Arizona Nuclear Power Project

DOCUMENT NUMBER
13-MC-HJ-253

TITLE/DESCRIPTION

TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM QUALITY CLASS Q : SAFETY RELATED

REV	REVISION DESCRIPTION	ORIGINATOR DATE	CHECKER DATE	RS DATE	QA DATE	NEM/PEM DATE
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INTERNAL CONTROL NO. 18601 -200 -CALC -001

CALCULATION COVER SHEET

SHEET 1

PROJECT ANPP PVNGS JOB NO. 18601-200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR THE MAIN CONTROL FILE NO.

ROOM PROJECT QUALITY CLASS QR DISCIPLINE MECH

COMPUTER PROGRAM	SCP	PROGRAM NO.(S)	VERSION/RELEASE NO.
	[X] YES [ ] NO	ME-204	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	JJ	—	TCB	—	APPR. 6/13/ FILM
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INFORMATION ENTERED IN THIS SPACE:
- SHOW PROFESSIONAL ENGINEER STAMP, IF REQUIRED.
- ENTER REFERENCE TO INCLUSION OF CHECKER'S ALTERNAT CALCULATIONS, IF USED.
- PROVDE ANY NOTES TO ASSIST CHECKING AND APPROVAL

NOTICE

Utilization of these calculations by persons without access to pertinent facts 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.

NOTICE

APS ACKNOWLEDGES THAT THESE DESIGN CALCULATIONS ARE ONLY AN ISOLATED PART OF THE COMPLETE DESIGN FOR THE SYSTEM THEY CONCERN, AND ARE SUBJECT TO BEING TAKEN OUT OF CONTEXT, MISINTERPRETED OR MISCONSTRUED IF USED WITHOUT BECHTEL POWER CORPORATION'S DIRECT PARTICIPATION.

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I. PURPOSE

The design basis for cooling the Main Control Room Complex uses Essential Air Handling Unit (AHU) and the Essential Chilled Water System (ECWS) for cooling. In the event that either the AHU or ECWS fails, the room temperature will rise rapidly. The purpose of this study is to determine the transient air temperature for 24 hours in the Main Control Room Complex for the following case:

- Large break LOCA
- Normal offsite power is available and all normally operating equipment continues to generate heat
- Normal HVAC stops and does not operate
- Essential chilled water system is not operating
- Essential air handlers/fans are operating
- Doors and other HVAC barriers remain in their normal closed position during the entire period of the study

Standard room heat-up (RMHTUP) computer program, ME 204, version A1, is used to study the room air heat-up by the equipment and other heat loads in the Main Control Room Complex.

The heat generated in the room is transferred to the room ambient air, stored in the room enclosure concrete (heat sink) and transferred to the air outside the room. The transient temperature for the Main Control Room Complex is calculated for a time period of 24 hours for the above mentioned conditions. The emphasis of this study is to estimate the room air temperature more accurately in the first 1 1/2 hours rather than the later part of the problem.

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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 for a response to EER 88-EC-018 being done by others.

The systems involved in this study are the control room HVAC (Normal and Essential), and Essential Chilled Water. Their design criteria are references 10 and 11.

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5. The main control room complex model is simplified as an enclosed space bounded by the same thickness of walls, ceiling and floor. Most of the room walls are 1'-9" thick (Ref 5). The floor and the walls around the cable shafts are 1'-Ø" thick (Ref 5), while the ceiling is 11" thick (Ref 6). For this study, all surfaces are considered to be 1'-Ø" thick. No credit is taken for the wall thickness being more than 1'-Ø", except that the ceiling is also considered as 1'-Ø" thick for computer modeling.

   The emphasis in this calculation is to improve the accuracy of the calculation in the initial 90 minutes. Thus, heat sinks are modeled in a way that takes credit for thinner heat sink walls than would be used in modeling for accuracy in the 12 to 24 hour time frame.

   Due to the low heat load generated during the first 1 1/2 hours compared to the thermal capacity of the existing walls to absorb the heat, additional thickness does not appreciably affect the room ambient air temperature.

6. The walls, ceiling and floor are used as a heat sink. For details, refer to Section VI.C of this study.

7. The heat generated within the room is considered as being constant. This is due to the fact that the heat load equipment continues to operate during this study. In addition, a constant heat load is required for the computer model as shown in section VI.D.

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8. The dimensions of the Main Control Room Complex for all three units are essentially identical. In addition, the chillers, fans, other equipment, the lighting and the room dimensions are virtually the same for all of these rooms. This study is performed for the Main Control Room Complex for Unit 1 and is applicable to the Main Control Rooms for all three units.

9. Per assumption 3 above, the essential chilled water is not available during the time period of this study. For a conservative approach, the AHU fans are assumed running, without chilled water through the essential coils as indicated in Section I.

10. 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.

11. 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 (approximately 1/8") and 1.41 respectively. For details, see sections VI.A and B.

CALCULATION SHEET

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SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 9

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12. Concrete has the following properties:

    A. Density 144 lbs/ft^3 (Ref 12, table A-2) K: 8b/hr ft °F
    B. Thermal conductivity 0.54 (Ref 12, table A-2)
    C. Specific heat 0.2 btu/lb-°F (Ref 12, table A-2)

13. The net Control Room Complex volume is required as input to the computer model. For calculation of net room volume, the volume of the HVAC equipment, the control panels and other electrical equipment in the Main Control Room Complex is insignificant and is neglected.

    Most equipment in the main control room complex is control panels and instrument racks. These items are mostly air (i.e. approximately 90+% of the gross volume occupied by the panel is air. Much less than 10% is actually metal, wire, circuit boards, terminal boards, etc.).

    In addition, the air has low thermal capacity. A small difference in the room volume does not have significant effect on the room temperature as shown by volume sensitivity analysis Case B of Reference 17.

14. All miscellaneous metal items (e.g. structural steel, platforms, cold piping) which could be considered as heat sinks are conservatively ignored. This is due to the computer program limitation which allows for a single heat sink to be included in the model.

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15. At the start of this study, both trains of the Essential Control Room Complex HVAC will be started. For calculation of heat loads, both of these trains continue to operate during the entire period of this calculation. This assumption complies with Section I.

16. The temperature of the outside makeup air is 101.3°F. This is based on the actual measurements made by ANPP at the operating unit (Ref. 16). The walls around the outside air chase are neglected for calculation of the heat sink effect. These walls effectively act as a heat source during initial period but act as a heat sink during the later period. The amount of heat added during the initial stages is insignificant because the structural steel and the thin metal items (e.g. cabinet sheet metal) act as a heat sink, the effect of which has been excluded (see Assumption 14 and Section VII.F).

17. Room surface area adjustment for panels etc. mounted on the concrete floor and walls is not done because the panels, instrument racks, etc. generate heat internally and generally have open bottoms which allow the heat to have ready access to the heat sink.

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IV. REFERENCES:

1. ASHRAE Handbook of Fundamentals, 1972.
2. Control Room Complex - Heat Load Calculations, Calculation number 13-MC-HJ-051, Rev. 2.
3. P & I diagram, Control Building HVAC, drawing number 01-M-HJP-001, Rev. 12.
4. Basic Flow Diagram, HVAC Control Room - Control Building, drawing number 13-M-HJF-001, Rev. 3
5. Control Building Plan at Elevation 140'-0", drawing number 13-C-ZJS-140, Rev. 19.
6. Control Building Plan at Elevation 160'-0", drawing number 13-C-ZJS-150, Rev. 14.
7. Control Building, Control Room Plan and Interior Elevations, drawing number 13-A-ZJD-503, Rev. 14.
8. 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.
9. Updated Final Safety Analysis Report, Palo Verde Nuclear Generating Station, Revision 0.
10. Detailed Design Criteria, Part III, System HJ, HVAC Control Building, Rev.5.
11. Detailed Design Criteria, Part III, System EC, Essential Chilled Water System, Rev. 3.
12. Principles of heat transfer, third edition, Frank Kreith, Intext Education Publishers, table A-1, Properties of Metals and Alloys, page 634 and table A-2, Physical Properties of Some Nonmetals, page 635.
13. Operation and Maintenance Manual for Control Room Essential Air Handling Units, CTI Nuclear Inc., SDR Log M721B-582-4

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14. Control Room Complex Essential Cooling System Equipment Sizing Calculations, Number 13-MC-HJ-251, Rev 2.
15. Project General Design Criteria, Part II, Rev. 19.
16. Actual Temperature Measurement Data by ANPP for an Operating unit, June 10, 1988 (3 pages attached).
17. Transient Temperature Study for Essential Cooling Water Pump Rooms, Calculation Number 13-MC-HA-253, Rev. 0.

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V. SUMMARY OF RESULTS:

The calculated transient room temperature summary for the Main Control Room Complex is shown below. The transient room air temperature for the Main Control Room Complex obtained from the computer output, is shown in Figure 1. The transient temperature output, Appendix A, shows that with both essential AHU fans of Trains A & B operating under conditions outlined in Section I, the calculated temperature in the pump room will be as shown below. For cases with one or no fans running, the transient temperature outputs, Appendices B and C, are also presented:

Time Period	Appendix A Control Room w/2 ESF Fans Temp. °F	Appendix B Control Room w/1 ESF Fan Temp. °F	Appendix C Control Room w/No ESF Fans Temp. °F
0 min	75.5	75.5	75.5
2 min	86.07	83.79	81.49
4 min	93.65	89.78	85.86
6 min	99.00	94.06	89.02
12 min	107.43	100.95	94.23
36 min	115.21	107.38	99.19
60 min	118.50	110.00	101.12
84 min	121.05	112.03	102.60
96 min	122.18	112.92	103.25
2 hr	124.21	114.52	104.42
4 hr	132.05	120.73	108.95
6 hr	138.02	125.45	112.38
8 hr	143.03	129.40	115.26
12 hr	151.46	136.06	120.10
24 hr	171.00	151.48	131.31

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It is readily apparent that the ESF AHU fan motors (100 bhp each) dramatically affect the control room temperature. Stopping at least one fan quickly should be a high priority.

As shown in section VII.F, after the control room temperature exceeds the outside makeup air temperature, the control room temperature is slightly over estimated because the ventilation cooling effect of the 1000 CFM per train flowing through the control room from the control room pressurization is neglected.

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VI. ROOM HEAT-UP COMPUTER MODEL

A. Model Description: (Reference 8)

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 (approximately 1/8"), the second layer thickness is 0.0141 ft (approximately 3/16"), third layer 0.01 X $(1.41)^2$ 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:

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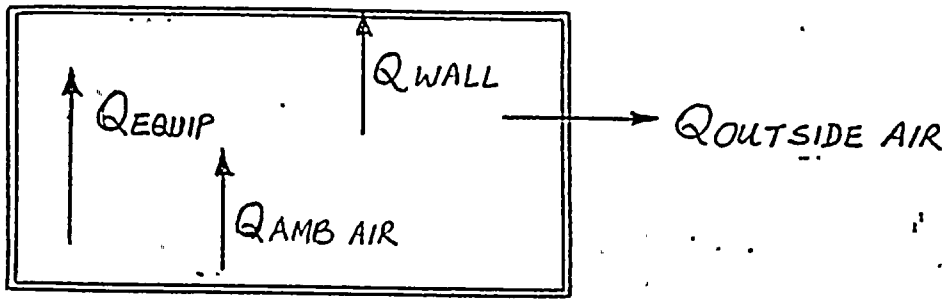

$Q_{EQUIP} = Q_{AMB\ AIR} + Q_{WALL} + Q_{OUTSIDE\ AIR}$

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 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.

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B. Input Required for the Computer Model:

The following information is required as input for transient temperature study in the Main Control Room Complex:

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 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

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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 floor.
2. The gross room volume is corrected for the volume occupied by piping and equipment (see Assumption 13).
3. The gross room surface area of the room enclosure is corrected for the area occupied by equipment (see Assumption 17).
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 same homogeneous 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, ^{o}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

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VII. STUDY:

This study is performed for the following case: Control Room Complex operates at the design flow. Normal HVAC and Essential Chillers are not available. However, both essential air handling unit fans are operating.

A. Heat Loads:

Design basis cooling for the Control Room Complex is provided by the Essential Air Handling Unit HJA-FØ4 or HJB-FØ4. Essential chilled water is recirculated through the AHU cooling coils. In the event that either the essential AHU or the essential chilled water system fails, the control room temperature will rise rapidly.

1. Essential AHU Fan Motors Heat Load:

This heat load consists of the heat generated by the Air Handling Units (HJA-FØ4 and HJB-FØ4) vaneaxial fan motors. Both essential AHU fans are running without the essential chilled water through the essential AHU cooling coils (See Assumption 9).

Essential AHU Fan Motor BHP = 1ØØ hp (Ref. 13)
(125 hp nameplate)

Motor efficiency at full load = 92.9% (Ref. 13)

All the fan motor energy is transmitted to the Control Room Complex, although the motor is physically located, at floor elevation 74'-Ø". However, it is located entirely within the recirculated air stream.

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

Heat gain from Essential AHU fan motor $= \frac{\text{Bhp X 2545}}{\text{\% eff}}$

$= \frac{100 \text{ X } 2545}{0.929}$

$= 273{,}950$ BTU/HR

AHU Fan motors for both essential trains are in operation during time period of this study (Refer to assumption 15).

Therefore, essential AHU Fan motors heat load for Trains A & B = 2 x 273,950 BTU/HR = 547,900 BTU/HR

2. Main Control Room Complex Heat Loads:

The Control Room normal HVAC and essential cooling system are designed to maintain the required "environment" for personnel occupancy and equipment operation during normal and emergency operations.

The heat loads in the Main Control Room Complex are different during normal and emergency conditions. The following Table 1 compares the heat loads during these two situations. The greater of each load is selected to satisfy the scenario of Section I. These heat loads include the lighting and personnel occupancy in the Main Control Room Complex and are taken from pages 6 and 7 of Reference 2.

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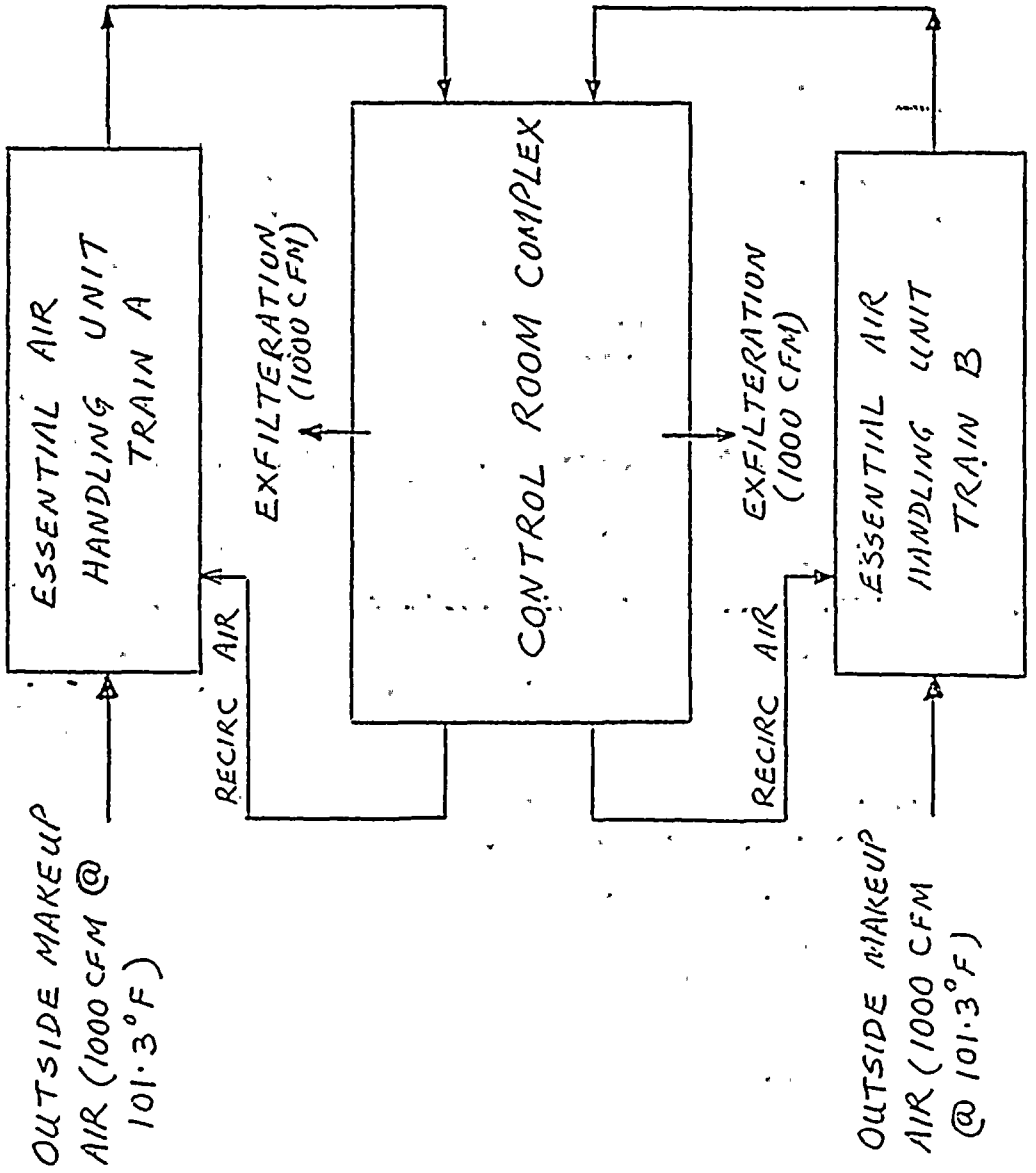

SYSTEM LAYOUT

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TABLE 1

CONTROL ROOM COMPLEX HEAT LOADS

	NORMAL OPERATION HEAT LOAD BTU/HR	ESSENTIAL OPERATION HEAT LOAD BTU/HR	MAX OF NORMAL/ESSENTIAL OPERATION HEAT LOAD BTU/HR
OPERATOR CONSOLE	77,127	64,385	77,127
CABINET AREA	358,185	280,000	358,185
COMPUTER ROOM	90,110	90,110	90,110
CORRIDOR	7,195	7,195	7,195
SHIFT SUPERVISOR	5,775	5,775	5,775
KITCHEN & PANTRY	9,660	9,660	9,660
OFFICE #1	4,200	4,200	4,200
OFFICE #2 & 3	13,300	13,300	13,300
INSTRUMENT REPAIR	16,000	16,000	16,000
CONFERENCE ROOM	13,875	13,875	13,875
MEN'S TOILET	2,335	2,335	2,335
WOMEN'S TOILET	2,085	2,085	2,085
RETURN AIR PLENUM	68,028	68,028	68,028
COMMUNICATIONS 120' LEVEL	22,500		22,500
SUBTOTAL	690,375	576,948	690,375
MARGIN		35,052	
TOTAL	690,375	612,000	690,375

NOTE:
1. The heat load data is taken from the calculation 13-MC-HJ-051, Rev. 2 (Reference 2).
2. The lighting loads are included in these heat loads.
3. The personnel occupancy heat loads are included in the above shown heat loads.

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3. Total Heat Loads:

Summary of the heat loads in the Control Room Complex:

Essential AHU fan motors heat load
for Train A & B = 547,900 BTU/HR [see section VII.A.1]
Main Control Room Complex
heat load = 690,375 BTU/HR [see section VII.A.2]
Total Heat Load = 1,238,275 BTU/HR

B. MAIN CONTROL ROOM COMPLEX SURFACE AREA AND VOLUME:

Main Control Room Complex Surface Area:

Slab thickness at elevation 140'-0" = 1'-0" [Ref. 5]
Slab thickness at elevation 160'-0" = 11" [Ref. 5]
Height of the control room = 160'-140'-(0'-11") = 19'-1"
Conservatively, use room height = 19'-0"

Thickness of the control room outside walls= 1'-9" [Ref. 5]
Thickness of the control room inside walls around cable shafts and HVAC chase = 1'-0" [Ref 5]

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The following wall lengths are shown in Reference 5.

For 1'-9" thick wall

Length of East Side Wall =
(82'-6") - (8'-3") - (10'-3") = 64'-0"
Length of North Wall =
(110'-6") - (13'-3") - (20'-3") = 77'-0"
Length of West Wall =
(82'-6") - (13-3") - (7'-3") = 62'-0"
Length of South Wall =
(110'-6") -(12'-9") - (24'-3") = 73'-6"
Total Wall length = (64'-0") + (77'-0") + (62'-0")
+ (73'-6") = 276'-6"
Wall Surface Area (276'-6") x (19'-0") = 5253.5 ft^2
Door area = (7'-4 1/2") x (11'-0") + (3'-4 1/2")
x (7'-2 1/4") = 81.13 + 24.26 = 105.39 ft^2

Net wall surface area = 5253.5 - 105.39 = 5148.11 ft^2

For 1'-0" Thick Walls:

The walls around the outside air chase are neglected because these walls act as a heat source during the initial period and act as a heat sink during the later period (Refer to Assumption 16).

The length of the walls around the cable shafts and HVAC chases in contact with the control room
= (13'-3") + (10-3") + (13'-3") + (20'-3") + (12'-9") +
(7'-3") + (17'-3")
= 94'-3"

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Wall surface area = (94'-3") x (19'-0")
= 1790.75 ft^2

Less door area = (3'-4 1/2") x (7'-2 1/4")
= 24.26 ft^2

Net wall surface area = 1790.75 - 24.26 = 1766.49 ft^2

Floor area = [(110'-6") x (82'-6")] - [(13'-3") x (10'-3")
+ (20'-3") x (13'-3") + (12'-9") x (7'-3")
+ (24'-3") x (8'-3")]
= 9116.25 - 696.63 = 8419.62 ft^2

Ceiling area (same as the floor area) = 8419.62 ft^2

Therefore net surface area = 5148.11 + 1766.49 + 8419.62 + 8419.62 = 23,753.84 ft^2

Use net surface area = 23,754 ft^2

As we are interested in short term results, all the heat transfer surfaces will be considered 1'-0" thick. The heat sink effect of the walls thicker than 1'-0" is significant only for the longer term. (Assumption 5).

Main Control Room Complex Volume

Floor area = 8419.62 ft^2 Height = 19'-0"
Volume = 8419.62 x 19 = 159,973 ft^3

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	6-13-88	[illegible]	6/13/88						

C. Input Data:

The following input data for the computer model is used:

1. Initial room ambient temp. = 75.5° F [Assumption 1]
2. Initial outside ambient temp. = 75.5° F [Assumption 2]
3. Equipment and other net heat generated in the room = 1,238,275 BTU/HR [See Section VII.A.3]
4. Net room surface area = 23,754 FT^2 [See Section VII.B]
5. Net room volume = 159,973 FT^3 [See Section VII.B]
6. Thickness of room enclosure = 1'-Ø" FT [Ref 5 and Assumption 5]
7. Density of room enclosure material = 144 LBS/FT^3 [Ref 12]
8. Thermal conductivity of room enclosure material = Ø.54 BTU/HR-FT-°F [Ref 12]
9. Specific heat of room enclosure material = Ø.2 BTU/LB-°F [Ref 12]
10. One period of increment for calculation = 2 min [Assumption 10]
11. Imaginary thickness of first layer of concrete enclosure = Ø.Ø1 FT [Assumption 11]
12. Multiplication factor of imaginary thickness of other layers = 1.41 [Assumption 11]

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-253

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 27

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDI-
0	PSS	6-13-88	[signature]	6/13/88						

Effect of AHUs on Control Room Complex Temperature

The two ESF AHU fans are 44% of the total heat load. To evaluate this sensitivity two additional computer runs are made for the cases where only one or none of the two ESF AHU fan motors are running. Only input data item #3 in the above table is changed.

For one ESF AHU fan motor running, the heat load is 1,238,275 - 273,950 = 964,325 BTU/HR.

For no ESF AHU fans running, the heat load is 1,238,275 - 2 x 273,950 = 690,375 BTU/HR.

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-253

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 28

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	6-13-88	Power	6/13/88						

D. RESULTS:

The transient room air temperature for the Main Control Room Complex obtained from the computer output, is shown in Figure 1. The transient temperature output, Appendix A, shows that with both essential AHU fans of Trains A & B operating under conditions outlined in Section I, the calculated temperature in the pump room will be as shown below. For cases with one or no fans running, the transient temperature outputs, Appendices B and C, are also presented:

Time Period	Appendix A Control Room w/2 ESF Fans Temp. °F	Appendix B Control Room w/1 ESF Fan Temp. °F	Appendix C Control Room w/No ESF Fans Temp. °F
0 min	75.5	75.5	75.5
2 min	86.07	83.79	81.49
4 min	93.65	89.78	85.86
6 min	99.00	94.06	89.02
12 min	107.43	100.95	94.23
36 min	115.21	107.38	99.19
60 min	118.50	110.00	101.12
84 min	121.05	112.03	102.60
96 min	122.18	112.92	103.25
2 hr	124.21	114.52	104.42
4 hr	132.05	120.73	108.95
6 hr	138.02	125.45	112.38
8 hr	143.03	129.40	115.26
12 hr	151.46	136.06	120.10
24 hr	171.00	151.48	131.31

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	6-13-88	[illegible]	6/13/88						

E. DISCUSSION of RESULTS:

As shown in Appendix A, the temperature inside the Main Control Room Complex is lower than the outside temperature of 101.3°F (Reference 16) for the first 6 to 8 minutes (for the base case of 2 fans running) and is higher after this time period. Therefore, a small percentage of the total heat will be added to the Control Room Complex by the outside makeup air during the first few minutes, while it will provide a very small amount of cooling after this time interval. The initial heat source effect is insignificant as shown in Section VII.F and is excluded.

Reviewing the above results, it is concluded that the temperature after the first 6 to 8 minutes (for the base case) is slightly overestimated due to the ventilation cooling effect of the two essential control room pressurization trains. Each of these two trains has a flow of 1000 cfm through the Main Control Room Complex (Ref. 14, page 2). The total ventilation cooling effect would only be on the order of 5% of the control room heat load when the control room temperature reached 130°F.

As can be readily seen by looking at the results of the cases with less than two ESF AHU fans operating, stopping one of the fans as soon as possible will dramatically decrease the rate of temperature rise in the control room complex. Stopping both fans may be undesirable, because "hot spots" could result in the various small rooms within the complex. Further evaluation would be required to assess this effect. Stopping both fans also is not consistent with the LOCA scenario described in section I.

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	6-13-88	[signature]	6/17/88						

F. EFFECT OF OUTSIDE MAKEUP AIR

Outside makeup air flow for each ESF AHU train= 1000 cfm [Ref. 14, page 2]

Outside makeup air temperature = 101.3°F [Ref. 16]

Time required for the Main Control Room Complex to reach 101.3°F, when both ESF AHU fans are operating = 6 to 8 minutes [Ref. Appendix A]

The makeup air flow will act as a heat source initially and later as a heat sink.

The average rate of heat added to the Main Control Room Complex due to both essential makeup trains before the control room temperature equals the outside makeup air temperature is

$$= 1.08 \times \text{cfm} \times \frac{\Delta T}{2}$$ [Reference 1, Chapter 19, Page 343, Equation 5].

$$= 1.08 \times (2 \times 1000) \times \frac{101.3 - 75.5}{2} \text{ BTU/HR}$$

$$= 27{,}864 \text{ BTU/HR}$$

Therefore, heat load added to the Main Control Room Complex

$$= \frac{27{,}864}{60 \text{ minutes}} \times 8 \text{ minutes} = 3715 \text{ BTU}$$

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-253

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 31

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDIC.
0	PSS	6-13-88	[signature]	6/13/88						

Specific heat of steel = 0.104 BTU/lb - ^{o}F [Ref. 12, table A-1]

Weight of steel required to absorb the added heat load

$$= \frac{3715 \text{ BTU}}{0.104 \text{ BTU/lb} - {}^{o}\text{F} \times (101.3 - 75.5)\ {}^{o}\text{F}} = 1385 \text{ lb}$$

Similarly, for the cases of one and no ESF AHU fans running, the times at which the control room temperature equals the outside air temperature are approximately 15 minutes and 60 minutes respectively. The heat load added to the control room are 6,966 and 27,864 BTU requiring approximately 2,600 and 10,400 lb of steel, respectively, to absorb that heat.

By inspection, it is obvious that the Main Control Room has a large amount of steel consisting of panels, cabinets, beams, reinforcements, etc. that is many times more than the required weight of 10,400 lb.

Therefore, the heat source effect of the outside makeup air is insignificant and does not need to be included.

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601. - 200 CALC. NO. 13-MC-HJ-253

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 32

REV	ORIGINATOR	DATE	CHECKER	DATE	REV.	ORIGINATOR	DATE	CHECKER	DATE	REV. INDI-
0	PSS	6-13-88	[illegible]	6/13/88						

In order to obtain slightly more accurate transient temperatures for the main control room, the Bechtel Computer Program NE-100 (COPPATTA-7) may be used instead of ME-204. The computer program NE-100 has the following advantages over ME-204:

1. Heat Sink Model:

The metal items (e.g. cabinets, cable trays, structural steel and concrete) in the main control room can be modeled with much more complexity and accuracy rather than consideration as a lump sum mass. This will lead to higher accuracy in predicting long term (e.g. 24 hours) room temperatures.

2. Effect of Outside Air:

The effect of the outside air in terms of the flow and temperature is accounted for in NE-100 and, therefore, represents a better temperature profile over the short term (e.g. 90 minutes).

3. Air Handling Units On and Off Simulation:

AHU performance is used as an input in the computer program NE-100. The temperature transient can be determined at any given time following the restoration of the chilled water through the AHU.

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 33

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/16/88	1				
2					3				

REV. IND.

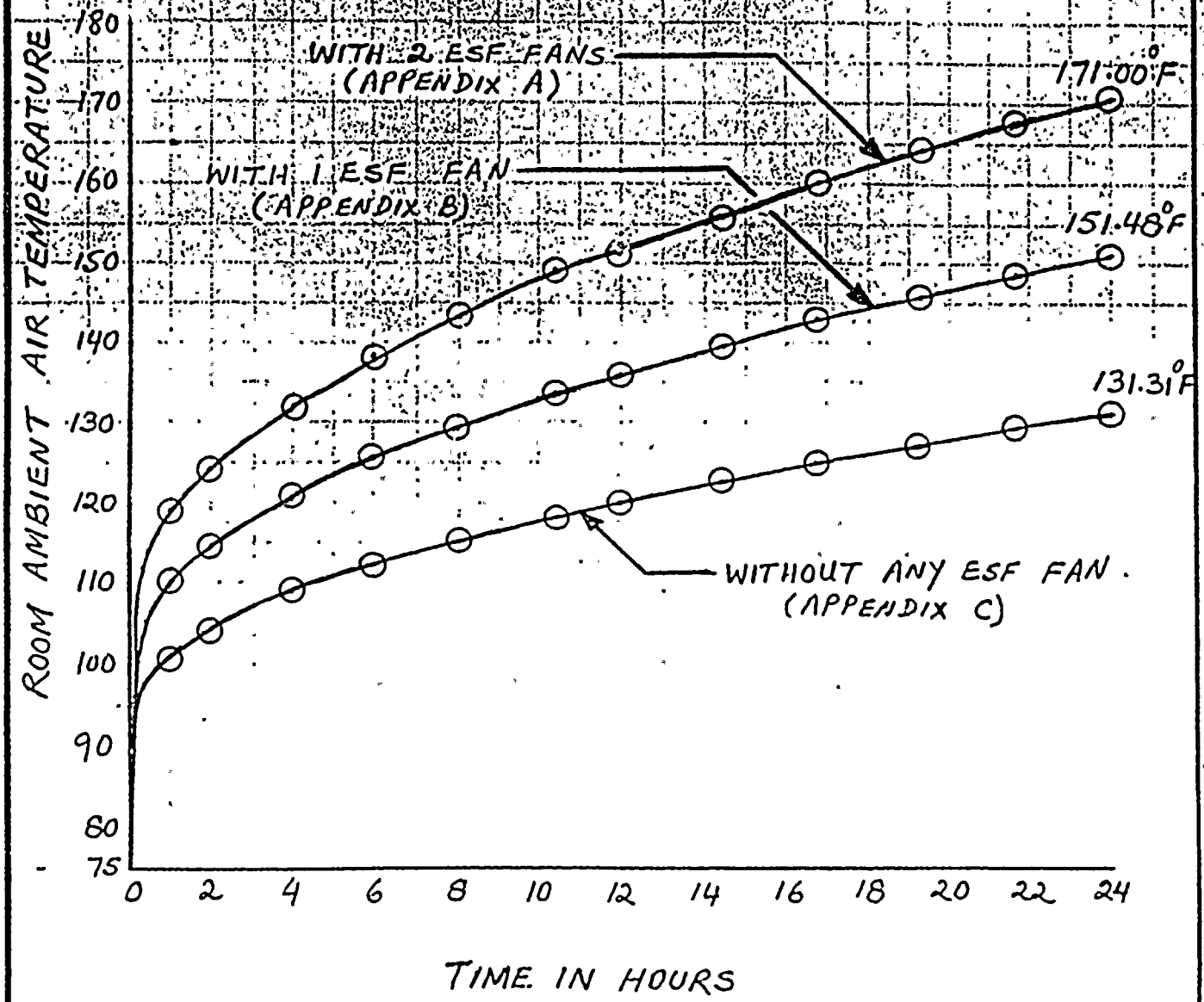

FIGURE 1

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25?

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 34

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/13/88					

REV. MINOR

APPENDIX A

```
     INITIAL INTERNAL ROOM AMBIENT TEMPERATURE, DEG. F=?
>75.5
     INITIAL ADJACENT ROOM AMBIENT TEMPERATURE, DEG. F=?
>75.5
     EQUIPMENT HEAT GENERATED IN THE INTERNAL ROOM, BTU/HR=?
>1238275
     NET INTERNAL ROOM SURFACE AREA, SQ. FT.=?
>23754
     NET INTERNAL ROOM VOLUME, CU.FT.=?
>159973
     THICKNESS OF ROOM ENCLOSURE, FT.=?
>1
     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= 11

     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       .26685

2MIN 1 PERIOD  QAT=  30146.  QST=   11130.  QOT=        0. HCI=1.4057 HCO= .0000
      TAF=  86.07
      T1,T2,T3,----------T(M+1)
      76.073       75.889       75.729       75.612       75.542       75.512
      75.502       75.500       75.500       75.500       75.500       75.500

     2 PERIOD  QAT=  51331.  QST=   31219.  QOT=        0. HCI=1.5099 HCO= .0000
      TAF=  93.65
      T1,T2,T3,----------T(M+1)
      76.845       76.484       76.135       75.845       75.648       75.547
      75.510       75.501       75.500       75.500       75.500       75.500
```

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-253

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 35

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDICATOR
0	PSS	6-13-88	Mont	6/13/88						

3 PERIOD QAT= 66090. QST= 57736. QOT= 0. HCI=1.5694 HCO= .0000
TAF= 99.00
T1,T2,T3,----------T(M+1)
77.659 77.158 76.639 76.169 75.817 75.612
75.527 75.504 75.500 75.500 75.500 75.500

6 PERIOD QAT= 89025. QST= 158627. QOT= 0. HCI=1.6490 HCO= .9473
TAF= 107.43
T1,T2,T3,----------T(M+1)
79.875 79.138 78.287 77.394 76.583 75.984
75.654 75.531 75.504 75.500 75.500 75.500

12 PERIOD QAT= 103455. QST= 391850. QOT= 0. HCI=1.6893 HCO= .9538
TAF= 112.81
T1,T2,T3,----------T(M+1)
83.033 82.172 81.091 79.817 78.450 77.182
76.237 75.721 75.540 75.504 75.500 75.500

18 PERIOD QAT= 109848. QST= 633106. QOT= 2. HCI=1.7039 HCO= .9621
TAF= 115.21
T1,T2,T3,----------T(M+1)
85.286 84.396 83.246 81.827 80.195 78.516
77.063 76.091 75.643 75.519 75.501 75.501

24 PERIOD QAT= 114581. QST= 876017. QOT= 9. HCI=1.7141 HCO= .9718
TAF= 116.99
T1,T2,T3,----------T(M+1)
87.117 86.214 85.031 83.535 81.751 79.808
77.973 76.582 75.818 75.555 75.504 75.502

1HR 30 PERIOD QAT= 118574. QST= 1119654. QOT= 30. HCI=1.7226 HCO= .9823
TAF= 118.50
T1,T2,T3,----------T(M+1)
88.702 87.792 86.587 85.042 83.156 81.027
78.900 77.145 76.058 75.616 75.510 75.507

36 PERIOD QAT= 122103. QST= 1363727. QOT= 80. HCI=1.7301 HCO= .9930
TAF= 119.84
T1,T2,T3,----------T(M+1)
90.121 89.205 87.985 86.405 84.446 82.176
79.818 77.750 76.349 75.704 75.521 75.514

42 PERIOD QAT= 125301. QST= 1608083. QOT= 177. HCI=1.7370 HCO=1.0039
TAF= 121.05
T1,T2,T3,----------T(M+1)
91.417 90.497 89.266 87.659 85.643 83.263
80.716 78.377 76.680 75.817 75.538 75.526

48 PERIOD QAT= 128247. QST= 1852622. QOT= 345. HCI=1.7433 HCO=1.0147
TAF= 122.18
T1,T2,T3,----------T(M+1)
92.617 91.694 90.454 88.826 86.764 84.295
81.590 79.015 77.043 75.956 75.564 75.542

2HR 60 PERIOD QAT= 133569. QST= 2341939. QOT= 1007. HCI=1.7548 HCO=1.0358
TAF= 124.21

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 36

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/13/88					

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T1,T2,T3,----------T(M+1)
94.801      93.873      92.619      90.959      88.828      86.221
83.266      80.298      77.832      76.295      75.641      75.593

72 PERIOD  QAT= 138328.  QST= 2831166.  QOT=     2323. HCI=1.7652 HCO=1.0559
  TAF= 126.03
  T1,T2,T3,----------T(M+1)
  96.766      95.835      94.571      92.888      90.705      87.995
  84.849      81.568      78.675      76.702      75.757      75.669

84 PERIOD  QAT= 142670.  QST= 3319877.  QOT=     4572. HCI=1.7747 HCO=1.0749
  TAF= 127.69
  T1,T2,T3,----------T(M+1)
  98.568      97.634      96.363      94.661      92.440      89.650
  86.351      82.811      79.548      77.161      75.914      75.770

96 PERIOD  QAT= 146687.  QST= 3807692.  QOT=     8043. HCI=1.7836 HCO=1.0928
  TAF= 129.24
  T1,T2,T3,----------T(M+1)
  100.24      99.305      98.028      96.312      94.059      91.204
  87.781      84.024      80.435      77.661      76.110      75.896

108 PERIOD  QAT= 150441.  QST= 4294262.  QOT=    13019. HCI=1.7919 HCO=1.1097
  TAF= 130.69
  T1,T2,T3,----------T(M+1)
  101.81      100.87      99.591      97.863      95.584      92.675
  89.147      85.204      81.326      78.193      76.344      76.045

4HR 120 PERIOD  QAT= 153976.  QST= 4779273.  QOT=    19773. HCI=1.7999 HCO=1.1256
  TAF= 132.05
  T1,T2,T3,----------T(M+1)
  103.29      102.35      101.07      99.330      97.029      94.074
  90.456      86.351      82.215      78.749      76.612      76.215

132 PERIOD  QAT= 157325.  QST= 5262439.  QOT=    28557. HCI=1.8075 HCO=1.1406
  TAF= 133.35
  T1,T2,T3,----------T(M+1)
  104.70      103.76      102.47      100.73      98.405      95.410
  91.715      87.466      83.099      79.326      76.912      76.403

144 PERIOD  QAT= 160514.  QST= 5743502.  QOT=    39605. HCI=1.8147 HCO=1.1547
  TAF= 134.59
  T1,T2,T3,----------T(M+1)
  106.05      105.11      103.81      102.06      99.721      96.692
  92.927      88.552      83.976      79.920      77.239      76.607

156 PERIOD  QAT= 163563.  QST= 6222226.  QOT=    53131. HCI=1.8217 HCO=1.1681
  TAF= 135.78
  T1,T2,T3,----------T(M+1)
  107.34      106.39      105.10      103.34      100.98      97.924
  94.099      89.610      84.844      80.526      77.592      76.826

168 PERIOD  QAT= 166488.  QST= 6698404.  QOT=    69327. HCI=1.8284 HCO=1.1808
  TAF= 136.92
  T1,T2,T3,----------T(M+1)
  108.57      107.63      106.33      104.57      102.20      99.113
  95.233      90.642      85.704      81.144      77.966      77.057
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CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 37

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. IND.
0	PSS	6-13-88	[illegible]	6/13/88						

6HR 180 PERIOD QAT= 169303. QST= 7171850. QOT= 88365. HCI=1.8350 HCO=1.1929
TAF= 138.02
T1,T2,T3,----------T(M+1)
109.77 108.82 107.52 105.75 103.38 100.26
96.333 91.649 86.554 81.770 78.359 77.299

192 PERIOD QAT= 172017. QST= 7642399. QOT= 110400. HCI=1.8413 HCO=1.2043
TAF= 139.08
T1,T2,T3,----------T(M+1)
110.92 109.98 108.68 106.90 104.51 101.38
97.402 92.634 87.395 82.403 78.769 77.549

204 PERIOD QAT= 174642. QST= 8109906. QOT= 135567. HCI=1.8474 HCO=1.2153
TAF= 140.11
T1,T2,T3,----------T(M+1)
112.04 111.09 109.79 108.01 105.61 102.46
98.443 93.598 88.227 83.042 79.193 77.807

216 PERIOD QAT= 177186. QST= 8574241. QOT= 163986. HCI=1.8534 HCO=1.2257
TAF= 141.11
T1,T2,T3,----------T(M+1)
113.13 112.18 110.87 109.09 106.68 103.51
99.458 94.543 89.049 83.684 79.628 78.071

228 PERIOD QAT= 179655. QST= 9035290. QOT= 195762. HCI=1.8593 HCO=1.2356
TAF= 142.08
T1,T2,T3,----------T(M+1)
114.18 113.23 111.93 110.14 107.72 104.53
100.45 95.469 89.864 84.330 80.074 78.340

8HR 240 PERIOD QAT= 182056. QST= 9492960. QOT= 230985. HCI=1.8650 HCO=1.2451
TAF= 143.03
T1,T2,T3,----------T(M+1)
115.21 114.26 112.95 111.16 108.74 105.53
101.42 96.379 90.669 84.977 80.528 78.613

264 PERIOD QAT= 186678. QST=10397839. QOT= 312073. HCI=1.8761 HCO=1.2630
TAF= 144.85
T1,T2,T3,----------T(M+1)
117.19 116.24 114.93 113.13 110.70 107.47
103.30 98.151 92.255 86.274 81.455 79.167

288 PERIOD QAT= 191087. QST=11288342. QOT= 407749. HCI=1.8868 HCO=1.2795
TAF= 146.60
T1,T2,T3,----------T(M+1)
119.09 118.14 116.83 115.02 112.58 109.32
105.10 99.868 93.809 87.570 82.400 79.727

312 PERIOD QAT= 195315. QST=12164094. QOT= 518358. HCI=1.8971 HCO=1.2947
TAF= 148.27
T1,T2,T3,----------T(M+1)
120.91 119.96 118.65 116.84 114.39 111.11
106.85 101.54 95.332 88.858 83.354 80.290

336 PERIOD QAT= 199385. QST=13024844. QOT= 644126. HCI=1.9072 HCO=1.3089

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-2[illegible]

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 38

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	Momen	6/13/88					

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```
      TAF= 149.89
      T1,T2,T3,-------------T(M+1)
      122.67        121.72        120.41        118.59        116.13        112.84
      108.54        103.16        96.825        90.137        84.311        80.850

12 HR 360 PERIOD  QAT= 203316.  QST=13870448.  QOT=   785179. HCI=1.9169 HCO=1.3221
      TAF= 151.46
      T1,T2,T3,-------------T(M+1)
      124.38        123.43        122.11        120.29        117.82        114.51
      110.19        104.74        98.290        91.402        85.265        81.406

      432 PERIOD  QAT= 214410.  QST=16316066.  QOT=  1300238. HCI=1.9450 HCO=1.3570
      TAF= 155.91
      T1,T2,T3,-------------T(M+1)
      129.21        128.25        126.93        125.11        122.62        119.27
      114.87        109.26        102.52        95.099        88.083        83.032

      504 PERIOD  QAT= 224648.  QST=18626323.  QOT=  1951468. HCI=1.9714 HCO=1.3863
      TAF= 160.05
      T1,T2,T3,-------------T(M+1)
      133.69        132.74        131.42        129.59        127.08        123.70
      119.23        113.50        106.50        98.624        90.790        84.574

      576 PERIOD  QAT= 234181.  QST=20805265.  QOT=  2734703. HCI=1.9966 HCO=1.4113
      TAF= 163.92
      T1,T2,T3,-------------T(M+1)
      137.89        136.94        135.61        133.78        131.26        127.86
      123.33        117.48        110.27        101.97        93.361        86.022

      648 PERIOD  QAT= 243095.  QST=22858263.  QOT=  3644503. HCI=2.0206 HCO=1.4331
      TAF= 167.56
      T1,T2,T3,-------------T(M+1)
      141.84        140.89        139.56        137.72        135.19        131.76
      127.18        121.24        113.82        105.12        95.787        87.376

24 HR 720 PERIOD  QAT= 251449.  QST=24791227.  QOT=  4674899. HCI=2.0435 HCO=1.4522
      TAF= 171.00
      T1,T2,T3,-------------T(M+1)
      145.56        144.60        143.27        141.43        138.89        135.44
      130.81        124.77        117.16        108.10        98.070        88.640
```

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-2

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 39

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/13/88					

RFV

APPENDIX B

```
     INITIAL INTERNAL ROOM AMBIENT TEMPERATURE, DEG. F=?
>75.5
     INITIAL ADJACENT ROOM AMBIENT TEMPERATURE, DEG. F=?
>75.5
     EQUIPMENT HEAT GENERATED IN THE INTERNAL ROOM, BTU/HR=?
>964325
     NET INTERNAL ROOM SURFACE AREA, SQ. FT.=?
>23754
     NET INTERNAL ROOM VOLUME, CU.FT.=?
>159973
     THICKNESS OF ROOM ENCLOSURE, FT.=?
>1
     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= 11

     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       .26685

2MIN 1 PERIOD QAT=  23648.  QST=    8495.  QOT=         0. HCI=1.3656 HCO= .0000
     TAF=  83.79
     T1,T2,T3,----------T(M+1)
     75.937       75.797       75.675       75.585       75.532       75.509
     75.502       75.500       75.500       75.500       75.500       75.500

     2 PERIOD QAT=  40472.  QST=   23816.  QOT=         0. HCI=1.4593 HCO= .0000
     TAF=  89.78
     T1,T2,T3,----------T(M+1)
     76.526       76.251       75.984       75.763       75.613       75.536
     75.507       75.501       75.500       75.500       75.500       75.500
```

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 40

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/13/88					

REV.

```
3 PERIOD  QAT=  52355.  QST=  44076.  QOT=      0. HCI=1.5129 HCO= .0000
 TAF=  94.06
 T1,T2,T3,-------------T(M+1)
 77.149        76.766        76.370        76.011        75.742        75.585
 75.520        75.503        75.500        75.500        75.500        75.500

6 PERIOD  QAT=  71261.  QST= 121600.  QOT=      0. HCI=1.5848 HCO= .9468
 TAF= 100.95
 T1,T2,T3,-------------T(M+1)
 78.859        78.292        77.637        76.951        76.329        75.871
 75.618        75.524        75.503        75.500        75.500        75.500

12 PERIOD  QAT=  83423.  QST= 302301.  QOT=      0. HCI=1.6211 HCO= .9530
 TAF= 105.43
 T1,T2,T3,-------------T(M+1)
 81.327        80.658        79.820        78.832        77.775        76.795
 76.066        75.670        75.531        75.503        75.500        75.500

18 PERIOD  QAT=  88687.  QST= 489897.  QOT=      1. HCI=1.6331 HCO= .9607
 TAF= 107.38
 T1,T2,T3,-------------T(M+1)
 83.089        82.397        81.503        80.400        79.133        77.832
 76.707        75.956        75.610        75.515        75.501        75.500

24 PERIOD  QAT=  92522.  QST= 678918.  QOT=      7. HCI=1.6412 HCO= .9696
 TAF= 108.80
 T1,T2,T3,-------------T(M+1)
 84.520        83.817        82.896        81.733        80.346        78.837
 77.414        76.336        75.746        75.542        75.503        75.502

1 HR
30 PERIOD  QAT=  95742.  QST= 868542.  QOT=     23. HCI=1.6479 HCO= .9791
 TAF= 110.00
 T1,T2,T3,-------------T(M+1)
 85.757        85.048        84.111        82.909        81.442        79.787
 78.136        76.774        75.931        75.589        75.507        75.505

36 PERIOD  QAT=  98585.  QST= 1058523.  QOT=     61. HCI=1.6538 HCO= .9890
 TAF= 111.07
 T1,T2,T3,-------------T(M+1)
 86.863        86.150        85.201        83.972        82.447        80.683
 78.850        77.244        76.157        75.657        75.516        75.511

42 PERIOD  QAT= 101160.  QST= 1248735.  QOT=    136. HCI=1.6591 HCO= .9990
 TAF= 112.03
 T1,T2,T3,-------------T(M+1)
 87.874        87.158        86.199        84.949        83.380        81.529
 79.549        77.732        76.415        75.746        75.530        75.520

48 PERIOD  QAT= 103530.  QST= 1439096.  QOT=    265. HCI=1.6640 HCO=1.0090
 TAF= 112.92
 T1,T2,T3,-------------T(M+1)
 88.810        88.091        87.126        85.859        84.254        82.333
 80.230        78.228        76.696        75.853        75.549        75.533

2 HR
60 PERIOD  QAT= 107814.  QST= 1820025.  QOT=    776. HCI=1.6729 HCO=1.0284
 TAF= 114.52
```

T1,T2,T3,----------T(M+1)
90.512 89.789 88.813 87.521 85.862 83.834
81.535 79.227 77.310 76.116 75.609 75.572

72 PERIOD QAT= 111645. QST= 2200903. QOT= 1789. HCI=1.6809 HCO=1.0469
TAF= 115.97
T1,T2,T3,----------T(M+1)
92.043 91.318 90.334 89.024 87.325 85.216
82.768 80.215 77.966 76.433 75.699 75.631

84 PERIOD QAT= 115140. QST= 2581397. QOT= 3522. HCI=1.6882 HCO=1.0644
TAF= 117.28
T1,T2,T3,----------T(M+1)
93.447 92.720 91.731 90.406 88.677 86.505
83.938 81.184 78.646 76.790 75.821 75.710

96 PERIOD QAT= 118374. QST= 2961211. QOT= 6196. HCI=1.6950 HCO=1.0808
TAF= 118.51
T1,T2,T3,----------T(M+1)
94.751 94.022 93.028 91.692 89.938 87.716
85.052 82.128 79.336 77.179 75.973 75.809

108 PERIOD QAT= 121397. QST= 3340078. QOT= 10028. HCI=1.7014 HCO=1.0963
TAF= 119.65
T1,T2,T3,----------T(M+1)
95.974 95.244 94.246 92.901 91.126 88.861
86.116 83.047 80.030 77.593 76.155 75.925

4 HR 120 PERIOD QAT= 124245. QST= 3717751. QOT= 15228. HCI=1.7075 HCO=1.1109
TAF= 120.73
T1,T2,T3,----------T(M+1)
97.129 96.398 95.396 94.043 92.252 89.951
87.135 83.940 80.722 78.026 76.364 76.058

132 PERIOD QAT= 126944. QST= 4094013. QOT= 21991. HCI=1.7133 HCO=1.1247
TAF= 121.76
T1,T2,T3,----------T(M+1)
98.227 97.494 96.490 95.130 93.324 90.992
88.115 84.809 81.410 78.475 76.597 76.205

144 PERIOD QAT= 129514. QST= 4468658. QOT= 30494. HCI=1.7188 HCO=1.1377
TAF= 122.74
T1,T2,T3,----------T(M+1)
99.274 98.541 97.534 96.169 94.349 91.990
89.060 85.655 82.093 78.937 76.851 76.365

156 PERIOD QAT= 131972. QST= 4841512. QOT= 40902. HCI=1.7241 HCO=1.1500
TAF= 123.68
T1,T2,T3,----------T(M+1)
100.28 99.544 98.535 97.164 95.333 92.950
89.972 86.478 82.769 79.409 77.126 76.536

168 PERIOD QAT= 134331. QST= 5212414. QOT= 53363. HCI=1.7292 HCO=1.1617
TAF= 124.58
T1,T2,T3,----------T(M+1)
101.24 100.51 99.497 98.122 96.281 93.876
90.856 87.282 83.438 79.890 77.417 76.718

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 42

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	Nomura	6/13/88					

REV.

6HR 180 PERIOD QAT= 136601. QST= 5581218. QOT= 68007. HCI=1.7342 HCO=1.1727
TAF= 125.45

T1,T2,T3,----------T(M+1)					
102.17	101.44	100.42	99.045	97.195	94.772
91.712	88.066	84.100	80.377	77.723	76.907

192 PERIOD QAT= 138791. QST= 5947801. QOT= 84954. HCI=1.7390 HCO=1.1832
TAF= 126.29

T1,T2,T3,----------T(M+1)					
103.07	102.34	101.32	99.938	98.080	95.639
92.545	88.834	84.755	80.870	78.042	77.104

204 PERIOD QAT= 140909. QST= 6312049. QOT= 104308. HCI=1.7437 HCO=1.1932
TAF= 127.10

T1,T2,T3,----------T(M+1)					
103.94	103.21	102.19	100.80	98.938	96.481
93.356	89.584	85.403	81.367	78.372	77.307

216 PERIOD QAT= 142961. QST= 6673865. QOT= 126159. HCI=1.7482 HCO=1.2028
TAF= 127.89

T1,T2,T3,----------T(M+1)					
104.79	104.05	103.03	101.64	99.771	97.300
94.146	90.320	86.043	81.867	78.712	77.514

228 PERIOD QAT= 144955. QST= 7033162. QOT= 150589. HCI=1.7526 HCO=1.2119
TAF= 128.65

T1,T2,T3,----------T(M+1)					
105.61	104.87	103.85	102.46	100.58	98.099
94.918	91.041	86.677	82.370	79.059	77.726

8HR 240 PERIOD QAT= 146893. QST= 7389865. QOT= 177666. HCI=1.7570 HCO=1.2206
TAF= 129.40

T1,T2,T3,----------T(M+1)					
106.41	105.67	104.65	103.26	101.37	98.877
95.672	91.750	87.305	82.874	79.413	77.941

264 PERIOD QAT= 150626. QST= 8095242. QOT= 239995. HCI=1.7653 HCO=1.2370
TAF= 130.84

T1,T2,T3,----------T(M+1)					
107.95	107.22	106.19	104.80	102.90	100.38
97.135	93.130	88.540	83.884	80.137	78.378

288 PERIOD QAT= 154188. QST= 8789580. QOT= 313526. HCI=1.7734 HCO=1.2520
TAF= 132.22

T1,T2,T3,----------T(M+1)					
109.43	108.69	107.67	106.27	104.36	101.83
98.543	94.467	89.750	84.893	80.874	78.820

312 PERIOD QAT= 157605. QST= 9472593. QOT= 398527. HCI=1.7812 HCO=1.2660
TAF= 133.54

T1,T2,T3,----------T(M+1)					
110.85	110.11	109.09	107.68	105.77	103.22
99.903	95.765	90.936	85.897	81.619	79.264

336 PERIOD QAT= 160886. QST=10144086. QOT= 495171. HCI=1.7887 HCO=1.2789

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 43

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/13/88					

REV.

```
      TAF= 134.82
      T1,T2,T3,----------T(M+1)
      112.22        111.48        110.46        109.05        107.13        104.57
      101.22        97.028        92.099        86.893        82.367        79.708

12 HR 360 PERIOD  QAT= 164075.  QST=10803951.  QOT=   603557. HCI=1.7960 HCO=1.2910
      TAF= 136.06
      T1,T2,T3,----------T(M+1)
      113.55        112.81        111.78        110.37        108.45        105.87
      102.50        98.259        93.240        87.880        83.113        80.148

      432 PERIOD  QAT= 173055.  QST=12713487.  QOT=   999325. HCI=1.8170 HCO=1.3229
      TAF= 139.57
      T1,T2,T3,----------T(M+1)
      117.31        116.57        115.54        114.12        112.19        109.58
      106.15        101.78        96.533        90.763        85.319        81.437

      504 PERIOD  QAT= 181352.  QST=14519037.  QOT=  1499768. HCI=1.8368 HCO=1.3495
      TAF= 142.83
      T1,T2,T3,----------T(M+1)
      120.81        120.07        119.03        117.61        115.66        113.03
      109.55        105.09        99.643        93.516        87.441        82.664

      576 PERIOD  QAT= 189088.  QST=16223610.  QOT=  2101749. HCI=1.8555 HCO=1.3723
      TAF= 145.89
      T1,T2,T3,----------T(M+1)
      124.08        123.34        122.31        120.88        118.92        116.27
      112.74        108.19        102.58        96.128        89.458        83.818

      648 PERIOD  QAT= 196333.  QST=17831216.  QOT=  2801153. HCI=1.8733 HCO=1.3921
      TAF= 148.77
      T1,T2,T3,----------T(M+1)
      127.16        126.42        125.38        123.95        121.98        119.31
      115.75        111.12        105.35        98.597        91.366        84.899

24 HR 720 PERIOD  QAT= 203133.  QST=19346347.  QOT=  3593460. HCI=1.8903 HCO=1.4095
      TAF= 151.48
      T1,T2,T3,----------T(M+1)
      130.06        129.32        128.28        126.85        124.87        122.18
      118.58        113.88        107.97        100.93        93.163        85.911
```

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 44

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[signature]	6/13/88					

REV.

APPENDIX C

```
     INITIAL INTERNAL ROOM AMBIENT TEMPERATURE, DEG. F=?
>75.5
     INITIAL ADJACENT ROOM AMBIENT TEMPERATURE, DEG. F=?
>75.5
     EQUIPMENT HEAT GENERATED IN THE INTERNAL ROOM, BTU/HR=?
>690375
     NET INTERNAL ROOM SURFACE AREA, SQ. FT.=?
>23754
     NET INTERNAL ROOM VOLUME, CU.FT.=?
>159973
     THICKNESS OF ROOM ENCLOSURE, FT.=?
>1
     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= 11

     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       .26685

2 MIN  1 PERIOD  QAT=  17078.  QST=    5934.  QOT=        0. HCI=1.3185 HCO= .0000
       TAF=  81.49
       T1,T2,T3,----------T(M+1)
       75.805      75.708      75.622      75.560      75.523      75.506
       75.501      75.500      75.500      75.500      75.500      75.500

       2 PERIOD  QAT=  29400.  QST=   16624.  QOT=        0. HCI=1.4002 HCO= .0000
       TAF=  85.86
       T1,T2,T3,----------T(M+1)
       76.216      76.024      75.838      75.684      75.579      75.525
       75.505      75.501      75.500      75.500      75.500      75.500
```

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 45

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[signature]	6/13/88					

REV.

```
 3 PERIOD  QAT=  38244.  QST=   30792.  QOT=        0. HCI=1.4468 HCO= .0000
  TAF=  89.02
  T1,T2,T3,-------------T(M+1)
  76.652        76.385        76.108        75.857        75.669        75.560
  75.514        75.502        75.500        75.500        75.500        75.500

 6 PERIOD  QAT=  52704.  QST=   85368.  QOT=        0. HCI=1.5099 HCO= .9468
  TAF=  94.23
  T1,T2,T3,-------------T(M+1)
  77.863        77.463        77.002        76.519        76.081        75.760
  75.583        75.517        75.502        75.500        75.500        75.500

12 PERIOD  QAT=  62267.  QST=  213877.  QOT=        0. HCI=1.5417 HCO= .9520
  TAF=  97.71
  T1,T2,T3,-------------T(M+1)
  79.635        79.158        78.562        77.859        77.108        76.415
  75.899        75.620        75.522        75.502        75.500        75.500

18 PERIOD  QAT=  66301.  QST=  347915.  QOT=        1. HCI=1.5512 HCO= .9589
  TAF=  99.19
  T1,T2,T3,-------------T(M+1)
  80.904        80.409        79.771        78.984        78.081        77.154
  76.355        75.822        75.577        75.510        75.501        75.500

24 PERIOD  QAT=  69175.  QST=  483108.  QOT=        5. HCI=1.5573 HCO= .9669
  TAF= 100.24
  T1,T2,T3,-------------T(M+1)
  81.933        81.430        80.772        79.941        78.950        77.874
  76.860        76.093        75.674        75.530        75.502        75.501

1HR
30 PERIOD  QAT=  71574.  QST=  618769.  QOT=       16. HCI=1.5622 HCO= .9754
  TAF= 101.12
  T1,T2,T3,-------------T(M+1)
  82.821        82.314        81.643        80.784        79.736        78.554
  77.376        76.405        75.806        75.563        75.505        75.504

36 PERIOD  QAT=  73687.  QST=  754700.  QOT=       43. HCI=1.5664 HCO= .9843
  TAF= 101.90
  T1,T2,T3,-------------T(M+1)
  83.615        83.105        82.426        81.546        80.457        79.196
  77.887        76.741        75.967        75.612        75.511        75.508

42 PERIOD  QAT=  75600.  QST=  890807.  QOT=       96. HCI=1.5703 HCO= .9932
  TAF= 102.60
  T1,T2,T3,-------------T(M+1)
  84.340        83.827        83.142        82.247        81.125        79.802
  78.387        77.090        76.151        75.675        75.521        75.514

48 PERIOD  QAT=  77360.  QST= 1027027.  QOT=      187. HCI=1.5738 HCO=1.0021
  TAF= 103.25
  T1,T2,T3,-------------T(M+1)
  85.011        84.496        83.806        82.899        81.752        80.378
  78.875        77.445        76.352        75.751        75.535        75.523

2 HR
60 PERIOD  QAT=  80540.  QST= 1299630.  QOT=      548. HCI=1.5801 HCO=1.0194
  TAF= 104.42
```

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 46

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-86	[signature]	6/13/86					

REV.

```
T1,T2,T3,----------T(M+1)
86.230      85.713      85.015      84.091      82.904      81.453
79.809      78.160      76.791      75.939      75.578      75.552

72 PERIOD  QAT=  83383.  QST= 1572213.  QOT=     1264. HCI=1.5858 HCO=1.0360
  TAF= 105.47
  T1,T2,T3,----------T(M+1)
  87.328      86.809      86.105      85.167      83.952      82.443
  80.692      78.867      77.260      76.165      75.642      75.594

84 PERIOD  QAT=  85978.  QST= 1844538.  QOT=     2488. HCI=1.5910 HCO=1.0516
  TAF= 106.44
  T1,T2,T3,----------T(M+1)
  88.334      87.813      87.105      86.157      84.920      83.366
  81.530      79.560      77.746      76.421      75.729      75.650

96 PERIOD  QAT=  88379.  QST= 2116390.  QOT=     4377. HCI=1.5958 HCO=1.0663
  TAF= 107.33
  T1,T2,T3,----------T(M+1)
  89.268      88.746      88.035      87.079      85.824      84.233
  82.328      80.236      78.240      76.699      75.837      75.721

108 PERIOD  QAT=  90624.  QST= 2387579.  QOT=     7083. HCI=1.6004 HCO=1.0802
  TAF= 108.16
  T1,T2,T3,----------T(M+1)
  90.144      89.621      88.907      87.944      86.674      85.054
  83.089      80.894      78.736      76.995      75.967      75.804

4 IIR
120 PERIOD  QAT=  92740.  QST= 2657934.  QOT=    10755. HCI=1.6047 HCO=1.0933
  TAF= 108.95
  T1,T2,T3,----------T(M+1)
  90.971      90.448      89.731      88.763      87.480      85.834
  83.819      81.534      79.232      77.304      76.116      75.900

132 PERIOD  QAT=  94745.  QST= 2927299.  QOT=    15527. HCI=1.6087 HCO=1.1056
  TAF= 109.70
  T1,T2,T3,----------T(M+1)
  91.757      91.233      90.514      89.541      88.248      86.580
  84.521      82.156      79.725      77.626      76.282      76.006

144 PERIOD  QAT=  96656.  QST= 3195530.  QOT=    21527. HCI=1.6126 HCO=1.1172
  TAF= 110.41
  T1,T2,T3,----------T(M+1)
  92.507      91.982      91.262      90.285      88.982      87.294
  85.198      82.761      80.213      77.956      76.465      76.121

156 PERIOD  QAT=  98483.  QST= 3462504.  QOT=    28869. HCI=1.6163 HCO=1.1282
  TAF= 111.09
  T1,T2,T3,----------T(M+1)
  93.226      92.701      91.979      90.998      89.687      87.982
  85.851      83.351      80.697      78.294      76.661      76.245

168 PERIOD  QAT= 100237.  QST= 3728103.  QOT=    37656. HCI=1.6199 HCO=1.1386
  TAF= 111.75
  T1,T2,T3,----------T(M+1)
  93.917      93.391      92.668      91.683      90.366      88.645
  86.483      83.926      81.176      78.638      76.869      76.376
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CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 47

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/13/88					

REV.

6 HR 180 PERIOD QAT= 101926. QST= 3992231. QOT= 47982. HCI=1.6234 HCO=1.1484
TAF= 112.38

T1,T2,T3,----------T(M+1)					
94.583	94.057	93.332	92.345	91.020	89.286
87.097	84.488	81.650	78.986	77.088	76.513

192 PERIOD QAT= 103555. QST= 4254796. QOT= 59929. HCI=1.6268 HCO=1.1578
TAF= 112.99

T1,T2,T3,----------T(M+1)					
95.227	94.700	93.974	92.984	91.654	89.907
87.693	85.037	82.119	79.339	77.317	76.656

204 PERIOD QAT= 105131. QST= 4515719. QOT= 73569. HCI=1.6300 HCO=1.1667
TAF= 113.58

T1,T2,T3,----------T(M+1)					
95.850	95.323	94.596	93.604	92.268	90.510
88.273	85.574	82.582	79.695	77.553	76.802

216 PERIOD QAT= 106659. QST= 4774933. QOT= 88968. HCI=1.6332 HCO=1.1752
TAF= 114.15

T1,T2,T3,----------T(M+1)					
96.455	95.928	95.200	94.206	92.865	91.097
88.839	86.101	83.041	80.053	77.796	76.953

228 PERIOD QAT= 108143. QST= 5032375. QOT= 106180. HCI=1.6363 HCO=1.1833
TAF= 114.71

T1,T2,T3,----------T(M+1)					
97.044	96.516	95.788	94.791	93.446	91.668
89.392	86.617	83.495	80.412	78.045	77.106

8 HR 240 PERIOD QAT= 109587. QST= 5287995. QOT= 125256. HCI=1.6393 HCO=1.1911
TAF= 115.26

T1,T2,T3,----------T(M+1)					
97.617	97.089	96.360	95.361	94.012	92.226
89.932	87.125	83.944	80.773	78.299	77.262

264 PERIOD QAT= 112368. QST= 5793589. QOT= 169160. HCI=1.6451 HCO=1.2057
TAF= 116.30

T1,T2,T3,----------T(M+1)					
98.723	98.194	97.464	96.462	95.105	93.304
90.979	88.113	84.828	81.496	78.818	77.579

288 PERIOD QAT= 115023. QST= 6291427. QOT= 220945. HCI=1.6507 HCO=1.2191
TAF= 117.30

T1,T2,T3,----------T(M+1)					
99.781	99.252	98.520	97.515	96.153	94.338
91.987	89.070	85.694	82.219	79.348	77.901

312 PERIOD QAT= 117570. QST= 6781304. QOT= 280800. HCI=1.6561 HCO=1.2314
TAF= 118.27

T1,T2,T3,----------T(M+1)					
100.80	100.27	99.535	98.528	97.161	95.335
92.961	89.999	86.543	82.938	79.883	78.225

336 PERIOD QAT= 120025 QST= 7263080. QOT= [illegible]

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-25:

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 48

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDI-
0	PSS	6-13-88	[signature]	6/13/88						

TAF= 119.20
T1,T2,T3,----------T(M+1)

101.78	101.25	100.52	99.507	98.134	96.298
93.904	90.904	87.376	83.652	80.421	78.548

12HR 360 PERIOD QAT= 122397. QST= 7736676. QOT= 425159. HCI=1.6664 HCO=1.2537
TAF= 120.10
T1,T2,T3,----------T(M+1)

102.73	102.20	101.46	100.45	99.077	97.233
94.821	91.785	88.193	84.359	80.958	78.870

432 PERIOD QAT= 129104. QST= 9108150. QOT= 703796. HCI=1.6808 HCO=1.2819
TAF= 122.65
T1,T2,T3,----------T(M+1)

105.42	104.89	104.16	103.14	101.75	99.888
97.432	94.310	90.553	86.428	82.546	79.814

504 PERIOD QAT= 135311. QST=10406394. QOT= 1056153. HCI=1.6944 HCO=1.3056
TAF= 125.02
T1,T2,T3,----------T(M+1)

107.93	107.40	106.66	105.64	104.24	102.36
99.870	96.676	92.783	88.405	84.078	80.714

576 PERIOD QAT= 141107. QST=11633488. QOT= 1480075. HCI=1.7072 HCO=1.3257
TAF= 127.24
T1,T2,T3,----------T(M+1)

110.27	109.74	109.00	107.98	106.58	104.68
102.16	98.905	94.891	90.283	85.537	81.564

648 PERIOD QAT= 146544. QST=12792212. QOT= 1972721. HCI=1.7194 HCO=1.3433
TAF= 129.33
T1,T2,T3,----------T(M+1)

112.48	111.95	111.21	110.19	108.78	106.87
104.32	101.01	96.882	92.060	86.918	82.363

24HR 720 PERIOD QAT= 151656. QST=13885662. QOT= 2530963. HCI=1.7310 HCO=1.3586
TAF= 131.31
T1,T2,T3,----------T(M+1)

114.57	114.03	113.29	112.26	110.85	108.93
106.35	102.99	98.763	93.741	88.222	83.111

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CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-253

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 49

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE	REV. INDI-
0	PSS	6-13-88	[signature]	6/13/88						

APPENDIX D

EA

ENGINEERING EVALUATIONS

Sheet 2 of 3

PALO VERDE NUCLEAR GENERATING STATION

ENGINEERING ANALYSIS WORK SHEET

Title: INITIAL TEMPERATURES CONCRETE

TRAIN A Performed by: E.A. ZARBO Date: 6-9-88

References: START 1743
STOP 1845

Review Method by: Alternate Calcs ☐ Detailed Review ☐ Qualification Test ☐

Reviewed by: Date:

ROOM	TEMP / HUM	TEMP / HUM	AVG TEMP	AVG HUMID.
HPSI	81.3			
LPSI	81.4			
CS	80.8			
AF	100.4			
ELEC PEN 1	90.1			
EW	79.9			
ESF SWITCH GEAR	78.4			
CONTROL ROOM	75.5			
AMBIENT	100.5 START	97.8 FINISH		

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-253

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 50

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	5-13-88	[signature]	6/13/88					

EA

Sheet 3 of 3

ENGINEERING EVALUATIONS
PALO VERDE NUCLEAR GENERATING STATION
ENGINEERING ANALYSIS WORK SHEET

Title: INITIAL TEMPERATURES - CONCRETE

TRAIN B Performed by: R.A. ZAREO Date: 6-9-88

References: START 1243
STOP 1845

Review Method by: Alternate Calcs ☐ Detailed Review ☐ Qualification Test ☐

Reviewed by: Date:

ROOM	TEMP / HUM	TEMP / HUM	AVG TEMP	AVG HUMID.
HPSI	83.0			
LPSI LOCKED HIGH RAD	-			
CS	81.2			
AF	94.8			
ELEC PEN 1	92.1			
EW	79.9			
ESF SWITCH GEAR	75.1			
CONTROL ROOM	75.5			
AMBIENT	100.5 START	97.8 FINISH		

CALCULATION SHEET

PROJECT ANPP JOB NO. 18601 - 200 CALC. NO. 13-MC-HJ-2

SUBJECT TRANSIENT TEMPERATURE STUDY FOR MAIN CONTROL ROOM SHEET NO. 51

REV	ORIGINATOR	DATE	CHECKER	DATE	REV	ORIGINATOR	DATE	CHECKER	DATE
0	PSS	6-13-88	[illegible]	6/13/88					

EA

ENGINEERING EVALUATIONS Sheet 2 of 2

PALO VERDE NUCLEAR GENERATING STATION

ENGINEERING ANALYSIS WORK SHEET

Title: METEOROLOGICAL DATA TAKEN FROM MET TOWER CHARTS FOR 5/20/88 THRU 5/29/88 AND 6/9/88

Performed by: R.A. ZARBO Date: 6/10/88

References:

Review Method by: Alternate Calcs ☐ Detailed Review ☐ Qualification Test ☐

Reviewed by: Date:

DATE	HIGH TEMP (°F)
5/20/88	93.9
5/21/88	96.6
5/22/88	100.1
5/23/88	99.9
5/24/88	98.4
5/25/88	99.1
5/26/88	101.3
5/27/88	97.0
5/28/88	94.2
5/29/88	78.9
6/9/88	99.8