CALCULATION TITLE PAGE

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Calc No. M-0073-125 DCP/FIDCN/ FCN No. & Rev. _____ CCN CONVERSION: CCN NO. CCN-

Subject: Relative humidity at Charcoal Beds (E-418 &419), No Heating Sheet _____ of _____

System Number/Primary Station System Designators 1510 /GKA SONGS Unit 2/3 Q-Class II

Tech. Spec. Affecting? ● NO ○ YES Section No. _____ Equipment Tag No. _____

CONTROLLED COMPUTER PROGRAM/ DATABASE	☐ PROGRAM ☐ DATABASE According to SO123-XXIV-5.1	PROGRAM/ DATABASE NAME(S) ☐ ALSO, LISTED BELOW	VERSION/ RELEASE NO. (S)

RECORD OF ISSUES

REV. DISC	DESCRIPTION	TOTAL SHTS. LAST SHT	PREPARED (Print name/sign/date)	APPROVED (Signature/date)	
0	ISSUE FOR USE	15	ORIG. F. UDREA	FLS	OTHER IPRE
		15	IRE M. GREGOVICH	OTHER	OTHER
			ORIG.	FLS	OTHER
			IRE	OTHER	OTHER
			ORIG.	FLS	OTHER
			IRE	OTHER	OTHER
			ORIG.	FLS	OTHER
			IRE	OTHER	OTHER

Space for RPE Stamp, identify use of an alternate calc., and notes as applicable.

This calc. was prepared for the identified DCP/FCN. DCP/FCN completion and turnover acceptance to be verified by receipt of a memorandum directing DCN Conversion. Upon receipt, this calc. represents the as-built condition. Memo date. _____ by _____

9512210348 951218
PDR ADOCK 05000361
P PDR

CALCULATION CROSS-INDEX

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Calculation No. Relative Humidity at Charcoal Beds (418&419), no heating Sheet No. 2 of 15

Calc. rev. number and responsible FLS initials and date	INPUTS: These interfacing calculations and/or documents provide input to the subject calculation and if revised may require revision of the subject calculation.		OUTPUTS: Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calc/ document require revision?	Identify output interface calc/document CCN, DCN, TCN/Rev., FIDCN, or tracking number.
	Calc / Document No.	Rev. No.	Calc / Document No.	Rev. No.	YES / NO	
V 3 12/4/95	M-73-041 M-73-041 ICCN C-6 M-73-041 ICCN C-7 DWG. 40030 DWG. 40096 DWG. 41358 DWG.41368	7 0 0 13 13 12 9	M-73-125	0	NO	
V 3 12/4/95	SO23 410-1-8 SO23-410-798	11 0				

SCE 26-424 REV. 2 8/95 [REFERENCE: SO123-XXIV-7.15]

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Subject RELATIVE HUMIDITY AT CHARCOAL BEDS (E-418&419),NO OSA HEATING Sheet No. 3

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	F. Udrea		Gregovich						

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Subject RELATIVE HUMIDITY AT CHAECOAL BEDS (E-418&419), NO HEATING Sheet No. 4

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	F. Udrea		Gregovich						

I. PURPOSEBACKGROUND:

Determine the condition of the air upstream of the charcoal filter (E-418 and E-419). Per "USNRC Regulatory Guide RG 152" (Reference 10), the maximum allowable air humidity upstream of the charcoal beds is 70%.

PCN 407 requested that no credit be taken for Emergency Ventilation Unit Heaters E-296 or E-297, during the monthly 10-hour surveillance of the CREACUS test, because SCE is not currently taking credit for Emergency Ventilation Units (A-206 or E-207). In their review, the NRC expressed concern that the charcoal in the Emergency Air Conditioning Units may degrade to an unacceptable level without the monthly drying presently accomplished by the E-296 and E-297 heaters.

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Subject RELATIVE HUMIDITY AT CHARCOAL BEDS (E-418&419),NO OSA HEATING Sheet No. 5

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	F. Udrea		Gregovich						

II. RESULTS/CONCLUSIONS:

For the evaluated scenario the relative humidity of the air upstream of the charcoal filter in the Emergency Air Conditioning Unit will not exceed the required maximum of 70%.

III. ASSUMPTIONS:

1. During non operating periods, the moisture in air is trapped in volume (V),Train B, defined by the A-206 fan assembly, the ductwork between A-206 and E-419, E-419 plenum upstream of the charcoal filter and the HV-9778 damper on the return air duct (see sketch in the appendix).
There are no dampers on the return ducts on Train A, therefore the moisture in the air is dissipated to the rooms. Thus no calculation is performed Train A.

2. The temperature of moist air entrapped in the volume (V), during the 30 day idle period, will reach equilibrium with the fan room temperature.

3. Fire dampers located at the common wall between the fan room and computer room are open and air is being transferred from the computer room to the fan room.

4. Fan Room lights are on, normal operating condition due to operation action and inspection requirements.

5. Heat of compression for the outside supply air is significant enough to be considered in the evaluation.

6. Evaluation is performed during winter operation when outside air relative humidity is 100%.

7. From Reference 7, the fan efficiency is assumed to be 70%.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
	F. Udrea		Gregovich						

IV. DESIGN INPUT:

1. OSA (outside supply air): 2,050 CFM at 36^0 FDB and 100% RH (Reference 1 & 6), point 1 on the psychrometric chart, sheet 13

2. Return Air: 33,655 CFM at 70^0 FDB and 50% RH (Reference 1), point 3 on the psychrometric chart, sheet 13

3. Transfer Air to the Fan Room: 860 CFM at 70^0 FDB and 50% RH (Reference 1)

4. Exhaust Air from the Fan Room: 820 CFM (Reference 1)

5. Fan Room (233) Lighting Load: 4,670 Btuh (Reference 6)

6. Emergency Ventilating Units A-206 & A-207 and Emergency Air Conditioning Units E-419 & E-418 (CREACUS) test is performed every 30 days (Reference 10).

7. Unit 206, fan outlet area: $0.37ft^2$ (based on as built measurements, see sketch in the appendix)

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	F. Udrea		Gregovich						

V. METHODOLOGY:

The calculation indicates that the worst impact to the Emergency Recirculation charcoal filter is during winter operation. The Normal Control Room Complex Air Conditioning (E-295) System is normally operating when a CRIS is actuated or the CREACUS surveillance is due. One Train of the Control Room Complex Emergency Air Conditioning System operates automatically/manually. During this condition, outside air is supplied by the Emergency Ventilation Unit (A-206) and enters the inlet end of the Emergency Air Conditioning Unit (E-419) and is mixed with the return air coming from the different areas of the control room complex. Air from Computer Room, 232, is transferred to Fan Room 233 to maintain an acceptable temperature.

To determine the condition of the entrapped air, the temperature of the mixed return air and outside air will be calculated. Fan Room 233 temperature is calculated by using the room heat balance. Subsequent to the 10 hour CREACUS test, the temperature of the entrapped air in volume (V) will reach equilibrium with Room 233 temperature. The final condition of the entrapped air will be determined using the psychometric chart by cooling the entrapped air to the calculated room temperature.

VI. REFERENCES

1. Air Flow Diagram Train B - Control Bldgs.-El 30'-0", 40096 Rev.13

2. Equipment Schedule HV&AC, 40030 Rev.13

3. Area CA9, HV&AC El 50'-0" to 30'-0", 41358 Rev.12

4. Fan Engineering by Buffalo Forge Co., Fifth Edition

5. ASHRAE Fundamentals 1985 Edition

6. Calculation M-73-041 Rev. 7. ICCN C-6, ICCN C-7

7. Barry Blower Fan, S023 410-1-798 Rev. 0

8. Filter House, Aux. Bldg., Control Room Complex Emergency Air Conditioning Unit # E419, S023 410-1-8 Rev. 11

9. Area CA9 & CA10 HV&AC Partial Plan, 41368 Rev. 9

10. USNRC Regulatory Guide RG 152 Rev. 2

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	F. Udrea		Gregovich						

VII. NOMENCLATURE

Nomenclature is defined in the body of the calculation.

VIII. CALCULATION

1. Temperature rise due to the compression of OSA, unit A-206

Increase in temperature is: 0.367[(total pressure/ total efficiency) -velocity pressure] (Reference 4 page 165)

Temperature increase = $0.367\ [(10.6/0.7) - 1.85] = 4.88^0F$

where: Fan static pressure = 10.6 inch WC (Reference 2)
Fan outlet velocity = 2,050 CFM/0.37 sq. Ft.= 5,540 FT/min (Design input 7)
Velocity pressure = 1.85 inches WC (Reference 5, page 33.25)

Efficiency = 70% (Assumption 7)

Air temperature at the fan outlet opening (t_F) is:

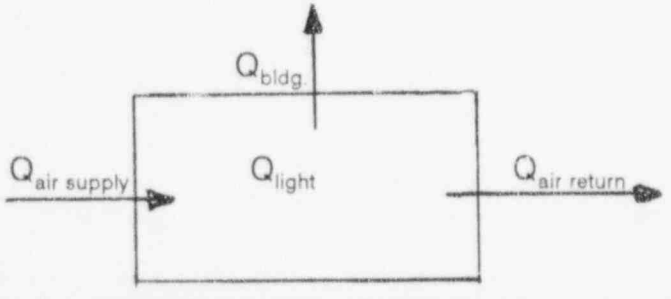
$t_F = 36 + 4.88 = 40.88^0F$ (36 ^0F is from Design Input 1), point 2 on the psychrometric chart, sheet 13

2. Mixed air temperature in E-419 plenum (point 4 on the psychometric chart sheet 13)

$$t_m = \frac{33{,}655 \times 70 + 2{,}050 \times 40.88}{33{,}655 + 2{,}050} = 68.32^0F \text{ at } 51\% \text{ RH}$$

This is the temperature and relative humidity (RH) of the volume (V) at the end of 10 hours surveillance.

3. Fan Room 233 temperature t_{room} (psychrometric chart, Page 13):



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Subject RELATIVE HUMIDITY AT CHARCOAL BEDS (E-418&419), NO OSA HEATING Sheet No. 12

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	F. Udrea		Gregovich						

Fan room heat balance:

$$Q_{light} - Q_{bldg} + Q_{air\ supply} - Q_{air\ return} = 0$$

Building Load Q (Btu/h) = A x U x Δt

Where: A = area in ft^2 (Reference 3 & 9)

U = heat transfer coefficient in BTU/ ft^2, Δt, ^{0}F (Reference 6)

Δt = temperature difference in ^{0}F (Reference 6)

$$Q_{ceiling} = 1370 \times 0.2 \times (t_{room} - 50) = 274\ t_{room} - 13{,}700$$

$$Q_{floor} = 1370 \times 0.36 \times (t_{room} - 50) = 493\ t_{room} - 24{,}660$$

$$Q_{wall\ N} = 520 \times 0.3 \times (t_{room} - 50) = 156\ t_{room} - 7{,}800$$

$$Q_{wall\ W} = 800 \times 0.3 \times (t_{room} - 36) = 240\ t_{room} - 8{,}640$$

$$Q_{wall\ S} = 721 \times 0.29 \times (t_{room} - 70) = 209\ t_{room} - 14{,}636$$

$$Q_{wall\ E} = 800 \times 0.29 \times (t_{room} - 70) = 232 t_{room} - 16{,}240$$

$$Q_{bldg} = 1{,}604\ t_{room} - 85{,}676$$

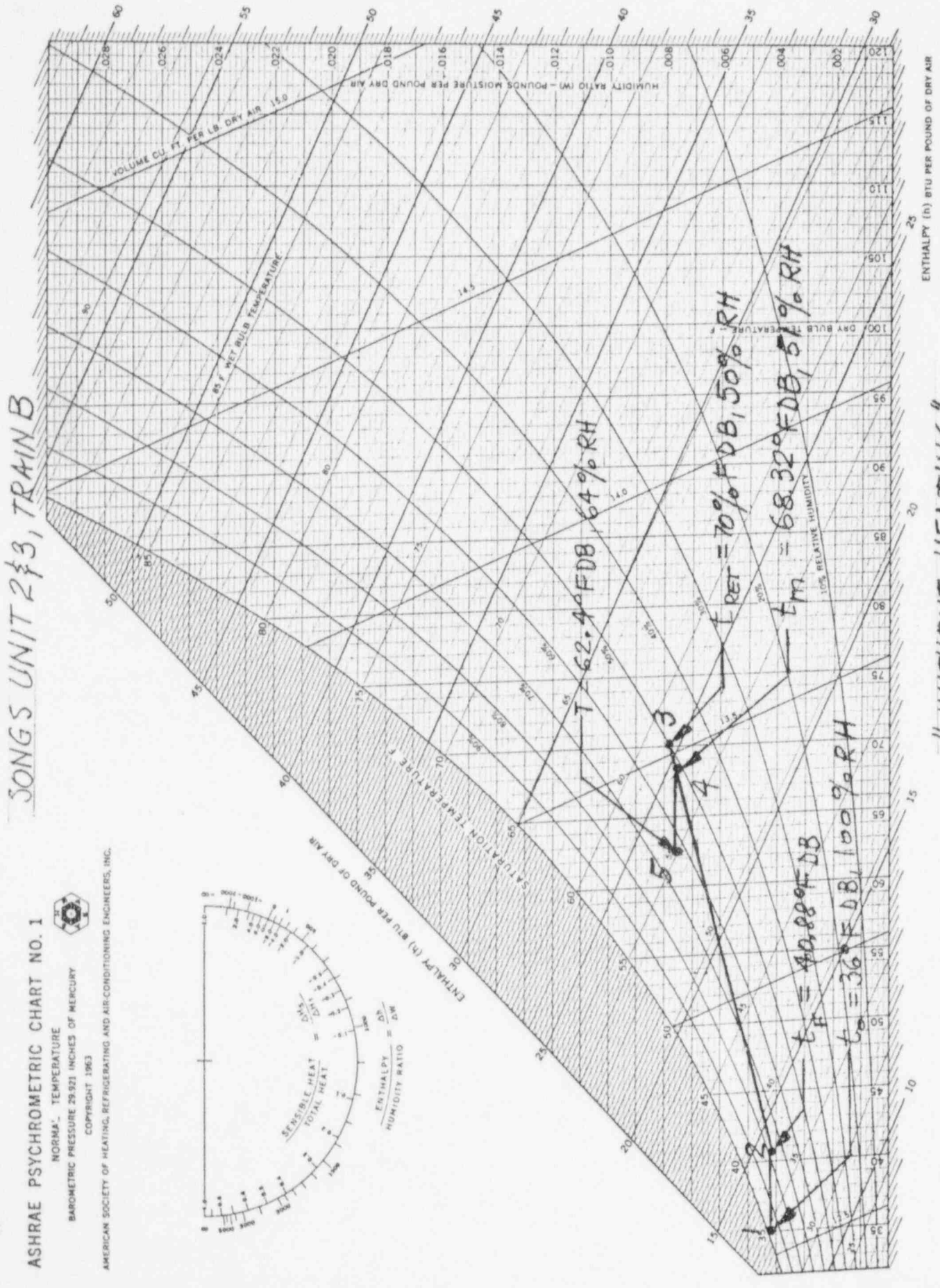
Heat Balance:

$$4{,}670 - (1{,}604\ t_{room} - 85{,}676) + (860 \times 1.08 \times 70) - (820 \times 1.08 \times t_{room}) = 0$$

$$4{,}670 - 1{,}604\ t_{room} + 85{,}676 + 65{,}016 - 885.6\ t_{room} = 0$$

$$2{,}489.6\ t_{room} = 155{,}362 \qquad t_{room} = 62.4^0\ F$$

After sensible cooling, the final temperature of air of the volume (V) becomes equal with the Fan Room temperature, $t_{room} = T = 62.4^0$F, point 5 on the psychometric chart sheet 13, with the relative humidity 64% RH.
Therefore the relative humidity upstream of the charcoal filter in the Emergency Air Conditioning unit will not exceed 70% RH.


SONGS UNIT 2&3, TRAIN B
"WITHOUT HEATING"
ASHRAE PSYCHROMETRIC CHART NO. 1
NORMAL TEMPERATURE
BAROMETRIC PRESSURE 29.921 INCHES OF MERCURY
COPYRIGHT 1953
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
HUMIDITY RATIO (W) – POUNDS MOISTURE PER POUND DRY AIR
VOLUME CU. FT. PER LB. DRY AIR
85° F. WET BULB TEMPERATURE
DRY BULB TEMPERATURE °F
ENTHALPY (h) BTU PER POUND OF DRY AIR
SATURATION TEMPERATURE °F
ENTHALPY (h) BTU PER POUND OF DRY AIR
10% RELATIVE HUMIDITY
SENSIBLE HEAT / TOTAL HEAT
ENTHALPY / HUMIDITY RATIO
T = 62.4°FDB 64% RH
t_RET = 70°FDB, 50% RH
t_m = 68.32°FDB, 51% RH
t_F = 40.88°FDB
t_o = 36°FDB, 100% RH
1
2
3
4
5

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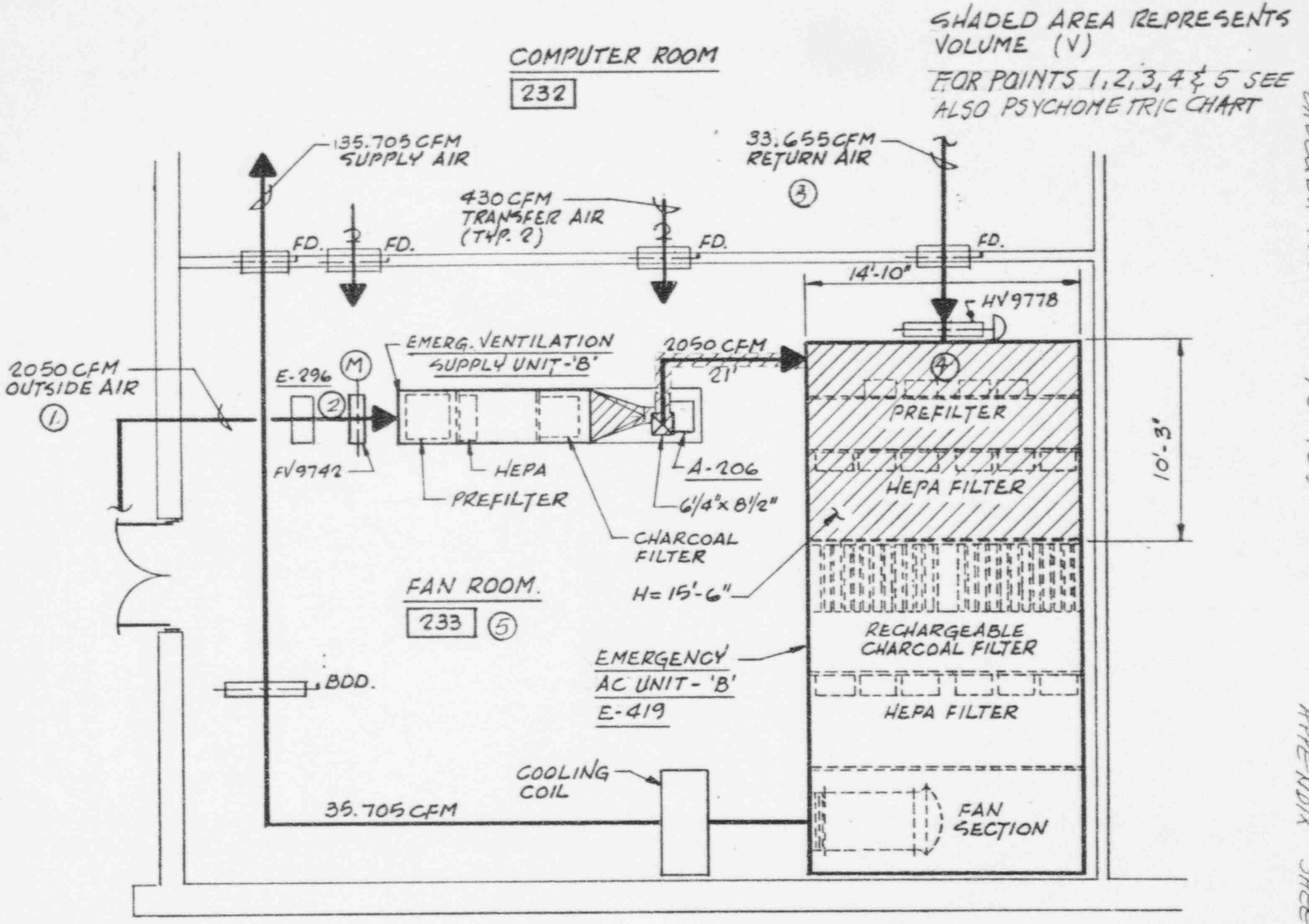
	F. Udrea		Gregovich						

IX. APPENDICES



FAN ROOM 233 - TRAIN 'B'

REF. 8.

CALCULATION M-73-125

APPENDIX SHEET 15