

CLARIFICATION NOTES  
FOR CALCULATION 13-MC-EC-253 REV. 1

1. CLARIFICATION ON TABLE 1 PERTAINING TO THE AIR THERMAL MASS FOR THE "SG" AND "DC" ROOM: THE VALUE SHOULD BE 1211.81 NOT 121.81.
2. ATTACHMENT 2 - NOTE THAT THE HEAT LOADS AND ROOM VOLUMES WERE NOT USED IN CALCULATION. THE ONLY DATA USED FROM THIS ATTACHMENT WAS THE EC FLOW (GPM) AND COIL CAPACITY (GAL.)
3. CLARIFICATION TO BE MADE ON OTHER PAGES.

THE ABOVE CLARIFICATIONS WILL BE MADE BY A REVISION TO THE CALCULATION.

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PDR ADOCK 05000528  
P PDC

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Arizona Nuclear Power Project

DOCUMENT NUMBER

13-MC-EC-253

TITLE/DESCRIPTION

E.C. SYSTEM & CONTROL ROOM  
TEMPERATURE RISE STUDY

QUALITY CLASS : Q  
SAFETY RELATED

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1	INCORP CCNTR 1 AND REVISED METHODOLOGY REPLACE REVQ IN ITS ENTIRTY	Adam 10/6/88	Doc C 10/11/88	Henry Riley 10/11/88	N/A	N/A
0	INITIAL ISSUE	Adam 7/26/88	Doc C 8/11/88	Henry Riley 8/17/88	N/A	N/A
REV	REVISION DESCRIPTION	ORIGINATOR DATE	CHECKER DATE	RS DATE	QA DATE	NEM/PEM DATE



## ENGINEERING SKETCH PAD

REV 1

BY: <i>ANON</i>	DATE: <i>10/6/88</i>	SUBJECT: <i>EC SYSTEM AND CONTROL</i>	SHEET NO.: <i>1 of 54</i>
CHECKED BY: <i>DS Li</i>	DATE: <i>10/11/88</i>	ROOM TEMPERATURE RISE STUDY	JOB NO.: <i>13-MC-EC-253</i>

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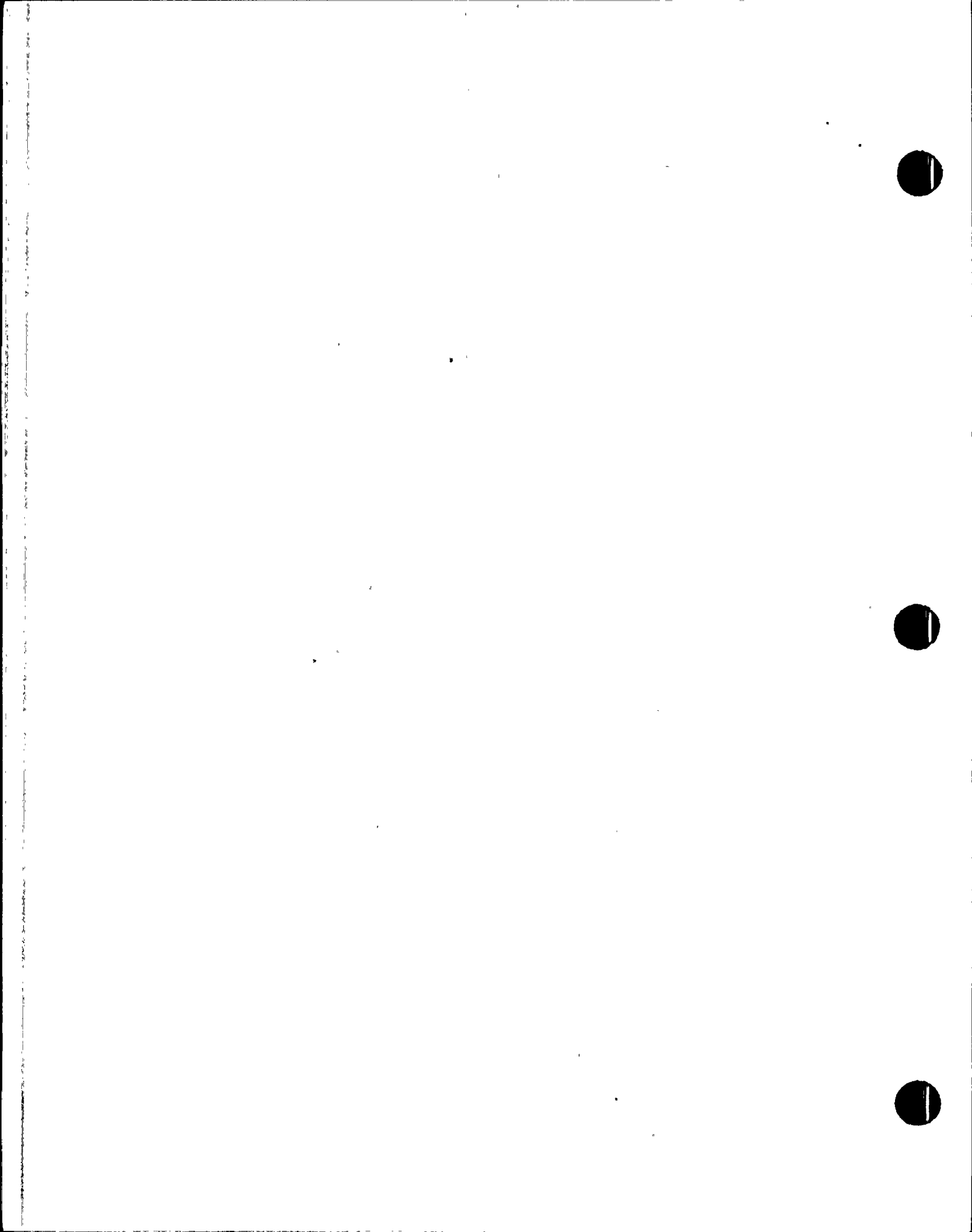
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VERIFICATION OF CONTROL ROOM  
DATA



## ENGINEERING SKETCH PAD

REV 1

BY: <i>Adnan</i>	DATE: <i>10/6/84</i>	SUBJECT: <i>EC SYSTEM AND CONTROL</i>	SHEET NO.: <i>2</i> of <i>5</i>
CHECKED BY: <i>De C</i>	DATE: <i>10/11/88</i>	<i>ROOM TEMPERATURE RISE STUDY</i>	JOB NO.: <i>13-MC-EC-2</i>

PURPOSE:

The purpose of this calculation is to determine

1. Time taken to raise EC system temperature to  
100 F

2. Temperature of ESF equipment rooms as a  
function of time

The above determination is made under LOCA & L  
conditions and when the Essential Chiller's assumed  
inoperable.

The results of this calculation are to be  
used by others to evaluate the operability of  
the safety related components under these  
unusual event.





## ENGINEERING SKETCH PAD

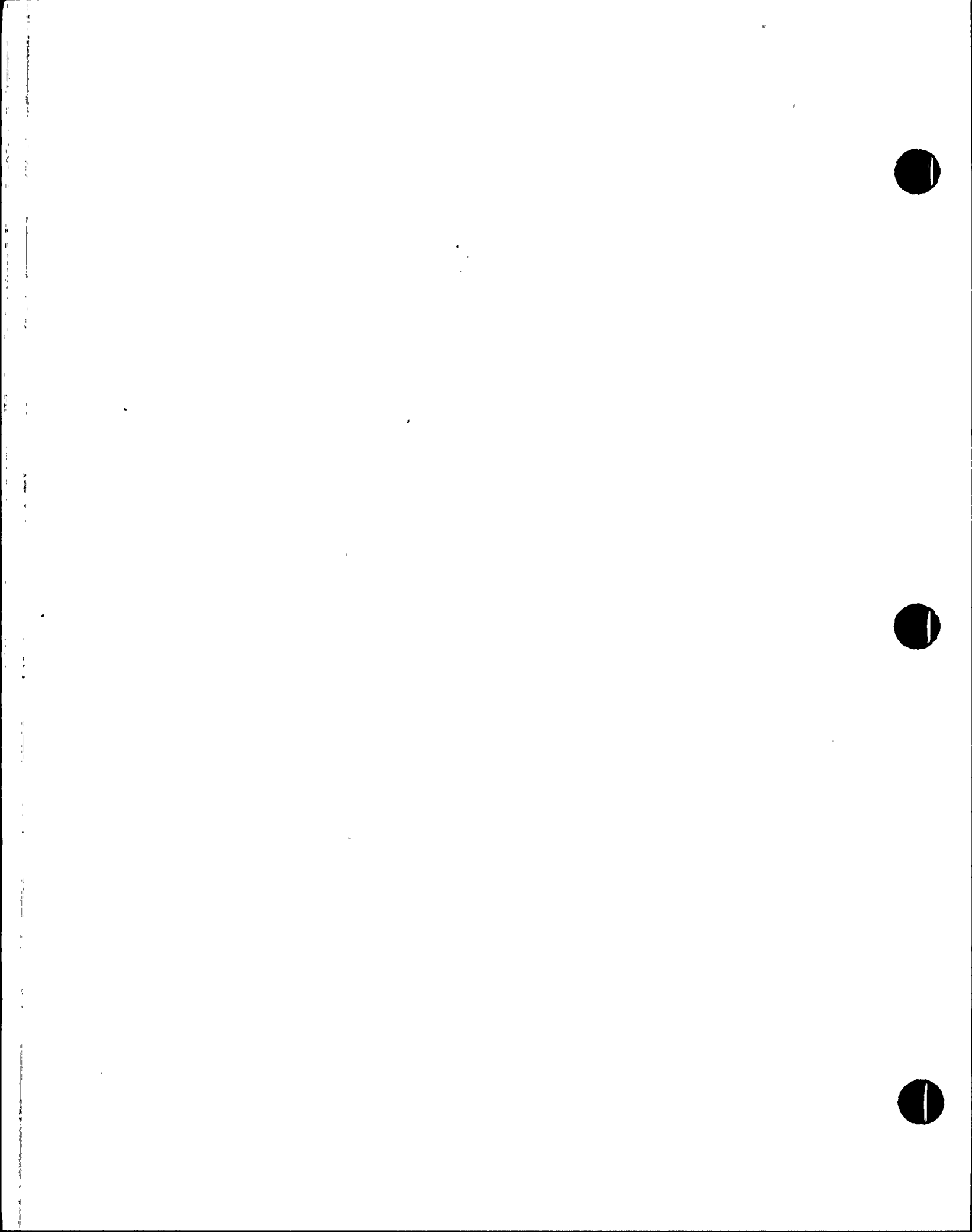
REV 1

BY: <u>Alan</u>	DATE: <u>10/6/88</u>	SUBJECT: <u>EC SYSTEM AND CONTROL</u>	SHEET NO.: <u>3 of 54</u>
CHECKED BY: <u>DSL</u>	DATE: <u>10/11/88</u>	ROOM TEMPERATURE RISE STUDY	JOB NO.: <u>13-MC-EC-253</u>

SUMMARY

It is concluded from TABLE 2 that the EC system temperature rises to 100 F in approximately 35 minutes.

Furthermore Table 2 <sup>represents</sup> is EST equipment rooms air temperature as a function of time when HVAC system is not operable. This Table can be used by others to determine the operability of safety related equipment under the conditions described in this calculations.



## ENGINEERING SKETCH PAD

REV 1

BY: <u>ADG</u>	DATE: <u>10/6/88</u>	SUBJECT: <u>EC SYSTEM AND CONTROL</u>	SHEET NO.: <u>4 of 54</u>
CHECKED BY: <u>DL</u>	DATE: <u>10/11/88</u>	ROOM TEMPERATURE RISE STUDY	JOB NO.: <u>13-MC-EC-2</u>

CRITERIA AND ASSUMPTIONS

The basic applicable criteria to the ESF equipment rooms is that the temperature of each room does not exceed the values stated in PUNGS FSAR TABLE 3E-1. This calculation provides temperature histories in excess of the design basis values in order to determine the margin above the design basis for equipment operability.

The equations describing the room heat-up energy are derived from an energy balance for room air, heat sinks and EC water. The following basic assumptions were made to arrive at a simplified system of equations:

1. The air in each room is assumed well mixed (neglect temperature stratification) and the air properties were assumed constant during the transient.



## ENGINEERING SKETCH PAD

REV 1

BY: <i>Albany</i>	DATE: 10/6/88	SUBJECT: EC SYSTEM AND CONTROL	SHEET NO.: 5 of 54
CHECKED BY: <i>De Li</i>	DATE: 10/11/88	ROOM TEMPERATURE RISE STUDY	JOB NO.: 13-MC-EC-253

2. The chilled water is well mixed (neglect temperature spatial distribution) and the water thermal properties were assumed constant during the transient.

3. The only heat sink considered is the room concrete wall. Other heat sinks are neglected in all rooms with exception of the control room (see Appendix B for further analysis).

4. The heat sources in each room are the design basis values with exception of the control room (see Appendix B for further details).



## ENGINEERING SKETCH PAD

REV 1

BY: <u>ADam</u>	DATE: <u>10/6/88</u>	SUBJECT: <u>EC SYSTEM AND CONTROL</u>	SHEET NO.: <u>6 of 54</u>
CHECKED BY: <u>Des Lin</u>	DATE: <u>10/11/88</u>	<u>ROOM TEMPERATURE RISE STUDY</u>	JOB NO.: <u>13-MC-EC-25</u>

INPUT DATA

The model developed in this calculation requires the following input data relating to the ESF equipment rooms serviced by the chilled water system:

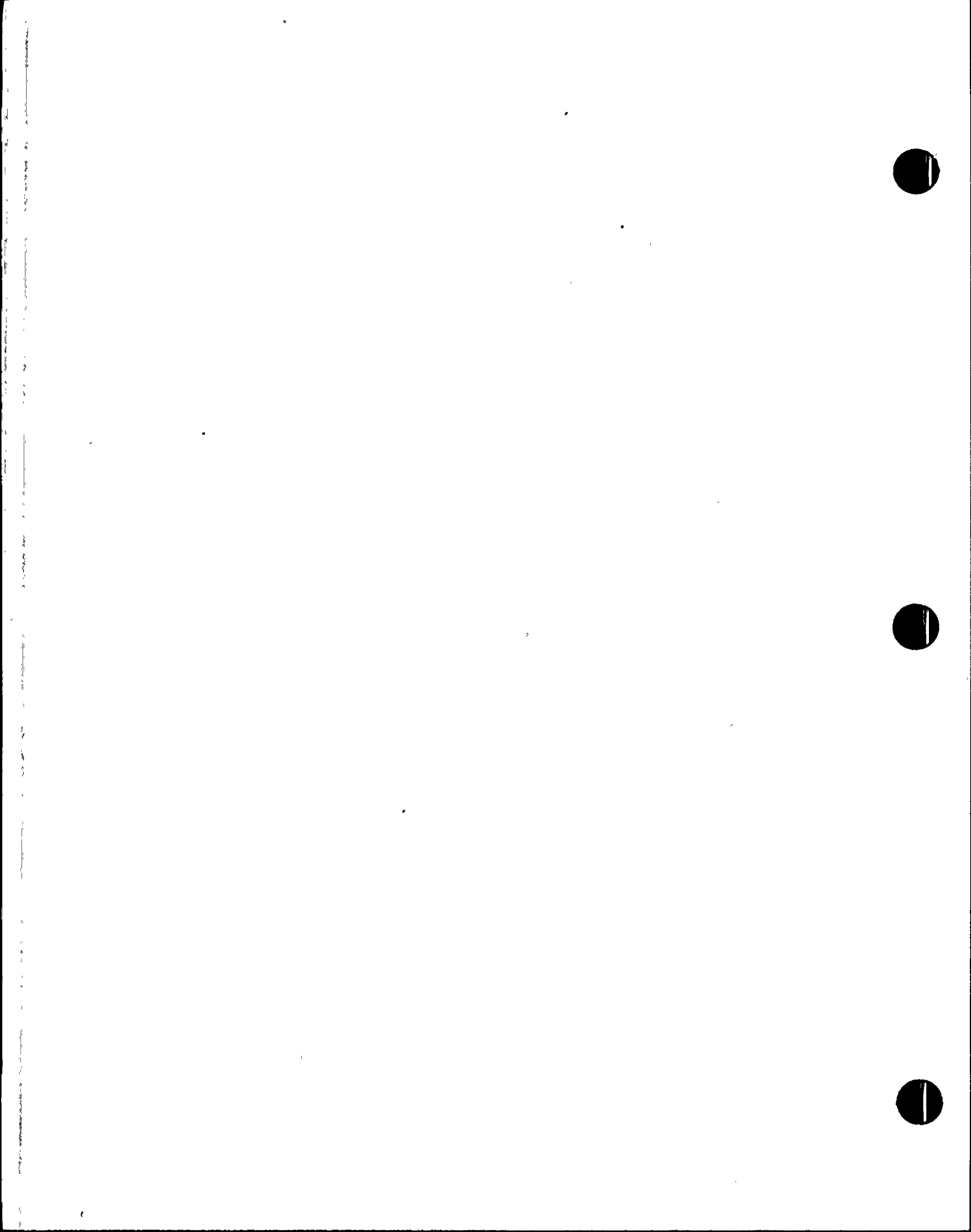
1. Initial equipment rooms temperature which <sup>were</sup> ~~was~~ obtained from actual measurements. (See attachment 1)

2. Initial equipment room concrete wall temperature which were assumed slightly less than air temperature <sup>compute</sup>. This is a code requirement to avoid dividing by zero.

3. The air thermal masses ( $\rho \cdot C \cdot V$ ,  $\rho$  = density of air,  $C$  = specific heat of air at constant pressure,  $V$  = Room air volume) which were obtained from BPC calculations (REF 1 thro' 8)

4. Equipment heat loads were also obtained from BPC calculations (REF 1 thro' 8) with exception of the control room (See Appendix B) and REF 10)

5. Air to concrete wall transmissivities ( $H_c A_c$ ,  $H_c$  = Heat transfer coefficient,  $A_c$  = concrete surface area) were also obtained from





# ENGINEERING SKETCH PAD

REV 1

BY: <i>ADW</i>	DATE: 10/16/88	SUBJECT: EC system and control	SHEET NO.: 7 of 54
CHECKED BY: <i>AS</i>	DATE: 10/11/88	room temperature rise study	JOB NO.: 13-MC-EC-253

(REF 1 thro' 8.) with the exception of the control room heat up test as described in Appendix B

6. Finally, to model the heat transfer between air and chilled water across the respective air handling units (AHU's), The transmissivity of the AHU were obtained as follows, using the AHU data in Attachment 2

The heat transfer from air to water across the AHU,  $Q_i$  is given by

$$Q_i = \epsilon_i m_{a_i} C_{a_i} (T_{a_i} - T_w) \quad (\text{REF. 11})$$

where

$\epsilon_i$  = Effectiveness of AHU assumed constant thro' transient

$m_{a_i}$  = Mass flow rate of air thro' AHU assumed constant thro' transient (lb/min)

$C_{a_i}$  = Specific heat of air, assumed constant thro' transient, Btu/lb F

$T_{a_i}$  = Air temperature entering the AHU, F

$T_w$  = Chilled water temperature

Then  $h_i = \epsilon_i m_{a_i} C_{a_i} = \frac{Q_i}{(T_{a_i} - T_w)}$ , Btu/Fmin

is obtained from Attachment 2

All input data are summarized in Table 1



# ENGINEERING SKETCH PAD

REV. 1

DATE 10/16/88	SUBJECT EC System & Control Room	SHEET NO. 8 of 54
DATE 10/11/88	TEMPERATURE RISE STUDY	JOB NO. 13-MC-EC-253

	TABLE 1	INPUT	TO	HELM (2 C.R. FAN & EC FLOW)		
	(A) INITIAL AIR-PT	(B) INITIAL CALCULATE OF	(C) AIR TEMPERATURE HEAT LOAD MASS-BTU/1 Q-BTU/hr	(D) TRANSMISSIVITY-BTU/hr/1" WALL-H <sub>2</sub> O CHILLED H <sub>2</sub> O-H <sub>2</sub> O (1)		
ECN Room	78.3	78	147.48	2296.40	75.66	60
CONT. Room	75.5	75	2649.15	17105	1000.26	365
SEED Room	85	78.4	121.81	6239.73	354.54	125
AIR FEED	91.2	97	160.32	2031.55	73.3	69.5
HP51 Room	80.3	80	151.58	2468.53	59.79	73.5
HP51 Room	78.8	78	155.65	2401.65	70.68	42
CS Room	78.8	78	155.65	2401.65	70.68	62.7
Kit	A: Actual and Temperature per Calc	B: Assume concrete Temp	C: 13-MC-HU-255- Two Fan operation	D: Per Table 1	E: 13-MC-EC-253 Sheet 5 of 20	F: 13-MC-EC-253 Sheet 19
E: Bechtel NE-204 Data	EXCEPT C.R. Heat Load & H <sub>c</sub> (Eq. 1-8)					

1: Adjusted H<sub>c</sub> (Per Appendix B)



## ENGINEERING SKETCH PAD

REV 1

BY: <u>Adrian</u>	DATE: <u>10/6/88</u>	SUBJECT: <u>EC SYSTEM AND CONTROL</u>	SHEET NO.: <u>9</u> of <u>54</u>
CHECKED BY: <u>de C</u>	DATE: <u>10/11/88</u>	<u>ROOM TEMPERATURE RISE STUDY</u>	JOB NO.: <u>13-HC-EC-253</u>

CALCULATION :

The purpose of this section is to formulate the equations used to calculate the transient ESF equipment room temperature with EC flow. Secondly, the input required to perform the calculation is defined and finally the results are presented.

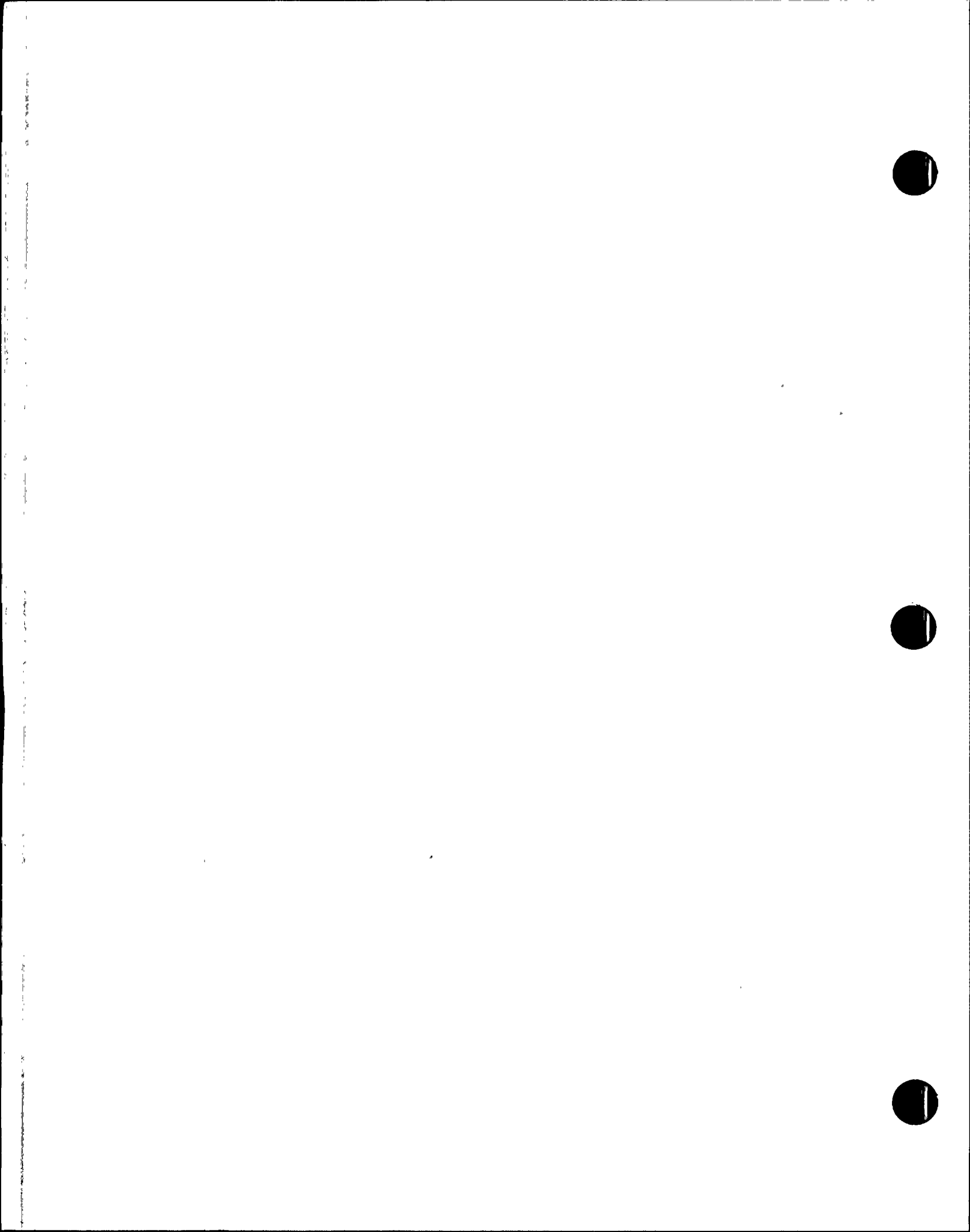
Verification of the algorithm is shown in Appendix A and the validation of input data for the control room is shown in Appendix B.

DESCRIPTION OF THE ALGORITHM:

To calculate the transient ESF equipment rooms temperature with EC flow, an energy balance on the system shown in FIG 1 was performed.

For each ESF room two equations are written: one equation represents the air energy balance and the second one represents the concrete wall energy balance. Additionally, an equation describing EC water energy balance is also written. Thus, the model consists of a total of  $2 \times N + 1$  ordinary differential equations to be solved simultaneously; ( $N$  is the number of rooms under consideration; Eight in this case).

The system of coupled differential equations are then solved numerically using the Euler method.

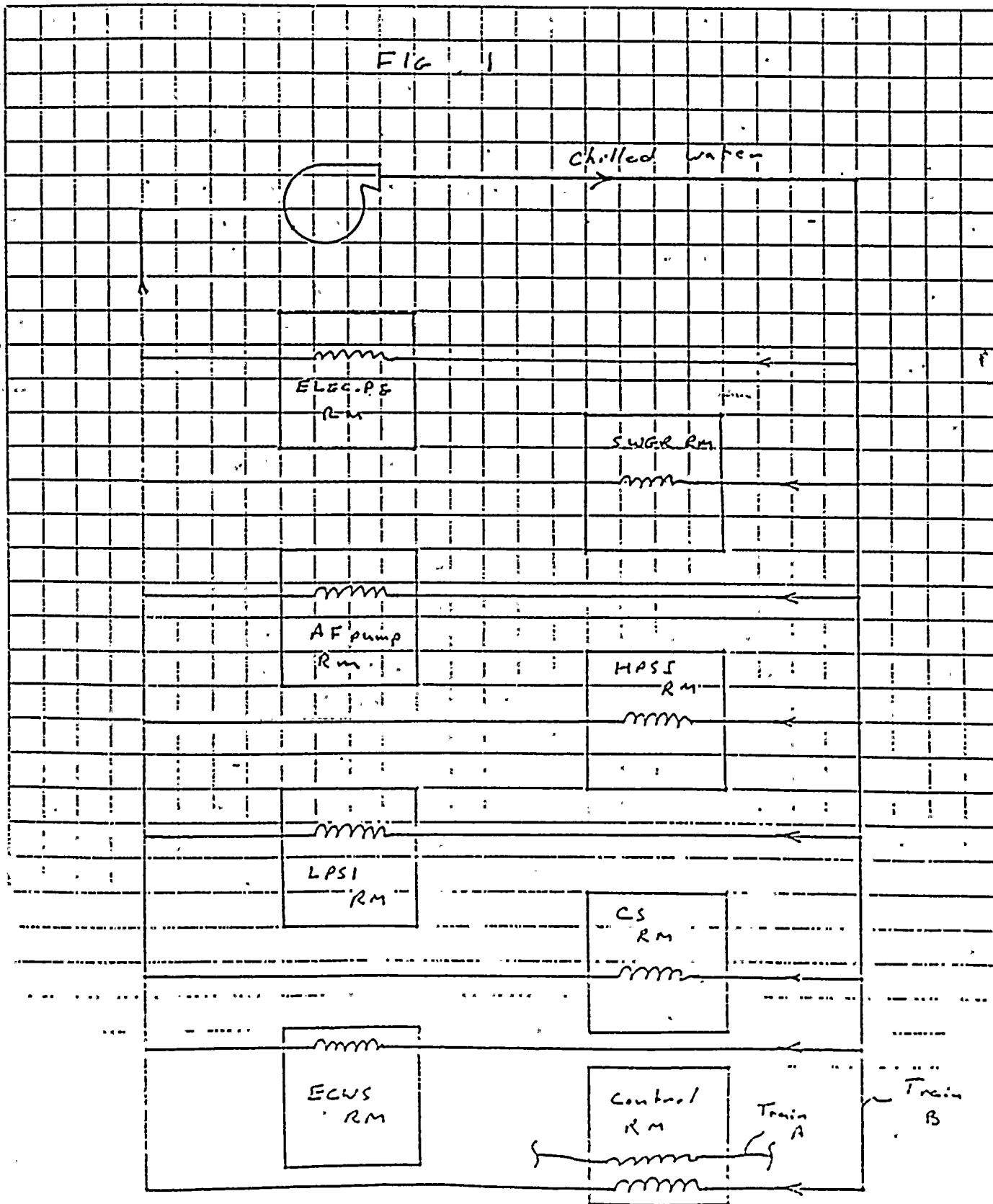


# ENGINEERING SKETCH PAD

REV 1

BY: <i>Adams</i>	DATE: 10/6/88	SUBJECT: EC system & control room	SHEET NO: 10 of 50
CHECKED BY: <i>DB</i>	DATE: 10/11/88	temperature rise study	JOB NO: 13-MC-EC-25

FIG 1







# ENGINEERING SKETCH PAD

REV 1

BY: <i>ASL</i>	DATE: 10/6/88	SUBJECT: EC system & control room	SHEET NO.: 11 of 54
CHECKED BY: <i>ASL</i>	DATE: 10/11/88	temperature rise study	JOB NO.: 13-MC-EC-25

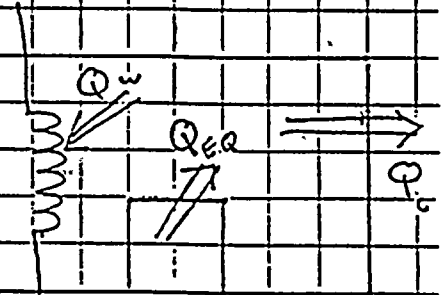
Air Energy balance :

For each room the air energy balance is written as follows (See Fig. 2)

The rate of air energy increase

$$= \dot{Q}_{in} - \dot{Q}_{out}$$

$$= \dot{Q}_{EQ} - \dot{Q}_w - \dot{Q}_c$$



Where:

$\dot{Q}_{EQ}$  = Heat generated by equipment

$\dot{Q}_w$  = Heat loss to chilled water

$\dot{Q}_c$  = Heat loss to concrete

This energy balance can then be expanded as follows

$$\rho_{ai} C_{ai} V_{ai} \frac{dT_{ai}}{dt} = \dot{Q}_{EQ} - H_{wi} A_{wi} (T_{ai} - T_w) - H_{ci} A_{ci} (T_{ai} - T_{ci})$$

Where :

$\rho$  = Density

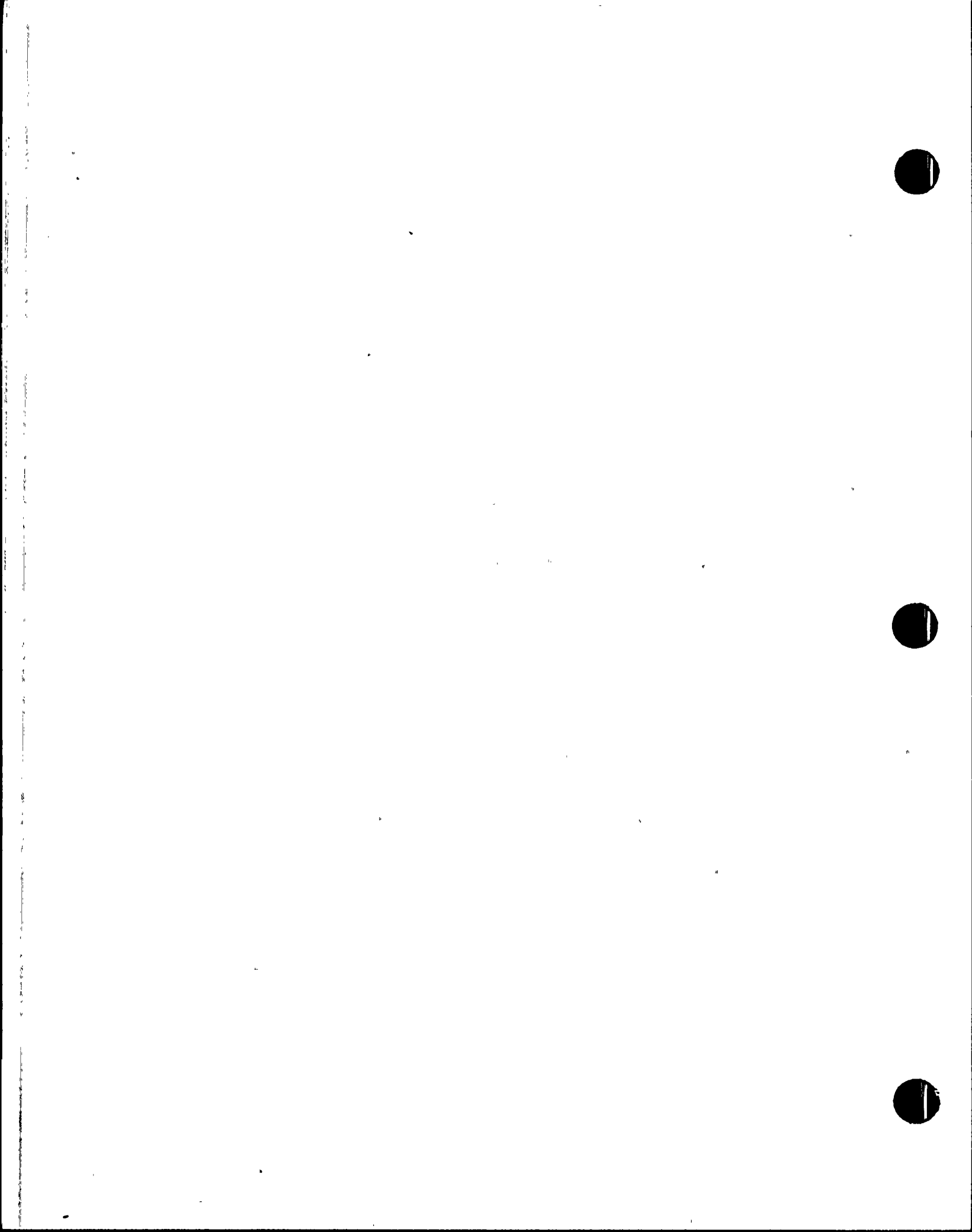
$C$  = Specific heat

$V$  = Volume

$H$  = Heat transfer coefficient

$A$  = Surface area for heat transfer

$T$  = Temperature



## ENGINEERING SKETCH PAD

REV 1

BY <i>ADAM</i>	DATE 10/6/86	SUBJECT EC system & Control room	SHEET NO. 12 of 54
CHECKED BY <i>ESL</i>	DATE 10/11/88	temperature rise study	JOB NO. 13-MC-EC-253

Subscripts

 $a_i$  - Air in room "i" $w$  - water average property $w_i$  - water in room "i" $c_i$  - Concrete in room "i"

Note

In this model the values of  $R, C, V, H, A$  and  $Q$  are assumed known and remain constant throughout the calculation.

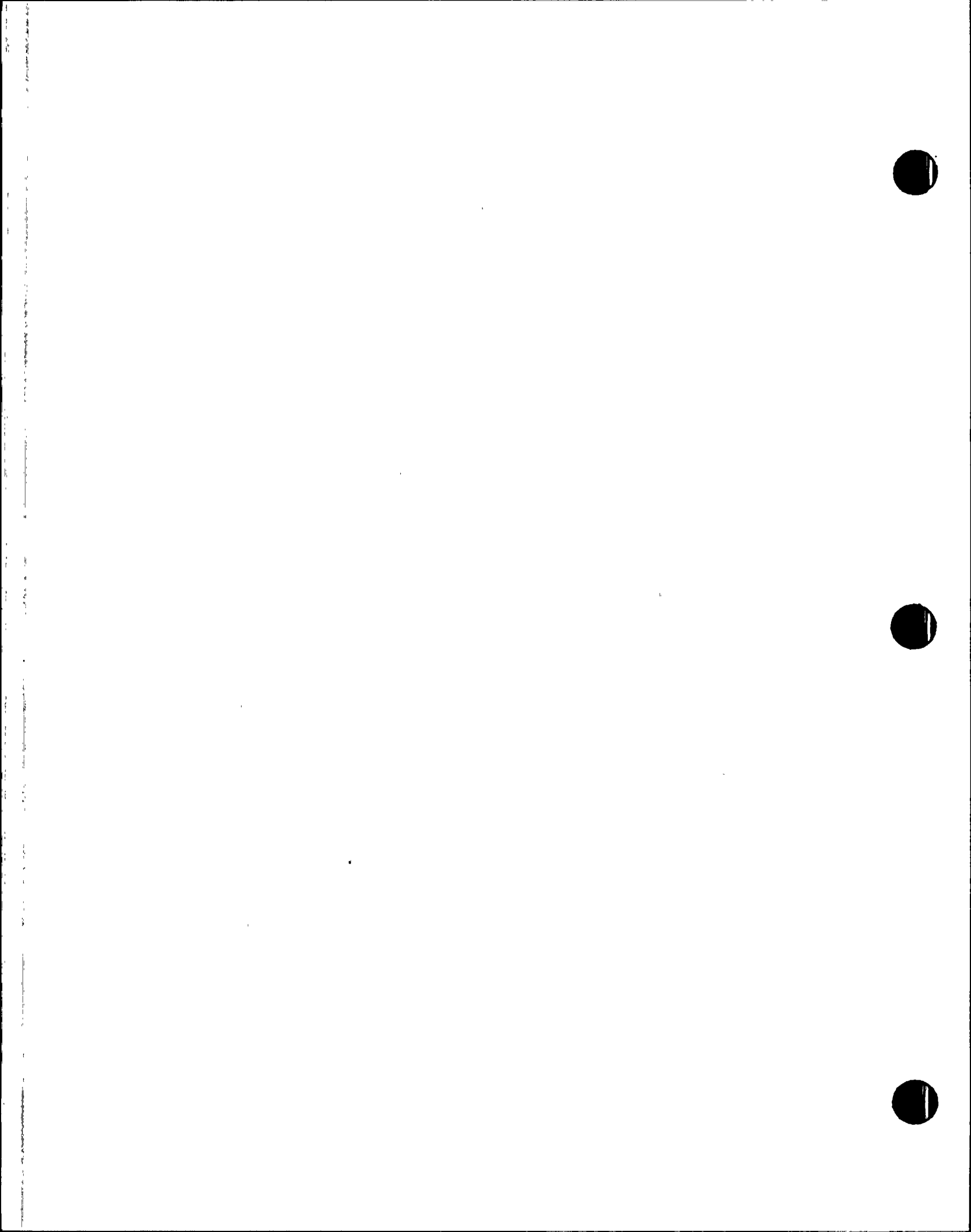
CHILLED WATER ENERGY BALANCE

The rate of water energy increase

$$= \dot{Q}_{in}$$

$$\text{i.e. } \sum_{i=1}^N H w_i A w_i (T_{a_i} - T_w) \quad (2)$$

where the summation  $\Sigma$  is carried over all the "N" rooms.



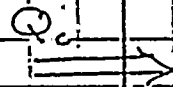
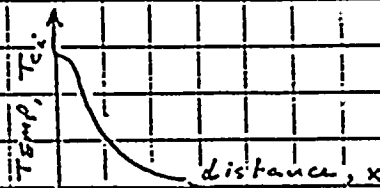
## ENGINEERING SKETCH PAD

REV 1

BY: <u>ADW</u>	DATE: <u>10/6/88</u>	SUBJECT: <u>EC system &amp; control room</u>	SHEET NO.: <u>13 of 54</u>
CHECKED BY: <u>ADW</u>	DATE: <u>10/11/88</u>	<u>temperature rise study</u>	JOB NO.: <u>13-MC-EC-25</u>

Concrete energy balance:

Refer to FIG - 3



AIR

CONCRETE

FIG - 3

The concrete cannot be lumped as was done for the air and water equations i.e. the air and water temperature can be assumed homogeneous. However the concrete temperature <sup>can</sup> not be realistically modelled as constant along the wall depth. In actuality the concrete surface temperature  $T_{ci}$  decreases monotonically to the initial concrete temperature  $T_{ci0}$  at a "penetration depth" of  $X$ .

Both  $T_{ci}$  and  $X$  increase with time as more heat is transferred to the concrete.



# ENGINEERING SKETCH PAD

REV 1

BY: <u>ADAN</u>	DATE: <u>10/6/88</u>	SUBJECT: <u>EC systeming &amp; control room</u>	SHEET NO.: <u>14 of 51</u>
CHECKED BY: <u>AS Lin</u>	DATE: <u>10/11/88</u>	<u>temperature rise study</u>	JOB NO.: <u>13-MC-EC-2</u>

To model these effects without the need to solve a system of "partial" differential equations an integral method developed by Goodman was used in this algorithm.

(Application of Integral methods to transient nonlinear heat transfer. Advances in heat transfer Vol. I Academic Press N.Y. 1964)  
(REF 9)

In particular Goodman's method yields the following ordinary differential equation for concrete energy balance

$$\frac{d}{dt} \left\{ \frac{(T_{ci} - T_{cio})^2}{f} \right\} = \frac{4}{3} \alpha_i f$$

where

$f$  = Heat transfer from air to concrete per unit area

$$= (H_{ci}/K_{ci}) (T_{ae} - T_{ci})$$

$K_{ci}$  = Concrete thermal conductivity in room "i"

$\alpha_i$  = Thermal diffusivity in room "i" of concrete

$$= K_{ci} / \rho_{ci} C_{ci}$$

The Goodman's equation can be rearranged

to yield where  $Z_i = (T_{ci} - T_{cio})$





# ENGINEERING SKETCH PAD

REV-1

BY: <u>ADW</u>	DATE: <u>10/6/88</u>	SUBJECT: <u>EC system { Control room</u>	SHEET NO.: <u>15</u> of <u>54</u>
CHECKED BY: <u>DO</u>	DATE: <u>10/16/88</u>	<u>temperature rise study</u>	JOB NO.: <u>13-MC-EC-25</u>

$$\frac{dZ^2}{dt} = \frac{4}{3} \alpha_i f^3 / (-f + Z H_c / 2 K_c) \quad (3.1)$$

## SUMMARY

The above discussion reduced the system inside of FIG C-1, to a system of  $(2N+1)$  first order ordinary differential equations which are repeated here for clarity.

For  $i = 1, N$

$$S_{ac} C_{ac} V_{ac} \frac{dT_{ac}}{dt} = Q_{EQ} - H_w A_{wc} (T_{ac} - T_w) - H_c A_{cc} (T_{ac} - T_{cc})$$

Ans (3.1)

$$\frac{dZ^2}{dt} = \frac{4}{3} \alpha_i f^3 / (-f + Z H_c / 2) \quad \text{Ans (3.2)}$$

$$\text{and } S_w C_w \frac{dT_w}{dt} = \sum_{i=1}^N H_{wi} A_{wi} (T_{ci} - T_w) \quad \text{Ans (3.3)}$$



RGV 1

## Numerical Solution

A simple integration scheme is provided by the Euler method. "Modern Introduction to Differential Equations" SCHLANN OUTLINE SERIES

$$\frac{dT}{dt} = f(T, t)$$
$$T_{t+\Delta t} = T_t + \Delta t f(T_t, t) \quad (4)$$

where  $\Delta t$  is time step selected for the problem



## ENGINEERING SKETCH PAD

REV 1

BY: <i>ADAM</i>	DATE: <i>10/6/88</i>	SUBJECT: <i>EC SYSTEM AND CONTROL</i>	SHEET NO.: <i>17 of 54</i>
CHECKED BY: <i>DS</i>	DATE: <i>10/11/88</i>	ROOM TEMPERATURE RISE STUDY	JOB NO.: <i>13-MC-EC-253</i>

VALIDATION OF EQUATIONS

Equations 1, 2 and 3 were written in the form of equation 4 in BASIC FORMAT and calculations were performed on an IBM PC using a time step of 0.1 minutes.

To determine the validity of the calculation, the ANPP method was benchmarked against references 1 thro' 8; The results of this validation are detailed in APPENDIX A

VERIFICATION OF INPUT DATA FOR THE CONTROL ROOM

To remove conservatism of the control room input data (control room heat load and control room heat sink transmissivity), a heat-up test was performed on the control room and input

data were refined to reproduce test results (see Appendix B)



## ENGINEERING SKETCH PAD

REV 1

BY: <i>ADW</i>	DATE: 10/11/88	SUBJECT: EC System and Control	SHEET NO.: 18 of 54
CHECKED BY: <i>AS</i>	DATE: 10/11/88	room temperature rise study	JOB NO.: 13 MC-EC-25

ESF EQUIPMENT ROOM TEMPERATURE HISTORIES

Having validated the calculation model and verifying the input data for the control room, a calculation was performed with the input data shown in TABLE 1 in the input data section. The results are summarized in TABLE 2 which documents the ESF Equipment room's temperature reported every minute up to 510 minutes. These results were then transferred to others to evaluate the operability of safety related ~~cond~~ components under these conditions.





# TABLE 2 2 C.R. FANS & EC FLOW

SHEET: 190854  
13-MC-EC-253  
REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFF RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
0	86.8	85	97.2	80.3	78.8	78.8	78.3	75.5	78
1	88.01	87.17	100.1	90.71	89.74	89.09	88.71	80.79	78.47
2	88.94	88.76	101.5	95.21	95.21	93.64	93.02	83.70	79.29
3	89.67	89.96	102.4	97.43	98.14	95.89	95.07	85.45	80.24
4	90.26	90.90	103.1	98.74	99.86	97.20	96.24	86.61	81.24
5	90.76	91.66	103.7	99.67	100.9	98.12	97.06	87.47	82.23
6	91.18	92.31	104.2	100.4	101.8	98.86	97.74	88.17	83.21
7	91.56	92.87	104.8	101.1	102.5	99.51	98.35	88.77	84.15
8	91.89	93.37	105.3	101.8	103.1	100.1	98.92	89.32	85.06
9	92.20	93.82	105.8	102.4	103.6	100.6	99.46	89.84	85.94
10	92.48	94.23	106.3	103.0	104.1	101.2	99.97	90.32	86.78
11	92.74	94.62	106.8	103.6	104.6	101.7	100.4	90.79	87.59
12	92.98	94.98	107.2	104.1	105.1	102.2	100.9	91.23	88.37
13	93.22	95.32	107.7	104.6	105.5	102.7	101.4	91.66	89.12
14	93.44	95.65	108.1	105.1	106.0	103.2	101.8	92.08	89.84
15	93.65	95.97	108.5	105.6	106.4	103.6	102.2	92.47	90.53
16	93.85	96.27	108.9	106.1	106.8	104.0	102.6	92.86	91.19
17	94.04	96.56	109.3	106.6	107.2	104.5	103.0	93.23	91.83
18	94.23	96.84	109.6	107.0	107.5	104.9	103.4	93.59	92.44
19	94.41	97.11	110.0	107.4	107.9	105.2	103.8	93.93	93.03
20	94.58	97.37	110.3	107.9	108.2	105.6	104.1	94.27	93.60
21	94.75	97.62	110.7	108.3	108.6	106.0	104.5	94.59	94.14
22	94.91	97.86	111.0	108.6	108.9	106.3	104.8	94.91	94.67
23	95.07	98.10	111.3	109.0	109.2	106.7	105.2	95.21	95.18
24	95.22	98.33	111.6	109.4	109.5	107.0	105.5	95.50	95.66
25	95.37	98.55	111.9	109.7	109.8	107.3	105.8	95.79	96.13
26	95.51	98.77	112.2	110.1	110.1	107.6	106.1	96.06	96.58
27	95.65	98.98	112.5	110.4	110.4	107.9	106.4	96.33	97.02
28	95.79	99.19	112.7	110.7	110.6	108.2	106.6	96.59	97.44
29	95.92	99.38	113.0	111.0	110.9	108.5	106.9	96.84	97.85
30	96.05	99.58	113.2	111.3	111.1	108.8	107.2	97.09	98.24
31	96.17	99.77	113.5	111.6	111.4	109.1	107.4	97.32	98.61
32	96.29	99.95	113.7	111.9	111.6	109.3	107.7	97.55	98.98
33	96.41	100.1	113.9	112.1	111.9	109.6	107.9	97.78	99.33
34	96.53	100.3	114.2	112.4	112.1	109.8	108.1	98.00	99.67
35	96.64	100.4	114.4	112.7	112.3	110.0	108.4	98.21	100.0
36	96.75	100.6	114.6	112.9	112.5	110.3	108.6	98.42	100.3
37	96.86	100.8	114.8	113.2	112.7	110.5	108.8	98.62	100.6
38	96.96	100.9	115.0	113.4	112.9	110.7	109.0	98.81	100.9
39	97.06	101.1	115.2	113.6	113.2	110.9	109.2	99.00	101.2
40	97.16	101.2	115.4	113.8	113.3	111.1	109.4	99.19	101.4
41	97.26	101.4	115.6	114.1	113.5	111.4	109.6	99.37	101.7
42	97.35	101.5	115.7	114.3	113.7	111.5	109.8	99.55	102.0
43	97.45	101.6	115.9	114.5	113.9	111.7	110.0	99.72	102.2
44	97.54	101.8	116.1	114.7	114.1	111.9	110.2	99.89	102.5
45	97.63	101.9	116.2	114.9	114.3	112.1	110.4	100.0	102.7
46	97.71	102.1	116.4	115.1	114.4	112.3	110.5	100.2	103.0
47	97.80	102.2	116.6	115.3	114.6	112.5	110.7	100.3	103.2
48	97.88	102.3	116.7	115.4	114.8	112.6	110.9	100.5	103.4
49	97.96	102.4	116.9	115.6	114.9	112.8	111.0	100.6	103.6
50	98.04	102.6	117.0	115.8	115.1	113.0	111.2	100.8	103.8
51	98.12	102.7	117.1	116.0	115.2	113.1	111.3	100.9	104.0

CHECKED BY: Jim D. D. 9-29-88

EC System & Control Room  
temperature rise study.



SHEET. 20 of 23  
13-MC-EC-253  
REV 1

CHECKED By: Jim Brown 9-25-88

By: ~~AS~~ C. 9/22/88

EC System & Control Room  
Temperature rise study

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
52	98.20	102.8	117.3	116.1	115.4	113.3	111.5	101.1	104.2
53	98.27	102.9	117.4	116.3	115.5	113.4	111.6	101.2	104.4
54	98.35	103.0	117.6	116.4	115.7	113.6	111.8	101.3	104.6
55	98.42	103.1	117.7	116.6	115.8	113.7	111.9	101.5	104.8
56	98.49	103.2	117.8	116.8	116.0	113.9	112.1	101.6	105.0
57	98.56	103.3	117.9	116.9	116.1	114.0	112.2	101.7	105.1
58	98.63	103.5	118.1	117.1	116.3	114.2	112.3	101.8	105.3
59	98.70	103.6	118.2	117.2	116.4	114.3	112.5	102.0	105.5
60	98.77	103.7	118.3	117.3	116.5	114.5	112.6	102.1	105.6
61	98.83	103.8	118.4	117.5	116.6	114.6	112.7	102.2	105.8
62	98.90	103.9	118.5	117.6	116.8	114.7	112.9	102.3	105.9
63	98.96	104.0	118.6	117.7	116.9	114.8	113.0	102.4	106.1
64	99.03	104.1	118.8	117.9	117.0	115.0	113.1	102.5	106.2
65	99.09	104.1	118.9	118.0	117.1	115.1	113.2	102.7	106.4
66	99.15	104.2	119.0	118.1	117.3	115.2	113.3	102.8	106.5
67	99.21	104.3	119.1	118.3	117.4	115.3	113.5	102.9	106.6
68	99.27	104.4	119.2	118.4	117.5	115.5	113.6	103.0	106.8
69	99.33	104.5	119.3	118.5	117.6	115.6	113.7	103.1	106.9
70	99.38	104.6	119.4	118.6	117.7	115.7	113.8	103.2	107.0
71	99.44	104.7	119.5	118.7	117.8	115.8	113.9	103.3	107.2
72	99.50	104.8	119.6	118.9	118.0	115.9	114.0	103.4	107.3
73	99.55	104.9	119.7	119.0	118.1	116.0	114.1	103.5	107.4
74	99.61	104.9	119.8	119.1	118.2	116.1	114.2	103.6	107.5
75	99.66	105.0	119.9	119.2	118.3	116.2	114.3	103.7	107.7
76	99.71	105.1	119.9	119.3	118.4	116.3	114.4	103.8	107.8
77	99.77	105.2	120.0	119.4	118.5	116.4	114.5	103.9	107.9
78	99.82	105.3	120.1	119.5	118.6	116.5	114.6	103.9	108.0
79	99.87	105.3	120.2	119.6	118.7	116.6	114.7	104.0	108.1
80	99.92	105.4	120.3	119.7	118.8	116.7	114.8	104.1	108.2
81	99.97	105.5	120.4	119.8	118.9	116.8	114.9	104.2	108.3
82	100.0	105.6	120.5	119.9	119.0	116.9	115.0	104.3	108.4
83	100.0	105.7	120.5	120.0	119.1	117.0	115.1	104.4	108.5
84	100.1	105.7	120.6	120.1	119.2	117.1	115.2	104.5	108.6
85	100.1	105.8	120.7	120.2	119.3	117.2	115.3	104.6	108.7
86	100.2	105.9	120.8	120.3	119.4	117.3	115.4	104.6	108.8
87	100.2	106.0	120.9	120.4	119.5	117.4	115.5	104.7	108.9
88	100.3	106.0	120.9	120.5	119.6	117.5	115.6	104.8	109.0
89	100.3	106.1	121.0	120.6	119.6	117.6	115.7	104.9	109.1
90	100.4	106.2	121.1	120.7	119.7	117.7	115.7	105.0	109.2
91	100.4	106.2	121.2	120.8	119.8	117.8	115.8	105.0	109.3
92	100.5	106.3	121.2	120.9	119.9	117.9	115.9	105.1	109.4
93	100.5	106.4	121.3	120.9	120.0	117.9	116.0	105.2	109.5
94	100.5	106.4	121.4	121.0	120.1	118.0	116.1	105.3	109.6
95	100.6	106.5	121.5	121.1	120.2	118.1	116.2	105.3	109.7
96	100.6	106.6	121.5	121.2	120.3	118.2	116.3	105.4	109.7
97	100.7	106.6	121.6	121.3	120.3	118.3	116.3	105.5	109.8
98	100.7	106.7	121.7	121.4	120.4	118.4	116.4	105.6	109.9
99	100.8	106.8	121.7	121.5	120.5	118.4	116.5	105.6	110.0
100	100.8	106.8	121.8	121.5	120.6	118.5	116.6	105.7	110.1
101	100.8	106.9	121.9	121.6	120.7	118.6	116.7	105.8	110.2
102	100.9	107.0	122.0	121.7	120.8	118.7	116.7	105.9	110.2

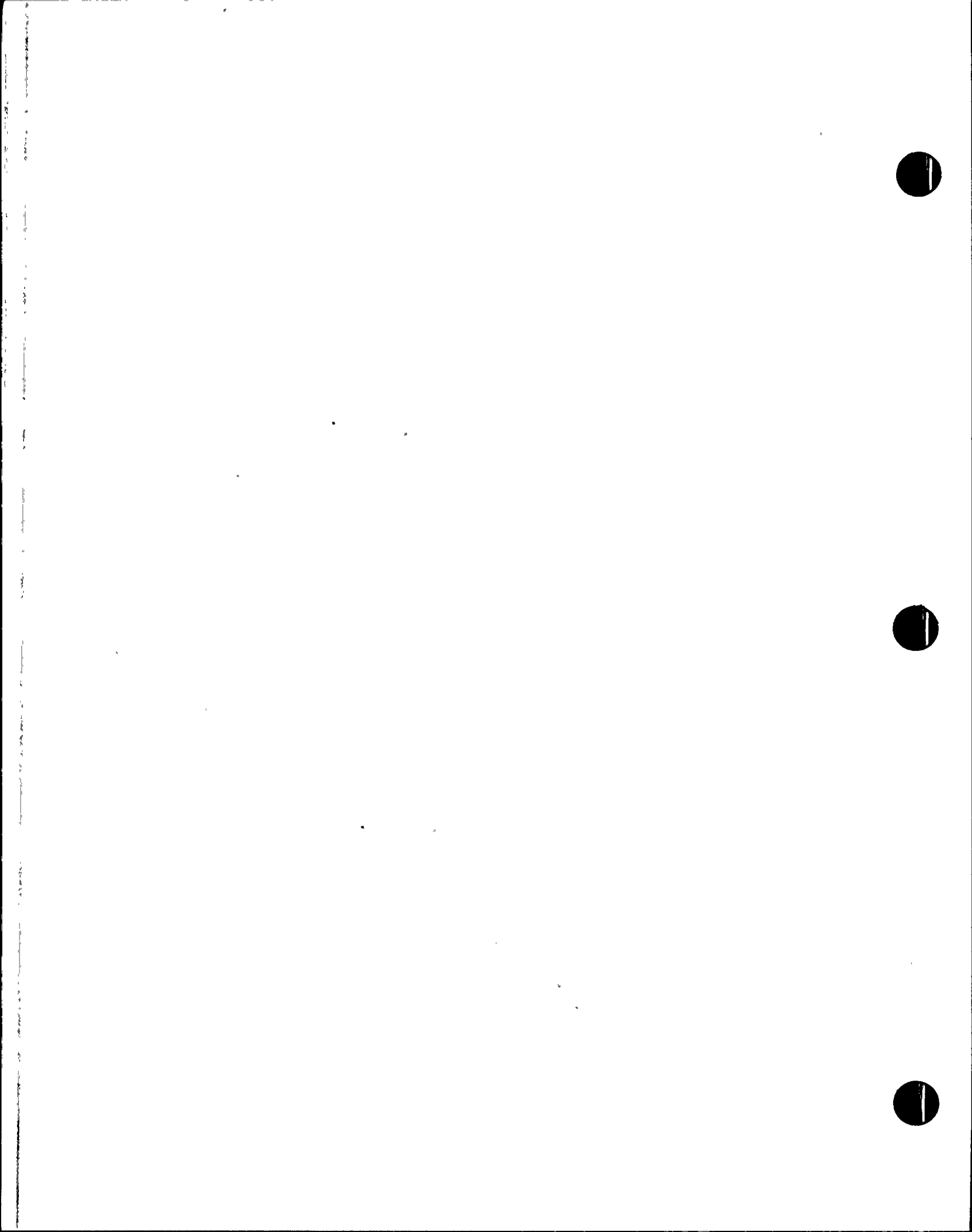


SHEET 21 of 51  
13 MC-EC-253  
REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
103	100.9	107.0	122.0	121.8	120.8	118.8	116.8	105.9	110.3
104	101.0	107.1	122.1	121.9	120.9	118.8	116.9	106.0	110.4
105	101.0	107.2	122.2	121.9	121.0	118.9	117.0	106.1	110.5
106	101.0	107.2	122.2	122.0	121.1	119.0	117.0	106.1	110.5
107	101.1	107.3	122.3	122.1	121.2	119.1	117.1	106.2	110.6
108	101.1	107.3	122.4	122.2	121.2	119.2	117.2	106.3	110.7
109	101.2	107.4	122.4	122.2	121.3	119.2	117.3	106.3	110.8
110	101.2	107.5	122.5	122.3	121.4	119.3	117.3	106.4	110.9
111	101.2	107.5	122.5	122.4	121.5	119.4	117.4	106.5	110.9
112	101.3	107.6	122.6	122.5	121.5	119.5	117.5	106.5	111.0
113	101.3	107.7	122.7	122.6	121.6	119.5	117.5	106.6	111.1
114	101.4	107.7	122.7	122.6	121.7	119.6	117.6	106.7	111.1
115	101.4	107.8	122.8	122.7	121.8	119.7	117.7	106.7	111.2
116	101.4	107.8	122.8	122.8	121.8	119.7	117.8	106.8	111.3
117	101.5	107.9	122.9	122.8	121.9	119.8	117.8	106.9	111.4
118	101.5	107.9	123.0	122.9	122.0	119.9	117.9	106.9	111.4
119	101.6	108.0	123.0	123.0	122.1	120.0	118.0	107.0	111.5
120	101.6	108.1	123.1	123.1	122.1	120.0	118.0	107.0	111.6
121	101.6	108.1	123.1	123.1	122.2	120.1	118.1	107.1	111.6
122	101.7	108.2	123.2	123.2	122.3	120.2	118.2	107.2	111.7
123	101.7	108.2	123.3	123.3	122.3	120.2	118.2	107.2	111.8
124	101.7	108.3	123.3	123.3	122.4	120.3	118.3	107.3	111.8
125	101.8	108.3	123.4	123.4	122.5	120.4	118.4	107.4	111.9
126	101.8	108.4	123.4	123.5	122.5	120.4	118.4	107.4	112.0
127	101.8	108.4	123.5	123.5	122.6	120.5	118.5	107.5	112.0
128	101.9	108.5	123.6	123.6	122.7	120.6	118.6	107.5	112.1
129	101.9	108.6	123.6	123.7	122.8	120.6	118.6	107.6	112.2
130	102.0	108.6	123.7	123.7	122.8	120.7	118.7	107.7	112.2
131	102.0	108.7	123.7	123.8	122.9	120.8	118.8	107.7	112.3
132	102.0	108.7	123.8	123.9	123.0	120.8	118.8	107.8	112.3
133	102.1	108.8	123.8	123.9	123.0	120.9	118.9	107.8	112.4
134	102.1	108.8	123.9	124.0	123.1	121.0	119.0	107.9	112.5
135	102.1	108.9	123.9	124.1	123.2	121.0	119.0	107.9	112.5
136	102.2	108.9	124.0	124.1	123.2	121.1	119.1	108.0	112.6
137	102.2	109.0	124.0	124.2	123.3	121.2	119.1	108.1	112.7
138	102.2	109.0	124.1	124.3	123.4	121.2	119.2	108.1	112.7
139	102.3	109.1	124.2	124.3	123.4	121.3	119.3	108.2	112.8
140	102.3	109.1	124.2	124.4	123.5	121.4	119.3	108.2	112.8
141	102.3	109.2	124.3	124.4	123.6	121.4	119.4	108.3	112.9
142	102.4	109.2	124.3	124.5	123.6	121.5	119.5	108.3	113.0
143	102.4	109.3	124.4	124.6	123.7	121.5	119.5	108.4	113.0
144	102.4	109.3	124.4	124.6	123.7	121.6	119.6	108.4	113.1
145	102.5	109.4	124.5	124.7	123.8	121.7	119.6	108.5	113.1
146	102.5	109.4	124.5	124.8	123.9	121.7	119.7	108.6	113.2
147	102.5	109.5	124.6	124.8	123.9	121.8	119.8	108.6	113.2
148	102.6	109.5	124.6	124.9	124.0	121.8	119.8	108.7	113.3
149	102.6	109.6	124.7	124.9	124.1	121.9	119.9	108.7	113.4
150	102.6	109.6	124.7	125.0	124.1	122.0	119.9	108.8	113.4
151	102.7	109.7	124.8	125.1	124.2	122.0	120.0	108.8	113.5
152	102.7	109.7	124.8	125.1	124.2	122.1	120.0	108.9	113.5
153	102.7	109.8	124.9	125.2	124.3	122.1	120.1	108.9	113.6

BY: *[Signature]* 9/22/88  
CHECKED BY: *[Signature]* 9-29-88

EC System & Control Room  
Temperature rise study



SHEET. 2.2 of 5

13-MK-EC-253

REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
154	102.8	109.8	124.9	125.2	124.4	122.2	120.2	109.0	113.6
155	102.8	109.9	125.0	125.3	124.4	122.3	120.2	109.0	113.7
156	102.8	109.9	125.0	125.4	124.5	122.3	120.3	109.1	113.7
157	102.9	110.0	125.1	125.4	124.5	122.4	120.3	109.1	113.8
158	102.9	110.0	125.1	125.5	124.6	122.4	120.4	109.2	113.9
159	102.9	110.1	125.2	125.5	124.7	122.5	120.4	109.2	113.9
160	103.0	110.1	125.2	125.6	124.7	122.5	120.5	109.3	114.0
161	103.0	110.2	125.3	125.6	124.8	122.6	120.6	109.3	114.0
162	103.0	110.2	125.3	125.7	124.8	122.7	120.6	109.4	114.1
163	103.0	110.3	125.4	125.8	124.9	122.7	120.7	109.4	114.1
164	103.1	110.3	125.4	125.8	125.0	122.8	120.7	109.5	114.2
165	103.1	110.4	125.5	125.9	125.0	122.8	120.8	109.6	114.2
166	103.1	110.4	125.5	125.9	125.1	122.9	120.8	109.6	114.3
167	103.2	110.5	125.6	126.0	125.1	122.9	120.9	109.7	114.3
168	103.2	110.5	125.6	126.0	125.2	123.0	120.9	109.7	114.4
169	103.2	110.6	125.6	126.1	125.2	123.1	121.0	109.8	114.4
170	103.3	110.6	125.7	126.1	125.3	123.1	121.1	109.8	114.5
171	103.3	110.6	125.7	126.2	125.4	123.2	121.1	109.8	114.5
172	103.3	110.7	125.8	126.3	125.4	123.2	121.2	109.9	114.6
173	103.3	110.7	125.8	126.3	125.5	123.3	121.2	109.9	114.7
174	103.4	110.8	125.9	126.4	125.5	123.3	121.3	110.0	114.7
175	103.4	110.8	125.9	126.4	125.6	123.4	121.3	110.0	114.8
176	103.4	110.9	126.0	126.5	125.6	123.4	121.4	110.1	114.8
177	103.5	110.9	126.0	126.5	125.7	123.5	121.4	110.1	114.9
178	103.5	111.0	126.1	126.6	125.8	123.5	121.5	110.2	114.9
179	103.5	111.0	126.1	126.6	125.8	123.6	121.5	110.2	115.0
180	103.6	111.1	126.2	126.7	125.9	123.6	121.6	110.3	115.0
181	103.6	111.1	126.2	126.7	125.9	123.7	121.6	110.3	115.1
182	103.6	111.1	126.2	126.8	126.0	123.8	121.7	110.4	115.1
183	103.6	111.2	126.3	126.8	126.0	123.8	121.7	110.4	115.2
184	103.7	111.2	126.3	126.9	126.1	123.9	121.8	110.5	115.2
185	103.7	111.3	126.4	126.9	126.1	123.9	121.8	110.5	115.3
186	103.7	111.3	126.4	127.0	126.2	124.0	121.9	110.6	115.3
187	103.8	111.4	126.5	127.1	126.2	124.0	121.9	110.6	115.4
188	103.8	111.4	126.5	127.1	126.3	124.1	122.0	110.7	115.4
189	103.8	111.4	126.6	127.2	126.4	124.1	122.0	110.7	115.4
190	103.8	111.5	126.6	127.2	126.4	124.2	122.1	110.8	115.5
191	103.9	111.5	126.6	127.3	126.5	124.2	122.1	110.8	115.5
192	103.9	111.6	126.7	127.3	126.5	124.3	122.2	110.8	115.6
193	103.9	111.6	126.7	127.4	126.6	124.3	122.2	110.9	115.6
194	104.0	111.7	126.8	127.4	126.6	124.4	122.3	110.9	115.7
195	104.0	111.7	126.8	127.5	126.7	124.4	122.3	111.0	115.7
196	104.0	111.7	126.9	127.5	126.7	124.5	122.4	111.0	115.8
197	104.0	111.8	126.9	127.6	126.8	124.5	122.4	111.1	115.8
198	104.1	111.8	126.9	127.6	126.8	124.6	122.5	111.1	115.9
199	104.1	111.9	127.0	127.7	126.9	124.6	122.5	111.2	115.9
200	104.1	111.9	127.0	127.7	126.9	124.7	122.6	111.2	116.0
201	104.2	112.0	127.1	127.8	127.0	124.7	122.6	111.3	116.0
202	104.2	112.0	127.1	127.8	127.0	124.8	122.7	111.3	116.1
203	104.2	112.0	127.2	127.9	127.1	124.8	122.7	111.3	116.1
204	104.2	112.1	127.2	127.9	127.1	124.9	122.8	111.4	116.2

BX: *As* *→* 9/22/88  
 CHECKED BY: *Jim Miller* 9-23-88

EC System & Control Room  
 Temperature rise slowly





SHEET. 2.3 of 54  
13-MC-EC-253  
REV 1

CHECKED BY: J. Di Donna 9-23-88

BY: J. Di Donna 9/22/88

EC System & Control Room temperature  
rise study

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
205	104.3	112.1	127.2	128.0	127.2	124.9	122.8	111.4	116.2
206	104.3	112.2	127.3	128.0	127.2	125.0	122.9	111.5	116.2
207	104.3	112.2	127.3	128.1	127.3	125.0	122.9	111.5	116.3
208	104.4	112.2	127.4	128.1	127.3	125.1	123.0	111.6	116.3
209	104.4	112.3	127.4	128.2	127.4	125.1	123.0	111.6	116.4
210	104.4	112.3	127.4	128.2	127.4	125.2	123.1	111.7	116.4
211	104.4	112.4	127.5	128.3	127.5	125.2	123.1	111.7	116.5
212	104.5	112.4	127.5	128.3	127.5	125.3	123.2	111.7	116.5
213	104.5	112.5	127.6	128.3	127.6	125.3	123.2	111.8	116.6
214	104.5	112.5	127.6	128.4	127.6	125.4	123.3	111.8	116.6
215	104.5	112.5	127.6	128.4	127.7	125.4	123.3	111.9	116.7
216	104.6	112.6	127.7	128.5	127.7	125.5	123.4	111.9	116.7
217	104.6	112.6	127.7	128.5	127.8	125.5	123.4	112.0	116.7
218	104.6	112.7	127.8	128.6	127.8	125.6	123.5	112.0	116.8
219	104.6	112.7	127.8	128.6	127.9	125.6	123.5	112.0	116.8
220	104.7	112.7	127.9	128.7	127.9	125.6	123.5	112.1	116.9
221	104.7	112.8	127.9	128.7	128.0	125.7	123.6	112.1	116.9
222	104.7	112.8	127.9	128.8	128.0	125.7	123.6	112.2	117.0
223	104.8	112.9	128.0	128.8	128.1	125.8	123.7	112.2	117.0
224	104.8	112.9	128.0	128.9	128.1	125.8	123.7	112.3	117.0
225	104.8	112.9	128.1	128.9	128.2	125.9	123.8	112.3	117.1
226	104.8	113.0	128.1	129.0	128.2	125.9	123.8	112.3	117.1
227	104.9	113.0	128.1	129.0	128.3	126.0	123.9	112.4	117.2
228	104.9	113.0	128.2	129.1	128.3	126.0	123.9	112.4	117.2
229	104.9	113.1	128.2	129.1	128.4	126.1	124.0	112.5	117.3
230	104.9	113.1	128.2	129.1	128.4	126.1	124.0	112.5	117.3
231	105.0	113.2	128.3	129.2	128.5	126.2	124.0	112.5	117.4
232	105.0	113.2	128.3	129.2	128.5	126.2	124.1	112.6	117.4
233	105.0	113.2	128.4	129.3	128.6	126.3	124.1	112.6	117.4
234	105.0	113.3	128.4	129.3	128.6	126.3	124.2	112.7	117.5
235	105.1	113.3	128.4	129.4	128.7	126.3	124.2	112.7	117.5
236	105.1	113.4	128.5	129.4	128.7	126.4	124.3	112.7	117.6
237	105.1	113.4	128.5	129.5	128.8	126.4	124.3	112.8	117.6
238	105.1	113.4	128.6	129.5	128.8	126.5	124.4	112.8	117.6
239	105.2	113.5	128.6	129.6	128.9	126.5	124.4	112.9	117.7
240	105.2	113.5	128.6	129.6	128.9	126.6	124.4	112.9	117.7
241	105.2	113.5	128.7	129.6	128.9	126.6	124.5	113.0	117.8
242	105.2	113.6	128.7	129.7	129.0	126.7	124.5	113.0	117.8
243	105.3	113.6	128.7	129.7	129.0	126.7	124.6	113.0	117.9
244	105.3	113.7	128.8	129.8	129.1	126.7	124.6	113.1	117.9
245	105.3	113.7	128.8	129.8	129.1	126.8	124.7	113.1	117.9
246	105.3	113.7	128.9	129.9	129.2	126.8	124.7	113.2	118.0
247	105.4	113.8	128.9	129.9	129.2	126.9	124.8	113.2	118.0
248	105.4	113.8	128.9	129.9	129.3	126.9	124.8	113.2	118.1
249	105.4	113.8	129.0	130.0	129.3	127.0	124.8	113.3	118.1
250	105.4	113.9	129.0	130.0	129.4	127.0	124.9	113.3	118.1
251	105.5	113.9	129.1	130.1	129.4	127.1	124.9	113.4	118.2
252	105.5	114.0	129.1	130.1	129.4	127.1	125.0	113.4	118.2
253	105.5	114.0	129.1	130.2	129.5	127.1	125.0	113.4	118.3
254	105.5	114.0	129.2	130.2	129.5	127.2	125.1	113.5	118.3
255	105.6	114.1	129.2	130.3	129.6	127.2	125.1	113.5	118.3



TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
256	105.6	114.1	129.2	130.3	129.6	127.3	125.1	113.5	118.4
257	105.6	114.1	129.3	130.3	129.7	127.3	125.2	113.6	118.4
258	105.6	114.2	129.3	130.4	129.7	127.4	125.2	113.6	118.5
259	105.7	114.2	129.3	130.4	129.8	127.4	125.3	113.7	118.5
260	105.7	114.3	129.4	130.5	129.8	127.4	125.3	113.7	118.5
261	105.7	114.3	129.4	130.5	129.9	127.5	125.4	113.7	118.6
262	105.7	114.3	129.5	130.6	129.9	127.5	125.4	113.8	118.6
263	105.8	114.4	129.5	130.6	129.9	127.6	125.4	113.8	118.7
264	105.8	114.4	129.5	130.6	130.0	127.6	125.5	113.9	118.7
265	105.8	114.4	129.6	130.7	130.0	127.7	125.5	113.9	118.7
266	105.8	114.5	129.6	130.7	130.1	127.7	125.6	113.9	118.8
267	105.9	114.5	129.6	130.8	130.1	127.7	125.6	114.0	118.8
268	105.9	114.5	129.7	130.8	130.2	127.8	125.6	114.0	118.9
269	105.9	114.6	129.7	130.8	130.2	127.8	125.7	114.0	118.9
270	105.9	114.6	129.7	130.9	130.2	127.9	125.7	114.1	118.9
271	106.0	114.6	129.8	130.9	130.3	127.9	125.8	114.1	119.0
272	106.0	114.7	129.8	131.0	130.3	127.9	125.8	114.2	119.0
273	106.0	114.7	129.9	131.0	130.4	128.0	125.9	114.2	119.1
274	106.0	114.8	129.9	131.1	130.4	128.0	125.9	114.2	119.1
275	106.1	114.8	129.9	131.1	130.5	128.1	125.9	114.3	119.1
276	106.1	114.8	130.0	131.1	130.5	128.1	126.0	114.3	119.2
277	106.1	114.9	130.0	131.2	130.6	128.2	126.0	114.4	119.2
278	106.1	114.9	130.0	131.2	130.6	128.2	126.1	114.4	119.2
279	106.2	114.9	130.1	131.3	130.6	128.2	126.1	114.4	119.3
280	106.2	115.0	130.1	131.3	130.7	128.3	126.1	114.5	119.3
281	106.2	115.0	130.1	131.3	130.7	128.3	126.2	114.5	119.4
282	106.2	115.0	130.2	131.4	130.8	128.4	126.2	114.5	119.4
283	106.2	115.1	130.2	131.4	130.8	128.4	126.3	114.6	119.4
284	106.3	115.1	130.2	131.5	130.8	128.4	126.3	114.6	119.5
285	106.3	115.1	130.3	131.5	130.9	128.5	126.3	114.6	119.5
286	106.3	115.2	130.3	131.5	130.9	128.5	126.4	114.7	119.6
287	106.3	115.2	130.3	131.6	131.0	128.6	126.4	114.7	119.6
288	106.4	115.2	130.4	131.6	131.0	128.6	126.5	114.8	119.6
289	106.4	115.3	130.4	131.7	131.1	128.6	126.5	114.8	119.7
290	106.4	115.3	130.5	131.7	131.1	128.7	126.5	114.8	119.7
291	106.4	115.3	130.5	131.7	131.1	128.7	126.6	114.9	119.7
292	106.5	115.4	130.5	131.8	131.2	128.8	126.6	114.9	119.8
293	106.5	115.4	130.6	131.8	131.2	128.8	126.7	114.9	119.8
294	106.5	115.5	130.6	131.9	131.3	128.8	126.7	115.0	119.9
295	106.5	115.5	130.6	131.9	131.3	128.9	126.7	115.0	119.9
296	106.6	115.5	130.7	131.9	131.4	128.9	126.8	115.0	119.9
297	106.6	115.6	130.7	132.0	131.4	129.0	126.8	115.1	120.0
298	106.6	115.6	130.7	132.0	131.4	129.0	126.8	115.1	120.0
299	106.6	115.6	130.8	132.1	131.5	129.0	126.9	115.2	120.0
300	106.6	115.7	130.8	132.1	131.5	129.1	126.9	115.2	120.1
301	106.7	115.7	130.8	132.1	131.6	129.1	127.0	115.2	120.1
302	106.7	115.7	130.9	132.2	131.6	129.2	127.0	115.3	120.1
303	106.7	115.8	130.9	132.2	131.6	129.2	127.0	115.3	120.2
304	106.7	115.8	130.9	132.3	131.7	129.2	127.1	115.3	120.2
305	106.8	115.8	131.0	132.3	131.7	129.3	127.1	115.4	120.3
306	106.8	115.9	131.0	132.3	131.8	129.3	127.2	115.4	120.3

SHEET 24 of  
13-MC-EC-253  
REV 1

CHECKED BY: Jim Dixon 9-25-88

BY: DGL 9/22/88

EC System & Control Room  
Temperature rise initial



SHEET 25 of 54

13-MC-EC-253

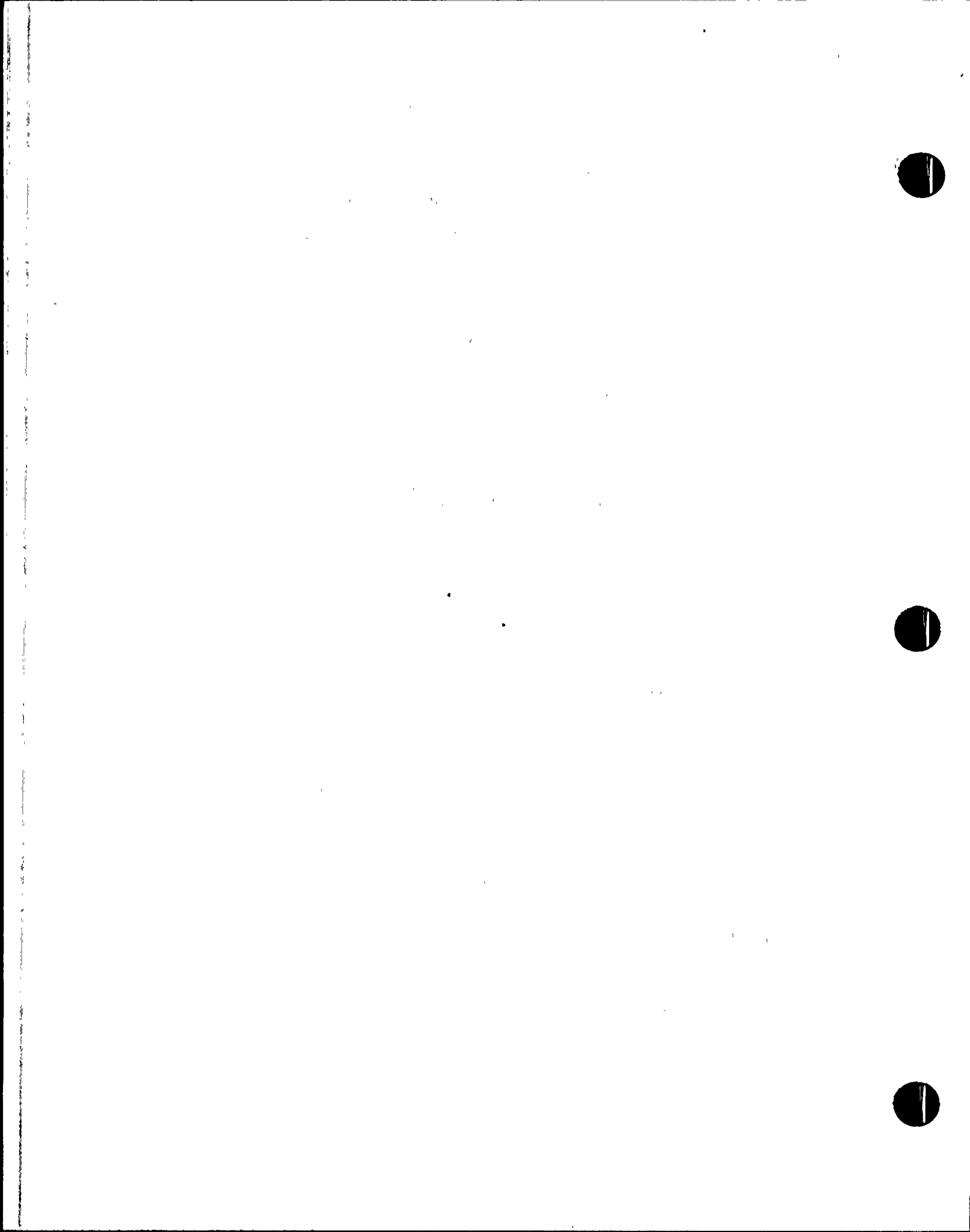
REV 1

CHECKED BY: Jim Dixon 9-25-88

By: ~~Jim~~ 9/22/88.

EC System & Control Room  
temperature rise study

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	APF RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECMS RH (F)	CONT RH (F)	EC WATER (F)
358	107.9	117.5	132.7	134.3	133.8	131.3	129.1	117.2	122.1
359	107.9	117.6	132.7	134.3	133.8	131.3	129.1	117.2	122.1
360	108.0	117.6	132.7	134.3	133.9	131.3	129.1	117.2	122.2
361	108.0	117.6	132.8	134.4	133.9	131.4	129.2	117.3	122.2
362	108.0	117.6	132.8	134.4	133.9	131.4	129.2	117.3	122.2
363	108.0	117.7	132.8	134.4	134.0	131.4	129.2	117.3	122.3
364	108.0	117.7	132.9	134.5	134.0	131.5	129.3	117.4	122.3
365	108.1	117.7	132.9	134.5	134.0	131.5	129.3	117.4	122.3
366	108.1	117.8	132.9	134.5	134.1	131.5	129.3	117.4	122.4
367	108.1	117.8	133.0	134.6	134.1	131.6	129.4	117.5	122.4
368	108.1	117.8	133.0	134.6	134.1	131.6	129.4	117.5	122.4
369	108.2	117.9	133.0	134.6	134.2	131.6	129.5	117.5	122.5
370	108.2	117.9	133.0	134.7	134.2	131.7	129.5	117.6	122.5
371	108.2	117.9	133.1	134.7	134.3	131.7	129.5	117.6	122.5
372	108.2	118.0	133.1	134.8	134.3	131.7	129.6	117.6	122.6
373	108.2	118.0	133.1	134.8	134.3	131.8	129.6	117.7	122.6
374	108.3	118.0	133.2	134.8	134.4	131.8	129.6	117.7	122.6
375	108.3	118.0	133.2	134.9	134.4	131.9	129.7	117.7	122.6
376	108.3	118.1	133.2	134.9	134.4	131.9	129.7	117.7	122.7
377	108.3	118.1	133.3	134.9	134.5	131.9	129.7	117.8	122.7
378	108.3	118.1	133.3	135.0	134.5	132.0	129.8	117.8	122.7
379	108.4	118.2	133.3	135.0	134.5	132.0	129.8	117.8	122.8
380	108.4	118.2	133.3	135.0	134.6	132.0	129.8	117.9	122.8
381	108.4	118.2	133.4	135.1	134.6	132.1	129.9	117.9	122.8
382	108.4	118.3	133.4	135.1	134.7	132.1	129.9	117.9	122.9
383	108.4	118.3	133.4	135.1	134.7	132.1	129.9	118.0	122.9
384	108.5	118.3	133.5	135.2	134.7	132.2	130.0	118.0	122.9
385	108.5	118.3	133.5	135.2	134.8	132.2	130.0	118.0	123.0
386	108.5	118.4	133.5	135.2	134.8	132.2	130.0	118.1	123.0
387	108.5	118.4	133.6	135.3	134.8	132.3	130.1	118.1	123.0
388	108.5	118.4	133.6	135.3	134.9	132.3	130.1	118.1	123.1
389	108.6	118.5	133.6	135.3	134.9	132.3	130.1	118.2	123.1
390	108.6	118.5	133.6	135.4	134.9	132.4	130.2	118.2	123.1
391	108.6	118.5	133.7	135.4	135.0	132.4	130.2	118.2	123.2
392	108.6	118.5	133.7	135.4	135.0	132.4	130.2	118.2	123.2
393	108.6	118.6	133.7	135.5	135.0	132.5	130.3	118.3	123.2
394	108.7	118.6	133.8	135.5	135.1	132.5	130.3	118.3	123.3
395	108.7	118.6	133.8	135.5	135.1	132.5	130.3	118.3	123.3
396	108.7	118.7	133.8	135.6	135.1	132.6	130.4	118.4	123.3
397	108.7	118.7	133.8	135.6	135.2	132.6	130.4	118.4	123.3
398	108.7	118.7	133.9	135.6	135.2	132.6	130.4	118.4	123.4
399	108.8	118.8	133.9	135.7	135.3	132.7	130.5	118.5	123.4
400	108.8	118.8	133.9	135.7	135.3	132.7	130.5	118.5	123.4
401	108.8	118.8	134.0	135.7	135.3	132.7	130.5	118.5	123.5
402	108.8	118.8	134.0	135.8	135.4	132.8	130.6	118.6	123.5
403	108.8	118.9	134.0	135.8	135.4	132.8	130.6	118.6	123.5
404	108.9	118.9	134.1	135.8	135.4	132.8	130.6	118.6	123.6
405	108.9	118.9	134.1	135.9	135.5	132.9	130.7	118.6	123.6
406	108.9	119.0	134.1	135.9	135.5	132.9	130.7	118.7	123.6
407	108.9	119.0	134.1	135.9	135.5	132.9	130.7	118.7	123.7
408	108.9	119.0	134.2	136.0	135.6	133.0	130.8	118.7	123.7



SHEET 26 of 5  
13-MC-EC-253  
REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	APP RH (F)	HPST RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
307	106.8	115.9	131.0	132.4	131.8	129.4	127.2	115.4	120.3
308	106.8	115.9	131.1	132.4	131.8	129.4	127.2	115.5	120.4
309	106.8	116.0	131.1	132.4	131.9	129.4	127.3	115.5	120.4
310	106.9	116.0	131.1	132.5	131.9	129.5	127.3	115.5	120.4
311	106.9	116.0	131.2	132.5	132.0	129.5	127.3	115.6	120.5
312	106.9	116.1	131.2	132.6	132.0	129.6	127.4	115.6	120.5
313	106.9	116.1	131.2	132.6	132.0	129.6	127.4	115.7	120.5
314	107.0	116.1	131.3	132.6	132.1	129.6	127.5	115.7	120.6
315	107.0	116.2	131.3	132.7	132.1	129.7	127.5	115.7	120.6
316	107.0	116.2	131.3	132.7	132.2	129.7	127.5	115.8	120.7
317	107.0	116.2	131.4	132.8	132.2	129.7	127.6	115.8	120.7
318	107.1	116.3	131.4	132.8	132.2	129.8	127.6	115.8	120.7
319	107.1	116.3	131.4	132.8	132.3	129.8	127.7	115.9	120.8
320	107.1	116.3	131.5	132.9	132.3	129.9	127.7	115.9	120.8
321	107.1	116.4	131.5	132.9	132.4	129.9	127.7	115.9	120.8
322	107.1	116.4	131.5	132.9	132.4	129.9	127.8	116.0	120.9
323	107.2	116.4	131.6	133.0	132.4	130.0	127.8	116.0	120.9
324	107.2	116.4	131.6	133.0	132.5	130.0	127.8	116.0	120.9
325	107.2	116.5	131.6	133.1	132.5	130.0	127.9	116.1	121.0
326	107.2	116.5	131.7	133.1	132.6	130.1	127.9	116.1	121.0
327	107.3	116.5	131.7	133.1	132.6	130.1	127.9	116.1	121.0
328	107.3	116.6	131.7	133.2	132.6	130.2	128.0	116.2	121.1
329	107.3	116.6	131.8	133.2	132.7	130.2	128.0	116.2	121.1
330	107.3	116.6	131.8	133.2	132.7	130.2	128.1	116.2	121.1
331	107.3	116.7	131.8	133.3	132.8	130.3	128.1	116.3	121.2
332	107.4	116.7	131.9	133.3	132.8	130.3	128.1	116.3	121.2
333	107.4	116.7	131.9	133.4	132.8	130.3	128.2	116.3	121.2
334	107.4	116.8	131.9	133.4	132.9	130.4	128.2	116.4	121.3
335	107.4	116.8	131.9	133.4	132.9	130.4	128.2	116.4	121.3
336	107.4	116.8	132.0	133.5	132.9	130.5	128.3	116.4	121.3
337	107.5	116.9	132.0	133.5	133.0	130.5	128.3	116.5	121.4
338	107.5	116.9	132.0	133.5	133.0	130.5	128.4	116.5	121.4
339	107.5	116.9	132.1	133.6	133.1	130.6	128.4	116.5	121.5
340	107.5	117.0	132.1	133.6	133.1	130.6	128.4	116.6	121.5
341	107.6	117.0	132.1	133.6	133.1	130.6	128.5	116.6	121.5
342	107.6	117.0	132.2	133.7	133.2	130.7	128.5	116.6	121.6
343	107.6	117.1	132.2	133.7	133.2	130.7	128.5	116.7	121.6
344	107.6	117.1	132.2	133.8	133.3	130.8	128.6	116.7	121.6
345	107.6	117.1	132.3	133.8	133.3	130.8	128.6	116.7	121.7
346	107.7	117.2	132.3	133.8	133.3	130.8	128.6	116.8	121.7
347	107.7	117.2	132.3	133.9	133.4	130.9	128.7	116.8	121.7
348	107.7	117.2	132.4	133.9	133.4	130.9	128.7	116.8	121.8
349	107.7	117.2	132.4	133.9	133.4	130.9	128.7	116.9	121.8
350	107.8	117.3	132.4	134.0	133.5	131.0	128.8	116.9	121.8
351	107.8	117.3	132.5	134.0	133.5	131.0	128.8	116.9	121.9
352	107.8	117.3	132.5	134.0	133.6	131.0	128.9	117.0	121.9
353	107.8	117.4	132.5	134.1	133.6	131.1	128.9	117.0	121.9
354	107.8	117.4	132.5	134.1	133.6	131.1	128.9	117.0	122.0
355	107.9	117.4	132.6	134.2	133.7	131.1	129.0	117.1	122.0
356	107.9	117.5	132.6	134.2	133.7	131.2	129.0	117.1	122.0
357	107.9	117.5	132.6	134.2	133.7	131.2	129.0	117.1	122.1

CHECKED BY: Jim Datta 9-25-88

Bx: ASL - 9/22/88

EC System & Control Room  
Temperature Rise Study





SHEET 28 of.  
13-MC-EC-253  
REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
460	110.0	120.5	135.6	137.6	137.3	134.6	132.4	120.3	125.2
461	110.0	120.5	135.7	137.7	137.3	134.7	132.4	120.3	125.3
462	110.0	120.5	135.7	137.7	137.4	134.7	132.5	120.3	125.3
463	110.0	120.5	135.7	137.7	137.4	134.7	132.5	120.4	125.3
464	110.0	120.6	135.7	137.7	137.4	134.8	132.5	120.4	125.4
465	110.1	120.6	135.8	137.8	137.5	134.8	132.6	120.4	125.4
466	110.1	120.6	135.8	137.8	137.5	134.8	132.6	120.4	125.4
467	110.1	120.7	135.8	137.8	137.5	134.9	132.6	120.5	125.4
468	110.1	120.7	135.8	137.9	137.6	134.9	132.7	120.5	125.5
469	110.1	120.7	135.9	137.9	137.6	134.9	132.7	120.5	125.5
470	110.1	120.7	135.9	137.9	137.6	134.9	132.7	120.6	125.5
471	110.2	120.8	135.9	138.0	137.7	135.0	132.7	120.6	125.6
472	110.2	120.8	135.9	138.0	137.7	135.0	132.8	120.6	125.6
473	110.2	120.8	136.0	138.0	137.7	135.0	132.8	120.6	125.6
474	110.2	120.8	136.0	138.0	137.7	135.1	132.8	120.7	125.6
475	110.2	120.9	136.0	138.1	137.8	135.1	132.9	120.7	125.7
476	110.3	120.9	136.1	138.1	137.8	135.1	132.9	120.7	125.7
477	110.3	120.9	136.1	138.1	137.8	135.2	132.9	120.7	125.7
478	110.3	120.9	136.1	138.2	137.9	135.2	133.0	120.8	125.8
479	110.3	121.0	136.1	138.2	137.9	135.2	133.0	120.8	125.8
480	110.3	121.0	136.2	138.2	137.9	135.3	133.0	120.8	125.8
481	110.4	121.0	136.2	138.3	138.0	135.3	133.0	120.9	125.8
482	110.4	121.1	136.2	138.3	138.0	135.3	133.1	120.9	125.9
483	110.4	121.1	136.2	138.3	138.0	135.3	133.1	120.9	125.9
484	110.4	121.1	136.3	138.3	138.1	135.4	133.1	120.9	125.9
485	110.4	121.1	136.3	138.4	138.1	135.4	133.2	121.0	126.0
486	110.4	121.2	136.3	138.4	138.1	135.4	133.2	121.0	126.0
487	110.5	121.2	136.3	138.4	138.2	135.5	133.2	121.0	126.0
488	110.5	121.2	136.4	138.5	138.2	135.5	133.2	121.1	126.0
489	110.5	121.2	136.4	138.5	138.2	135.5	133.3	121.1	126.1
490	110.5	121.3	136.4	138.5	138.2	135.6	133.3	121.1	126.1
491	110.5	121.3	136.5	138.6	138.3	135.6	133.3	121.1	126.1
492	110.6	121.3	136.5	138.6	138.3	135.6	133.4	121.2	126.2
493	110.6	121.3	136.5	138.6	138.3	135.6	133.4	121.2	126.2
494	110.6	121.4	136.5	138.6	138.4	135.7	133.4	121.2	126.2
495	110.6	121.4	136.6	138.7	138.4	135.7	133.5	121.2	126.2
496	110.6	121.4	136.6	138.7	138.4	135.7	133.5	121.3	126.3
497	110.6	121.4	136.6	138.7	138.5	135.8	133.5	121.3	126.3
498	110.7	121.5	136.6	138.8	138.5	135.8	133.5	121.3	126.3
499	110.7	121.5	136.7	138.8	138.5	135.8	133.6	121.4	126.3
500	110.7	121.5	136.7	138.8	138.6	135.9	133.6	121.4	126.4
501	110.7	121.5	136.7	138.9	138.6	135.9	133.6	121.4	126.4
502	110.7	121.6	136.7	138.9	138.6	135.9	133.7	121.4	126.4
503	110.8	121.6	136.8	138.9	138.7	135.9	133.7	121.5	126.5
504	110.8	121.6	136.8	138.9	138.7	136.0	133.7	121.5	126.5
505	110.8	121.7	136.8	139.0	138.7	136.0	133.7	121.5	126.5
506	110.8	121.7	136.8	139.0	138.7	136.0	133.8	121.5	126.5
507	110.8	121.7	136.9	139.0	138.8	136.1	133.8	121.6	126.6
508	110.8	121.7	136.9	139.1	138.8	136.1	133.8	121.6	126.6
509	110.9	121.8	136.9	139.1	138.8	136.1	133.9	121.6	126.6
510	110.9	121.8	136.9	139.1	138.9	136.1	133.9	121.7	126.6

CHECKED BY: Jim Dixon 9-29-88

BY: ~~Jim Dixon~~ 9/29/88

EC System & Control Room  
Temperature rise. Alarming



# ENGINEERING SKETCH PAD

REV

REV 1

BY: <i>Aditya</i>	DATE: 6/6/88	SUBJECT: EC SYSTEM AND CONTROL	SHEET NO.: 29 of 54
CHECKED BY: <i>28</i>	DATE: 10/11/88	ROOM TEMPERATURE RISE STUDY	JOB NO.: 13-MC-EC-253

"Follow by page 29A of 54"

## REFERENCES

1. B.P.C. CALCULATION 13-MC-HA-802  
"ANPP AUX BLDG turbine driven AFW pump room"
2. B.P.C. CALCULATION 13-MC-HA-A02  
"Transient temp. study for EPSI pump room"
3. B.P.C. CALCULATION 13-MC-HA-A03  
"Transient temperature study for Aux feed water "B" pump room"
4. B.P.C. CALCULATION 13-MC-HA-A05  
"Transient temperature study for containment spray pump room"
5. B.P.C. CALCULATION 13-MC-HJ-253  
"Transient temperature study for main control room"
6. B.P.C. CALCULATION 13-MC-HJ-254  
"Transient temperature for ESF Switch gear Battery and O.C Equipment rooms"
7. B.P.C. CALCULATION 13-MC-HA-252  
"Transient temperature study for electrical penetration rooms"
8. B.P.C. CALCULATION 13-MC-HA-253  
"Transient temperature study for essential cooling water pump rooms"
9. T.R. GOODMAN "Applications of integral methods to transient non-linear heat transfer" Advances in Heat transfer Vol 1, 1964
10. ANPP CALC. 13-MC-HJ-255



# ENGINEERING SKETCH PAD

REV 1

BY: <i>Adrian</i>	DATE: <i>10/6/88</i>	SUBJECT: <i>EC SYSTEM AND CONTROL</i>	SHEET NO.: <i>29A of 54</i>
CHECKED BY: <i>[Signature]</i>	DATE: <i>10/11/88</i>	<i>ROOM TEMPERATURE RISE STUDY</i>	JOB NO.: <i>13-MC-EC-25</i>

11- F. KREITH "Principles of heat transfer"

3rd edition Inter Educational publishers

Followed by page 30 of 54



## ENGINEERING SKETCH PAD

REV 1

BY: <i>ANW</i>	DATE: <i>10/6/88</i>	SUBJECT: <i>EC SYSTEM AND CONTROL</i>	SHEET NO.: <i>30 of 54</i>
CHECKED BY: <i>DL</i>	DATE: <i>10/11/88</i>	<i>ROOM TEMPERATURE RISE</i>	JOB NO.: <i>13-MC-EC-253</i>

### APPENDIX A VERIFICATION VALIDATION OF COMPUTER MODEL

B.P.C. computer program ME-204 is a standard and validated computer program which determines the room heat up in the absence of HVAC system. ME-204, however, does not have the capability to model EC flow and hence it was necessary to develop an internal PC computer program with EC flow capability.

ME 204 based calculation (REF. 1 through 8) <sup>AM</sup> who were used to validate the algorithm

described in this calculation. It was necessary to perform a computer run without equation (8) <sup>2 AM</sup>

and by assuming  $H_{wi} = 0$  in equation (1), thus

eliminating the EC flow option. TABLE A1 is the

input data for validation and TABLES A2 through A9

is the comparison between ME-204 results and the model

developed in this calculation. TABLE A10 is the ESF





# ENGINEERING SKETCH PAD

BY: <i>ADW</i>	DATE: 10/6/88	SUBJECT: EESystem and control	SHEET NO.: 3 of 54
CHECKED BY: <i>[Signature]</i>	DATE: 10/11/88	room temperature rise study	JOB NO.: 13-MC-EC-253

equipment room temperature using the input data developed in this Appendix (Table A-1.)

The comparison indicates that the model developed in this calculation is as valid as ME 20.4 (standard computer program) to determine equipment room temperature when HVAC system is inoperable.



# ENGINEERING SKETCH PAD

REV 1

BY <i>Adams</i>	DATE 10/6/88	SUBJECT EC System & Control Room	SHEET NO. 32 of 54
CHECKED BY: <i>J. Smith</i>	DATE 10/11/88	temperature rise study	13-MC-EC-253

TABLE A1 - INPUT TO HEAT LOAD MODEL (BENCHMARK)

	(A) INITIAL AIR-OF	(B) INITIAL CONCRETE OF	(A) AIR TEMPERATURE MASS-M-BN/°F	(A) HEAT LOAD Q-BT/min	(A) TRANSMISSIVITY-BT/min OF WALL-HA CHILLED H2O-HW	
Elec. Rm. Room	92.0	91.8	52.568	1049.32	139.45	N/A
ECN/S Room	80.0	79.5	147.48	2296.4	75.66	N/A
CONT. Room	75.5	75.4	2649.15	20,638	682.77	N/A
SG&DC Room	78.4	78.3	1211.81	6239.73	354.54	N/A
AUX FEED	75.0	74.8	16032	2031.55	73.3	N/A
HPS/Room	75.0	74.8	158.56	2468.53	69.47	N/A
CRS/Room	75.0	74.8	155.65	2401.65	70.68	N/A
C.S. Room	75.0	74.8	155.65	2401.65	70.68	N/A
REFERENCE:						
A: Belltel ME-204 design chh=13-MC-HA-A02, A03, A05, 253, 253, 13-MC-HT-253, 254						
B: Assume con. temp to be lower than air temp (for model junction)						



# ENGINEERING SKETCH PAD

REV 1

BY: <i>ADW</i>	DATE: 10/6/88	SUBJECT: EC System & Control Room	SHEET NO.: 33 of 54
CHECKED BY: <i>AS</i>	DATE: 10/11/88	Temperature rise study	JOB NO.: 13-MK-EC-252

TIME MIN	TEMP. BENCH (A) OF MECH	TEMP. ASSEMBLY OF	VARIANCE (+/-) %
0	92	92	0
30	101.2	101.2	0
60	102.2	102.3	+0.07
90	103.0	103.1	+0.07

REF: A BENCH CALC 13-MK-HA-252



# ENGINEERING SKETCH PAD

REV 1

BY: <i>ADW</i>	DATE: 10/11/88	EC System & Control Room Temperature rise study	SHEET NO.: 34 of 54
CHECKED BY: <i>AS Li</i>	DATE: 10/11/88		JOB NO.: 13-MC-EC-253

TABLE A3: BENCHMARK RUN			
ECIN S ROOM			
TIME MIN	TEMP-BECHTEL (A) °F	TEMP-ALGORITHM °F	VARIANCE (+/-) %
0	80	80	0
30	119.7	118.7	(-) 0.84
60	124.6	122.8	(-) 1.44
90	127.4	125.9	(-) 0.93

REF: A - BECHTEL CALC 13-MC-HA-253





## ENGINEERING SKETCH PAD

REV 1

BY: <i>Adm</i>	DATE: <i>10/8/88</i>	SUBJECT: <i>EC System &amp; Control Room</i>	SHEET NO.: <i>35</i> of <i>54</i>
CHECKED BY: <i>de C</i>	DATE: <i>10/11/88</i>	<i>temperature rise study</i>	JOB NO.: <i>13-MC-EC-253</i>

TIME MIN.	TEMP-BEHTTEL(A) PF ME-ROA	TEMP-ALSOCTH PF	VARIANCE (+/-) - %
0	75.50	75.50	0
30	114.00	113.2	(-) 0.70
60	118.50	117.6	(-) 0.76
90	121.62	120.7	(-) 0.76

REF: A - BEHTTEL CALC 13-MC-175-253

TABLE A - BENCHMARK RUN

CONTROL ROOM

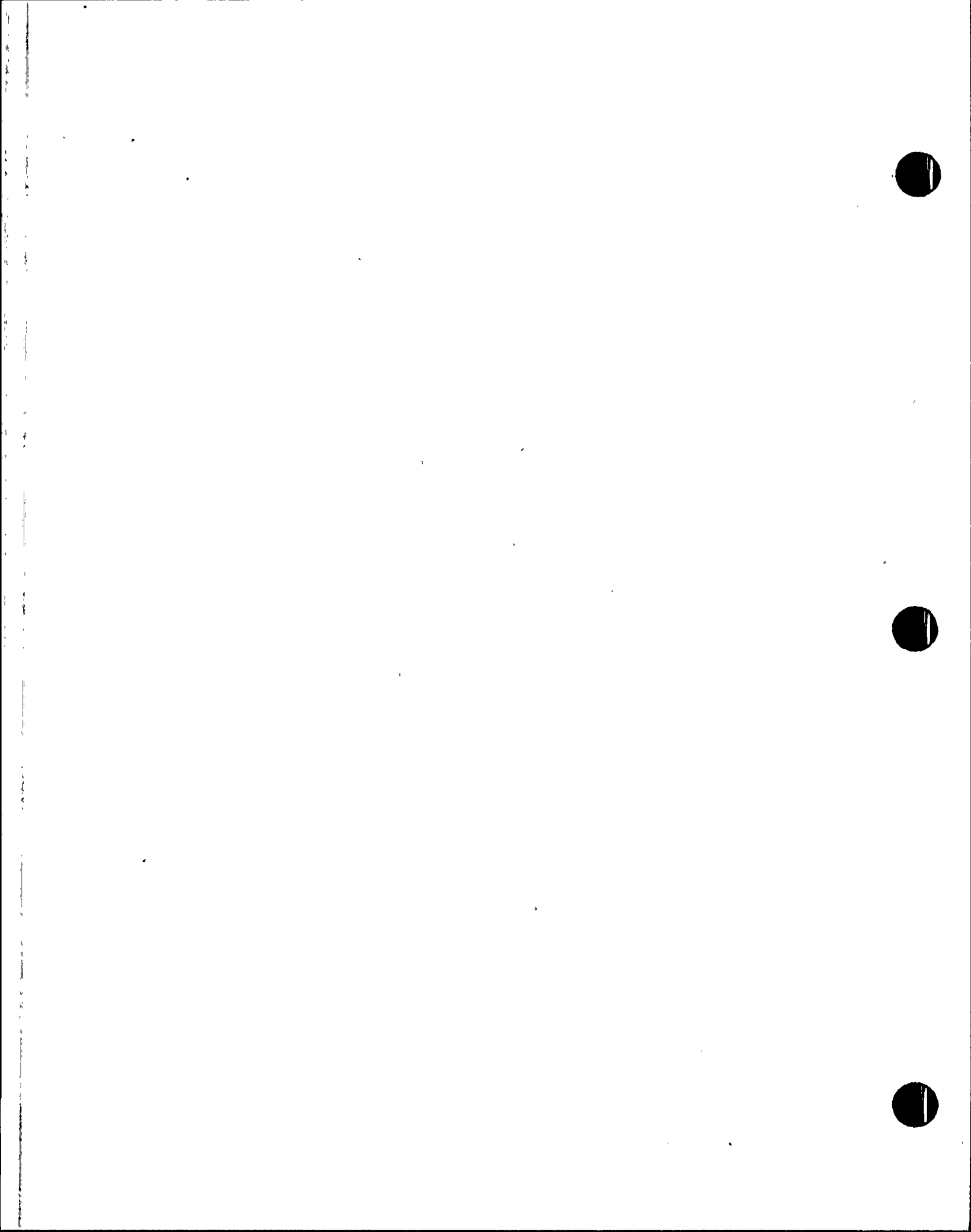


# ENGINEERING SKETCH PAD

REV 1

BY: <i>Adams</i>	DATE: <i>10/11/88</i>	SUBJECT: <i>EC System &amp; Control room</i>	SHEET NO. <i>36</i> of <i>54</i>
CHECKED BY: <i>John</i>	DATE: <i>10/11/88</i>	<i>Temperature rise study</i>	JOB NO. <i>13-MC-FC-253</i>

TABLE A5 BENCHMARK RUN				
S/G & DC ROOM				
TIME MIN.	TEMP - BECHTEL (A) °F	TEMP - ASSOCIATION °F	VARIANCE (+/-) - %	
0	78.4	78.4	0	0
30	100.4	100.4	0	0
60	102.8	102.9	(+) 0.09	
90	104.5	104.7	(+) 0.19	
REF: A - BECHTEL CALC 13-MC-HTR54				



# ENGINEERING SKETCH PAD

REV 1

BY: <i>ADW</i>	DATE: 10/6/88	SUBJECT: EC System & Control Room	SHEET NO.: 37 of 54
CHECKED BY: <i>J. L. T.</i>	DATE: 10/11/88	temperature rise study	JOB NO.: 13-MC-EC-253

TIME MIN.	TEMP. BECHTEL (A) °F ME-ROK	TEMP. ALGOKITHY °F	VARIANCE (+/-) %
0	75	75	0
30	110.9	110.3	(-) 0.54
60	114.7	114.0	(-) 0.61
90	117.4	116.9	(-) 0.43

REF: A- BECHTEL CALC 13-MC-11A-1103

AUX LEAD ROOM

TABLE A-6 BENCHMARK RUN



# ENGINEERING SKETCH PAD

REV 1

BY: <i>ADW</i>	DATE: 10/6/88	FC System & Control Room	SHEET NO. 38 of 5
CHECKED BY: <i>ASL</i>	DATE: 10/11/88	temperature rise study	13-MC-EC-2

TIME MIN.	TEMP-BECHTEL (A) OF ME-ROK	TEMP ALGORITHM OF	VARIANCE (+/-) %
0	75	75	0
30	123.4	120.2	2.59
60	128.7	125.1	2.80
90	132.5	128.7	2.87

REF: A - BECHTEL CALC 13-MC-11A - A02





# ENGINEERING SKETCH PAD

REV 1

BY: <i>ADAM</i>	DATE: <i>10/11/88</i>	SUBJECT: <i>EC System &amp; Control room</i>	SHEET NO.: <i>39 of 54</i>
CHECKED BY: <i>ADAM</i>	DATE: <i>10/11/88</i>	<i>temperature rise study</i>	JOB NO.: <i>13-MC-EC-253</i>

TIME MIN.	TEMP. BENCHTEL (A) °F	TEMP. ALGOKITHM °F	VARIANCE (+/-) - %
0	75	75	0
30	119.6	118.3	(-) 1.09
60	124.31	122.8	(-) 1.21
90	127.8	126.4	(-) 1.09
REF: A - BENCHTEL CALC # 13-MC-HA-A05			
TABLE A8 BENCHMARK RUN FIRST /CS ROOM			



## ENGINEERING SKETCH PAD

REV 1

BY: <i>Arbun</i>	DATE: 10/11/84	SUBJECT: EC System & Control room	SHEET NO: 40 of 54
CHECKED BY: <i>De</i>	DATE: 10/11/88	temperature rise study	JOB NO: 13-MC-EC-253

TABLE 9

ME-204 - ANPP HEAT LOAD MODEL

BENCHMARK @ 90 MINUTES

ROOM	TEMPERATURE - OF		VARIANCE
			%
	ME-204 ANPP HLM		
ELEC. PEN.	103.0	103.1	0.09
ECWS	127.14	125.9	0.98
CONTROL	121.62	120.7	0.76
SG&DC	104.5	104.7	0.19
AUX FEED	117.4	116.9	0.43
APSI	132.5	128.7	2.87
ΔPSI	127.8	126.4	1.09
C.S.	127.8	126.4	1.09



## TABLE A10

SHEET 41 of 54

13-MC-EC-253

REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	APP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
0	92	78.4	75	75	75	75	80	75.5	78
1	93.73	82.88	85.33	87.82	87.62	87.62	92.41	82.42	78
2	95.08	86.27	92.00	96.24	95.77	95.77	99.99	87.83	78
3	96.13	88.87	96.38	101.8	101.1	101.1	104.7	92.10	78
4	96.96	90.87	99.33	105.7	104.7	104.7	107.7	95.49	78
4.999	97.63	92.42	101.3	108.4	107.2	107.2	109.8	98.21	78
5.999	98.16	93.65	102.7	110.3	109.0	109.0	111.1	100.4	78
6.999	98.59	94.62	103.8	111.7	110.3	110.3	112.1	102.1	78
7.999	98.95	95.41	104.6	112.7	111.3	111.3	112.9	103.6	78
9	99.24	96.04	105.2	113.6	112.0	112.0	113.5	104.8	78
10	99.48	96.57	105.7	114.3	112.7	112.7	114.0	105.8	78
11	99.69	97.01	106.1	114.8	113.2	113.2	114.4	106.7	78
12	99.87	97.39	106.5	115.3	113.6	113.6	114.7	107.4	78
13	100.0	97.71	106.8	115.7	114.0	114.0	115.1	108.1	78
14	100.1	97.99	107.1	116.1	114.4	114.4	115.4	108.6	78
15.00	100.2	98.24	107.4	116.5	114.7	114.7	115.6	109.1	78
16.00	100.3	98.46	107.6	116.8	115.0	115.0	115.9	109.5	78
17.00	100.4	98.66	107.9	117.1	115.3	115.3	116.2	109.9	78
18.00	100.5	98.85	108.1	117.4	115.6	115.6	116.4	110.3	78
19.00	100.6	99.02	108.3	117.7	115.9	115.9	116.6	110.6	78
20.00	100.7	99.18	108.5	118.0	116.1	116.1	116.8	110.9	78
21.00	100.7	99.33	108.7	118.2	116.4	116.4	117.1	111.2	78
22.00	100.8	99.48	108.9	118.5	116.6	116.6	117.3	111.5	78
23.00	100.9	99.61	109.1	118.7	116.8	116.8	117.5	111.7	78
24.00	100.9	99.74	109.3	118.9	117.1	117.1	117.7	112.0	78
25.00	101.0	99.87	109.4	119.2	117.3	117.3	117.8	112.2	78
26.00	101.0	99.99	109.6	119.4	117.5	117.5	118.0	112.4	78
27.00	101.1	100.1	109.8	119.6	117.7	117.7	118.2	112.6	78
28.00	101.1	100.2	109.9	119.8	117.9	117.9	118.4	112.8	78
29.00	101.2	100.3	110.1	120.0	118.1	118.1	118.6	113.0	78
30.00	101.2	100.4	110.3	120.2	118.3	118.3	118.7	113.2	78
31.00	101.3	100.5	110.4	120.4	118.5	118.5	118.9	113.4	78
32.00	101.3	100.6	110.6	120.6	118.7	118.7	119.1	113.6	78
33.00	101.4	100.7	110.7	120.8	118.8	118.8	119.2	113.8	78
34.00	101.4	100.8	110.9	121.0	119.0	119.0	119.4	113.9	78
35.00	101.4	100.9	111.0	121.2	119.2	119.2	119.5	114.1	78
36.00	101.5	101.0	111.2	121.4	119.4	119.4	119.7	114.3	78
37	101.5	101.1	111.3	121.6	119.5	119.5	119.9	114.4	78
38	101.6	101.2	111.4	121.7	119.7	119.7	120.0	114.6	78
39	101.6	101.3	111.6	121.9	119.9	119.9	120.1	114.8	78
39.99	101.6	101.3	111.7	122.1	120.0	120.0	120.3	114.9	78
40.99	101.7	101.4	111.8	122.2	120.2	120.2	120.4	115.1	78
41.99	101.7	101.5	112.0	122.4	120.4	120.4	120.6	115.2	78
42.99	101.7	101.6	112.1	122.6	120.5	120.5	120.7	115.4	78
43.99	101.8	101.7	112.2	122.7	120.7	120.7	120.9	115.5	78
44.99	101.8	101.8	112.3	122.9	120.8	120.8	121.0	115.6	78
45.99	101.9	101.8	112.5	123.1	121.0	121.0	121.1	115.8	78
46.99	101.9	101.9	112.6	123.2	121.1	121.1	121.3	115.9	78
47.99	101.9	102.0	112.7	123.4	121.3	121.3	121.4	116.1	78
48.99	102.0	102.1	112.8	123.5	121.4	121.4	121.5	116.2	78
49.99	102.0	102.2	112.9	123.7	121.6	121.6	121.6	116.3	78
50.99	102.0	102.2	113.0	123.8	121.7	121.7	121.8	116.5	78

By: *SEL*  
 CHECKED By: *John Brown*

DATE: 9/22/88  
 9-29-88

EC System & Control Room Temperature  
 Ride Study.



SHEET 42 of 5

13-MK-EC-253

REV

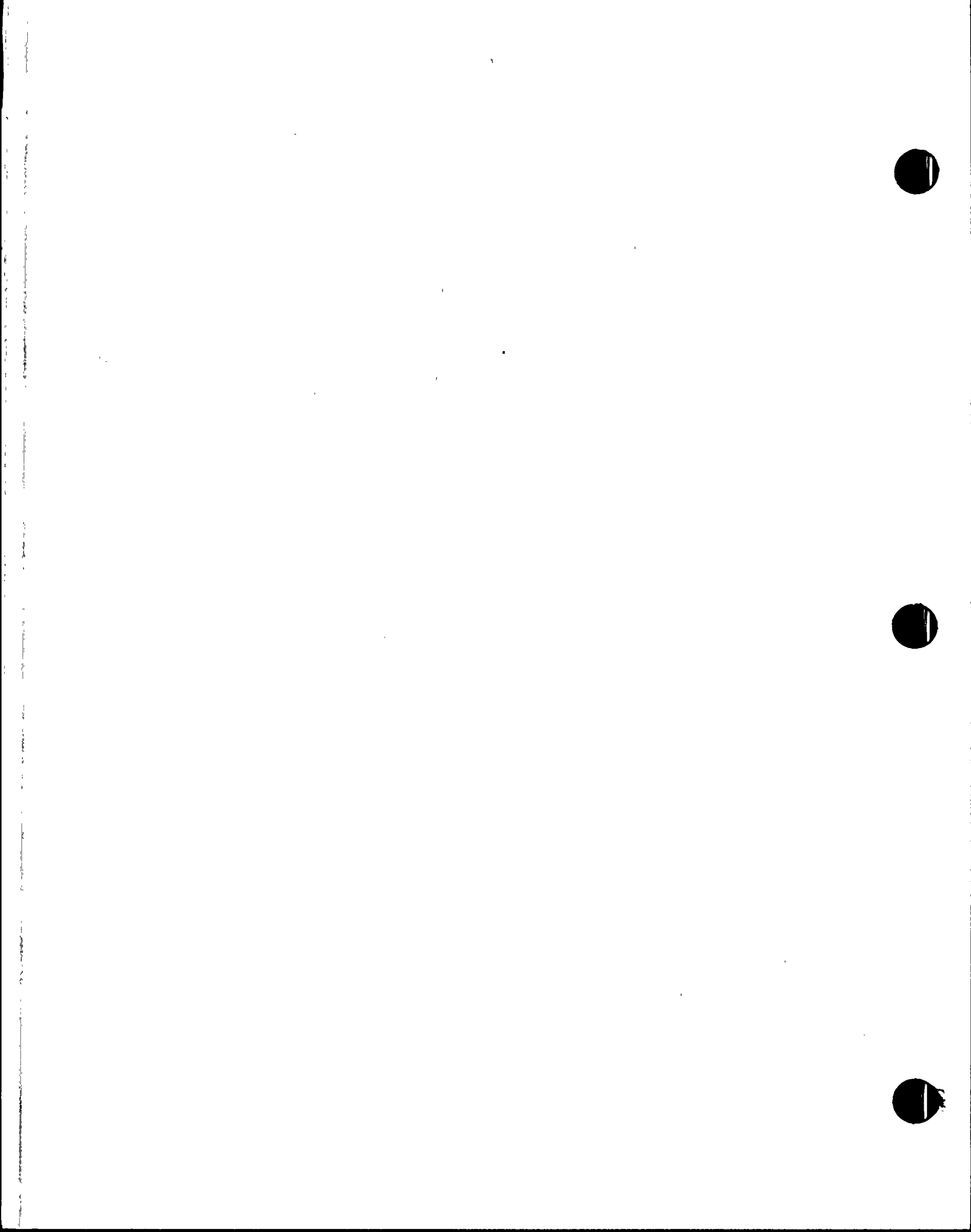
CHECKED BY: Jim Bidman

9-25-98

BY: Ash in 9/22/98

EC System & Control Room  
Temperature rise slowly.

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPST RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
51.99	102.1	102.3	113.2	124.0	121.8	121.8	121.9	116.6	78
52.99	102.1	102.4	113.3	124.1	122.0	122.0	122.0	116.7	78
53.99	102.1	102.5	113.4	124.3	122.1	122.1	122.1	116.8	78
54.99	102.1	102.5	113.5	124.4	122.3	122.3	122.3	117.0	78
55.99	102.2	102.6	113.6	124.5	122.4	122.4	122.4	117.1	78
56.99	102.2	102.7	113.7	124.7	122.5	122.5	122.5	117.2	78
57.99	102.2	102.7	113.8	124.8	122.7	122.7	122.6	117.3	78
58.99	102.3	102.8	113.9	125.0	122.8	122.8	122.7	117.5	78
59.99	102.3	102.9	114.0	125.1	122.9	122.9	122.8	117.6	78
60.99	102.3	102.9	114.1	125.2	123.0	123.0	123.0	117.7	78
61.99	102.4	103.0	114.2	125.4	123.2	123.2	123.1	117.8	78
62.99	102.4	103.1	114.4	125.5	123.3	123.3	123.2	117.9	78
63.99	102.4	103.2	114.5	125.6	123.4	123.4	123.3	118.0	78
64.99	102.4	103.2	114.6	125.8	123.5	123.5	123.4	118.2	78
65.99	102.5	103.3	114.7	125.9	123.7	123.7	123.5	118.3	78
66.99	102.5	103.3	114.8	126.0	123.8	123.8	123.6	118.4	78
67.99	102.5	103.4	114.9	126.1	123.9	123.9	123.7	118.5	78
68.99	102.6	103.5	115.0	126.3	124.0	124.0	123.8	118.6	78
69.99	102.6	103.5	115.1	126.4	124.2	124.2	124.0	118.7	78
70.99	102.6	103.6	115.1	126.5	124.3	124.3	124.1	118.8	78
71.99	102.6	103.7	115.2	126.6	124.4	124.4	124.2	118.9	78
72.99	102.7	103.7	115.3	126.8	124.5	124.5	124.3	119.0	78
73.99	102.7	103.8	115.4	126.9	124.6	124.6	124.4	119.1	78
74.99	102.7	103.8	115.5	127.0	124.7	124.7	124.5	119.3	78
75.99	102.7	103.9	115.6	127.1	124.9	124.9	124.6	119.4	78
76.99	102.8	104.0	115.7	127.2	125.0	125.0	124.7	119.5	78
77.99	102.8	104.0	115.8	127.4	125.1	125.1	124.8	119.6	78
78.99	102.8	104.1	115.9	127.5	125.2	125.2	124.9	119.7	78
79.99	102.8	104.1	116.0	127.6	125.3	125.3	125.0	119.8	78
80.99	102.9	104.2	116.1	127.7	125.4	125.4	125.1	119.9	78
81.99	102.9	104.3	116.2	127.8	125.5	125.5	125.2	120.0	78
82.99	102.9	104.3	116.3	127.9	125.6	125.6	125.3	120.1	78
83.99	102.9	104.4	116.3	128.0	125.7	125.7	125.4	120.2	78
84.99	103.0	104.4	116.4	128.2	125.8	125.8	125.5	120.3	78
85.99	103.0	104.5	116.5	128.3	126.0	126.0	125.6	120.4	78
86.99	103.0	104.5	116.6	128.4	126.1	126.1	125.7	120.5	78
87.99	103.0	104.6	116.7	128.5	126.2	126.2	125.7	120.6	78
88.99	103.1	104.7	116.8	128.6	126.3	126.3	125.8	120.6	78
89.99	103.1	104.7	116.9	128.7	126.4	126.4	125.9	120.7	78
90.99	103.1	104.8	117.0	128.8	126.5	126.5	126.0	120.8	78
91.99	103.1	104.8	117.0	128.9	126.6	126.6	126.1	120.9	78
92.99	103.2	104.9	117.1	129.0	126.7	126.7	126.2	121.0	78
93.99	103.2	104.9	117.2	129.1	126.8	126.8	126.3	121.1	78
94.99	103.2	105.0	117.3	129.3	126.9	126.9	126.4	121.2	78
95.99	103.2	105.0	117.4	129.4	127.0	127.0	126.5	121.3	78
96.99	103.2	105.1	117.4	129.5	127.1	127.1	126.6	121.4	78
97.99	103.3	105.1	117.5	129.6	127.2	127.2	126.7	121.5	78
98.99	103.3	105.2	117.6	129.7	127.3	127.3	126.7	121.6	78
99.99	103.3	105.2	117.7	129.8	127.4	127.4	126.8	121.7	78
100.9	103.3	105.3	117.8	129.9	127.5	127.5	126.9	121.8	78
101.9	103.4	105.3	117.9	130.0	127.6	127.6	127.0	121.8	78





## ENGINEERING SKETCH PAD

RGV 1

BY: <i>ADW</i>	DATE: 10/6/88	SUBJECT: EC SYSTEM AND CONTROL	SHEET NO.: 43 of 54
CHECKED BY: <i>DS</i>	DATE: 10/11/88	ROOM TEMPERATURE RISE STUDY	JOB NO.: 13-MC-EC-263

## APPENDIX B

## VERIFICATION OF CONTROL ROOM DATA

A preliminary computer run without EC flow has resulted in a computer <sup>room</sup> temperature of ~~123~~ <sup>121.8</sup> after ~~10.2~~ <sup>10.2</sup> minutes (see TABLE A10). This result was believed to be conservative because of the following:

- 1- The heat load in the control room was assumed based on design basis calculation which postulate name plate rating as the equipment heat load.
- 2- The heat sinks other than the concrete walls were not incorporated in the model.
- 3- Plant operating experience ~~has~~ <sup>observed</sup> which simulated the room, for a short period of time, loss of HVAC in the control ~~room~~ <sup>room</sup> has not resulted in a rapid rise of control room temperature ~~as~~ <sup>than</sup> as indicated in TABLE ~~A10~~ <sup>A10</sup>.

To refine the room heat-up model, and to provide a more realistic input, a heat-up test



## ENGINEERING SKETCH PAD

REV 2

BY: <i>ADW</i>	DATE: 10/6/88	SUBJECT: EC System and Control Room	SHEET NO.: 44 of 54
CHECKED BY: <i>DS</i>	DATE: 10/11/88	temperature rise study	JOB NO.:

was performed in the control room. This test is documented in REF 10. In the heat up test the control room was stabilized at 62.5 F air and concrete temperature. Subsequently, the control room air temperature at pre-selected location were measured at different time intervals (F16-B1). Also (REF 10) calculated actual control heat load from test data. Since the heat up was performed with one HVAC fan running and without EC flow, the input data to room heat up model were adjusted to model the test condition (Table B1), and the results (Table B2) were compared to heat up test (F16-B1). It was concluded that the control room model was conservative as anticipated.



# ENGINEERING SKETCH PAD

REV 1

BY: <i>ADG</i>	DATE: 10/6/88	SUBJECT: EC System & Control Room	SHEET NO: 45 of 54
CHECKED BY: <i>DS</i>	DATE: 10/14/88	Temperature rise study	JOB NO: 13-MC-EC-253

AA  
Run #2

B1

TABLE 10. INPUT TO HCM (CONSERVATIVE)

	INITIAL AIR-°F	INITIAL CONCRETE-°F	AIR THERMAL MASS-BTU/°F	HEAT LOAD Q-BTU/HR	TRANSMISSIVITY-BTU/HR-°F WALL-HE	CHILLED 160-HW
ELEC. PEN ROOM	86.8	86.5	525.68	1049.32	139.45	N/A
ECNS ROOM	78.3	78.0	147.48	2296.4	75.66	N/A
CONT. ROOM	62.54	62.54	2649.15	16072.0	682.77	N/A
SG&DC ROOM	85	78.40	1211.81	6239.73	354.54	N/A
AUX FEED	97.2	97.0	160.32	2031.55	73.3	N/A
HPSI ROOM	80.3	80	158.56	2468.53	69.47	N/A
LPSI ROOM	78.8	78	155.65	2401.65	70.68	N/A
C.S. ROOM	78.8	78	155.65	2401.65	70.68	N/A

REF:

Attachment 1

A: Actual temperatures - Sheet 19 of this calc, except Control Room (13-MC-11J-2.5% ATTACHMENT 1)

B: Bechtel Calc 13-MC-HJ-253 - One fan operation.

C: Bechtel ME-204 design data (REF 1 thru 8)

D: Assume concrete temp to be lower than air



TABLE B2

(CONSERVATIVE)

SHEET 46 of 54

13-MC-EC-253

REV 1

TIME (MIN)	ELEC PE (F)	SWGR RM (F)	AFR RM (F)	HPSI RM (F)	LPSI RM (F)	CS RM (F)	ECWS RM (F)	CONT RM (F)	EC WATER (F)
0	86.8	85	97.2	80.3	78.8	78.8	78.3	62.54	78
1	88.51	87.89	107.5	93.94	91.20	91.20	90.67	67.92	78
2	89.84	90.13	114.2	103.2	99.23	99.23	98.23	72.12	78
3	90.88	91.87	118.5	109.7	104.5	104.5	102.9	75.44	78
4	91.70	93.24	121.5	114.3	108.1	108.1	106.0	78.08	78
4.999	92.36	94.32	123.5	117.7	110.5	110.5	108.0	80.19	78
5.999	92.89	95.19	124.9	120.1	112.3	112.3	109.4	81.90	78
6.999	93.31	95.90	126.0	121.9	113.5	113.5	110.4	83.29	78
7.999	93.66	96.48	126.8	123.3	114.5	114.5	111.1	84.43	78
9	93.95	96.96	127.4	124.4	115.3	115.3	111.7	85.37	78
10	94.20	97.36	127.9	125.3	115.9	115.9	112.2	86.16	78
11	94.40	97.71	128.3	126.1	116.4	116.4	112.6	86.83	78
12	94.57	98.01	128.7	126.7	116.9	116.9	112.9	87.40	78
13	94.72	98.28	129.0	127.2	117.3	117.3	113.3	87.90	78
14	94.86	98.52	129.3	127.7	117.6	117.6	113.6	88.33	78
15.00	94.97	98.73	129.6	128.2	117.9	117.9	113.8	88.71	78
16.00	95.08	98.93	129.8	128.6	118.2	118.2	114.1	89.05	78
17.00	95.17	99.10	130.1	129.0	118.5	118.5	114.4	89.35	78
18.00	95.26	99.27	130.3	129.3	118.8	118.8	114.6	89.63	78
19.00	95.34	99.43	130.5	129.6	119.1	119.1	114.8	89.89	78
20.00	95.41	99.58	130.7	130.0	119.3	119.3	115.0	90.13	78
21.00	95.48	99.72	130.9	130.3	119.6	119.6	115.3	90.35	78
22.00	95.54	99.85	131.1	130.6	119.8	119.8	115.5	90.55	78
23.00	95.60	99.98	131.3	130.9	120.0	120.0	115.7	90.75	78
24.00	95.66	100.1	131.5	131.1	120.3	120.3	115.9	90.94	78
25.00	95.72	100.2	131.6	131.4	120.5	120.5	116.1	91.12	78
26.00	95.77	100.3	131.8	131.7	120.7	120.7	116.2	91.29	78
27.00	95.82	100.4	132.0	131.9	120.9	120.9	116.4	91.45	78
28.00	95.87	100.5	132.1	132.2	121.1	121.1	116.6	91.61	78
29.00	95.92	100.6	132.3	132.4	121.3	121.3	116.8	91.76	78
30.00	95.97	100.7	132.5	132.7	121.5	121.5	116.9	91.91	78
31.00	96.01	100.8	132.6	132.9	121.7	121.7	117.1	92.06	78
32.00	96.06	100.9	132.8	133.1	121.9	121.9	117.3	92.20	78
33.00	96.10	101.0	132.9	133.3	122.0	122.0	117.4	92.34	78
34.00	96.14	101.1	133.1	133.6	122.2	122.2	117.6	92.47	78
35.00	96.19	101.2	133.2	133.8	122.4	122.4	117.7	92.60	78
36.00	96.23	101.3	133.4	134.0	122.6	122.6	117.9	92.73	78
37	96.27	101.4	133.5	134.2	122.7	122.7	118.1	92.86	78
38	96.31	101.5	133.6	134.4	122.9	122.9	118.2	92.98	78
39	96.35	101.6	133.8	134.6	123.1	123.1	118.3	93.10	78
39.99	96.38	101.7	133.9	134.8	123.2	123.2	118.5	93.22	78
40.99	96.42	101.7	134.0	135.0	123.4	123.4	118.6	93.34	78
41.99	96.46	101.8	134.2	135.2	123.6	123.6	118.8	93.46	78
42.99	96.49	101.9	134.3	135.4	123.7	123.7	118.9	93.57	78
43.99	96.53	102.0	134.4	135.6	123.9	123.9	119.1	93.68	78
44.99	96.56	102.1	134.5	135.8	124.0	124.0	119.2	93.79	78
45.99	96.60	102.1	134.7	136.0	124.2	124.2	119.3	93.90	78
46.99	96.63	102.2	134.8	136.1	124.3	124.3	119.5	94.01	78
47.99	96.67	102.3	134.9	136.3	124.5	124.5	119.6	94.12	78
48.99	96.70	102.4	135.0	136.5	124.6	124.6	119.7	94.22	78
49.99	96.73	102.5	135.1	136.7	124.8	124.8	119.8	94.33	78
50.99	96.77	102.5	135.2	136.8	124.9	124.9	120.0	94.43	78

CHECKED BY: [Signature]

9-29-88

BY: [Signature]

9/22/88

EC System & Control Room  
temperature rise study.





(CONSERVATIVE)

SHEET 47 of 54

13-MC-EC-253

REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
51.99	96.80	102.6	135.4	137.0	125.0	125.0	120.1	94.53	78
52.99	96.83	102.7	135.5	137.2	125.2	125.2	120.2	94.63	78
53.99	96.86	102.7	135.6	137.4	125.3	125.3	120.3	94.73	78
54.99	96.89	102.8	135.7	137.5	125.5	125.5	120.5	94.83	78
55.99	96.92	102.9	135.8	137.7	125.6	125.6	120.6	94.92	78
56.99	96.96	103.0	135.9	137.9	125.7	125.7	120.7	95.02	78
57.99	96.99	103.0	136.0	138.0	125.9	125.9	120.8	95.11	78
58.99	97.02	103.1	136.1	138.2	126.0	126.0	120.9	95.21	78
59.99	97.05	103.2	136.2	138.3	126.1	126.1	121.0	95.30	78
60.99	97.07	103.2	136.3	138.5	126.2	126.2	121.2	95.39	78
61.99	97.10	103.3	136.4	138.6	126.4	126.4	121.3	95.48	78
62.99	97.13	103.4	136.6	138.8	126.5	126.5	121.4	95.57	78
63.99	97.16	103.4	136.7	139.0	126.6	126.6	121.5	95.66	78
64.99	97.19	103.5	136.8	139.1	126.8	126.8	121.6	95.75	78
65.99	97.22	103.6	136.9	139.3	126.9	126.9	121.7	95.84	78
66.99	97.25	103.6	137.0	139.4	127.0	127.0	121.8	95.93	78
67.99	97.27	103.7	137.1	139.6	127.1	127.1	121.9	96.02	78
68.99	97.30	103.8	137.2	139.7	127.2	127.2	122.0	96.10	78
69.99	97.33	103.8	137.3	139.9	127.4	127.4	122.2	96.19	78
70.99	97.35	103.9	137.3	140.0	127.5	127.5	122.3	96.27	78
71.99	97.38	103.9	137.4	140.1	127.6	127.6	122.4	96.35	78
72.99	97.41	104.0	137.5	140.3	127.7	127.7	122.5	96.44	78
73.99	97.43	104.1	137.6	140.4	127.8	127.8	122.6	96.52	78
74.99	97.46	104.1	137.7	140.6	127.9	127.9	122.7	96.60	78
75.99	97.49	104.2	137.8	140.7	128.1	128.1	122.8	96.68	78
76.99	97.51	104.2	137.9	140.8	128.2	128.2	122.9	96.76	78
77.99	97.54	104.3	138.0	141.0	128.3	128.3	123.0	96.84	78
78.99	97.56	104.4	138.1	141.1	128.4	128.4	123.1	96.92	78
79.99	97.59	104.4	138.2	141.3	128.5	128.5	123.2	97.00	78
80.99	97.61	104.5	138.3	141.4	128.6	128.6	123.3	97.08	78
81.99	97.64	104.5	138.4	141.5	128.7	128.7	123.4	97.16	78
82.99	97.66	104.6	138.5	141.7	128.8	128.8	123.5	97.24	78
83.99	97.69	104.6	138.5	141.8	128.9	128.9	123.6	97.31	78
84.99	97.71	104.7	138.6	141.9	129.1	129.1	123.7	97.39	78
85.99	97.73	104.8	138.7	142.1	129.2	129.2	123.8	97.46	78
86.99	97.76	104.8	138.8	142.2	129.3	129.3	123.9	97.54	78
87.99	97.78	104.9	138.9	142.3	129.4	129.4	123.9	97.61	78
88.99	97.81	104.9	139.0	142.4	129.5	129.5	124.0	97.69	78
89.99	97.83	105.0	139.1	142.6	129.6	129.6	124.1	97.76	78
90.99	97.85	105.0	139.2	142.7	129.7	129.7	124.2	97.84	78

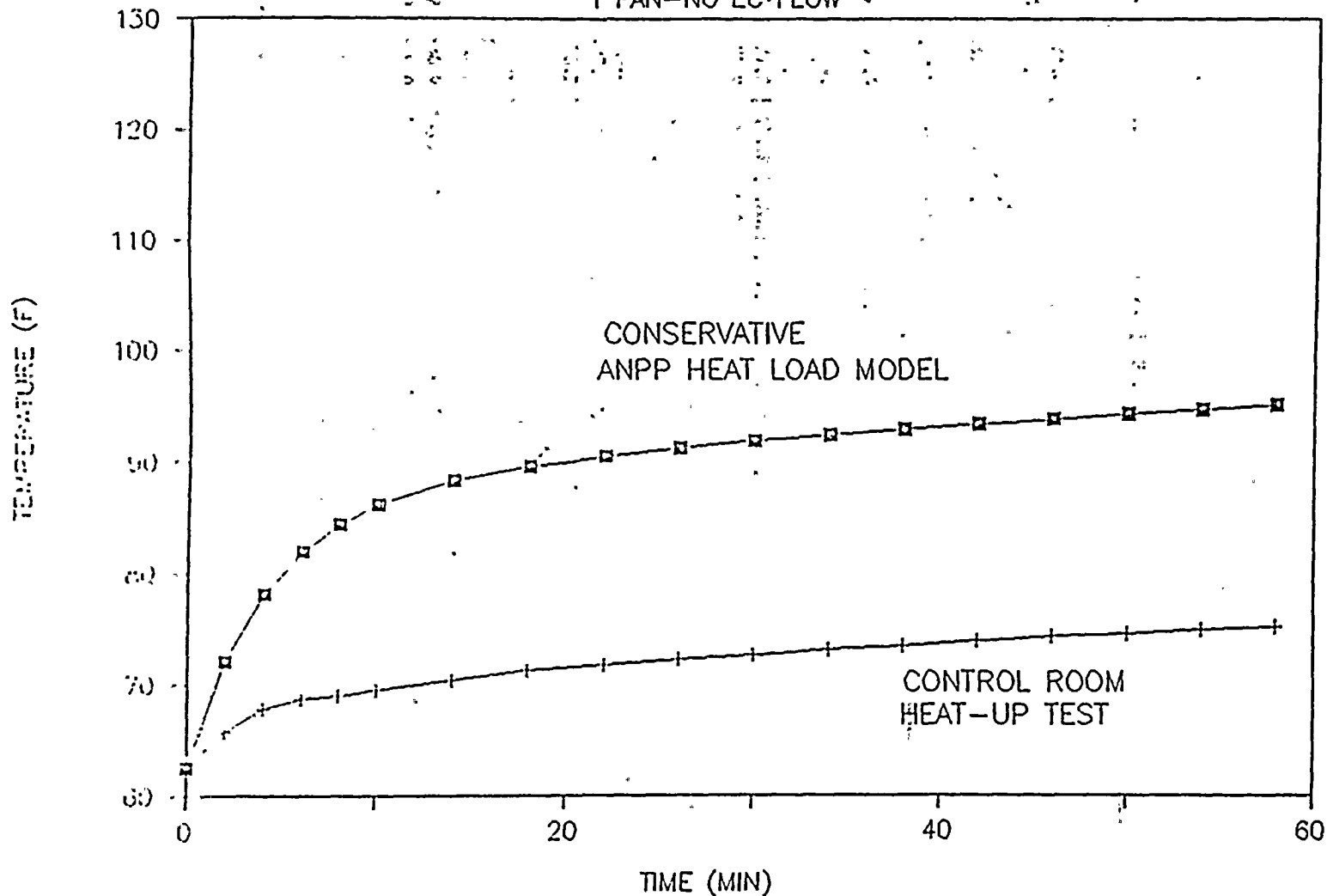
Checked By: *David Dixon*  
9-25-88  
9/22/88

EC System & Control Room  
temperature rise study



# CONTROL ROOM TEMPERATURE

1 FAN-NO EC FLOW



RUN # 2

SHEET 48 OF 55  
13-MC-EC-253  
REV 1

study

CHECKED BY: J. B. B. 9-25-88



## ENGINEERING SKETCH PAD

REV 1

BY: <i>Adrian</i>	DATE: 10/6/88	SUBJECT: EC System and Control	SHEET NO.: 49 of 54
CHECKED BY: <i>De C</i>	DATE: 10/11/88	room temperature rise study	JOB NO.: 13-ME-EC-283

To remove the conservatism in the control room model actual heat loads were substituted for the design basis heat load; This however removed only one source of conservatism.

The second source of conservatism, namely the neglect of additional heat sink is more difficult to incorporate. These heat sinks include (1) heat loss to furnishing, rails, partition walls etc (2) heat loss from equipment directly to the walls by radiation and (3) heat loss by air to surrounding cooler areas by chimney effects thro' cracks and by exfiltration. The inclusion of these effects in the model will increase the number of equations to be solved and would complicate the modeling effort.

The alternative used here is to lump all additional heat sinks by increasing the product of air to concrete heat transfer coefficient times the area



## ENGINEERING SKETCH PAD

REV. 1

BY: <i>ADW</i>	DATE: <i>10/6/88</i>	SUBJECT: <i>EC system and control</i>	SHEET NO.: <i>50 of 54</i>
CHECKED BY: <i>DS</i>	DATE: <i>10/11/88</i>	<i>room temperature rise study</i>	JOB NO.: <i>13-MC-EC-25</i>

in the increased transmissivity between air and concrete wall represents an effective transmissivity which models these ~~etc~~ additional heat sinks.

The criteria for increasing the transmissivity from 682.77 Btu/lin (Table B1) to 1000.26 Btu/lin (Table B3) is that the latter value result in a control room temperature closer to the heat-up test as seen in Table B4 and FIG. B2.

This value of 1000.26 Btu/lin was then used as a representative of the control room transmissivity. No corrections

in the transmissivity of other ESF equipment rooms were attempted as there is no test data available to develop a representative number.





# ENGINEERING SKETCH PAD

REV. 1

BY: *ADAMS* DATE: *10/6/84*

CHECKED BY: *DE C. I.* DATE: *10/11/88*

SUBJECT: *EC System & Control Room*

SHEET NO.: *51 of 54*

POST NO.: *13-MC-EC-255*

*Temperature rise study*

TABLE H- INPUT TO ALM (REALISTIC)

	INITIAL AIR-°F	INITIAL CONCRETE-°F	AIR THERMAL MASS-BTU/°F	HEAT LOAD Q-BTU/MIN	TRANSMISSIVITY-BTU/MIN/°F WALL-H <sub>c</sub>	CHILLED H <sub>2</sub> O-HW
ELEC. PEN ROOM	86.8	86.5	525.68	1049.32	139.45	N/A
ECNS ROOM	78.3	78	147.48	2296.4	75.66	N/A
CONT. ROOM	62.54	62.44	2649.15	14011 <sup>(C)</sup>	1000.26 <sup>(D)</sup>	N/A
SG&DC ROOM	85	78.4	1211.81	6239.73	354.54	N/A
AUX FEED	97.2	97	160.32	2031.55	73.30	N/A
HPSI ROOM	80.3	80	158.56	2468.53	69.47	N/A
LPSI ROOM	78.8	78	155.65	2401.65	70.68	N/A
C.S. ROOM	78.8	78	155.65	2401.65	70.68	N/A

- REF: *Actual temperature - Sheet F9, except Control Room (Ext. data 13-MC-HJ-255)*
- A: *Actual temperature - Sheet F9, except Control Room (Ext. data 13-MC-HJ-255)*
- B: *Assume concrete temp to be lower than air.*
- C: *ANPP calc. 13-MC-HJ-255 - one fan operation.*
- D: *Adjusted to account for additional heat sinks.*
- E: *BECHTEL - ZME-204 DATA (except C.R. heat load & Transmissivity of Wall-H<sub>c</sub>)*

ATTACHMENT I



TABLE B4

(REALISTIC)

SHEE. 52 of 6  
13-MC-EC-253  
REV 1

TIME (MIN)	ELEC PE (F)	SWGR RM (F)	AFP RM (F)	HPSI RM (F)	LPST RM (F)	CS RM (F)	ECWS RM (F)	CONT RM (F)	EC WATER (F)
0	86.8	85	97.2	80.3	78.8	78.8	78.3	62.54	78
1	88.51	87.89	107.5	93.94	91.20	91.20	90.67	67.00	78
2	89.84	90.13	114.2	103.2	99.23	99.23	98.23	70.11	78
3	90.88	91.87	118.5	109.7	104.5	104.5	102.9	72.30	78
4	91.70	93.24	121.5	114.3	108.1	108.1	106.0	73.88	78
4.999	92.36	94.32	123.5	117.7	110.5	110.5	108.0	75.03	78
5.999	92.89	95.19	124.9	120.1	112.3	112.3	109.4	75.88	78
6.999	93.31	95.90	126.0	121.9	113.5	113.5	110.4	76.52	78
7.999	93.66	96.48	126.8	123.3	114.5	114.5	111.1	77.02	78
9	93.95	96.96	127.4	124.4	115.3	115.3	111.7	77.42	78
10	94.20	97.36	127.9	125.3	115.9	115.9	112.2	77.74	78
11	94.40	97.71	128.3	126.1	116.4	116.4	112.6	78.00	78
12	94.57	98.01	128.7	126.7	116.9	116.9	112.9	78.22	78
13	94.72	98.28	129.0	127.2	117.3	117.3	113.3	78.42	78
14	94.86	98.52	129.3	127.7	117.6	117.6	113.6	78.59	78
15.00	94.97	98.73	129.6	128.2	117.9	117.9	113.8	78.75	78
16.00	95.08	98.93	129.8	128.6	118.2	118.2	114.1	78.89	78
17.00	95.17	99.10	130.1	129.0	118.5	118.5	114.4	79.02	78
18.00	95.26	99.27	130.3	129.3	118.8	118.8	114.6	79.15	78
19.00	95.34	99.43	130.5	129.6	119.1	119.1	114.8	79.26	78
20.00	95.41	99.58	130.7	130.0	119.3	119.3	115.0	79.37	78
21.00	95.48	99.72	130.9	130.3	119.6	119.6	115.3	79.48	78
22.00	95.54	99.85	131.1	130.6	119.8	119.8	115.5	79.58	78
23.00	95.60	99.98	131.3	130.9	120.0	120.0	115.7	79.68	78
24.00	95.66	100.1	131.5	131.1	120.3	120.3	115.9	79.77	78
25.00	95.72	100.2	131.6	131.4	120.5	120.5	116.1	79.87	78
26.00	95.77	100.3	131.8	131.7	120.7	120.7	116.2	79.96	78
27.00	95.82	100.4	132.0	131.9	120.9	120.9	116.4	80.04	78
28.00	95.87	100.5	132.1	132.2	121.1	121.1	116.6	80.13	78
29.00	95.92	100.6	132.3	132.4	121.3	121.3	116.8	80.21	78
30.00	95.97	100.7	132.5	132.7	121.5	121.5	116.9	80.29	78
31.00	96.01	100.8	132.6	132.9	121.7	121.7	117.1	80.37	78
32.00	96.06	100.9	132.8	133.1	121.9	121.9	117.3	80.45	78
33.00	96.10	101.0	132.9	133.3	122.0	122.0	117.4	80.53	78
34.00	96.14	101.1	133.1	133.6	122.2	122.2	117.6	80.60	78
35.00	96.19	101.2	133.2	133.8	122.4	122.4	117.7	80.68	78
36.00	96.23	101.3	133.4	134.0	122.6	122.6	117.9	80.75	78
37	96.27	101.4	133.5	134.2	122.7	122.7	118.1	80.82	78
38	96.31	101.5	133.6	134.4	122.9	122.9	118.2	80.89	78
39	96.35	101.6	133.8	134.6	123.1	123.1	118.3	80.96	78
39.99	96.38	101.7	133.9	134.8	123.2	123.2	118.5	81.03	78
40.99	96.42	101.7	134.0	135.0	123.4	123.4	118.6	81.10	78
41.99	96.46	101.8	134.2	135.2	123.6	123.6	118.8	81.16	78
42.99	96.49	101.9	134.3	135.4	123.7	123.7	118.9	81.23	78
43.99	96.53	102.0	134.4	135.6	123.9	123.9	119.1	81.29	78
44.99	96.56	102.1	134.5	135.8	124.0	124.0	119.2	81.36	78
45.99	96.60	102.1	134.7	136.0	124.2	124.2	119.3	81.42	78
46.99	96.63	102.2	134.8	136.1	124.3	124.3	119.5	81.48	78
47.99	96.67	102.3	134.9	136.3	124.5	124.5	119.6	81.54	78
48.99	96.70	102.4	135.0	136.5	124.6	124.6	119.7	81.60	78
49.99	96.73	102.5	135.1	136.7	124.8	124.8	119.8	81.66	78
50.99	96.77	102.5	135.2	136.8	124.9	124.9	120.0	81.72	78

BY: DOL  
 CHECKED BY: Jim Dittus  
 9-29-88

EC System & Control Room Configuration  
 rise study.



(REALISTIC)

SHEET 53 of 54

13-MC-EC-253

REV 1

TIME (MIN)	ELEC PE (F)	SWGR RH (F)	AFP RH (F)	HPSI RH (F)	LPSI RH (F)	CS RH (F)	ECWS RH (F)	CONT RH (F)	EC WATER (F)
51.99	96.80	102.6	135.4	137.0	125.0	125.0	120.1	81.78	78
52.99	96.83	102.7	135.5	137.2	125.2	125.2	120.2	81.84	78
53.99	96.86	102.7	135.6	137.4	125.3	125.3	120.3	81.90	78
54.99	96.89	102.8	135.7	137.5	125.5	125.5	120.5	81.95	78
55.99	96.92	102.9	135.8	137.7	125.6	125.6	120.6	82.01	78
56.99	96.96	103.0	135.9	137.9	125.7	125.7	120.7	82.06	78
57.99	96.99	103.0	136.0	138.0	125.9	125.9	120.8	82.12	78
58.99	97.02	103.1	136.1	138.2	126.0	126.0	120.9	82.17	78
59.99	97.05	103.2	136.2	138.3	126.1	126.1	121.0	82.23	78
60.99	97.07	103.2	136.3	138.5	126.2	126.2	121.2	82.28	78
61.99	97.10	103.3	136.4	138.6	126.4	126.4	121.3	82.33	78
62.99	97.13	103.4	136.6	138.8	126.5	126.5	121.4	82.39	78
63.99	97.16	103.4	136.7	139.0	126.6	126.6	121.5	82.44	78
64.99	97.19	103.5	136.8	139.1	126.8	126.8	121.6	82.49	78
65.99	97.22	103.6	136.9	139.3	126.9	126.9	121.7	82.54	78
66.99	97.25	103.6	137.0	139.4	127.0	127.0	121.8	82.59	78
67.99	97.27	103.7	137.1	139.6	127.1	127.1	121.9	82.64	78
68.99	97.30	103.8	137.2	139.7	127.2	127.2	122.0	82.69	78
69.99	97.33	103.8	137.3	139.9	127.4	127.4	122.2	82.74	78
70.99	97.35	103.9	137.3	140.0	127.5	127.5	122.3	82.79	78

CHECKED BY: Jim Brown

9-29-88

By: JSL - 9/22/88

EC System & Control Room (in) /  
rise study.



SHEET 54 of 53  
13-MC-EC-253  
REV 1

REALISTIC MODEL

CHECKED BY: Jim Dixon 9-29-88

rise study.

# CONTROL ROOM TEMPERATURE

HEATUP TEST vs COMPUTER MODEL

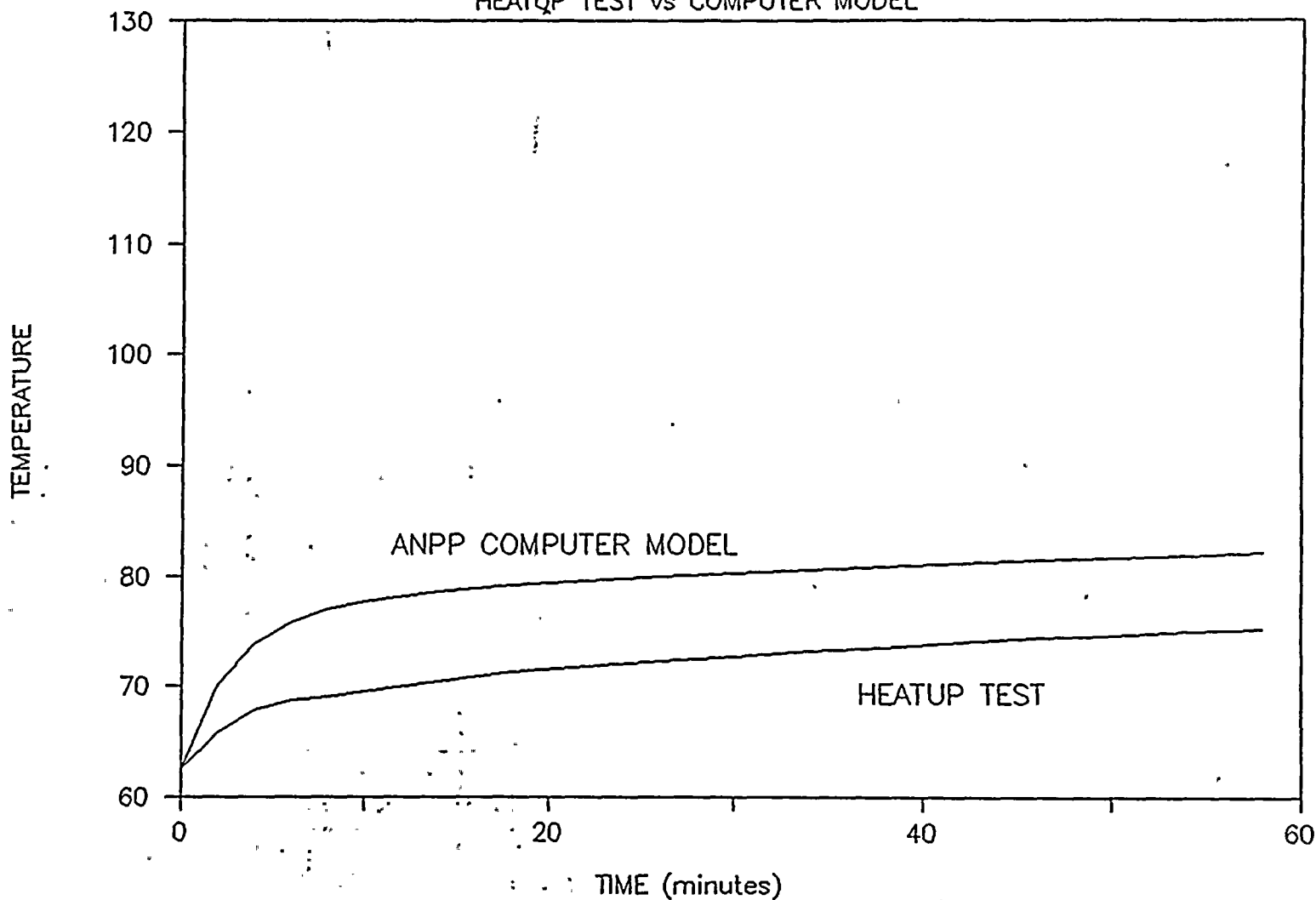


FIG B-2





CALC 13-MC-EC-253

REV 0 AM  
REV 1

## ATTACHMENT 1

EA \_\_\_\_\_

Sheet 19 of 20

AN AA

ENGINEERING EVALUATIONS  
PALO VERDE NUCLEAR GENERATING STATION  
ENGINEERING ANALYSIS WORK SHEET

TITLO: INITIAL TEMPERATURES				
TRAIN B		Performed by: R.A. ZARBO		Date: 6-9-88
References: START 1342 STOP 1504		Review Method by: Alternate Calcs Detailed Review Qualification Test		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Reviewed by:		Circ:		
ROOM	TEMP/HUM	TEMP/HUM	AVG TEMP	AVG HUMID.
HPST	80.2 16.8	80.4 17.6	80.3	
LPSI	LOCKED HIGH RAD		78.8*	* TRAIN A READING.
CS	79.9 17.5	79.6 17.9	79.8	
AF	96.3 17.6	98.2 16.4	97.2	
ELEC PEN	86.6 14.4	87.1 15.1	86.8	
EW	78.3 18.5	78.3 18.8	78.3	
ESP SWITCH GEAR	86.7 27.0	83.8 28.5	85	
CONTROL ROOM	77.8 37.4	75.9 40.1	76.8	
AMBIENT	98.3 13.6	97.2 12.5	99.2	



## ATTACHMENT 2

## EC TRAIN A SERVICE AREA

EQUIPMENT ROOM	ESF AHU #	HEAT LOAD Q; (BTUH)	EC FLOW (GPM)	COIL CAP. (GAL)	ROOM VOL V; (CU FT)	CON AREA
ESF SWITCHGEAR RM	HJA-Z03	170,100	36.0	4.63	73,177	13,
DC EQUIPMENT ROOM	HJA-Z04	135,000	40.5	7.40	INCL	
CONTROL ROOM	HJA-F04	885,950	110.0	42.00	159,973	23,
AFW (TURB) PUMP RM	HAA-Z04	224,447	47.0	7.40	13,440	
ECW PUMP ROOM	HAA-Z05	164,494	37.0	6.95	9,152	
ELECT PENE ROOM	HAA-Z06	81,403	21.0	4.23	34,200	
LPSI PUMP ROOM	HAA-Z02	139,807	25.5	4.94	9,282	
HPSI PUMP ROOM	HAA-Z01	215,994	45.5	7.40	12,220	
CS PUMP ROOM	HAA-Z03	196,650	40.5	6.95	9,282	
	(PIPING)	215,172	N/A	1031.00	N/A	
	(ECA-PO1)	N/A	N/A	3.00	N/A	
	(ECA-E01)	N/A	N/A	100.12	N/A	
	(ECA-T01)	N/A	N/A	80.82	N/A	

TOTALS:

2,429,017

403.0

1226.02

320,726

37,

## EC TRAIN B SERVICE AREA

EQUIPMENT ROOM	ESF AHU #	HEAT LOAD Q; (BTUH)	EC FLOW (GPM)	COIL CAP. (GAL)	ROOM VOL V; (CU FT)	CON AREA
ESF SWITCHGEAR RM	HJB-Z03	170,100	35.0	4.63	73,177	13,
DC EQUIPMENT ROOM	HJB-Z04	135,000	39.0	7.40	INCL	
CONTROL ROOM	HJB-F04	885,950	107.0	42.00	159,973	23,
ECW PUMP ROOM	HAB-Z05	166,144	35.0	6.95	12,672	
ELECT PENE ROOM	HAB-Z06	102,916	16.0	4.23	36,000	
AFW (MOTOR) PUMP RM	HAB-Z04	229,688	45.0	7.40	13,440	
LPSI PUMP ROOM	HAB-Z02	139,807	25.0	4.94	9,282	
HPSI PUMP ROOM	HAB-Z01	215,994	45.0	7.40	12,220	
CS PUMP ROOM	HAB-Z03	196,650	40.0	6.95	9,282	
	(PIPING)	215,172	N/A	844.92	N/A	
	(ECB-PO1)	N/A	N/A	3.00	N/A	
	(ECB-E01)	N/A	N/A	100.12	N/A	
	(ECB-T01)	N/A	N/A	80.82	N/A	

TOTALS:

2,457,421

387.0

1039.94

326,046

37,

