ACT/007/006

July 1, 1987

TO: File

FROM: Pamela Grubaugh-Littig, Reclamation Engineer pgl

RE: Estimate of Water Evaporated Due to Coal Mine Ventilation, Plateau Mining Company, Star Point Mines, ACT/007/006, Folder #2, Carbon County, Utah

I reviewed the Memo to File from Lee Spencer dated May 21, 1987 (copy attached). The U.S. Forest Service provided detailed historical data from the Central Weather Station for the relative humidity for the Manti-LaSal Rh=52 percent. I, therefore, recalculated the Utah Power and Light estimate as well as the Plateau, Bear Canyon, and Hiawatha Mine evaporation due to mine ventilation.

The recalculated figures are:

Mine(s)	Ventilation Rate (cfm)	Approximate Discharge Rate (gpm)
Utah Power & Light	570,000	38
Bear Canyon	150,000	10
Star Point Mines	650,000	44
Hiawatha Mine Complex	350,000	24

(The calculations are attached.)

djh
Attachments
9075R/33
cc: JDW
RVS

CUS 6/26/87

Relative Humidity

Data from Central Weather Station from (SE 1/4, Sect. 26, T17S, R5E) 1967, 1968, 1969, 1971, 1972 and 1973

Jan	Feb	Mar	Apr	May	June
59%	68%	58%	52%	42%	42%

July	Aug	Sept	Oct	Nov	Dec
37%	40%	45%	51%	51%	70%

Avg Annual = 51.25%

Rick call
Dennis Kelly
637-2817

Kanti - Lasal
re: humidity

Avg. Annual Rel. Humidity

7200' → summer only

Barometer watended

SE 1/4 Sect 26 T17S R5E

8300'

Central Weather Station

1967, 68, 69, 71, 72, 73

Jan	Feb	March	Apr.	May
	67.80%	57.75%	52%	42

June	July	Aug	Sept	Oct	Nov
42	37	40	45	51	51

Dec. 70

METHOD IS THE SAME AS Lee Spencer, see memo to file 5/21/87.

Different Relative Humidity (now 52%). This affects Table 2 (T_W & T_d)

GIVEN:

$T_d = 50°$
$R_H = 52\%$
Elev. = 7600'
$Q = 570{,}000$ cfm

P_b (7600) = 22.56 in Hg

$T_W = 42°$ @ 23 in.

$p_s' = .2676$ @ 29.92 in (Psychrometric chart, pg. 311)

Correction for elevation of 7600'

$$p_s' = (.2676)\left(.491 \frac{psi}{in}\right) = 0.1314 \text{ psi}$$

$$\log p_2 = -0.88143 - \left(\frac{7600}{(122.8)(460+50)}\right) = -0.88143 - 0.1213$$

$$\log p_2 = 1.0027 \quad \therefore \quad p_2 = \frac{(0.0012)}{.491}($$

$p_s' \rightarrow 0.0024$ in Hg @ 22.56 in.

$$p_v = p_s' - \frac{(p_b - p_s')(t_d - t_w)}{2800 - 1.3(t_w)}$$

$$= 0.0024 - \frac{(22.65 - 0.0024)(50 - 42)}{2800 - (1.3)(502°)} \qquad (502 = 460 + 52)$$

$$p_v = \cancel{\frac{2328}{2447} = 1.0054} \qquad 0.0024 - 0.0105 = -0.0081$$

$$W_1 = 0.6223\left(\frac{P_v}{P_b - P_v}\right) \frac{lb}{lb\ dry\ air}$$

$$W_1 = 0.6223\left(\frac{-.0081}{22.56-(-.0081)}\right) = 0.00022335 \frac{lb\ H_2O}{lb\ dry\ air}$$

$$P_b = P_a + P_v \qquad P_a = P_b - P_v$$

$$P_a = 22.56 - .0081 = 22.55$$

$$v = \frac{RT_d}{P_a} = \frac{(53.3)(460+50)}{(22.55)(.491)(144)} = 17.05\ cf/lb_{dry\ air}$$

$$Q_{lbs} = 570{,}000\ \frac{cf}{minute} \times \frac{lb\ dry\ air}{17.05\ cf} = 33{,}431\ \frac{lbs\ dry\ air}{min.}$$

$$W_2 - W_1 = .00975\ \left(\text{from Lee Spencer "return" pg. 3}\right) - 0.000223 = 0.009527$$

$$Vol_{H_2O} = 33{,}431\ \frac{lbs\ dry\ air}{min} \times .00953\ \frac{lbs\ H_2O}{lbs\ dry\ air} \times \frac{gal}{8.33\ lb} = \boxed{38.25\ \frac{gal}{min}}$$

UP: L

PLATEAU

$$Q = 650{,}000\ cfm \times \frac{1\ lb}{17.05\ cf} = 38{,}123\ \frac{lb}{min.}$$

$$38{,}123 \times 0.009527 \times \frac{gal}{8.33\ lb} = \boxed{43.60\ \frac{gal}{min}}$$

HIAWATHA

HIAWATHA

$$Q = 350{,}000\ cfm \times \frac{1\ lb}{17.05\ cf} = \frac{20{,}528\ lbs}{min.}$$

$$\frac{20{,}528\ lb}{min} \times 0.009527 \times \frac{gal}{8.33\ lbs} = \boxed{\frac{23.48\ gal}{min}}$$

Bear Canyon

$$Q_{lbs.} = 150{,}000\ cfm \times \frac{lb}{17.05\ cf} = \frac{8798\ lb}{min}$$

$$\frac{8798\ lbs}{min} \times 0.009527 \frac{lbs_{H_2O}}{lb\text{-}d} \times \frac{gal}{8.33\ lbs.} = \boxed{\frac{10.06\ gal}{min}}$$

42-381 50 SHEETS 5 SQUARE
42-382 100 SHEETS 5 SQUARE
42-389 200 SHEETS 5 SQUARE
NATIONAL

In-Mine WATER LOSS FROM EVAPORATION

D1 ROGER FR4 UP+L 11/4/83

$$W = \frac{\text{Grains Moisture}}{\text{Pounds Air}} = \frac{4360}{\frac{P_B}{P_V} - 1}$$

where P_B = Barometric Pressure (in. Hg)
P_V = Vapor Pressure

P_V = Relative Humidity · P_S

Obtain P_S Value from Table A-4 (Saturation Press.)
Obtain P_B Table A-1

$$V = \frac{FT^3 \text{ Air}}{\text{Pound}} = \frac{.754 \cdot T_D}{P_B} \left(1 + \frac{w}{4360}\right)$$

exhaust air.

where T_D = Temperature Dry Bulb (Absolute)
$A^\circ = F^\circ + 460$

Grains Moisture Evaporation = Grains Moisture Exhaust − Grains Moisture Intake

Plateau 650,000 cfm
Hiawatha 350,000 cfm
Bear Cyn 150,000 cfm

Example

Intake Air: Volume 570,000 CFM
Temp 50°F
Relative Humidity 45%
Elevation 7600 Ft.

month by month
temp - humidity
yearly mean

Sat. pressure

at tw 10 min correct for altitude

$PV = .45 \cdot .3624 = .16308$

average
daily high
daily low

$$W = \frac{4360}{\frac{22.65}{.16303} - 1} = 31.62 \text{ grains/Lb}$$

14.45 (yearly total precip)
10-81
9-82

OK

$$V = .754 \frac{(50+460)}{22.65}\left(1 + \frac{31.62}{4360}\right) = 17.1 \text{ Ft}^3/\text{Lb}$$

Exaust Air: Temp 58°F
Relative Humidity 95%

$PV = .95 \cdot .4856 = .4613$

$$W = \frac{4360}{\frac{22.65}{.4613} - 1} = 90.64 \text{ grains/Lb}$$

90.64 grains/Lb Exit − 31.62 grains/Lb enter = 59.02 grains/pound

$$\left(\frac{59.02 \text{ Grains}}{\text{Lb, AIR}}\right) \cdot \left(\frac{570{,}000 \text{ Ft}^3/\text{min}}{17.1 \text{ Ft}^3/\text{Lb}}\right) \cdot \left(\frac{60 \text{ min}}{1 \text{ hr}}\right) \cdot \left(\frac{24 \text{ hr}}{1 \text{ Day}}\right) \cdot \left(\frac{365 \text{ day}}{1 \text{ year}}\right) \cdot \left(\frac{1 \text{ Lb}}{7000 \text{ grains}}\right) \cdot \left(\frac{1 \text{ Gal}}{8.33 \text{ Lb}}\right) =$$

V =

17,733,329 gallons/Year 34 gpm

33.74

31.1 g/hr. CFM

checks

REFERENCE TABLES

TABLE A-1

ATMOSPHERIC PRESSURE, BAROMETER READINGS, AND RELATIVE AIR DENSITY AT DIFFERENT ALTITUDES

Altitude above Sea Level (ft)	Atmospheric Pressure (psi)	Barometer Reading (in. mercury)	Relative Air Density*
0	14.69	29.92	1.000
500	14.42	29.38	0.981
1,000	14.16	28.86	0.964
1,500	13.91	28.33	0.947
2,000	13.66	27.82	0.930
2,500	13.41	27.31	0.913
3,000	13.16	26.81	0.896
3,500	12.92	26.32	0.880
4,000	12.68	25.84	0.864
4,500	12.45	25.36	0.848
5,000	12.22	24.89	0.832
5,500	11.99	24.43	0.816
6,000	11.77	23.98	0.799
6,500	11.55	23.53	0.786
7,000	11.33	23.09	0.774
7,500	11.12	22.65	0.758
8,000	10.91	22.22	0.739
8,500	10.70	21.80	0.728
9,000	10.50	21.38	0.715
9,500	10.30	20.98	0.701
10,000	10.10	20.58	0.687
10,500	9.90	20.18	0.674
11,000	9.71	19.75	0.661
11,500	9.52	19.40	0.648
12,000	9.34	19.03	0.636
12,500	9.15	18.65	0.624
13,000	8.97	18.29	0.611
13,500	8.80	17.93	0.599
14,000	8.62	17.57	0.587
14,500	8.45	17.22	0.576
15,000	8.28	16.88	0.564

* Based on standard air, temperature constant at 70 F.

SOURCES: F. W. O'Neil, ed., *Compressed Air Data* (5th ed.; New York: Ingersoll-Rand Co., 1954), p. 102; R. D. Madison, ed., *Fan Engineering* (5th ed.; Buffalo: Buffalo Forge Co., 1949), p. 28.

TABLE A-4

Psychrometric Data for Air-Water-Vapor Mixtures

Temperature, F t	Properties of Water and Steam: Saturation Pressure of Water and Steam, in. Hg p_s	Enthalpy: Saturated Water, Btu/lb h_f	Enthalpy: Saturated Steam, Btu/lb h_g	Specific Volume of Sat. Steam, cu ft/lb v_g	Properties of Dry Air at a Pressure of 29.921 in. Hg abs: True Specific Volume, cu ft/lb v_a	Enthalpy, Btu/lb h_a	Properties of Mixture of Dry Air and Sat. Steam at a Total Pressure of 29.921 in. Hg abs: Volume of Mixture per lb of Dry Air, ft³ v_s	Enthalpy of Mixture per lb of Dry Air, Btu h_s	Specific Humidity, Grains per lb of Dry Air W_s
32	0.1803	0.0	1075.2	3305	12.380	7.09	12.46	11.75	26.40
33	0.1878	1.0	1075.6	3180	12.414	7.93	12.49	12.16	27.40
34	0.1955	2.0	1076.0	3062	12.430	8.17	12.52	12.57	28.03
35	0.2034	3.0	1076.5	2948	12.464	8.41	12.55	13.00	29.80
36	0.2117	4.0	1076.9	2839	12.490	8.65	12.58	13.42	31.02
37	0.2202	5.0	1077.4	2734	12.515	8.89	12.61	13.86	32.28
38	0.2290	6.0	1077.8	2634	12.540	9.13	12.64	14.30	33.68
39	0.2382	7.0	1078.2	2538	12.565	9.37	12.67	14.75	34.94
40	0.2477	8.0	1078.7	2445	12.591	9.61	12.70	15.21	36.34
41	0.2575	9.0	1079.1	2357	12.616	9.85	12.73	15.68	37.80
42	0.2676	10.1	1079.5	2272	12.641	10.09	12.76	16.16	39.30
43	0.2781	11.1	1080.0	2190	12.667	10.34	12.79	16.64	40.86
44	0.2890	12.1	1080.4	2112	12.692	10.58	12.82	17.13	42.47
45	0.3002	13.1	1080.9	2037	12.717	10.82	12.85	17.63	44.14
46	0.3119	14.1	1081.3	1965	12.742	11.06	12.88	18.13	45.86
47	0.3239	15.1	1081.7	1896	12.768	11.30	12.91	18.66	47.65
48	0.3363	16.1	1082.2	1829	12.793	11.54	12.94	19.19	49.51
49	0.3491	17.1	1082.6	1766	12.818	11.78	12.97	19.73	51.42
50	0.3624	18.1	1083.1	1704	12.844	12.02	13.00	20.28	53.40
51	0.3761	19.1	1083.5	1645	12.869	12.26	13.03	20.84	55.44
52	0.3903	20.1	1083.9	1589	12.894	12.50	13.06	21.41	57.56
53	0.4049	21.1	1084.4	1534	12.919	12.74	13.10	21.99	59.75
54	0.4200	22.1	1084.8	1482	12.945	12.98	13.13	22.59	62.01
55	0.4356	23.1	1085.2	1431	12.970	13.22	13.16	23.20	64.36
56	0.4518	24.1	1085.7	1383	12.995	13.46	13.19	23.82	66.78
57	0.4684	25.1	1086.1	1336	13.020	13.70	13.23	24.45	69.28
58	0.4856	26.1	1086.5	1292	13.046	13.94	13.26	25.10	71.86
59	0.5033	27.1	108.70	1249	13.071	14.18	13.29	25.76	74.54
60	0.5216	28.1	1087.4	1207	13.096	14.42	13.33	26.43	77.29
61	0.5405	29.1	1087.9	1167	13.122	14.66	13.36	27.11	80.14
62	0.5600	30.1	1088.3	1129	13.147	14.90	13.40	27.82	83.09
63	0.5800	31.1	1088.7	1092	13.172	15.14	13.43	28.54	86.14
64	0.6007	32.1	1089.2	1022	13.197	15.38	13.47	29.27	89.27
65	0.6221	33.1	1089.6	1056	13.223	15.62	13.50	30.03	92.51
66	0.6441	34.1	1090.0	988.0	13.248	15.86	13.54	30.79	95.86
67	0.6668	35.1	1090.5	956.8	13.273	16.10	13.58	31.58	99.32
68	0.6902	36.1	1090.9	926.1	13.298	16.35	13.61	32.38	102.9

56	0.4518	24.1	1085.7	1383	12.995	13.46	13.19	23.82	66.78
57	0.4684	25.1	1086.1	1336	13.020	13.70	13.23	24.45	69.28
58	0.4850	26.1	1086.5	1292	13.046	13.94	13.26	25.10	71.86
59	0.5033	27.1	108.70	1249	13.071	14.18	13.29	25.76	74.54
60	0.5216	28.1	1087.4	1207	13.096	14.42	13.33	26.43	77.29
61	0.5405	29.1	1087.9	1167	13.122	14.66	13.36	27.11	80.14
62	0.5599	30.1	1088.3	1129	13.147	14.90	13.40	27.82	83.09
63	0.5800	31.1	1088.7	1092	13.172	15.14	13.43	28.54	86.14
64	0.6007	32.1	1089.2	1022	13.197	15.38	13.47	29.27	89.27
65	0.6221	33.1	1089.6	1056	13.223	15.62	13.50	30.03	92.51
66	0.6441	34.1	1090.0	988.0	13.248	15.86	13.54	30.79	95.86
67	0.6668	35.1	1090.5	958.8	13.273	16.10	13.58	31.58	99.32
68	0.6902	36.1	1090.9	920.1	13.298	16.35	13.61	32.38	102.9
69	0.7143	37.1	1091.3	896.5	13.324	16.59	13.65	33.20	106.6
70	0.7393	38.1	1091.8	868.0	13.349	16.83	13.69	34.04	110.4
71	0.7648	39.1	1092.2	840.5	13.374	17.07	13.72	34.90	114.3
72	0.7911	40.1	1092.6	814.0	13.399	17.31	13.76	35.79	118.4
73	0.8183	41.1	1093.1	788.4	13.425	17.55	13.80	36.69	122.6
74	0.8463	42.1	1093.5	763.8	13.450	17.79	13.84	37.61	126.9
75	0.8751	43.1	1093.9	740.0	13.475	18.03	13.88	38.56	131.3
76	0.9047	44.1	1094.4	717.0	13.501	18.27	13.92	39.52	135.9
77	0.9352	45.1	1094.8	694.9	13.526	18.51	13.96	40.51	140.6
78	0.9667	46.1	1095.2	673.5	13.551	18.75	14.00	41.52	145.5
79	0.9990	47.1	1095.7	652.9	13.576	18.99	14.04	42.56	150.6
80	1.0323	48.1	1096.1	633.0	13.602	19.23	14.09	43.63	155.8
81	1.0665	49.1	1096.6	613.8	13.627	19.47	14.13	44.72	161.2
82	1.1017	50.1	1097.0	595.3	13.652	19.71	14.17	45.84	166.7
83	1.1380	51.1	1097.4	577.4	13.678	19.95	14.22	46.98	172.4
84	1.1752	52.1	1097.8	560.1	13.703	20.19	14.26	48.16	178.3
85	1.2136	53.1	1098.3	543.3	13.738	20.43	14.31	49.36	184.4
86	1.2530	54.0	1098.7	527.2	13.753	20.67	14.35	50.59	190.8
87	1.2936	55.0	1099.1	511.6	13.778	20.91	14.40	51.86	197.0
88	1.3351	56.0	1099.6	496.5	13.804	21.15	14.45	53.14	203.7
89	1.3779	57.0	1100.0	482.0	13.829	21.39	14.50	54.48	210.6
90	1.4219	58.0	1100.4	467.9	13.854	21.64	14.55	55.85	217.6

TABLE A-4 (*continued*)

Temperature, F t	Properties of Water and Steam: Saturation Pressure of Water and Steam, in. Hg p_s	Enthalpy: Saturated Water, Btu/lb h_f	Enthalpy: Saturated Steam, Btu/lb h_g	Specific Volume of Sat. Steam, cu ft/lb v_g	Properties of Dry Air at a Pressure of 29.921 in. Hg abs: True Specific Volume, cu ft/lb v_a	Enthalpy, Btu/lb h_a	Properties of Mixture of Dry Air and Sat. Steam at a Total Pressure of 29.921 in. Hg abs: Volume of Mixture per lb of Dry Air, ft³ v_s	Enthalpy of Mixture per lb of Dry Air, Btu h_s	Specific Humidity, Grains per lb of Dry Air W_s
91	1.4071	59.0	1100.9	464.3	13.880	21.88	14.60	57.25	224.0
92	1.5136	60.0	1101.3	441.1	13.905	22.12	14.65	58.69	232.4
93	1.5613	61.0	1101.7	428.4	13.930	22.36	14.70	60.16	240.1
94	1.6103	62.0	1102.2	416.1	13.955	22.60	14.75	61.67	248.1
95	1.6607	63.0	1102.6	404.2	13.981	22.84	14.80	63.12	256.4
96	1.7124	64.0	1103.0	392.7	14.006	23.08	14.86	64.81	264.8
97	1.7655	65.0	1103.4	381.5	14.031	23.32	14.91	66.26	273.6
98	1.8200	66.0	1103.9	370.7	14.057	23.56	14.97	68.35	282.6
99	1.8759	67.0	1104.3	360.3	14.082	23.80	15.02	70.03	293.0
100	1.9334	68.0	1104.7	350.2	14.107	24.04	15.08	71.62	301.5
101	1.9923	69.0	1105.2	340.4	14.132	24.28	15.14	73.44	311.3
102	2.0529	70.0	1105.6	331.0	14.157	24.52	15.20	75.31	321.5
103	2.1149	71.0	1106.0	321.8	14.183	24.76	15.26	77.22	332.0
104	2.1786	72.0	1106.4	313.0	14.208	25.00	15.32	79.19	342.8
105	2.2440	73.0	1106.9	304.4	14.233	25.24	15.39	81.21	353.9
106	2.3110	74.0	1107.3	296.0	14.259	25.48	15.45	83.29	365.4
107	2.3798	75.0	1107.7	288.0	14.284	25.72	15.52	85.42	377.2
108	2.4503	76.0	1108.2	280.2	14.309	25.96	15.59	87.62	389.4
109	2.5226	77.0	1108.6	272.6	14.334	26.20	15.65	89.87	402.0
110	2.5968	78.0	1109.0	265.3	14.360	26.46	15.72	92.19	414.9
111	2.6728	79.0	1109.4	258.2	14.385	26.69	15.80	94.58	428.3
112	2.7507	80.0	1109.9	251.3	14.410	26.93	15.87	97.03	442.1
113	2.8306	81.0	1110.3	244.6	14.436	27.17	15.94	99.55	456.3
114	2.9125	82.0	1110.7	238.1	14.461	27.41	16.02	102.16	471.0
115	2.9963	83.0	1111.1	231.8	14.486	27.65	16.10	104.81	486.1
116	3.0823	84.0	1111.6	225.8	14.511	27.89	16.18	107.55	501.6
117	3.1703	85.0	1112.0	219.9	14.537	28.13	16.26	110.38	517.7
118	3.2606	86.0	1112.4	214.1	14.562	28.37	16.34	113.29	534.3
119	3.3530	87.0	1112.8	208.6	14.587	28.61	16.43	116.28	551.4
120	3.4477	88.0	1113.3	203.2	14.612	28.85	16.51	119.36	569.0
121	3.5446	89.0	1113.7	197.9	14.637	29.09	16.60	122.52	587.2
122	3.6439	90.0	1114.1	192.9	14.663	29.33	16.70	125.79	606.0
123	3.7455	91.0	1114.5	188.0	14.688	29.57	16.79	129.15	625.3
124	3.8496	92.0	1114.9	183.2	14.713	29.82	16.89	132.61	645.3
125	3.9561	93.0	1115.4	178.5	14.739	30.06	16.98	136.17	665.9
126	4.0651	94.0	1115.8	174.0	14.764	30.30	17.08	139.88	687.2
127	4.1768	95.0	1116.2	169.6	14.789	30.54	17.19	143.64	709.2
128	4.2910	96.0	1116.6	165.4	14.814	30.78	17.29	147.54	731.9
129	4.4078	97.0	1117.0	161.3	14.839	31.02	17.40	151.57	755.4

116	3.0823	84.0	1111.0	225.8	14.511	27.89	16.18	107.55	501.6
117	3.1703	85.0	1112.0	219.0	14.537	28.13	16.26	110.38	517.7
118	3.2606	86.0	1112.4	214.1	14.562	28.37	16.34	113.29	534.3
119	3.3530	87.0	1112.8	208.6	14.587	28.61	16.43	116.28	551.4
120	3.4477	88.0	1113.3	203.2	14.612	28.85	16.51	119.36	569.0
121	3.5446	89.0	1113.7	197.9	14.637	29.09	16.60	122.52	587.2
122	3.6439	90.0	1114.1	192.9	14.663	29.33	16.70	125.79	606.0
123	3.7455	91.0	1114.5	188.0	14.688	29.57	16.79	129.16	625.3
124	3.8496	92.0	1114.9	183.2	14.713	29.82	16.89	132.61	645.3
125	3.9561	93.0	1115.4	178.5	14.739	30.06	16.98	136.17	665.9
126	4.0651	94.0	1115.8	174.0	14.764	30.30	17.08	139.83	687.2
127	4.1766	95.0	1116.2	169.6	14.789	30.54	17.19	143.64	709.2
128	4.2910	96.0	1116.6	165.4	14.814	30.78	17.29	147.54	731.9
129	4.4078	97.0	1117.0	161.3	14.839	31.02	17.40	151.57	755.4
130	4.5274	98.0	1117.5	157.3	14.865	31.26	17.52	155.72	779.6
131	4.6498	99.0	1117.9	153.4	14.890	31.50	17.63	160.00	804.6
132	4.7750	100.0	1118.3	149.6	14.916	31.74	17.75	164.43	830.5
133	4.9030	101.0	1118.7	145.9	14.941	31.98	17.87	168.98	857.2
134	5.0340	102.0	1119.2	142.4	14.966	32.22	17.99	173.69	884.8
135	5.1679	103.0	1119.6	138.9	14.991	32.46	18.12	178.54	913.3
136	5.3049	104.0	1120.0	135.5	15.016	32.70	18.25	183.57	942.8
137	5.4450	105.0	1120.4	132.2	15.043	32.94	18.39	188.75	973.4
138	5.5881	106.0	1120.8	129.1	15.067	33.18	18.53	194.09	1000.0
139	5.7345	107.0	1121.2	126.0	15.092	33.43	18.67	199.64	1038
140	5.8842	108.0	1121.7	123.0	15.117	33.67	18.82	205.34	1071
141	6.0371	109.0	1122.1	120.0	15.143	33.91	18.97	211.27	1106
142	6.1934	110.0	1122.5	117.2	15.168	34.15	19.13	217.39	1143
143	6.3532	111.0	1122.9	114.4	15.193	34.39	19.29	223.70	1180
144	6.5164	112.0	1123.3	111.7	15.218	34.63	19.45	230.28	1219
145	6.6832	113.0	1123.7	109.1	15.244	34.87	19.62	236.94	1259
146	6.8536	114.0	1124.1	106.6	15.269	35.11	19.81	244.06	1301
147	7.0277	115.0	1124.6	104.1	15.294	35.35	19.99	251.34	1344
148	7.2056	116.0	1125.0	101.7	15.319	35.59	20.18	258.88	1389
149	7.3872	117.0	1125.4	99.32	15.345	35.83	20.37	266.71	1436
150	7.5727	118.0	1125.8	97.04	15.370	36.07	20.58	274.34	1485

Source: By permission from *Air Conditioning Refrigerating Data Book*, 10th ed. Copyright, 1957, Amer. Soc. Heating Refrig. Air Cond. Engrs.

Rick

May 21, 1987

TO: File

FROM: Leland C. Spencer, P.E.
Reclamation Mining Engineer

RE: Estimate of Water Evaporated due to Coal Mine Ventilation

UP&L's method of calculating evaporation of water from their mine is rough but reasonable. The calculation is only flawed by the validity of the input data, not correcting to elevation and pressure differential due to their fan.

Trail Mountains method of calculating evaporation can be done, however to do it correctly would be tedious. The difference in air densities from intake to return is not entirely from water. Since the dry air expands as it courses through the mine due to temperature and pressure from the fan. This method may be reasonable on a macro-scale under special conditions, that the density of the dry air remains constant from intake to return. It seems odd that Trail Mountain would go to the trouble of getting dry bulb and wet bulb temperatures which define the specific humidity of the air and then not realize the density change is not entirely dependent on the water.

Attached find calculations which make corrections for altitude and a fan pressure. The calculations presented, however assume correct data and in both cases- UP&L and Trail Mountain, the data is questionable. Trail Mountains data is reasonable, apparently measured actuals, however no barometric pressure at the time of measurement is given and then the amount of water evaporated would only be good for the same conditions. UP&L apparently has assumed mean conditions, however there is no backup for this information.

I would recommend that data be gathered from the Price Weather station- two state points for the month. Then the operators should provide state points and the barometer for intake and return air (quarterly measurements) that are compared with data from the same day from the weather station.

I could write a small program for psychrometric calculations where mean weather data and the mines air quantity and water gauge could be entered every year to determine the loss of water.

There are other water losses due to the mines presence as well. The loss of water that is combined with the coal that is taken out of the mine and shipped and the loss of water due to evaporation from ponds.

lcs
cc: S. Linner
R. Smith
J. Whitehead
0969X-75

LCS 5-19-87

METHOD

INPUT: FIND STATE POINTS. Psychrometric Formulas.
NEED (2) POINTS: T_d & T_w.

ASSUME: MEASUREMENTS ON INTAKE & RETURN BEFORE FAN.
AVERAGE FOR PERIOD. 1 lbs OF AIR ON RETURN/
FAN PULLS 4 in w.G. (RETURN)

USE:

SPECIFIC HUMIDITY: $W = 0.6223 \frac{P_v}{P_b - P_v}$ lb/lb dry air

VAPOR PRESSURE: $p_v = p_s' - \frac{(p_b - p_s')(t_d - t_w)}{2800 - 1.3 t_w}$, in Hg

SPECIFIC VOLUME: $v = \frac{RT_d}{P_a}$, cu ft/lb dry air; $P_b = P_a + P_v$

CONVERSIONS: 1 in Hg = 0.491 psi = 13.6 in water.

P_B = Table

Correction: $\log P_2 = \log P_1 - \left(\frac{h}{122.8 T_a}\right)$

NOTE: METHOD IS NOT OF VALUE UNLESS STATE OF AIR IS KNOWN.

- UP&L ASSUMES AN AVERAGE CONDITION
- TRAIL MTN MEASURES T_d & T_w which is better BUT STILL NEEDS TO RELATE TO YEAR & BAROMETER WHEN MEASUREMENTS MADE.

5/19/87

UP&L.

INTAKE

GIVEN:
$T_d = 50°$
$RH = 45\%$
ELEV = 7600
$Q = 570{,}000$ CFM

TABLES - (1)
$P_{b(7500)} = 22.65$ in Hg.
$P_{b(8000)}$ (7600) $= 22.22$ in Hg.

$\Delta_{ELEV} = 500'$; $\Delta - 0.43$ in Hg

$\Delta_{100'} = -.086$ in.

22.650
− .086
22.564

$P_{b\,7500} + \Delta_{100'} = 22.56$.

$P_{b\,(7600)} = 22.56$ in Hg.

Wet bulb

$T_{w_1} = 40°F.$ (2) (@ 23 in)

$p_s' = .2477$ in Hg (3) (@ 29.92)

CORRECTION FOR 7600'.

$P_s' = .2477 \times .491 \frac{lbs}{in} = .12137$ psi

$\log P_2 = -0.91588 - \left(\frac{7{,}600}{122.8(510)}\right)$

$\log P_2 = 1.03723$

$P_2 = .09178$ psi $\div .491$

$P_s' = 0.1869$ in Hg @ (22.56 in Hg)

5/70

RETURN

$T_d = 58°$
$RH = 95\%$

assumed

$P_{b(7600)} = 22.56$ in Hg.

$\Delta = 4$ in W.G. (water guage) $\times \frac{1 \text{ in Hg}}{13 \text{ in WG}} = .29$ in Hg.

$P_{b_2} = 22.27$ in Hg.

$T_{w_2} = 57°$ (2) (@ 23 in)

$p_s' = .4684$ (3) (@ 29.92)

CORRECTION TO 7600'

$P_s' = .4684 \times .491 \frac{psi}{in\ Hg} = 0.22998$

$\log P_2 = -0.63831 - \left(\frac{7942^*}{122.8(518)}\right)$

$\log P_2 = -0.96316$

$P_2 = .17252 \div 0.491$

$P_s' = 0.3514$ @ (22.27 in Hg)

5/19/87

INTAKE

Vapor Pressure.

$$p_v = p_a' - \left[\frac{(p_b - p_a')(t_d - t_w)}{2800 - 1.3 t_w}\right]$$

$$p_v = 0.1869 - \frac{(22.56 - 0.1869)(10°)}{2800 - 1.3(500°)}$$

$$p_v = 0.0828$$

Specific Humidity

$$W_1 = 0.6223 \frac{P_v}{P_b - P_v} \text{ lb/lb dry air}$$

$$W_1 = 0.6223 \frac{.0828}{22.56 - .0828}$$

$$W_1 = .00229 \text{ lb}_{H_2O}/\text{lb dry air}$$

Specific Volume

$$v = \frac{RTd}{P_a}$$

$$P_b = P_a + P_v$$

$$P_a = 22.56 - 0.0828$$

$$P_a = 22.48$$

$$v = \frac{53.3(460 + 50)}{(22.48)(0.491)(144)}$$

$$v = 17.1 \text{ cf/lb}_{\text{dry air}}$$

$$Q_{lbs} = 570{,}000 \frac{cf}{m} \times \frac{1 \text{ lb}}{17.1 \text{ cf}}$$

$$Q_{lbs} = 33{,}333.33 \frac{\text{lbs dry air}}{\text{min}}$$

RETURN

Vapor Pressure

$$P_v = p_a' - \frac{(p_b - p_a')(t_d - t_w)}{2800 - 1.3 t_w}$$

$$p_v = 0.3514 - \frac{(22.27 - 0.3514)(10)}{2800 - 1.3(517)}$$

$$p_v = 0.3437$$

$$W_2 = 0.6223 \frac{0.3437}{22.27 - 0.3437}$$

$$W_2 = .00975 \text{ lb}_{H_2O}/\text{lb dry air}$$

$$.1869 - [(22.37)(10)]$$

$$\frac{.1869 - 223.7}{2800 - 650} = \frac{223.5}{2150} = .1039$$

$$.1869 - .1040 =$$

Mass balance of air from intake.

$$Q_{lbs} = 33{,}333.33 \frac{\text{lbs dry}}{\text{min}}$$

Volume: $W_2 - W_1 = .00975 - .00229 = .00746$ lbs/lb dry air EVAPORATED.

$$Vol_{water} = 33{,}333.33 \frac{\text{lbs da}}{\text{min}} \times .00746 \frac{\text{lbs}}{\text{lbs da}} H_2O \times \frac{\text{gal}}{8.33 \text{ lbs}} = 29.85 \frac{\text{gal}}{\text{min}}$$

$$Vol/yr = 15{,}690{,}179 \text{ gal/yr}$$

$$48.2 \frac{AF}{yr}$$

TRAIL MTN (ASSUME MINE EXHAUSTING) 7/29/83

INTAKE $Q = 159{,}300$

GIVEN: $T_d = 63°$

$T_w = 55°$

ELEV: ASSUME 7290

$P_b = 23.35$ in Hg ①

$P'_s = .4356$ ② (@ 29.92

correction to 7290

$P'_s = .4356 \times .491 = 0.2139$ psi.

$\log P_2 = \log 0.2139 - \left(\frac{7290}{122.8(523)}\right)$

$P'_s = .16470$ psi $= .3354$

EXHAUST

GIVEN: $T_d = 58°F$

$T_w = 55°F$

$\Delta = 4$ in wg $= .29$ in Hg.

$P_b = 23.06$ in Hg.

$P'_s = .4356$

$\frac{.26}{.00088 \frac{in}{FT}} =$

$\log P_2 = \log 0.2139 - \left(\frac{7585}{122.8(518)}\right)$

$P'_s = .16254$ psi $= .3310$

VAPOR PRESSURE

$P_v = P'_s - \frac{(P_b - P'_s)(t_d - t_w)}{2800 - 1.3 t_w}$

$P_{1v} = .3354 - \frac{(23.35 - .3354)(8°)}{2800 - 1.3(515)}$

$P_{1v} = .2490$

$P_{2v} = .3310 - \frac{(23.06 - .3310)(3°)}{2800 - 1.3(515)}$

$P_{2v} = .2990$

Specific Humidity

$W = 0.6223 \frac{P_v}{P_b - P_v}$

$W_1 = 0.6223 \frac{0.2490}{23.35 - 0.2490} = .006708$

$W_2 = 0.6223 \frac{0.2990}{23.06 - 0.2990} = .008175$

Specific Vol

$P_b = P_a + P_{v_1}$

$P_a = 23.35 - .2490$

$P_a = 23.10$

$v = \frac{RT_d}{P_a} = \frac{53.3(460+63)}{23.10(0.491)(144)}$

$v_1 = 17.068$ $(d = .05859)$

$Q_{lbs} = 159{,}300 \frac{cfx}{m} \times \frac{1}{17.068} = 9333 \frac{\#\Delta}{da}$

$P_a = 23.06 - .2990$

$P_a = 22.76$

$v_2 = \frac{53.3(460+58)}{22.7574(0.491)(144)} = 17.156$

$v_2 = 17.156$ $(d = .05829 da.)$

VOLUME

$w_2 - w_1 = 0.008175 - .006708 = .001467$ lb/lb dry air EVAP.

$Vol = 9333 \frac{lb\ dair}{min} \times .001467 \frac{lb_{H_2O}}{lb\ dry\ air} \times \frac{gal}{8.33 lbs} = 1.644 \frac{gal}{min}$

$Vol_{gr} = 863{,}897 \frac{gal}{yr} = 2.65 \frac{AF}{yr}$

AIR DENSITY

$$w = \frac{1}{v}(W+1)$$

$$w_1 = \frac{1}{17.068}(.006708+1) = 0.058983 \text{ lb/cuft}$$

$$w_2 = \frac{1}{17.159}(.008175+1) = 0.058755 \text{ lb/cuft}$$

IN 9333 lbs da + 63 lbs wv.

OUT 9333 lbs dA + 77 lbs wv.

Trail Mtns use of density formula is ok.
BUT DENSITY OF THE DRY AIR IS NOT CONSTANT
NOR IS THE DENSITY OF THE WATER VAPOR.

THE GASES EXPAND AS THEY COARSE THE MINE
DUE TO INCREASE IN T_d & DECREASE IN P_B.

SO THE CHANGE IN DENSITY IS NOT DUE ENTIRELY
TO WATER VAPOR.

INTAKE 9/1/82 21%

Q = 159,300, ELEV 7290

Td = 74°

Tw = 52°

*Pb = 23.35 21%

P'a = .3902 @ 29.92

P'a = .3902 × .491 = 0.19159

$\log P_a = \log 0.19159 - \left(\frac{7290}{122.8(534)}\right)$

$P'_a = \frac{.14832}{.491} = \underline{0.3020}$ in Hg.

Td = 58° .29 Hg =

Tw = 55°

Pb = 23.06 85%

P'a = .4356

P'a = .4356 × .491 = 0.21388

$\log P_a = \log 0.21398 - \left[\frac{7585}{122.8(518)}\right]$

$P'_a = \frac{.164350}{.491} = \underline{0.334725}$ in Hg.

Vapor Pressure

$P_v = .3020 - \frac{(23.35 - .3020)(22°)}{2800 - 1.3(512)}$

$P_v = .064436$ RH.

$P_v = .3347 - \frac{(23.06 - .3347)(3°)}{2806 - 1.3(515)}$

$P_v = .302700$

Specific Humidity

$W = 0.6223 \frac{P_v}{P_b - P_v}$

$W_1 = 0.6223 \frac{.064436}{23.35 - 0.064436}$

$W_1 = .001722$

$W_2 = 0.6223 \frac{.302700}{23.06 - .3027}$

$W_2 = .008277$

Specific Volume

$P_b = P_a + P_v$

$P_a = 23.35 - .064436 = 23.29$

$v = \frac{53.3(460+74)}{23.29(.491)(144)} = 17.28 \frac{CF}{lb.}$

$Q = \frac{159,300}{17.28} = \underline{9219}$ #a/min.

Volume

$W_2 - W_1 = .008277 - .001722 = .006555$ lb/lb dry air. EVAP.

$VOL = 9219 \frac{\#d.A.}{} \times .006555 \frac{\#H_2O}{\#d.A.} \times \frac{gal}{8.3331 lbs} = 7.25 \frac{gal}{min}$

$\frac{VOL}{yr.} = 3,810,600 \frac{gal}{yr} = \div 325,826 = 11.7 \frac{AF}{yr.}$

INTAKE 2/11/83

$Q = 159,300$

$T_d = 29.5°$

$T_w = 27.0°$

$* P_b = 23.35$

$P'_s = .1431$ (at 29.95)

$P'_s = .1431 \times .491 = .07026$

$\log P_2 = \log .07026 - \frac{7290}{122.8(489.5)}$

$P'_s = \frac{.053141}{.491} = .10823$

Vapor Pressure

$P_v = .10823 - \frac{(23.35 - .10823)(2.5°)}{2800 - 1.3(487)}$

$P_v = .081415$ in Hg

Specific Humidity

$W_1 = 0.6223 \frac{.081415}{23.35 - .081415}$

$W_1 = .002177$

Specific Volume

$P_a = P_a + P_v.$

$P_a = 23.35 - .081415 = 23.269$

$v = \frac{53.3(460 + 29.5)}{23.35(.491)(144)} = 15.80 \frac{cf}{lb.}$

$Q = \frac{159,300}{15.80} = 10,082 \frac{\#_a}{min}$

$W_2 - W_1 = .006182 - .002177 = .004005 \frac{lb}{lb\ dry}$

$Vol = \frac{10,082 \times .004005}{8.33} = 4.85 \frac{gal}{min}.$

$Vol = 2,549,160 \div 325,826 = 7.82 \frac{AF}{yr.}$

EXHAUST

$T_d = 47.5°$

$T_w = 45.0°$

$* P_b = 23.06$

$P'_s = .3002$

$P'_s = .3002 \times .491 = 0.147398$

$\log P_2 = \log 0.147398 - \left[\frac{7585}{122.8(507.5)}\right]$

$P'_s = \frac{.111374}{.491} = .226831$

$P_v = 0.226831 - \frac{(23.06 - .226831)(2.5°)}{2800 - (1.3)(505)}$

$P_v = 0.20020$ in Hg.

$W_2 = 0.6223 \frac{.226831}{23.06 - .226831}$

$W_2 = .006182$

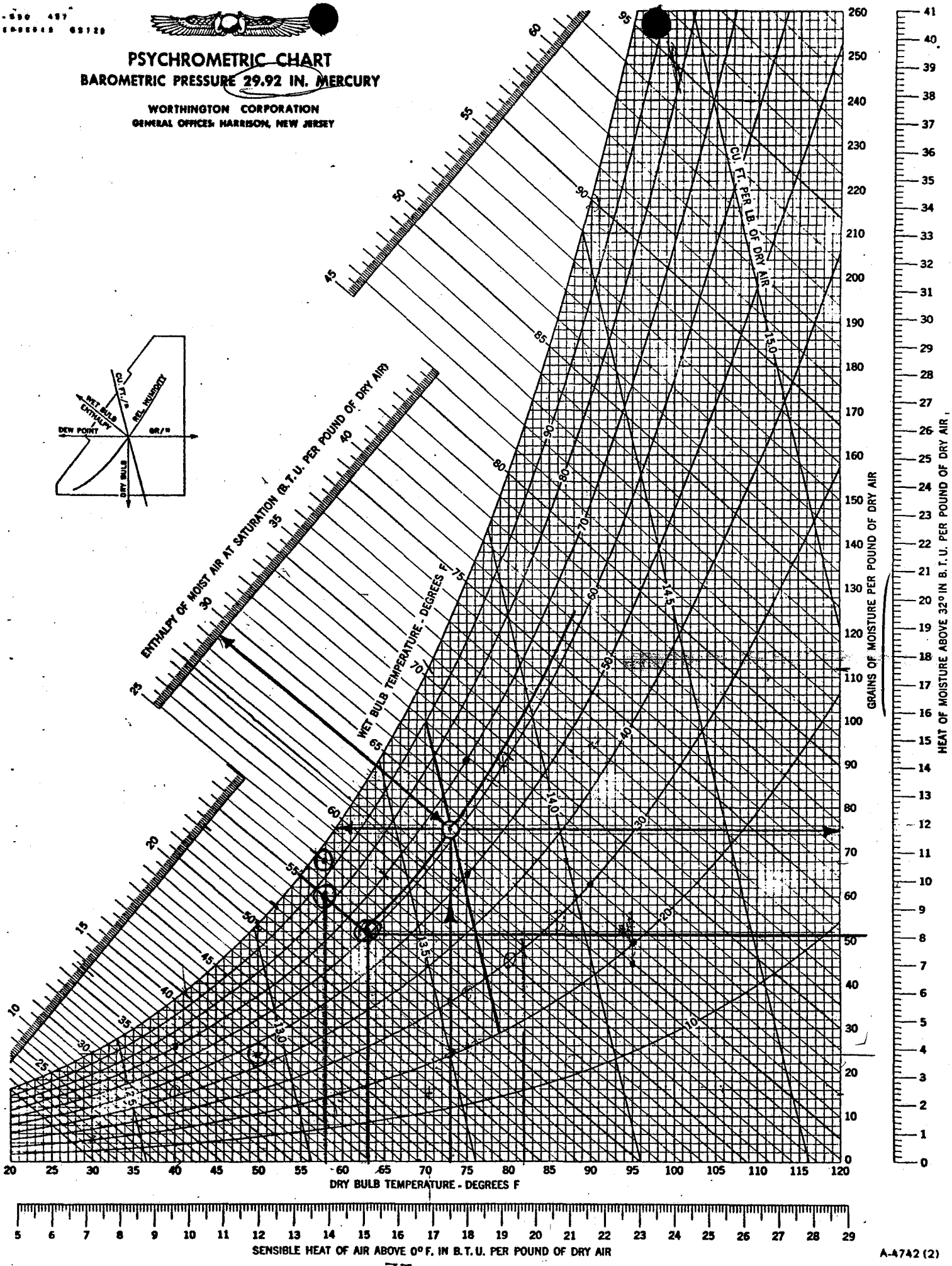
PSYCHROMETRIC CHART
BAROMETRIC PRESSURE 29.92 IN. MERCURY
WORTHINGTON CORPORATION
GENERAL OFFICES: HARRISON, NEW JERSEY
ENTHALPY OF MOIST AIR AT SATURATION (B.T.U. PER POUND OF DRY AIR)
WET BULB TEMPERATURE - DEGREES F
CU. FT. PER LB. OF DRY AIR
GRAINS OF MOISTURE PER POUND OF DRY AIR
HEAT OF MOISTURE ABOVE 32° IN B.T.U. PER POUND OF DRY AIR
DRY BULB TEMPERATURE - DEGREES F
SENSIBLE HEAT OF AIR ABOVE 0° F. IN B.T.U. PER POUND OF DRY AIR
CU. FT./#
WET BULB
ENTHALPY
REL. HUMIDITY
DEW POINT
GR/#
DRY BULB
A-4742 (2)

FIG. 15

PSYCHROMETRIC CHART—Normal Temperature

Barometric Pressure 29.92 In. Hg

ADDITIVE CORRECTIONS FOR W, h, AND v WHEN BAROMETRIC PRESSURE DIFFERS FROM STANDARD BAROMETER

Wet Bulb Temp. t'	Sat. Vapor Press. In. Hg	APPROXIMATE ALTITUDE IN FEET													
		−900		900		1800		2700		3700		4800		5900	
		Δp = +1		Δp = −1		Δp = −2		Δp = −3		Δp = −4		Δp = −5		Δp = −6	
		$\Delta W'_s$	Δh	$\Delta W'_s$	Δh	$\Delta W'_s$	Δh	$\Delta W'_s$	Δh	$\Delta W'_s$	Δh	$\Delta W'_s$	Δh	$\Delta W'_s$	Δh
20	.1027	−0.5	−0.08	0.5	0.08	1.1	0.17	1.7	0.26	2.3	0.36	3.0	0.46	3.8	0.58
21	.1078	−0.5	−0.08	0.5	0.08	1.1	0.17	1.8	0.27	2.4	0.37	3.2	0.49	4.0	0.61
22	.1130	−0.5	−0.08	0.6	0.09	1.2	0.18	1.9	0.29	2.6	0.40	3.4	0.52	4.2	0.64
23	.1185	−0.6	−0.09	0.6	0.09	1.3	0.19	2.0	0.30	2.7	0.41	3.6	0.55	4.4	0.67
24	.1243	−0.6	−0.09	0.6	0.10	1.3	0.20	2.1	0.32	2.8	0.43	3.7	0.57	4.6	0.71
25	.1303	−0.6	−0.10	0.7	0.10	1.4	0.21	2.2	0.33	3.0	0.46	3.9	0.60	4.9	0.75
26	.1366	−0.7	−0.10	0.7	0.11	1.4	0.22	2.3	0.35	3.1	0.48	4.1	0.63	5.1	0.78
27	.1431	−0.7	−0.11	0.7	0.11	1.5	0.23	2.4	0.37	3.2	0.50	4.3	0.66	5.4	0.83
28	.1500	−0.7	−0.11	0.8	0.12	1.6	0.24	2.5	0.38	3.4	0.52	4.5	0.69	5.6	0.86
29	.1571	−0.8	−0.12	0.8	0.12	1.7	0.26	2.6	0.40	3.6	0.55	4.7	0.72	5.8	0.89
30	.1645	−0.8	−0.12	0.8	0.13	1.7	0.27	2.7	0.42	3.8	0.58	4.9	0.75	6.1	0.92
31	.1723	−0.8	−0.13	0.9	0.13	1.8	0.28	2.8	0.44	3.9	0.60	5.1	0.78	6.3	0.95
32	.1803	−0.9	−0.13	0.9	0.14	1.9	0.29	3.0	0.45	4.1	0.63	5.3	0.82	6.6	1.01
33	.1878	−0.9	−0.14	1.0	0.15	2.0	0.30	3.1	0.47	4.3	0.66	5.5	0.85	6.9	1.06
34	.1955	−0.9	−0.14	1.0	0.15	2.1	0.32	3.2	0.49	4.4	0.68	5.7	0.88	7.2	1.11
35	.2034	−1.0	−0.15	1.0	0.16	2.1	0.33	3.4	0.51	4.6	0.71	6.0	0.92	7.5	1.16
36	.2117	−1.0	−0.15	1.1	0.17	2.2	0.35	3.5	0.53	4.8	0.74	6.2	0.96	7.8	1.20
37	.2202	−1.0	−0.16	1.1	0.17	2.3	0.36	3.6	0.56	5.0	0.77	6.5	1.00	8.1	1.25
38	.2290	−1.1	−0.17	1.2	0.18	2.4	0.37	3.8	0.58	5.2	0.80	6.8	1.05	8.4	1.30
39	.2382	−1.1	−0.18	1.2	0.19	2.5	0.39	3.9	0.61	5.5	0.85	7.1	1.09	8.8	1.36
40	.2476	−1.2	−0.18	1.3	0.20	2.6	0.41	4.1	0.63	5.7	0.88	7.4	1.14	9.2	1.42
41	.2573	−1.2	−0.19	1.3	0.20	2.7	0.42	4.3	0.66	5.9	0.91	7.7	1.19	9.6	1.48
42	.2676	−1.3	−0.20	1.4	0.21	2.8	0.44	4.4	0.69	6.1	0.94	8.0	1.23	10.0	1.54
43	.2781	−1.3	−0.21	1.4	0.22	3.0	0.45	4.6	0.71	6.4	0.99	8.4	1.29	10.4	1.61
44	.2890	−1.4	−0.22	1.5	0.23	3.1	0.47	4.8	0.74	6.7	1.04	8.7	1.34	10.8	1.67
45	.3002	−1.4	−0.22	1.6	0.24	3.2	0.49	5.0	0.77	6.9	1.07	9.1	1.40	11.3	1.75
46	.3119	−1.5	−0.23	1.6	0.25	3.3	0.51	5.2	0.80	7.2	1.11	9.4	1.45	11.7	1.81
47	.3239	−1.6	−0.24	1.7	0.26	3.4	0.53	5.4	0.84	7.5	1.16	9.8	1.52	12.1	1.87
48	.3363	−1.6	−0.25	1.8	0.27	3.6	0.56	5.6	0.87	7.8	1.21	10.2	1.58	12.6	1.95
49	.3491	−1.7	−0.26	1.8	0.28	3.7	0.58	5.8	0.90	8.1	1.25	10.5	1.63	13.1	2.03
50	.3624	−1.7	−0.27	1.9	0.29	3.9	0.60	6.1	0.94	8.4	1.30	10.9	1.69	13.6	2.11
51	.3761	−1.8	−0.28	2.0	0.30	4.0	0.63	6.3	0.97	8.7	1.35	11.3	1.75	14.0	2.18
52	.3903	−1.9	−0.29	2.0	0.32	4.2	0.65	6.5	1.01	9.0	1.40	11.8	1.83	14.7	2.28
53	.4049	−1.9	−0.30	2.1	0.33	4.4	0.68	6.7	1.05	9.3	1.44	12.2	1.89	15.2	2.36
54	.4200	−2.0	−0.31	2.2	0.34	4.5	0.70	7.0	1.09	9.7	1.50	12.7	1.97	15.8	2.45
55	.4356	−2.1	−0.32	2.3	0.35	4.7	0.73	7.3	1.13	10.1	1.57	13.2	2.05	16.4	2.54
56	.4518	−2.2	−0.34	2.4	0.37	4.9	0.76	7.6	1.18	10.5	1.63	13.7	2.13	17.1	2.66
57	.4684	−2.3	−0.35	2.4	0.37	5.1	0.79	7.9	1.22	10.9	1.69	14.2	2.21	17.7	2.75
58	.4855	−2.3	−0.37	2.5	0.39	5.3	0.82	8.2	1.27	11.3	1.76	14.7	2.28	18.4	2.86
59	.5033	−2.4	−0.38	2.6	0.41	5.4	0.85	8.5	1.32	11.7	1.82	15.3	2.38	19.1	2.97
60	.5216	−2.5	−0.40	2.7	0.42	5.7	0.88	8.8	1.37	12.2	1.90	15.9	2.47	19.9	3.09
61	.5405	−2.6	−0.41	2.8	0.44	5.9	0.91	9.2	1.43	12.7	1.98	16.5	2.57	20.7	3.22
62	.5599	−2.7	−0.43	2.9	0.46	6.1	0.95	9.5	1.48	13.2	2.05	17.1	2.66	21.4	3.33
63	.5800	−2.8	−0.44	3.0	0.48	6.3	0.98	9.9	1.54	13.7	2.13	17.7	2.76	22.3	3.47
64	.6007	−2.9	−0.46	3.1	0.49	6.5	1.02	10.2	1.59	14.2	2.21	18.4	2.87	23.1	3.60
65	.6221	−3.1	−0.48	3.3	0.51	6.8	1.06	10.6	1.65	14.7	2.29	19.1	2.98	23.9	3.73
66	.6441	−3.2	−0.50	3.4	0.53	7.1	1.10	11.0	1.72	15.3	2.38	19.8	3.09	24.8	3.87
67	.6668	−3.3	−0.51	3.5	0.55	7.3	1.14	11.4	1.78	15.8	2.47	20.5	3.20	25.7	4.01
68	.6902	−3.4	−0.53	3.7	0.57	7.6	1.18	11.8	1.84	16.4	2.56	21.3	3.32	26.7	4.16
69	.7143	−3.5	−0.55	3.8	0.59	7.9	1.23	12.2	1.90	17.0	2.65	22.1	3.45	27.7	4.32
70	.7392	−3.7	−0.57	3.9	0.61	8.1	1.27	12.7	1.98	17.6	2.75	22.9	3.58	28.7	4.48
71	.7648	−3.8	−0.59	4.1	0.64	8.4	1.32	13.1	2.05	18.2	2.84	23.7	3.70	29.7	4.64
72	.7911	−3.9	−0.61	4.2	0.66	8.7	1.36	13.6	2.13	18.8	2.94	24.6	3.84	30.9	4.82
73	.8183	−4.1	−0.63	4.4	0.69	9.0	1.41	14.1	2.20	19.5	3.05	25.5	3.99	31.9	4.99
74	.8463	−4.2	−0.66	4.6	0.71	9.4	1.46	14.6	2.28	20.2	3.16	26.4	4.14	33.1	5.18
75	.8750	−4.4	−0.68	4.7	0.74	9.7	1.52	15.1	2.36	20.9	3.27	27.4	4.28	34.3	5.37
76	.9047	−4.5	−0.71	4.9	0.77	10.0	1.57	15.7	2.46	21.7	3.39	28.3	4.42	35.5	5.56
77	.9352	−4.7	−0.73	5.1	0.79	10.4	1.63	16.3	2.55	22.5	3.52	29.4	4.61	36.9	5.77
78	.9667	−4.9	−0.76	5.2	0.82	10.8	1.69	16.9	2.65	23.3	3.65	30.5	4.77	38.2	5.98
79	.9990	−5.0	−0.79	5.4	0.85	11.2	1.75	17.5	2.74	24.2	3.79	31.6	4.95	39.6	6.20
80	1.032	−5.2	−0.82	5.6	0.88	11.6	1.82	18.1	2.84	25.1	3.93	32.7	5.13	41.0	6.43
81	1.067	−5.4	−0.85	5.8	0.91	12.0	1.88	18.8	2.95	26.0	4.08	33.9	5.32	42.5	6.66
82	1.102	−5.6	−0.88	6.0	0.94	12.5	1.36	19.5	3.06	27.0	4.24	35.1	5.51	44.0	6.90
83	1.138	−5.8	−0.91	6.2	0.97	12.9	2.02	20.2	3.17	28.0	4.39	36.4	5.71	45.6	7.15
84	1.175	−6.0	−0.94	6.4	1.00	13.3	2.10	20.9	3.28	28.9	4.54	37.7	5.92	47.2	7.41

t = Dry bulb temperature (F).
t' = Wet bulb temperature (F).
p = Barometric pressure (in. of Hg).
Δp = Pressure difference from standard barometer (in. of Hg).
W = Moisture content of air (gr per lb of dry air).
W'_s = Moisture content of air saturated at wet bulb temperature t' (gr per lb of dry air).
ΔW = Moisture content correction of air when barometric pressure differs from standard barometer (gr per lb of dry air).
$\Delta W'_s$ = Moisture content correction of air saturated at wet bulb temperature when barometric pressure differs from standard barometer (gr per lb of dry air).

NOTE: To obtain ΔW reduce value of $\Delta W'_s$ by 1% where $t - t' = 24$ F and correct proportionally when $t - t'$ is not 24 F.

h = Enthalpy of moist air (Btu per lb of dry air).
Δh = Enthalpy correction when barometer pressure differs from standard barometer, for saturated or unsaturated air. (Btu per lb of dry air).
v = Volume of moist air (cu ft per lb of dry air).

$$v = \frac{.754\,(t + 459.7)}{p}\left[1 + \frac{W}{4360}\right]$$

Example: At a barometric pressure of 25.92 with 90 F DB and 70 F WB, determine W, h, and v. $\Delta p = -4$ and from table $\Delta W'_s = 17.6$. From note above, $\Delta W = \Delta W'_s - \left(\frac{20}{24} \times .01 \times 17.6\right) = 17.6 - .15 = 17.45$.

Therefore $W = 78.0$ (from chart) $+ 17.45 = 95.45$ gr per lb of dry air. From table $\Delta h = 2.75$. Therefore h = saturation enthalpy from chart + deviation $+ 2.75 = 34.09 - .18 + 2.75 = 36.66$ Btu per lb of dry air. From equation above

$$v = \frac{.754\,(90 + 459.7)}{25.92}\left[1 + \frac{95.45}{4360}\right] = 16.34 \text{ cu ft per lb of dry air}$$

Fig. 14-8 (*Continued*).

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WET BULB TEMPERATURES

DRY BULB TEMPERATURES	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
51	-48 1	-16 5	-5 10	+3 14	9 18	14 23	18 27	22 32	25 36	28 41	31 46	33 51	36 56	38 61	40 66	42 72	44 77	46 83	48 88	49 94	51 100				
52		-27 3	-10 7	-1 11	+6 15	12 20	16 24	20 28	24 33	27 37	30 42	32 47	35 52	37 57	39 62	41 67	43 72	45 77	47 83	49 88	50 94	52 100			
53		-50 1	-18 5	-5 9	+3 13	9 17	14 21	18 25	22 30	25 34	28 38	31 43	34 48	36 52	38 57	40 62	42 67	44 73	46 78	48 83	50 89	51 94	53 100		
54			-29 2	-11 6	-1 10	+6 14	12 18	16 22	20 26	24 31	27 35	30 39	33 44	35 49	37 53	40 58	42 63	44 68	46 73	47 78	49 83	51 89	52 94	54 100	
55			-57	-19 4	-6 8	+3 12	9 16	14 20	18 24	22 28	26 32	29 36	31 40	34 45	36 49	39 54	41 59	43 64	45 68	47 73	48 79	50 84	52 89	53 94	55 100
56				-30 2	-11 6	-1 9	+6 13	12 17	16 21	21 25	24 29	27 33	30 37	33 41	35 46	38 50	40 55	42 59	44 64	46 69	48 74	50 79	51 84	53 89	54 95
57					-19 4	+6 7	+3 11	9 15	14 18	19 22	22 26	26 30	29 34	32 38	34 42	37 47	39 51	41 55	43 60	45 65	47 69	49 74	51 79	52 84	54 89
58					-32 2	-12 5	-1 9	+6 12	12 16	17 20	21 23	24 27	28 31	31 35	33 39	36 43	38 47	40 52	42 56	44 61	46 65	48 70	50 75	52 79	53 84
59						-20 3	-6 7	+3 10	9 14	15 17	19 21	23 25	26 28	29 32	32 36	35 40	37 44	39 48	42 52	44 57	46 61	48 66	49 70	51 75	53 80
60						-32 2	-12 5	-1 8	+6 12	12 15	17 18	21 22	25 26	28 29	31 33	34 37	36 41	39 45	41 49	43 53	45 57	47 62	49 66	50 71	52 75
61							-20 3	-6 6	+3 10	10 13	15 16	19 20	23 23	27 27	30 30	33 34	35 38	38 42	40 46	42 50	44 54	46 58	48 62	50 67	52 71
62							-32 2	-11 5	-1 8	+7 11	13 14	17 17	21 21	25 24	28 28	31 31	34 35	37 39	39 41	41 43	43 46	45 50	47 54	49 58	51 63
63								-19 3	-5 6	+4 9	10 12	15 15	20 19	24 22	27 25	30 28	33 32	36 36	38 40	40 43	43 47	45 51	47 55	49 59	50 63
64								-32 1	-11 4	0 7	+7 10	13 13	18 17	22 20	26 23	29 26	32 30	35 33	37 37	40 40	42 44	44 48	46 52	48 56	50 60
65									-19 3	-5 6	+4 9	11 12	16 15	20 18	24 21	28 24	31 27	34 31	36 34	39 38	41 41	43 45	45 49	47 52	49 56
66									-31 1	-10 4	0 7	+8 10	14 13	18 16	22 19	26 22	29 25	32 28	35 32	38 35	40 39	42 42	44 46	46 49	48 53
67										-18 3	-4 6	+5 8	11 11	16 14	21 17	25 20	28 23	31 26	34 29	37 33	39 36	41 39	44 43	46 46	48 50
68										-29 1	-9 4	+1 7	8 10	14 12	19 15	23 18	27 21	30 24	33 27	36 30	38 33	41 37	43 40	45 44	47 47
69										-58	-16 3	-3 5	+5 8	12 11	17 13	21 16	25 19	29 22	32 25	35 28	37 31	40 34	42 38	44 41	46 44
70											-27 2	-8 4	+2 7	9 9	15 12	20 15	24 17	27 20	31 23	34 26	36 29	39 32	41 35	43 38	45 42
71											-50	-15 3	-2 5	+6 8	13 10	18 13	22 16	26 18	29 21	32 24	35 27	38 30	40 33	43 36	45 39
72												-25 2	-7 4	+3 6	10 9	16 11	20 14	24 17	28 19	31 22	34 25	37 28	39 31	42 34	44 37
73												-43 1	-13 3	-1 5	+7 8	13 10	18 13	23 15	27 18	30 20	33 23	36 26	39 29	41 32	44 34
74													-22 2	-6 4	+4 6	11 9	16 11	21 14	25 16	29 19	32 21	35 24	38 27	40 29	43 32
75													-37 1	-12 3	0 5	+8 7	14 10	19 12	24 15	27 17	31 20	34 22	37 25	39 28	42 30
76														-19 2	-4 4	+5 6	12 9	17 11	22 13	26 16	30 18	33 21	36 23	38 26	41 28
77														-32 1	-10 3	+2 5	9 7	15 10	20 12	24 14	28 17	32 19	35 21	37 24	40 26
78															-17 2	-3 4	+6 6	13 8	18 11	23 13	27 15	30 17	33 20	36 22	39 25
79															-27 1	-8 3	+3 5	11 7	16 9	21 12	25 14	29 16	32 18	35 21	38 23
80															-52	-14 2	-1 4	+8 6	14 8	19 10	24 12	28 15	31 17	34 19	37 22

DRY BULB TEMPERATURES	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
51															
52															
53															
54															
55															
56	56 100														
57	57 100														
58	58 95	58 100													
59	59 90	59 95	59 100												
60	60 85	60 90	60 95	60 100											
61	61 80	61 85	61 90	61 95	61 100										
62	62 76	62 81	62 85	62 90	62 95	62 100									
63	63 72	63 76	63 81	63 85	63 90	63 95	63 100								
64	64 68	64 72	64 76	64 81	64 85	64 90	64 95	64 100							
65	65 64	65 68	65 72	65 76	65 81	65 86	65 90	65 95	65 100						
66	66 60	66 64	66 68	66 73	66 77	66 82	66 86	66 91	66 95	66 100					
67	67 57	67 61	67 65	67 69	67 73	67 78	67 82	67 86	67 91	67 95	67 100				
68	68 54	68 58	68 62	68 66	68 70	68 74	68 78	68 82	68 86	68 91	68 95	68 100			
69	69 51	69 55	69 58	69 62	69 66	69 70	69 74	69 78	69 82	69 86	69 91	69 95	69 100		
70	70 48	70 51	70 55	70 58	70 62	70 66	70 70	70 74	70 78	70 82	70 87	70 91	70 95	70 100	
71	71 45	71 48	71 52	71 55	71 59	71 63	71 66	71 70	71 74	71 78	71 82	71 87	71 91	71 95	71 100
72	72 42	72 45	72 48	72 52	72 55	72 59	72 63	72 67	72 71	72 75	72 79	72 83	72 87	72 91	72 96
73	73 39	73 42	73 45	73 48	73 52	73 55	73 59	73 62	73 67	73 71	73 75	73 79	73 83	73 87	73 91
74	74 36	74 39	74 42	74 45	74 48	74 51	74 55	74 58	74 62	74 66	74 71	74 75	74 79	74 83	74 87
75	75 34	75 37	75 39	75 42	75 45	75 48	75 51	75 55	75 58	75 62	75 66	75 71	75 75	75 79	75 83
76	76 31	76 34	76 37	76 40	76 43	76 46	76 49	76 52	76 55	76 59	76 63	76 67	76 71	76 75	76 80
77	77 28	77 31	77 34	77 37	77 40	77 43	77 46	77 49	77 52	77 55	77 59	77 62	77 66	77 70	77 74
78	78 25	78 28	78 31	78 34	78 37	78 40	78 43	78 46	78 49	78 52	78 55	78 58	78 62	78 66	78 70
79	79 22	79 25	79 28	79 31	79 34	79 37	79 40	79 43	79 46	79 49	79 52	79 55	79 58	79 62	79 66
80	80 19	80 22	80 24	80 27	80 30	80 33	80 36	80 39	80 42	80 45	80 48	80 51	80 54	80 57	80 60

DRY BULB TEMPERATURES	71	72	73	74	75	76	77	78	79	80
71	71 100									
72	72 96	72 100								
73	73 91	73 96	73 100							
74	74 87	74 91	74 96	74 100						
75	75 83	75 87	75 92	75 96	75 100					
76	76 80	76 84	76 88	76 92	76 96	76 100				
77	77 76	77 80	77 84	77 88	77 92	77 96	77 100			
78	78 73	78 76	78 80	78 84	78 88	78 92	78 96	78 100		
79	79 69	79 73	79 76	79 80	79 84	79 88	79 92	79 96	79 100	
80	80 63	80 66	80 70	80 73	80 77	80 81	80 84	80 88	80 92	80 96

WET BULB TEMPERATURES

DRY BULB TEMPERATURES	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
81	-3 1	-5 3	+5 5	12 7	17 9	22 11	26 13	30 16	33 18	36 20	39 22	42 25	44 27	46 30	48 32	50 35	52 37	54 40	56 43	58 45
82	-40 1	-11 2	+1 4	9 6	15 8	20 10	25 12	29 14	32 16	35 18	38 21	41 23	43 25	46 28	48 30	50 33	52 35	54 38	56 41	58 43
83		-19 2	-3 3	+6 5	13 7	19 9	23 11	27 13	31 15	34 17	37 19	40 22	42 24	45 26	47 29	49 31	51 33	53 35	55 38	57 41
84		-31 1	-8 3	+3 4	11 6	17 8	22 10	26 12	30 14	33 16	36 18	39 20	42 22	44 25	46 27	49 29	51 32	53 34	55 37	57 39
85			-15 2	-1 4	+8 5	14 7	20 9	24 11	28 13	32 15	35 17	38 19	41 21	43 23	45 25	48 28	50 30	52 32	54 35	56 37
86			-25 1	-6 3	+5 4	12 6	18 8	23 10	27 12	31 14	34 16	37 18	40 20	42 22	45 24	47 26	49 28	51 31	53 33	55 35
87			-44	-12 2	+1 4	9 5	16 7	21 9	26 11	29 13	33 15	36 17	39 19	42 20	44 22	46 24	49 26	51 28	53 29	55 31
88				-20 1	-3 3	+7 5	14 6	19 8	24 10	28 12	32 13	35 15	38 17	41 19	43 21	46 23	48 25	50 27	52 30	54 32
89				-33 1	-8 2	+3 4	11 5	17 7	22 9	27 11	30 12	34 14	37 16	40 18	43 20	45 22	47 24	50 26	52 28	54 30
90					-15 2	-1 3	+8 5	15 6	21 8	25 10	29 11	33 13	36 15	39 17	42 19	44 21	47 22	49 25	51 27	53 29
91					-25 1	-5 2	+5 4	13 5	19 7	24 9	28 10	32 12	35 14	38 16	41 17	43 19	46 21	48 23	50 25	53 27
92					-44	-11 2	+2 3	10 5	17 6	22 8	27 10	30 11	34 13	37 15	40 16	43 18	45 20	48 22	50 24	52 26
93						-18 1	-2 3	+8 4	15 6	20 7	25 9	29 10	33 12	36 14	39 15	42 17	44 19	47 21	49 23	51 24
94						-31 1	-7 2	+4 3	12 5	18 6	23 8	28 9	32 11	35 13	38 14	41 16	44 18	46 20	49 21	51 23
95							-13 1	+1 3	10 4	16 6	22 7	26 9	30 10	34 12	37 13	40 15	43 17	45 18	48 20	50 22
96							-22 1	-3 2	+7 4	14 5	20 6	25 8	29 9	33 11	36 12	39 14	42 16	45 17	47 19	50 21
97							-38	-9 2	+4 3	12 4	18 6	23 7	28 9	32 10	35 12	38 13	41 15	44 16	46 18	49 20
98								-16 1	0 2	+9 4	16 5	22 6	26 8	30 9	34 11	37 12	40 14	43 15	46 17	48 19
99								-26 1	-5 2	+6 3	14 4	20 6	25 7	29 9	33 10	36 11	39 13	42 14	45 16	48 18
100								-47	-10 1	+3 3	11 4	18 5	23 7	28 8	32 9	35 11	39 12	42 14	44 15	47 17
101									-18 1	-1 2	+9 3	16 5	22 6	26 7	31 9	34 10	38 11	41 13	43 14	46 16
102									-29 2	-6 3	+6 4	14 5	20 7	25 8	29 9	33 11	37 12	40 13	43 15	45 16
103										-12 1	+2 2	11 4	18 5	23 6	28 7	32 9	36 10	39 11	42 13	45 14
104										-20 1	-2 2	+9 3	16 4	22 5	27 7	31 8	35 9	38 10	41 12	44 13
105										-33	-6 1	+6 3	14 4	20 5	25 6	30 7	33 9	37 10	40 11	43 12
106											-13 1	+2 2	11 3	18 4	24 6	28 7	32 8	36 9	39 10	42 12
107											-21 1	-2 2	+9 3	16 4	22 5	27 6	31 7	35 9	38 10	41 11
108											-35	-7 1	+5 2	14 3	20 5	25 6	30 7	34 8	37 9	41 10
109												-13 1	+2 2	11 3	18 4	24 5	29 6	33 7	36 9	40 10

DRY BULB TEMPERATURES	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
81	60 48	61 51	63 54	64 57	66 60	65 64	67 67	70 70	72 74	73 77	75 81	76 84	77 88	75 92	80 96	81 100				
82	59 46	61 49	62 52	64 55	66 58	67 61	69 64	70 67	71 71	73 74	74 77	76 81	77 85	78 88	79 92	81 96	82 100			
83	59 44	60 47	62 49	64 52	65 55	67 58	68 61	70 64	71 68	73 71	74 74	75 78	77 81	78 85	79 88	80 92	82 96	83 100		
84	58 42	60 44	62 47	63 50	65 53	66 56	68 59	69 62	71 65	72 68	74 71	75 74	76 78	78 81	79 85	80 88	82 92	83 96	84 100	
85	58 39	59 41	61 44	63 47	64 50	66 53	68 56	69 59	70 62	72 65	73 68	75 71	76 75	77 78	79 81	80 85	81 89	83 92	84 96	85 100
86	57 37	59 39	61 42	62 45	64 48	66 50	67 53	69 56	70 59	72 62	73 65	74 68	76 71	77 75	78 78	80 81	81 85	82 89	84 92	85 96
87	57 35	59 37	60 40	62 42	64 45	65 48	67 50	68 53	70 56	71 59	73 62	74 65	75 68	77 71	78 75	79 78	81 82	82 85	83 89	85 92
88	56 33	58 36	60 38	62 41	63 43	65 46	66 48	68 51	69 54	71 57	72 60	74 63	75 66	77 69	78 72	79 75	81 78	82 82	83 85	84 89
89	56 31	58 34	59 36	61 39	63 41	64 44	66 46	68 49	69 52	71 54	73 57	75 60	76 63	78 66	79 69	80 72	82 75	83 79	84 82	85 86
90	55 29	57 32	59 34	61 37	62 39	64 42	66 44	67 47	69 49	70 52	72 55	73 58	75 60	76 63	77 66	79 69	80 72	81 76	83 79	84 82
91	55 27	57 29	58 31	60 34	62 36	64 39	65 41	67 44	68 47	70 49	71 52	73 55	74 58	76 61	77 64	78 67	80 70	81 73	82 76	84 79
92	54 25	56 28	58 30	60 32	61 34	63 37	65 39	66 42	68 44	70 47	71 50	73 53	74 56	75 59	77 62	78 65	79 68	81 71	82 74	83 77
93	53 23	55 26	57 28	59 30	61 32	63 35	64 37	66 40	68 42	69 45	71 48	72 51	74 54	75 57	76 60	78 63	79 66	81 69	82 72	83 75
94	53 21	55 23	57 26	59 28	61 30	62 33	64 35	66 38	67 40	69 43	70 46	72 49	73 52	75 55	76 58	78 61	79 64	80 67	82 70	83 73
95	52 19	54 21	56 24	58 26	60 28	62 31	63 33	65 36	67 38	69 41	70 44	72 47	73 50	75 53	76 56	78 59	79 62	80 65	81 68	83 71
96	52 17	54 19	56 22	58 24	60 26	61 29	63 31	65 34	67 36	68 39	70 42	71 45	73 48	74 51	76 54	77 57	78 60	80 63	81 66	82 69
97	51 15	53 17	55 20	57 22	59 24	61 27	62 29	64 32	66 34	68 37	69 40	71 43	72 46	74 49	75 52	76 55	78 58	79 61	80 64	82 67
98	50 13	52 15	54 18	56 20	58 22	60 25	62 27	63 30	65 32	67 35	68 38	70 41	71 44	73 47	74 50	75 53	76 56	78 59	79 62	81 65
99	50 11	52 13	54 16	56 18	58 20	60 23	62 25	64 28	65 30	67 33	69 36	70 39	72 42	73 45	75 48	76 51	78 54	79 57	80 60	82 63
100	49 9	51 11	54 14	56 16	58 18	60 21	61 23	63 26	65 28	67 31	68 34	70 37	71 40	73 43	74 46	76 49	77 52	79 55	80 58	81 61
101	49 7	51 9	53 12	55 14	57 16	59 19	61 21	63 24	65 26	66 29	68 32	70 35	71 38	73 41	74 44	76 47	77 50	78 53	80 56	81 59
102	48 5	50 7	53 10	55 12	57 14	59 17	61 19	62 22	64 24	66 27	68 30	69 33	71 36	73 39	74 42	76 45	77 48	79 51	80 54	82 57
103	47 3	50 5	52 8	54 10	56 12	58 15	60 17	62 20	64 22	66 25	67 28	69 31	71 34	72 37	74 40	75 43	77 46	78 49	80 52	81 55
104	46 1	49 3	51 6	54 8	56 10	58 13	60 15	62 18	63 20	65 23	67 26	68 29	70 32	72 35	73 38	75 41	76 44	78 47	79 50	81 53
105	46 1	48 3	51 4	53 6	55 8	57 11	59 13	61 16	63 18	65 21	66 24	68 27	70 30	71 33	73 36	74 39	76 42	77 45	79 48	80 51
106	45 1	48 3	50 4	52 6	55 8	57 10	59 13	61 15	63 17	64 20	66 23	68 26	69 29	71 32	73 35	74 38	76 41	77 44	79 47	80 50
107	44 1	47 3	49 4	52 6	54 8	56 10	58 12	60 15	62 17	64 20	66 22	67 25	69 28	71 31	72 34	74 37	75 40	77 43	78 46	80 49
108	43 1	46 3	49 4	51 6	53 8	56 10	58 12	60 14	62 17	63 19	65 22	67 25	69 28	70 31	72 34	74 37	75 40	77 43	78 46	79 49
109	43 1	45 3	48 4	51 6	53 8	55 10	57 12	59 14	61 17	63 19	65 22	66 25	68 28	70 31	71 34	73 37	74 40	76 43	77 46	79 49

REFERENCE TABLES

TABLE A-1

ATMOSPHERIC PRESSURE, BAROMETER READINGS, AND RELATIVE AIR DENSITY AT DIFFERENT ALTITUDES

Altitude above Sea Level (ft)	Atmospheric Pressure (psi)	Barometer Reading (in. mercury)	Relative Air Density*
0	14.69	29.92	1.000
500	14.42	29.38	0.981
1,000	14.16	28.86	0.964
1,500	13.91	28.33	0.947
2,000	13.66	27.82	0.930
2,500	13.41	27.31	0.913
3,000	13.16	26.81	0.896
3,500	12.92	26.32	0.880
4,000	12.68	25.84	0.864
4,500	12.45	25.36	0.848
5,000	12.22	24.89	0.832
5,500	11.99	24.43	0.816
6,000	11.77	23.98	0.799
6,500	11.55	23.53	0.786
7,000	11.33	23.09	0.774
7,500	11.12	22.65	0.758
8,000	10.91	22.22	0.739
8,500	10.70	21.80	0.728
9,000	10.50	21.38	0.715
9,500	10.30	20.98	0.701
10,000	10.10	20.58	0.687
10,500	9.90	20.18	0.674
11,000	9.71	19.75	0.661
11,500	9.52	19.40	0.648
12,000	9.34	19.03	0.636
12,500	9.15	18.65	0.624
13,000	8.97	18.29	0.611
13,500	8.80	17.93	0.599
14,000	8.62	17.57	0.587
14,500	8.45	17.22	0.576
15,000	8.28	16.88	0.564

* Based on standard air, temperature constant at 70 F.

SOURCES: F. W. O'Neil, ed., *Compressed Air Data* (5th ed.; New York: Ingersoll-Rand Co., 1954), p. 102; R. D. Madison, ed., *Fan Engineering* (5th ed.; Buffalo: Buffalo Forge Co., 1949), p. 28.