,12,13,-----T(M+1)

92.092	91.449	90.572	89.393	87.845	85.881
83.523	80.929	78.443	76.522	75.449	75.074
75.006	75.000	75.000	75.000		

108 PERIOD QAT= 6622. QST= 327472. QOT= 0. HCl=1.6589 HCO= .0000
TAF= 114.56

11,12,13,-----T(M+1)

93.160	92.516	91.636	90.450	88.884	86.884
84.455	81.736	79.057	76.894	75.604	75.112
75.010	75.000	75.000	75.000		

4HR 120 PERIOD QAT= 6775. QST= 364441. QOT= 0. HCl=1.6641 HCO= .0000
TAF= 115.51

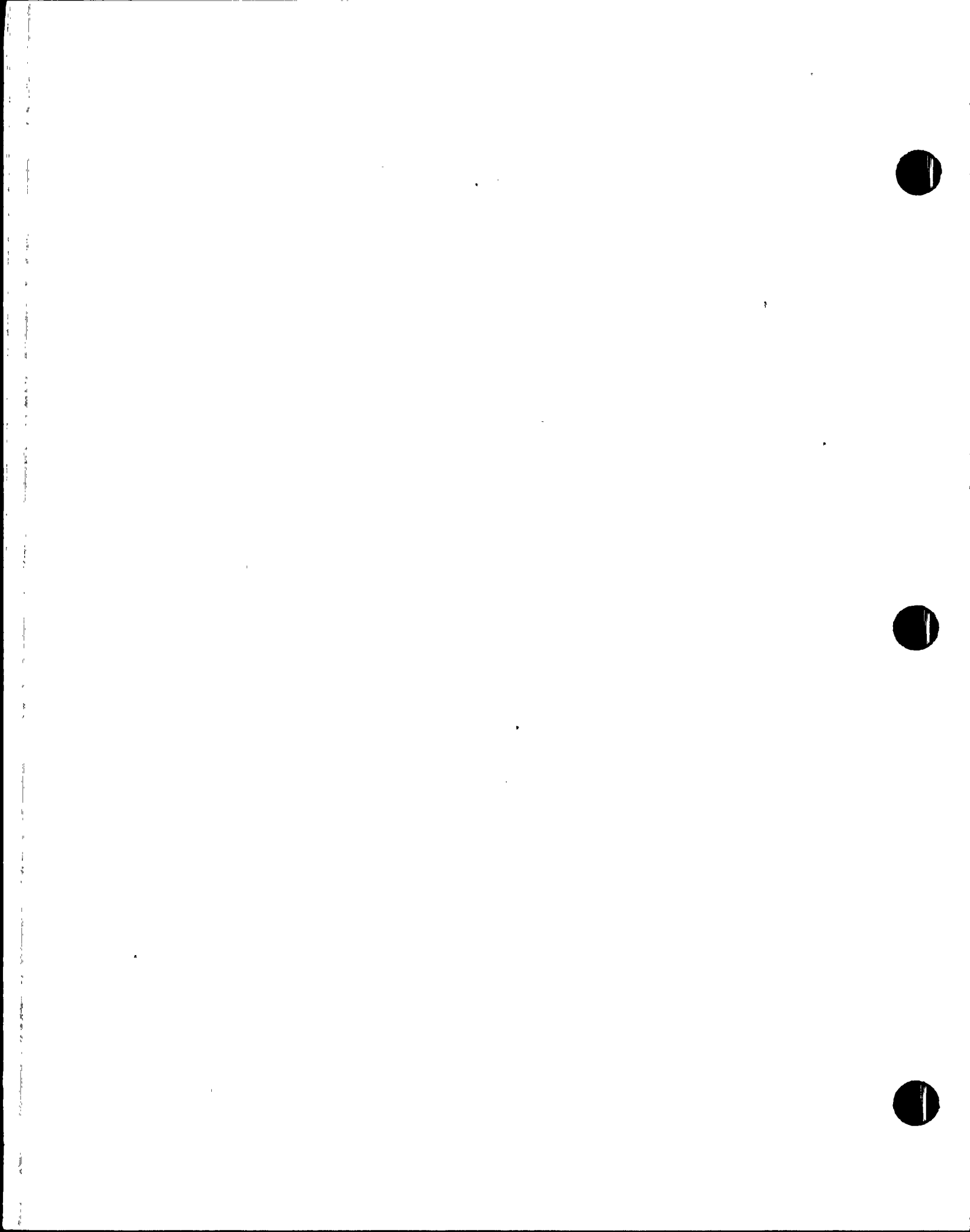
11,12,13,-----T(M+1)

94.170	93.525	92.643	91.450	89.869	87.838
85.350	82.522	79.669	77.281	75.779	75.158
75.016	75.001	75.000	75.000		

132 PERIOD QAT= 6919. QST= 401418. QOT= 0. HCl=1.6691 HCO= .9456
TAF= 116.41

11,12,13,-----T(M+1)

95.130	94.484	93.599	92.401	90.808	88.750
86.210	83.286	80.277	77.681	75.970	75.213
75.024	75.001	75.000	75.000		





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 49

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV.
1	PSS	4-1-88	G. W. M	4-1-88	1					INDI.
2					2					

144 PERIOD QAT= 7057. OST= 438401. OOT= 0. HCI=1.6739 HCO= .9467
TAF= 117.27

11,12,13,-----T(M+1)

96.046	95.400	94.513	93.310	91.706	89.625
87.039	84.030	80.881	78.090	76.175	75.278
75.034	75.002	75.000	75.000		

156 PERIOD QAT= 7189. OST= 475391. OOT= 0. HCI=1.6784 HCO= .9485
TAF= 118.09

11,12,13,-----T(M+1)

96.925	96.279	95.390	94.182	92.568	90.467
87.840	84.755	81.678	78.506	76.394	75.351
75.047	75.003	75.000	75.000		

168 PERIOD QAT= 7316. OST= 512386. OOT= 0. HCI=1.6829 HCO= .9500
TAF= 118.89

11,12,13,-----T(M+1)

97.770	97.123	96.233	95.021	93.399	91.280
88.616	85.462	82.069	78.927	76.623	75.433
75.063	75.004	75.000	75.000		

180 PERIOD QAT= 7438. OST= 549385. OOT= 0. HCI=1.6871 HCO= .9516
TAF= 119.65

11,12,13,-----T(M+1)

98.586	97.938	97.047	95.831	94.201	92.066
89.369	86.153	82.652	79.352	76.863	75.523
75.081	75.006	75.000	75.000		

192 PERIOD QAT= 7556. OST= 586389. OOT= 0. HCI=1.6913 HCO= .9533
TAF= 120.39

11,12,13,-----T(M+1)

99.374	98.726	97.833	96.615	94.978	92.827
90.100	86.827	83.228	79.778	77.111	75.621
75.102	75.008	75.000	75.000		

204 PERIOD QAT= 7670. OST= 623396. OOT= 1. HCI=1.6953 HCO= .9549
TAF= 121.11

11,12,13,-----T(M+1)

100.14	99.490	98.596	97.374	95.731	93.567
90.812	87.487	83.796	80.206	77.367	75.726
75.127	75.010	75.001	75.000		

216 PERIOD QAT= 7780. OST= 660407. OOT= 1. HCI=1.6992 HCO= .9566
TAF= 121.80

11,12,13,-----T(M+1)

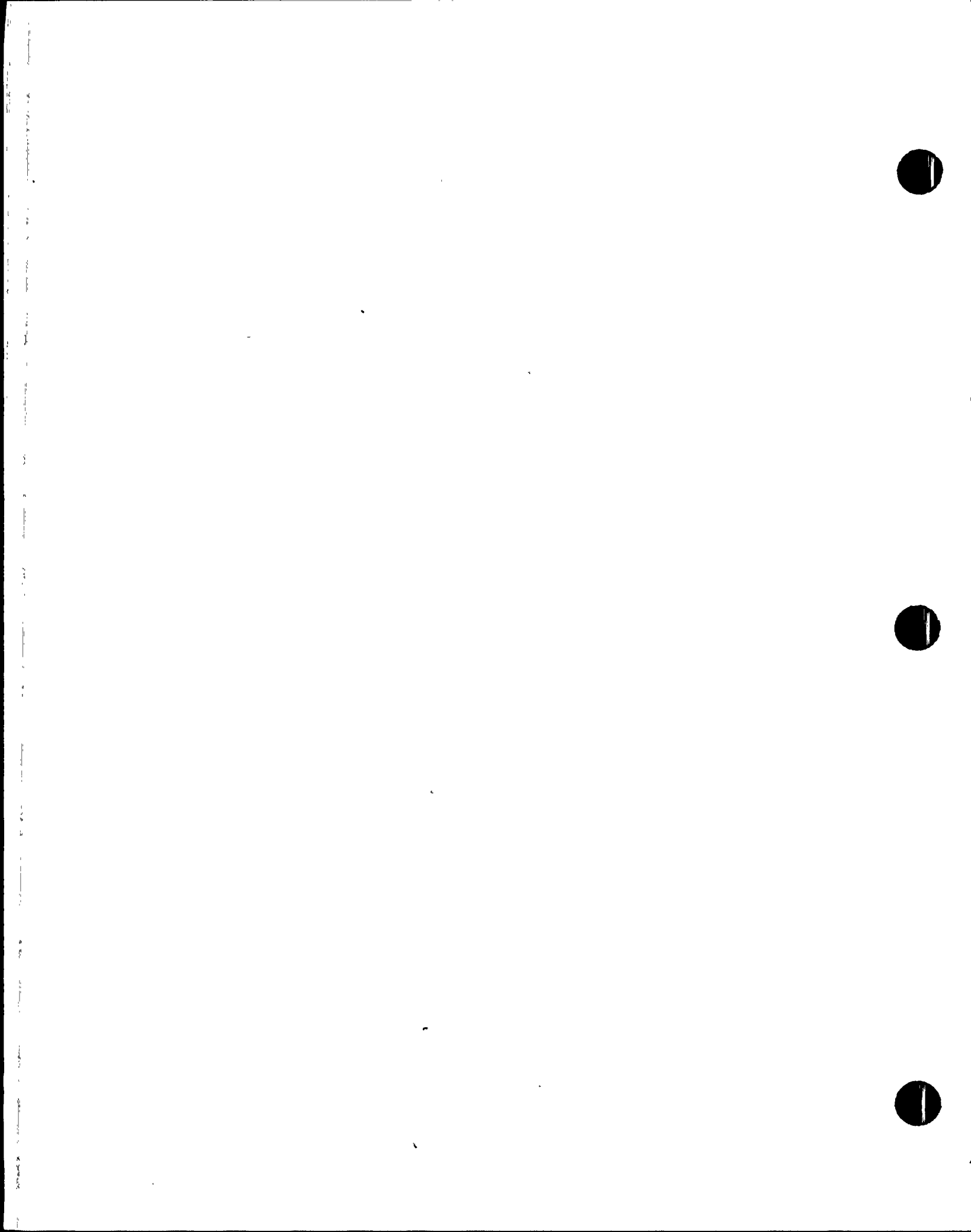
100.88	100.23	99.336	98.112	96.463	94.286
91.507	88.133	84.356	80.634	77.629	75.838
75.154	75.014	75.001	75.000		

228 PERIOD QAT= 7888. OST= 697420. OOT= 1. HCI=1.7030 HCO= .9583
TAF= 122.48

11,12,13,-----T(M+1)

101.60	100.95	100.06	98.829	97.175	94.987
92.184	88.766	84.909	81.062	77.897	75.956
75.185	75.017	75.001	75.001		

240 PERIOD QAT= 7992. OST= 734436. OOT= 2. HCI=1.7068 HCO= .9600
TAF= 123.16





CALCULATION SHEET

PROJECT ANPPJOB NO. 18601-183CALC. NO. 13-MC-HA-A03SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOMSHEET NO. 50

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
10	PSS	4-1-88	G.W.M	4-1-88	△				
△					△				

REV.
INDI-

11,12,13,-----T(M+1)

102.30	101.65	100.76	99.528	97.868	95.670
92.846	89.386	85.455	81.490	78.170	76.081
75.219	75.022	75.001	75.001		

264 PERIOD QAT= 8193. QST= 808476. QOT= 4. HCI=1.7140 HCO= .9636
TAF= 124.40

11,12,13,-----T(M+1)

103.66	103.01	102.11	100.88	99.207	96.989
94.126	90.592	86.525	82.341	78.729	76.348
75.296	75.033	75.002	75.001		

288 PERIOD QAT= 8385. QST= 882523. QOT= 7. HCI=1.7209 HCO= .9672
TAF= 125.62

11,12,13,-----T(M+1)

104.95	104.30	103.40	102.16	100.49	98.253
95.356	91.755	87.568	83.186	79.302	76.635
75.386	75.047	75.004	75.002		

312 PERIOD QAT= 8568. QST= 956577. QOT= 12. HCI=1.7276 HCO= .9710
TAF= 126.78

11,12,13,-----T(M+1)

106.19	105.54	104.64	103.40	101.71	99.466
96.539	92.880	88.584	84.022	79.884	76.941
75.489	75.064	75.006	75.003		

336 PERIOD QAT= 8744. QST= 1030636. QOT= 19. HCI=1.7340 HCO= .9748
TAF= 127.90

11,12,13,-----T(M+1)

107.38	106.73	105.83	104.59	102.90	100.64
97.682	93.970	89.577	84.850	80.473	77.262
75.604	75.085	75.008	75.004		

12 HR 360 PERIOD QAT= 8914. QST= 1104697. QOT= 30. HCI=1.7402 HCO= .9786
TAF= 128.97

11,12,13,-----T(M+1)

108.53	107.88	106.98	105.73	104.04	101.76
98.787	95.028	90.546	85.667	81.067	77.598
75.730	75.110	75.012	75.006		

432 PERIOD QAT= 9390. QST= 1326885. QOT= 90. HCI=1.7580 HCO= .9905
TAF= 132.01

11,12,13,-----T(M+1)

111.77	111.12	110.21	108.96	107.25	104.95
101.91	98.034	93.327	88.058	82.866	78.672
76.172	75.210	75.028	75.014		

504 PERIOD QAT= 9825. QST= 1549046. QOT= 216. HCI=1.7744 HCO= 1.0025
TAF= 134.80

11,12,13,-----T(M+1)

114.75	114.09	113.19	111.93	110.21	107.89
104.80	100.83	95.944	90.358	84.665	79.821
76.698	75.348	75.054	75.027		

576 PERIOD QAT= 10228. QST= 1771134. QOT= 447. HCI=1.7899 HCO= 1.0144
TAF= 137.40

11,12,13,-----T(M+1)

117.52	116.86	115.95	114.69	112.97	110.62
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CALCULATION SHEET

PROJECT ANPP JOB NO. 18601-183 CALC. NO. 13-MC-HA-A03

SUBJECT TRANSIENT TEMPERATURE STUDY FOR AFW B PUMP ROOM SHEET NO. 51

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
①	PSS	4-1-88	G.W.M	4-1-88	△					
△					△					

107.50 103.45 98.421 92.571 86.448 81.020
77.293 75.527 75.094 75.047

648 PERIOD QAT= 10606. GST= 1993099. QOT= 828. HCI=1.8046 HCO=1.0262
TAF= 139.84

T1, T2, T3, -----T(M+1)

120.12 119.46 118.55 117.29 115.56 113.20
110.04 105.93 100.78 94.703 88.207 82.251
77.946 75.744 75.148 75.074

24 HR 720 PERIOD QAT= 10962. GST= 2214879. QOT= 1411. HCI=1.8186 HCO=1.0377
TAF= 142.15

T1, T2, T3, -----T(M+1)

122.58 121.92 121.01 119.75 118.01 115.63
112.45 108.29 103.03 96.760 89.937 83.503
78.645 75.998 75.218 75.108

