

CALCULATION TITLE PAGE

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Calc No. <u>M-0073-126</u> DCP/FIDCN/ FCN No. & Rev. _____		CCN CONVERSION: CCN NO. CCN-	
Subject: <u>Evaporation Time of Entrapped Air Moisture in E-419</u>		Sheet _____ of _____	
System Number/Primary Station System Designators <u>1510</u> /GKA		SONGS Unit <u>2/3</u>	Q-Class <u>I</u>
Tech. Spec. Affecting? <input checked="" type="radio"/> NO <input type="radio"/> YES Section No. _____		Equipment Tag No. _____	
CONTROLLED COMPUTER PROGRAM/ DATABASE	<input type="checkbox"/> PROGRAM <input type="checkbox"/> DATABASE According to SO123-XXIV-5.1	PROGRAM/ DATABASE NAME(S) <input type="checkbox"/> 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 <u>F. UDREA</u> ^{12/11/95} FLS	OTHER <u>PRE</u>
		15	IRE <u>M. GREGOVICH</u> ^{12/11/95} OTHER	OTHER
			ORIG FLS	OTHER
			IRE <u>[Signature]</u> 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 _____


CALCULATION CROSS-INDEX

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Calculation No. M-0073-126 Evaporation Time of Entrapped Air Moisture in E-419

Sheet No. 2 of 15

CCN CONVERSION: CCN NO. CCN-

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	
	M-0073-125 SO23 410-1 DWG. 41358 DWG. 41368 DWG. 40096	0 11 12 9 13	TECHNICAL SPECIFICATION 3/4. 7.5 * CONTROL ROOM EMERGENCY CLEANUP SYSTEM "	Amend. 123	YEC	PCN 407

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Subject EVAPORATION TIME OF ENTRAPPED MOISTURE IN E-419 Sheet No. 3

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

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Subject EVAPORATION TIME OF ENTRAPPED MOISTURE IN E-419 Sheet No. 4

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

I. PURPOSE/BACKGROUND

During idle periods of operation, the entrapped air in the intake plenum of the Control Room Emergency Air Conditioning Units, E-418 and 419, contains moisture vapors that may degrade the effectiveness of the charcoal filters.

Calculation M-0073-125 determined that, under design conditions, the relative humidity of the entrapped air will not exceed the maximum allowable limit of 70%.

This calculation assumes that the water vapor in the entrapped air will reach its dewpoint and will condense into a water film on the bottom surface of E-419 unit plenum.

The purpose of this calculation is to determine the time for the condensed water to evaporate when the unit is restarted. Emergency Air Conditioning Unit, 419, is considered the conservative case based on the results of the Calculation M-0073-125.

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Subject EVAPORATION TIME OF ENTRAPPED MOISTURE IN E-419 Sheet No. 5

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
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II. RESULTS/CONCLUSIONS:

For the Control Room Emergency Air Conditioning Unit, E-419, the time to evaporate the condensation from the entrapped moist air is 1.34 hours.

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Subject EVAPORATION TIME OF ENTRAPPED MOISTURE IN E-419 Sheet No. 6

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	F. Udrea		Gregovich						

III. ASSUMPTIONS:

1. Upon shutdown of CREACUS, Train B, the air entrapped in volume (V), is initially at 68.32° F and 51% RH (Reference 1 and design Input 2).

It is assumed that the entrapped air will cool to the dew point, 50° F and 100% RH at which point condensation will occur (see point 2 on the psychrometric chart).

50° F is well below the coldest postulated temperature in the Fan Room. It is only assumed for purpose of forcing condensation in the entrapped air.

2. To conservatively evaluate the evaporation time, it was assumed that the moisture content of the entrapped air volume is confined within the volume inside E-419 directly upstream of charcoal filter beds and charcoal filter material is impervious to water.

3. All condensation will collect on the bottom surface of E-419 which will contain traces of moisture (see surface S on the sketch in the Appendix). Thus, moisture film (surface) evaporation will take place. This is conservative since it provides less evaporation surface than would otherwise be expected.

4. For conservatism, the evaporation rate is calculated from 100%RH to 70%RH (corresponding to 64° FDB temperature), point 3 to point 4 on the psychrometric chart (see sheet 13).

5. For conservative results, rate of evaporation for parallel flow will be used in the evaluation.

6. Air velocity at the boundary (duct sides) is considered 1/3 of the velocity across the E-419 filter section (Reference 3 page 106)

7. The mixing of outside air and return air is perfect.

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IV. DESIGN INPUT

1. Volume (V) : 2388 ft³ (References 4,5 and 6, see sketch in the appendix)

Where: (V) represents the volume define 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).

2. Conditions of trapped air (V) t_m : 68.32^o F and 51% RH (Reference 1)
(see point 1 on the psychrometric chart on sheet 13)

3. The moisture in contact with recirculated air tends to follow the saturation line to the wet bulb temperature of the recirculated air, point 3 (57.5^o F and 100% RH) on the psychrometric chart sheet 13 (Reference 2, page 5-13). This condition would apply to the condensed moisture when the HVAC Train is restarted.

4. Air flow across the Emergency Air Conditioning Unit E-419 is: 35,705 CFM (Reference 7)

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	F. Udrea		Gregovich						

V. METHODOLOGY

The total mass of moisture entrapped in volume (V) is determined from its initial condition. This entrapped air is assumed to cool to its dew point temperature and all moisture is assumed to condense and collect on the bottom surface of Emergency Air Conditioning Unit, E-419, plenum in an uniform water film.

The evaporation rate of the water film is calculated using the evaporation formula for parallel air flow (the air flow is parallel to the surface area of water being evaporated).

The evaporation time is then calculated by dividing the mass of condensed water by the evaporation rate.

All cooling and evaporation process are shown on the enclosed psychometric chart (sheet 13).

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	F. Udrea		Gregovich						

VI. REFERENCES:

1. Calculation M-0073-125
2. Fan Engineering by Buffalo Forge Co., Eighth Edition
3. Fan Engineering by Buffalo Forge Co., Fifth Edition
4. Filter House, Aux. Bldg., Control Room Complex Emergency Air Conditioning Unit # E419, SO23 410-1-8 Rev. 11
5. Area CA9, HV&AC El 50'-0" to 30'-0", 41358 Rev. 12
6. Area CA9 & CA10 HV&AC Partial Plan, 41368 Rev.9
7. Air Flow Diagram Train B - Control Bldg.- El 30'-0", 40096 Rev. 13

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VII. NOMENCLATURE

Nomenclature is defined in the body of the calculation.

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	F. Udrea		Gregovich						

VIII. CALCULATION:

1. Determine the mass of vapor in volume (V):

At 50°F, the vapor density is 0.000587 LB/ft³ (Reference 3, page 20)
 Total mass of water vapor in volume V = 2388 ft³ (Reference Design Input 1) is:
 2388 x 0.000587 = 1.4 LB water vapor

2. Determine the rate of evaporation:

The rate of evaporation with parallel air flow is (Reference 2 page 5-13)

$$m_{v \text{ parallel}} = S \frac{95 + 0.425 v}{h_{lw}} (p_{ws} - p_w)$$

Where: m_v = rate of evaporation in LB/Hr
 v = velocity of air flow in ft./min.
 p_{ws} = vapor pressure corresponding to water temperature in inches of mercury
 p_w = vapor pressure of the moist air in inches of mercury
 h_{lw} = latent heat of evaporation in BTU/LB
 S = exposed water surface in ft²

The air velocity across the E-419 unit is:

$$V = \frac{\text{CFM (Design Input 4)}}{\text{Cross Section Area E-419 (see sketch in Appendix)}} = \frac{35,705}{14.83 \times 15.5}$$

$$= 155.33 \text{ ft/min}$$

$$v = 155.33 / 3 = 51.77 \text{ ft/min (Assumption 6)}$$

$$p_{ws} = 0.4832 \text{ inches Hg (Design Input 3 and Reference 2, Table 1.7)}$$

point 3 on the psychrometric chart, sheet 13

$$p_w = p_s \times RH$$

Where: p_s = 0.6009 vapor pressure of the dry bulb temperature 64°FDB
 (Assumption 4 and Reference 2, Table 1.7)
 point 4 on the psychrometric chart, sheet 13

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RH = relative humidity, 70% (Assumption 4)
 point (4) on the psychrometric chart

$$p_w = 0.6009 \times 0.70 = 0.4206 \text{ inches Hg}$$

$$h_{lw} = 1065 \text{ BTU/LB at } 50^\circ \text{ FWB dew point (Assumption 1 and Reference 2, Fig. 1.5)}$$

$$S_{\text{bottom}} = 10.25 \times 14.83 = 152 \text{ ft}^2 \text{ (Assumption 3 and sketch in the Appendix)}$$

$$m_{v \text{ boundary}} = 152 \left(\frac{95 + 0.425 \times 51.77}{1065} \right) (0.4832 - 0.4206)$$

$$= 152 \times 0.1098 \times 0.0626 = 1.045 \text{ LB/Hr}$$

3. Determine the time to evaporate the entrapped moist air:

With an evaporation rate of 1.045 LB/H, will take 1.4 LB/ 1.045 LB/Hr = 1.34 Hr. .

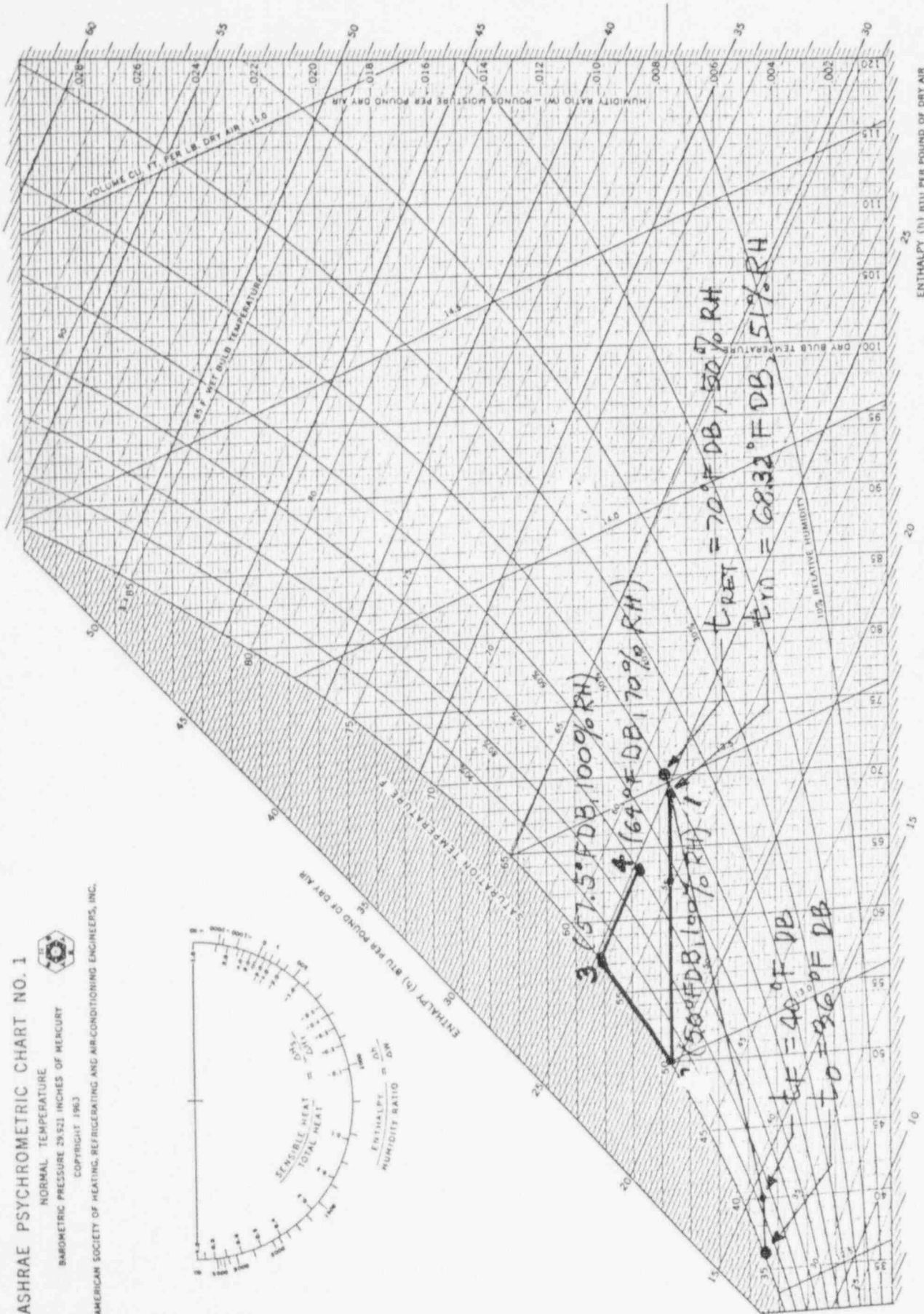
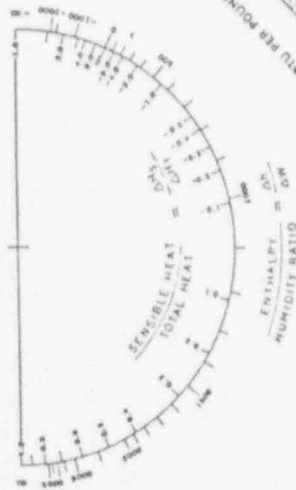
SONGS UNIT 2&3, TRAIN B

ASHRAE PSYCHROMETRIC CHART NO. 1



NORMAL TEMPERATURE
 BAROMETRIC PRESSURE 29.921 INCHES OF MERCURY
 COPYRIGHT 1963

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.



" WITHOUT HEATING "

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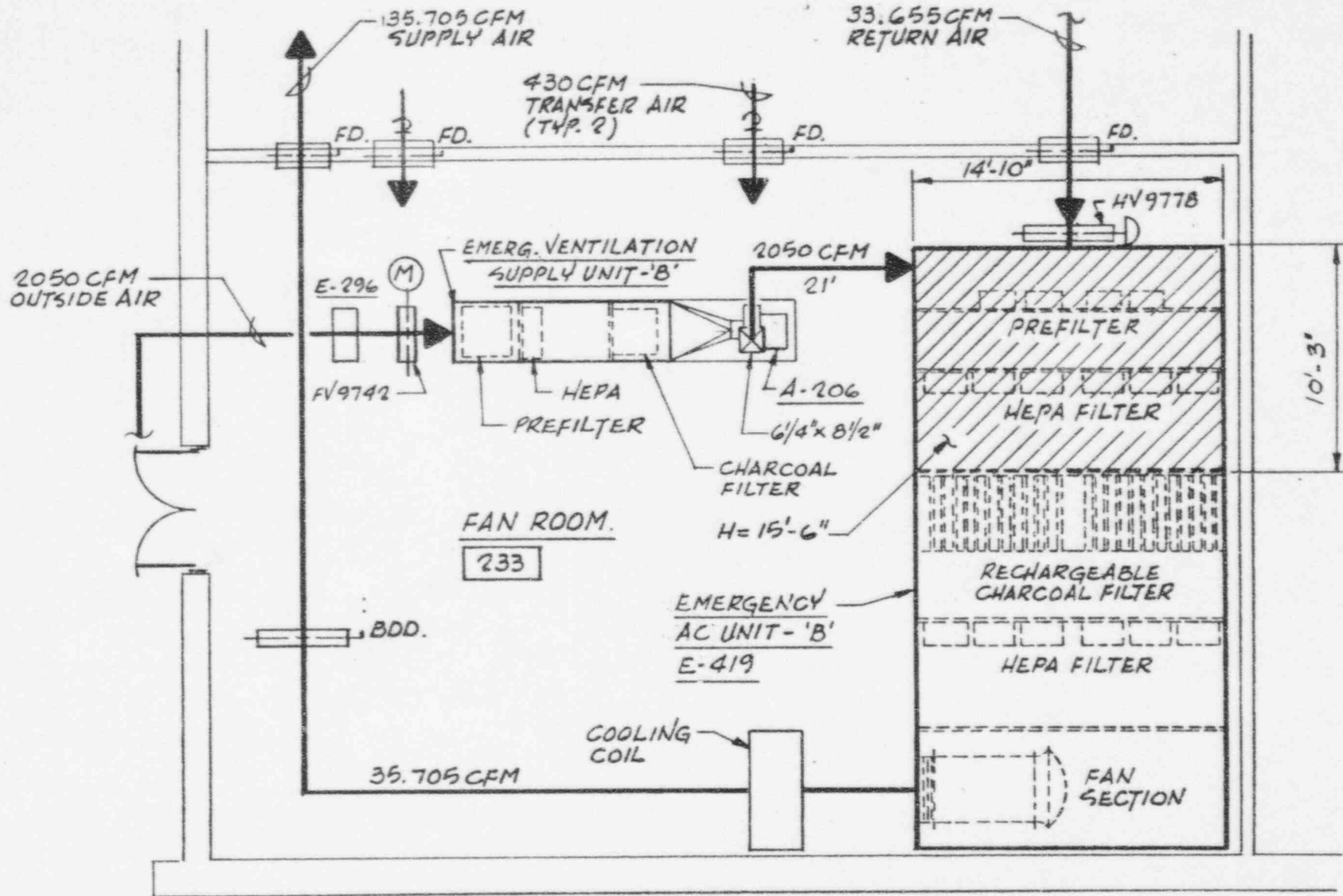
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I, APPENDICES

COMPUTER ROOM

232

SHADED AREA REPRESENTS
AREA OF EVAPORATION.
(5 BOTTOM)



FAN ROOM 233 - TRAIN 'B'

REF. 8.

APPENDIX
CALCULATIONS M-0073-126
SHEET 15