

ATTACHMENT XIII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 12: HF7N3C8

ATTACHMENT XIII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 12: HF7N3C8

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 75 years and a natural ventilation air flow rate of 3 m³/s from 75 to 300 years. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XIII-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-75 Years), and 3 m³/s (75-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.22	25.22	25.22	25.22	25.22
1.00	46.13	49.92	53.10	55.75	57.97	59.83
5.00	45.44	51.65	57.34	62.51	67.16	71.37
10.00	43.77	49.80	55.63	61.24	66.61	71.70
15.00	42.19	47.78	53.26	58.62	63.84	68.91
20.00	40.86	46.04	51.14	56.14	61.04	65.85
26.00	39.42	44.21	48.91	53.56	58.13	62.61
30.00	38.54	42.99	47.39	51.71	55.98	60.17
40.00	36.70	40.74	44.75	48.71	52.63	56.50
50.00	35.20	38.75	42.29	45.82	49.33	52.83
60.00	34.02	37.16	40.30	43.44	46.57	49.69
70.00	33.06	35.87	38.68	41.49	44.30	47.11
75.00	32.63	35.24	37.84	40.43	43.01	45.58
80.00	45.84	50.30	54.19	57.65	60.79	63.67
90.00	47.47	53.82	59.33	64.14	68.37	72.12
100.00	46.29	52.90	58.87	64.25	69.09	73.44
125.00	44.25	50.63	56.55	62.01	67.04	71.65
150.00	41.90	47.79	53.33	58.54	63.42	67.97
200.00	39.55	44.85	49.93	54.77	59.37	63.74
250.00	38.08	42.87	47.50	51.94	56.24	60.35
300.00	37.03	41.45	45.75	49.90	53.90	57.77

Source: DTN: MO0010MWDANS03.005

Table XIII-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-75 Years), and 3 m³/s (75-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.88	33.97	37.39	40.25	42.64	44.64
5.00	32.05	38.53	44.44	49.79	54.62	58.95
10.00	31.61	38.04	44.25	50.22	55.90	61.27
15.00	31.06	37.02	42.86	48.57	54.14	59.55
20.00	30.58	36.08	41.49	46.80	52.02	57.14
26.00	30.13	35.18	40.17	45.09	49.93	54.70
30.00	29.74	34.43	39.05	43.61	48.11	52.55
40.00	29.29	33.55	37.77	41.95	46.08	50.17
50.00	28.73	32.46	36.19	39.90	43.60	47.28
60.00	28.28	31.57	34.85	38.14	41.42	44.70
70.00	27.92	30.84	33.77	36.70	39.63	42.56
75.00	27.69	30.37	33.05	35.72	38.39	41.06
80.00	31.02	36.12	40.54	44.44	47.94	51.16
90.00	33.69	41.17	47.62	53.21	58.10	62.40
100.00	33.69	41.55	48.62	54.96	60.63	65.70
125.00	33.03	40.48	47.36	53.70	59.51	64.83
150.00	32.14	38.90	45.27	51.25	56.84	62.05
200.00	31.20	37.17	42.88	48.33	53.52	58.43
250.00	30.44	35.72	40.84	45.77	50.52	55.08
300.00	29.94	34.75	39.42	43.94	48.33	52.56

Source: DTN: MO0010MWDANS03.005

Table XIII-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-75 Years), and 3 m³/s (75-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.02	68.02	68.02	68.02	68.02
1.00	74.51	77.86	80.67	83.03	85.00	86.65
5.00	71.27	76.70	81.70	86.26	90.37	94.10
10.00	67.48	72.76	77.91	82.89	87.68	92.24
15.00	64.11	69.05	73.92	78.70	83.38	87.95
20.00	61.25	65.87	70.43	74.92	79.34	83.69
26.00	58.14	62.45	66.70	70.90	75.05	79.14
30.00	56.25	60.27	64.26	68.19	72.08	75.92
40.00	52.18	55.88	59.56	63.21	66.83	70.41
50.00	48.85	52.13	55.41	58.69	61.96	65.22
60.00	46.17	49.10	52.03	54.96	57.90	60.83
70.00	43.97	46.61	49.25	51.90	54.55	57.20
75.00	42.99	45.44	47.89	50.33	52.77	55.20
80.00	57.06	61.26	64.91	68.16	71.10	73.81
90.00	57.35	63.40	68.64	73.23	77.27	80.85
100.00	55.41	61.71	67.42	72.57	77.22	81.39
125.00	52.23	58.35	64.03	69.28	74.12	78.57
150.00	48.75	54.42	59.77	64.81	69.53	73.95
200.00	45.31	50.44	55.37	60.07	64.54	68.80
250.00	43.19	47.84	52.33	56.66	60.85	64.86
300.00	41.67	45.98	50.16	54.20	58.11	61.89

Source: DTN: MO0010MWDANS03.005

Table XIII-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-75 Years), and 3 m³/s (75-300 Years) (Drift Spacing = 81 m)

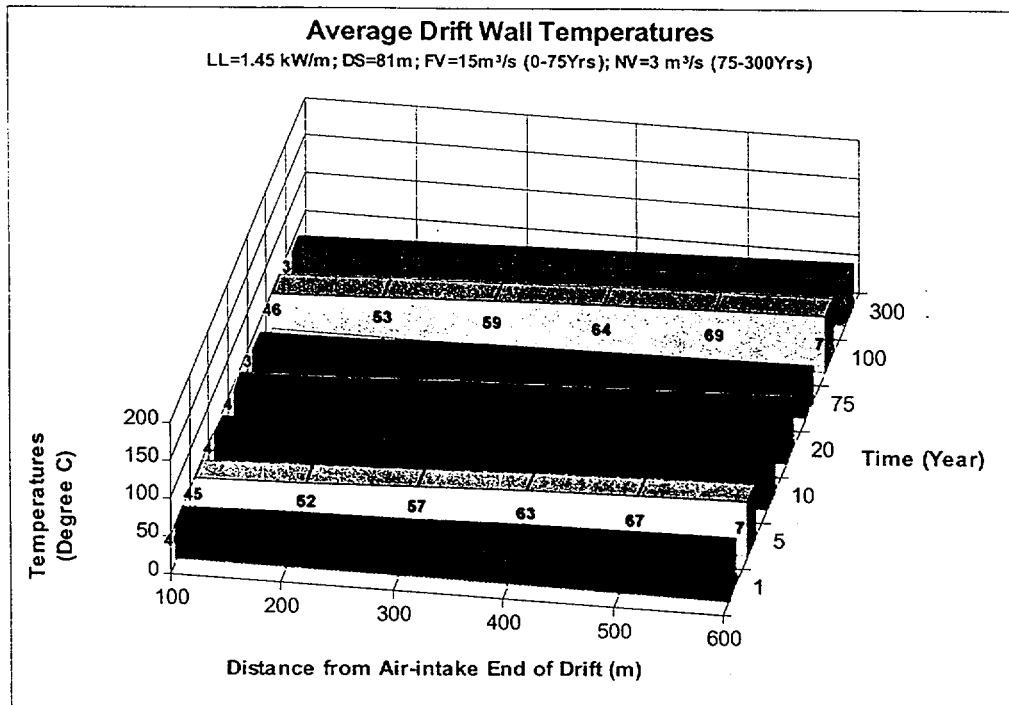
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.80	35.80	35.80	35.80	35.80
1.00	67.58	56.52	47.28	39.54	33.07	27.66
5.00	97.57	89.60	81.73	74.09	66.79	59.96
10.00	91.39	88.99	86.00	82.48	78.58	74.41
15.00	83.89	82.39	80.79	79.00	77.04	74.86
20.00	77.25	76.03	74.82	73.55	72.21	70.81
26.00	70.92	69.98	69.01	68.02	67.00	65.94
30.00	65.62	64.80	63.96	63.12	62.26	61.38
40.00	59.35	58.88	58.38	57.82	57.23	56.59
50.00	51.62	51.61	51.53	51.39	51.17	50.90
60.00	45.41	45.44	45.46	45.45	45.40	45.32
70.00	40.40	40.45	40.49	40.51	40.52	40.51
75.00	37.16	37.11	37.05	37.01	36.96	36.91
80.00	15.71	13.32	11.52	10.17	9.15	8.38
90.00	22.67	19.51	16.83	14.60	12.75	11.23
100.00	22.67	20.52	18.46	16.54	14.79	13.23
125.00	20.94	19.44	17.96	16.53	15.17	13.87
150.00	18.63	17.63	16.62	15.60	14.60	13.61
200.00	16.18	15.56	14.91	14.23	13.53	12.82
250.00	14.19	13.79	13.35	12.88	12.39	11.89
300.00	12.88	12.54	12.19	11.81	11.44	11.04

Source: DTN: MO0010MWDANS03.005

Table XIII-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-75 Years), and 3 m³/s (75-300 Years) (Drift Spacing = 81 m)

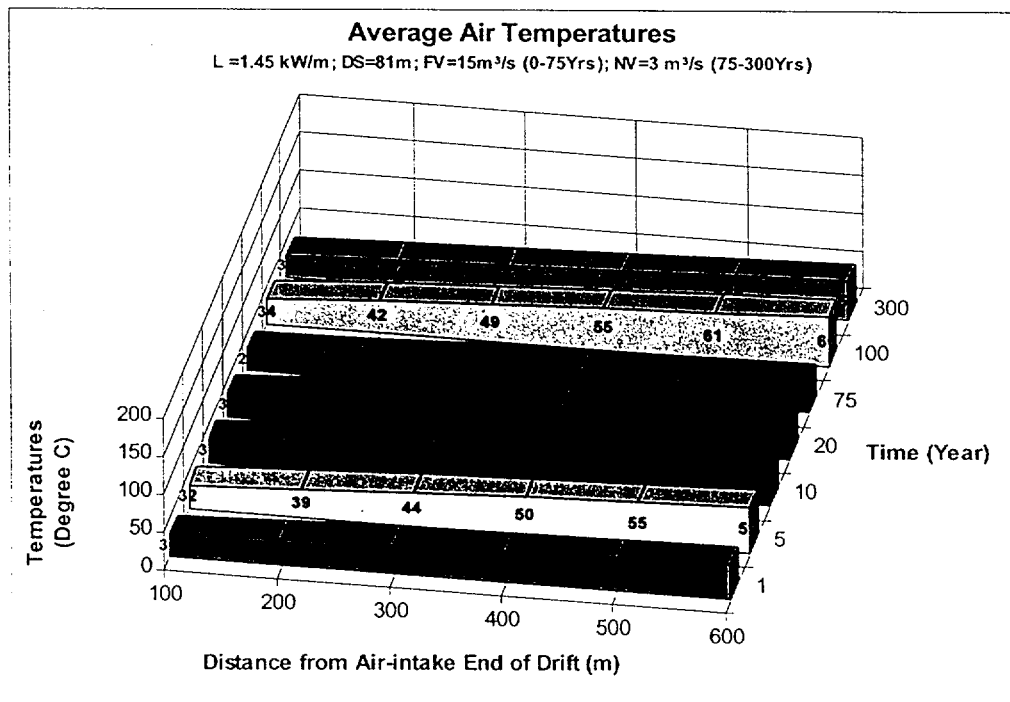
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.82	107.41	0.34
1.00	96.99%	843.84	856.92	27021.20	1.00	271.66	243.24	7670.07
5.00	87.93%	764.96	804.40	101470.60	5.00	469.74	370.70	46761.31
10.00	79.35%	690.37	727.67	114738.26	10.00	501.84	485.79	76599.37
15.00	72.23%	628.43	659.40	103973.79	15.00	477.97	489.91	77248.24
20.00	66.23%	576.22	602.32	94974.15	20.00	444.67	461.32	72740.48
26.00	59.89%	521.01	548.62	103807.02	26.00	410.86	427.76	80939.32
30.00	56.11%	488.18	504.60	63651.70	30.00	381.14	396.00	49952.75
40.00	48.24%	419.68	453.93	143151.62	40.00	348.25	364.69	115009.73
50.00	41.94%	364.89	392.29	123711.69	50.00	308.23	328.24	103513.19
60.00	36.88%	320.81	342.85	108121.88	60.00	272.48	290.35	91565.99
70.00	32.81%	285.42	303.12	95590.81	70.00	242.88	257.68	81262.48
75.00	31.03%	269.93	277.67	43783.66	75.00	222.20	232.54	36667.50
80.00	29.47%	256.40	270.91	85434.15	80.00	68.25	155.57	49059.34
90.00	26.76%	232.84	244.62	77142.91	90.00	97.60	82.92	26150.77
100.00	24.52%	213.32	223.08	70349.62	100.00	106.20	101.90	32134.84
125.00	21.21%	184.50	198.91	156819.84	125.00	103.93	105.06	82831.08
150.00	17.89%	155.68	170.09	134098.48	150.00	96.69	100.31	79082.02
200.00	14.85%	129.19	142.43	224589.03	200.00	87.23	91.96	144999.01
250.00	13.03%	113.33	121.26	191201.22	250.00	78.49	82.86	130649.44
300.00	11.76%	102.34	107.84	170036.07	300.00	71.91	75.20	118577.58
Total heat generated in 75 years (GJ)				1123999.12	Total heat removed in 75 years (GJ)			839930.78
Total heat generated in 100 years (GJ)				1356925.79	Total heat removed in 100 years (GJ)			947275.73
Total heat generated in 300 years (GJ)				2233670.43	Total heat removed in 300 years (GJ)			1503414.86
Percentage of total heat removal in 75 years = 75%								
Percentage of total heat removal in 100 years = 70%								
Percentage of total heat removal in 300 years = 67%								

Source: DTN: MO0010MWDANS03.005



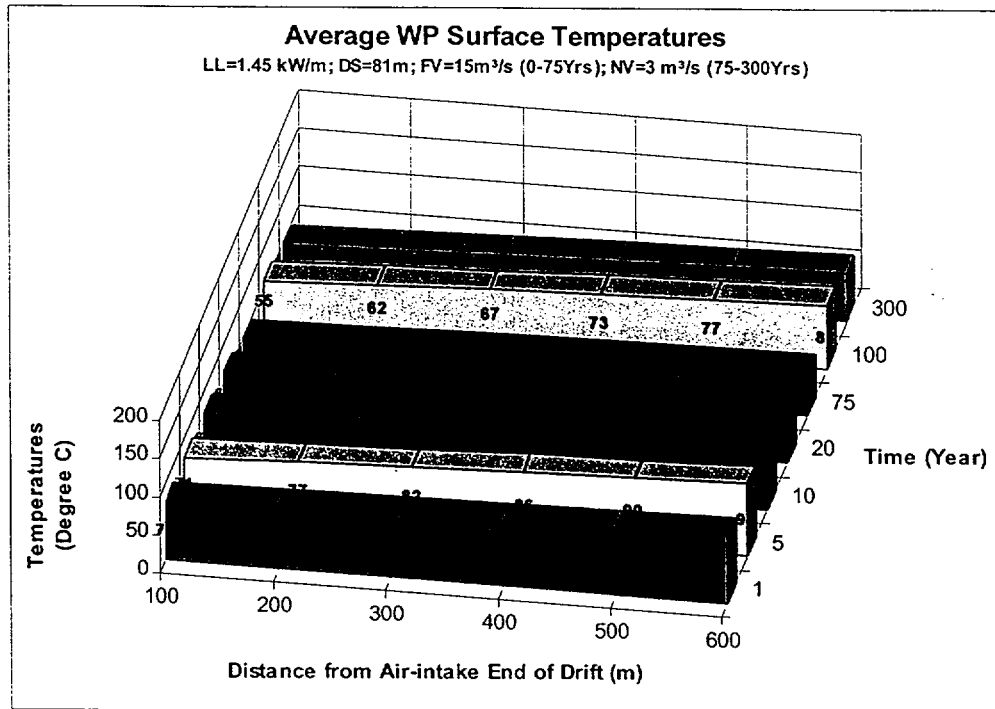
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
 For obliterated numbers, see Table XIII-1, p. XIII-2.

Figure XIII-1. Average Drift Wall Temperatures for Case 12: HF7N3C8



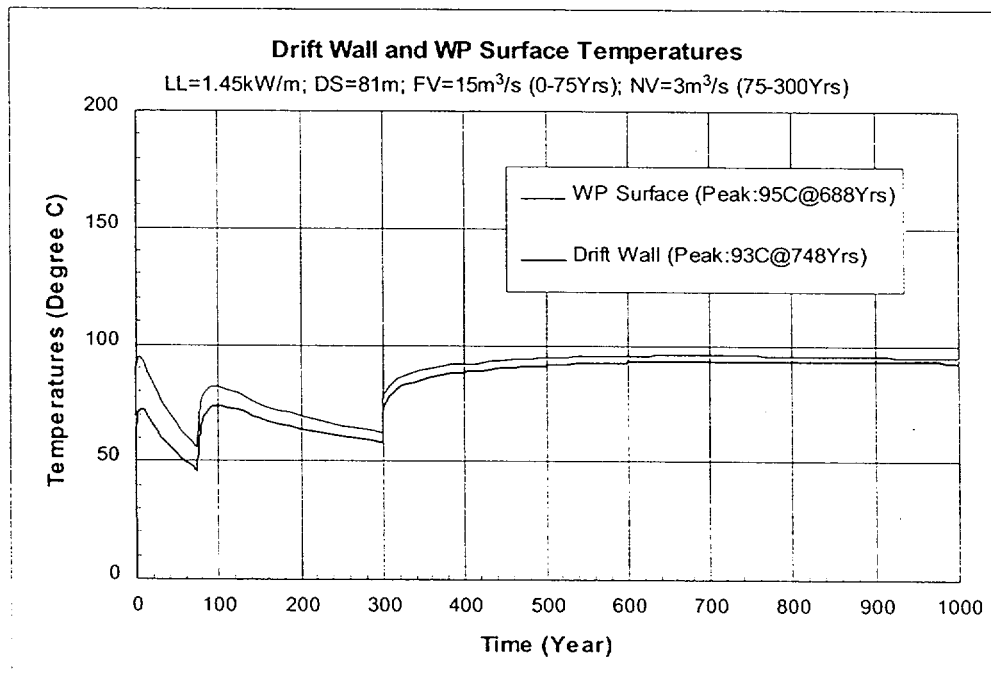
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
 For obliterated numbers, see Table XIII-2, p. XIII-3.

Figure XIII-2. Average Air Temperatures for Case 12: HF7N3C8



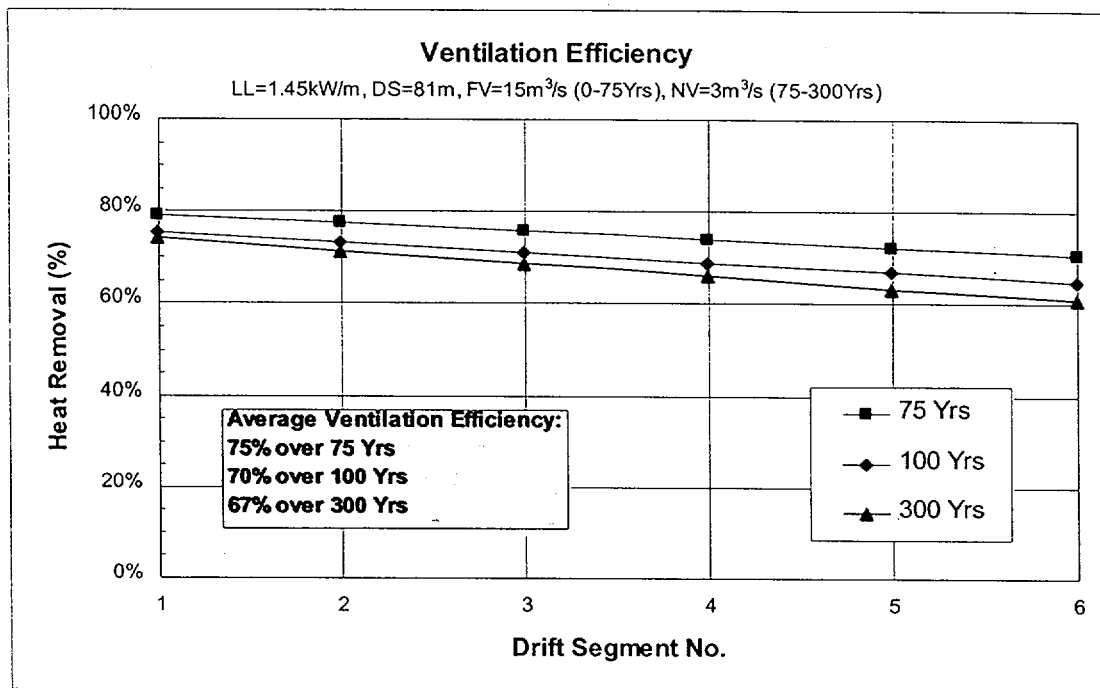
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XIII-3, p. XIII-4.

Figure XIII-3. Average Waste Package Surface Temperatures for Case 12: HF7N3C8



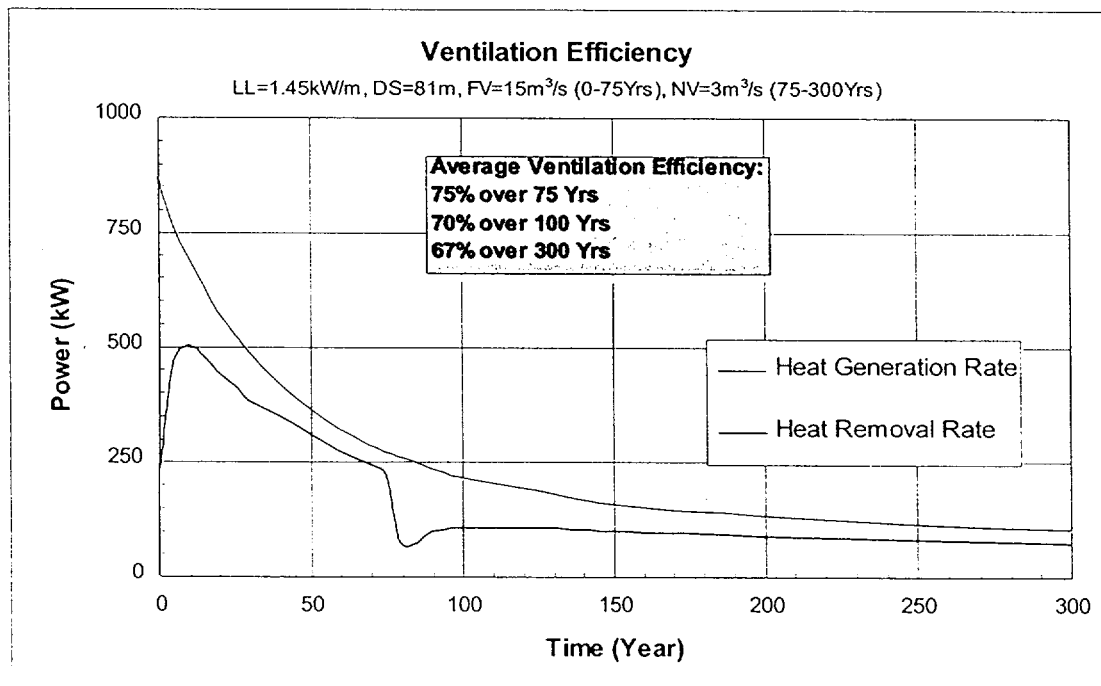
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIII-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 12: HF7N3C8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIII-5. Average Heat Removal Rates at Different Drift Segments for Case 12: HF7N3C8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIII-6. Overall Heat Generation and Removal Rates at Different Time for Case 12: HF7N3C8

ATTACHMENT XIV

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 13: HF7N5C8

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TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 13: HF7N5C8

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 75 years and a natural ventilation air flow rate of 5 m³/s from 75 to 300 years. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XIV-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-75 Years), and 5 m³/s (75-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.22	25.22	25.22	25.22	25.22
1.00	46.13	49.92	53.10	55.75	57.97	59.83
5.00	45.44	51.65	57.34	62.51	67.16	71.37
10.00	43.77	49.80	55.63	61.24	66.61	71.70
15.00	42.19	47.78	53.26	58.62	63.84	68.91
20.00	40.86	46.04	51.14	56.14	61.04	65.85
26.00	39.42	44.21	48.91	53.56	58.13	62.61
30.00	38.54	42.99	47.39	51.71	55.98	60.17
40.00	36.70	40.74	44.75	48.71	52.63	56.50
50.00	35.20	38.75	42.29	45.82	49.33	52.83
60.00	34.02	37.16	40.30	43.44	46.57	49.69
70.00	33.06	35.87	38.68	41.49	44.30	47.11
75.00	32.63	35.24	37.84	40.43	43.01	45.58
80.00	40.84	44.68	48.19	51.42	54.44	57.28
90.00	40.94	45.89	50.42	54.55	58.35	61.86
100.00	39.92	44.83	49.47	53.85	57.96	61.82
125.00	38.27	42.87	47.30	51.55	55.62	59.50
150.00	36.50	40.64	44.68	48.60	52.41	56.10
200.00	34.76	38.39	41.98	45.50	48.97	52.36
250.00	33.70	36.91	40.10	43.25	46.37	49.45
300.00	32.94	35.87	38.77	41.64	44.50	47.31

Source: DTN: MO0010MWDANS03.005

Table XIV-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-75 Years), and 5 m³/s (75-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.88	33.97	37.39	40.25	42.64	44.64
5.00	32.05	38.53	44.44	49.79	54.62	58.95
10.00	31.61	38.04	44.25	50.22	55.90	61.27
15.00	31.06	37.02	42.86	48.57	54.14	59.55
20.00	30.58	36.08	41.49	46.80	52.02	57.14
26.00	30.13	35.18	40.17	45.09	49.93	54.70
30.00	29.74	34.43	39.05	43.61	48.11	52.55
40.00	29.29	33.55	37.77	41.95	46.08	50.17
50.00	28.73	32.46	36.19	39.90	43.60	47.28
60.00	28.28	31.57	34.85	38.14	41.42	44.70
70.00	27.92	30.84	33.77	36.70	39.63	42.56
75.00	27.69	30.37	33.05	35.72	38.39	41.06
80.00	29.65	33.82	37.61	41.10	44.34	47.40
90.00	31.01	36.47	41.43	45.96	50.11	53.92
100.00	30.79	36.27	41.45	46.30	50.85	55.10
125.00	30.28	35.37	40.26	44.95	49.42	53.69
150.00	29.63	34.16	38.58	42.88	47.05	51.08
200.00	28.97	32.90	36.78	40.60	44.35	48.02
250.00	28.44	31.87	35.27	38.65	41.99	45.29
300.00	28.10	31.18	34.24	37.29	40.30	43.29

Source: DTN: MO0010MWDANS03.005

Table XIV-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-75 Years), and 5 m³/s (75-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.02	68.02	68.02	68.02	68.02
1.00	74.51	77.86	80.67	83.03	85.00	86.65
5.00	71.27	76.70	81.70	86.26	90.37	94.10
10.00	67.48	72.76	77.91	82.89	87.68	92.24
15.00	64.11	69.05	73.92	78.70	83.38	87.95
20.00	61.25	65.87	70.43	74.92	79.34	83.69
26.00	58.14	62.45	66.70	70.90	75.05	79.14
30.00	56.25	60.27	64.26	68.19	72.08	75.92
40.00	52.18	55.88	59.56	63.21	66.83	70.41
50.00	48.85	52.13	55.41	58.69	61.96	65.22
60.00	46.17	49.10	52.03	54.96	57.90	60.83
70.00	43.97	46.61	49.25	51.90	54.55	57.20
75.00	42.99	45.44	47.89	50.33	52.77	55.20
80.00	51.83	55.45	58.75	61.79	64.63	67.30
90.00	50.79	55.51	59.81	63.75	67.37	70.72
100.00	49.01	53.69	58.12	62.31	66.24	69.94
125.00	46.23	50.63	54.88	58.96	62.87	66.61
150.00	43.30	47.29	51.18	54.96	58.65	62.21
200.00	40.47	43.98	47.46	50.88	54.24	57.53
250.00	38.75	41.86	44.96	48.03	51.07	54.06
300.00	37.53	40.38	43.20	46.00	48.78	51.53

Source: DTN: MO0010MWDANS03.005

Table XIV-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-75 Years), and 5 m³/s (75-300 Years) (Drift Spacing = 81 m)

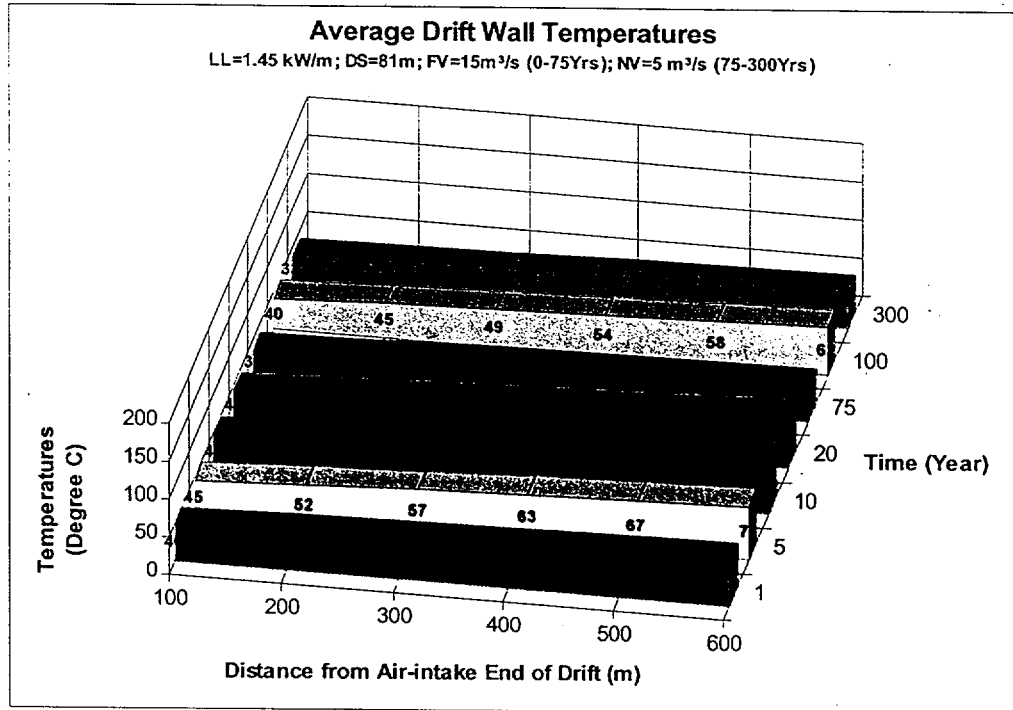
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.80	35.80	35.80	35.80	35.80
1.00	67.58	56.52	47.28	39.54	33.07	27.66
5.00	97.57	89.60	81.73	74.09	66.79	59.96
10.00	91.39	88.99	86.00	82.48	78.58	74.41
15.00	83.89	82.39	80.79	79.00	77.04	74.86
20.00	77.25	76.03	74.82	73.55	72.21	70.81
26.00	70.92	69.98	69.01	68.02	67.00	65.94
30.00	65.62	64.80	63.96	63.12	62.26	61.38
40.00	59.35	58.88	58.38	57.82	57.23	56.59
50.00	51.62	51.61	51.53	51.39	51.17	50.90
60.00	45.41	45.44	45.46	45.45	45.40	45.32
70.00	40.40	40.45	40.49	40.51	40.52	40.51
75.00	37.16	37.11	37.05	37.01	36.96	36.91
80.00	20.64	18.49	16.79	15.46	14.40	13.56
90.00	26.63	24.21	22.02	20.08	18.39	16.91
100.00	25.65	24.33	22.94	21.53	20.15	18.84
125.00	23.40	22.57	21.69	20.79	19.86	18.91
150.00	20.52	20.09	19.60	19.06	18.49	17.88
200.00	17.59	17.43	17.21	16.94	16.63	16.29
250.00	15.25	15.19	15.10	14.97	14.82	14.63
300.00	13.74	13.67	13.58	13.48	13.38	13.26

Source: DTN: MO0010MWDANS03.005

Table XIV-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-75 Years), and 5 m³/s (75-300 Years) (Drift Spacing = 81 m)

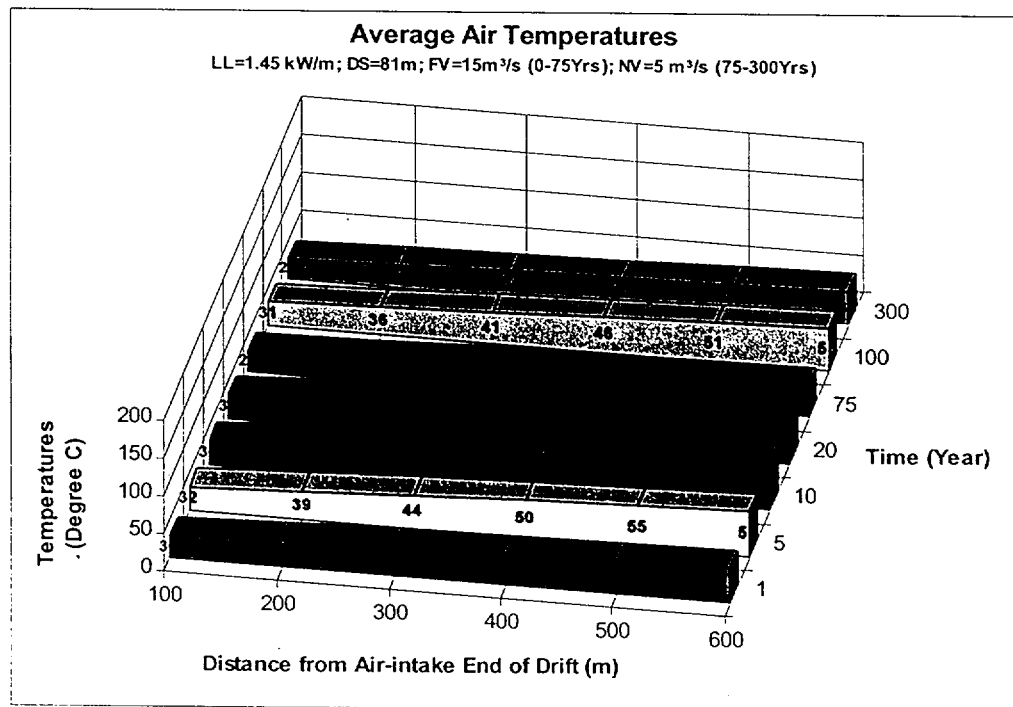
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.82	107.41	0.34
1.00	96.99%	843.84	856.92	27021.20	1.00	271.66	243.24	7670.07
5.00	87.93%	764.96	804.40	101470.60	5.00	469.74	370.70	46761.31
10.00	79.35%	690.37	727.67	114738.26	10.00	501.84	485.79	76599.37
15.00	72.23%	628.43	659.40	103973.79	15.00	477.97	489.91	77248.24
20.00	66.23%	576.22	602.32	94974.15	20.00	444.67	461.32	72740.48
26.00	59.89%	521.01	548.62	103807.02	26.00	410.86	427.76	80939.32
30.00	56.11%	488.18	504.60	63651.70	30.00	381.14	396.00	49952.75
40.00	48.24%	419.68	453.93	143151.62	40.00	348.25	364.69	115009.73
50.00	41.94%	364.89	392.29	123711.69	50.00	308.23	328.24	103513.19
60.00	36.88%	320.81	342.85	108121.88	60.00	272.48	290.35	91565.99
70.00	32.81%	285.42	303.12	95590.81	70.00	242.88	257.68	81262.48
75.00	31.03%	269.93	277.67	43783.66	75.00	222.20	232.54	36667.50
80.00	29.47%	256.40	270.91	85434.15	80.00	99.33	171.11	53959.86
90.00	26.76%	232.84	244.62	77142.91	90.00	128.24	113.78	35882.60
100.00	24.52%	213.32	223.08	70349.62	100.00	133.44	130.84	41261.99
125.00	21.21%	184.50	198.91	156819.84	125.00	127.21	130.33	102748.97
150.00	17.89%	155.68	170.09	134098.48	150.00	115.64	121.43	95732.41
200.00	14.85%	129.19	142.43	224589.03	200.00	102.09	108.87	171660.16
250.00	13.03%	113.33	121.26	191201.22	250.00	89.97	96.03	151417.80
300.00	11.76%	102.34	107.84	170036.07	300.00	81.11	85.54	134882.34
Total heat generated in 75 years (GJ)				1123999.12	Total heat removed in 75 years (GJ)			839930.78
Total heat generated in 100 years (GJ)				1356925.79	Total heat removed in 100 years (GJ)			971035.23
Total heat generated in 300 years (GJ)				2233670.43	Total heat removed in 300 years (GJ)			1627476.91
Percentage of total heat removal in 75 years = 75%								
Percentage of total heat removal in 100 years = 72%								
Percentage of total heat removal in 300 years = 73%								

Source: DTN: MO0010MWDANS03.005



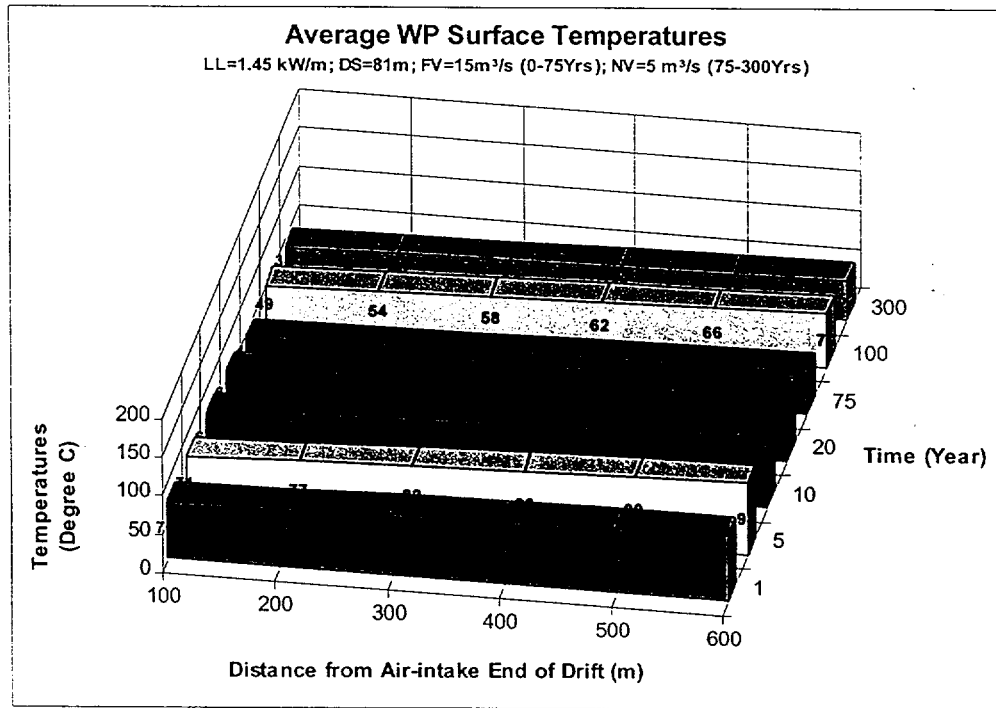
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XIV-1, p. XIV-2.

Figure XIV-1. Average Drift Wall Temperatures for Case 13: HF7N5C8



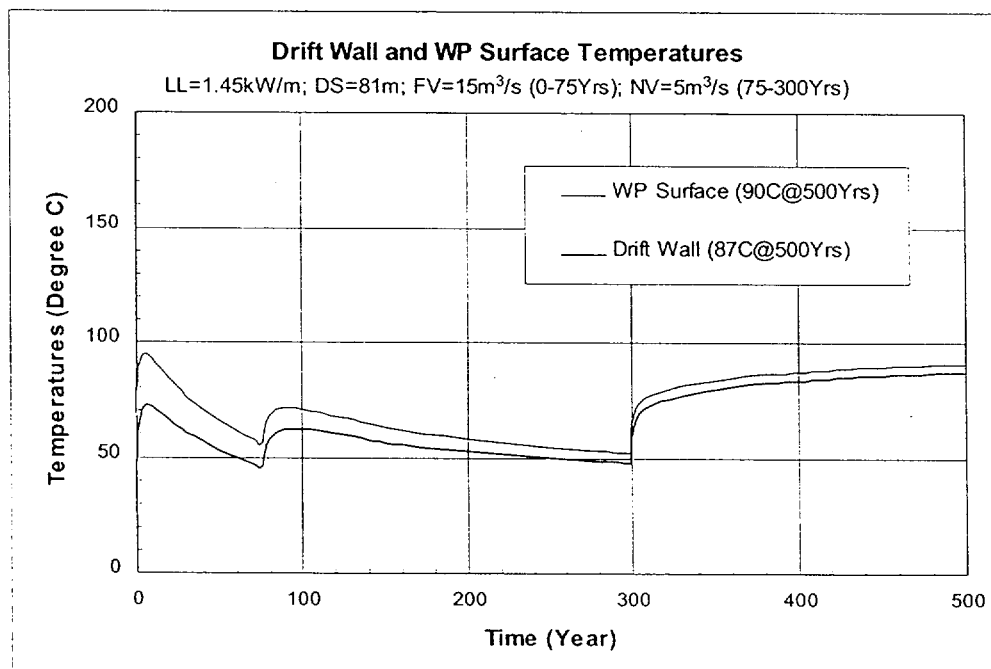
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XIV-2, p. XIV-3.

Figure XIV-2. Average Air Temperatures for Case 13: HF7N5C8



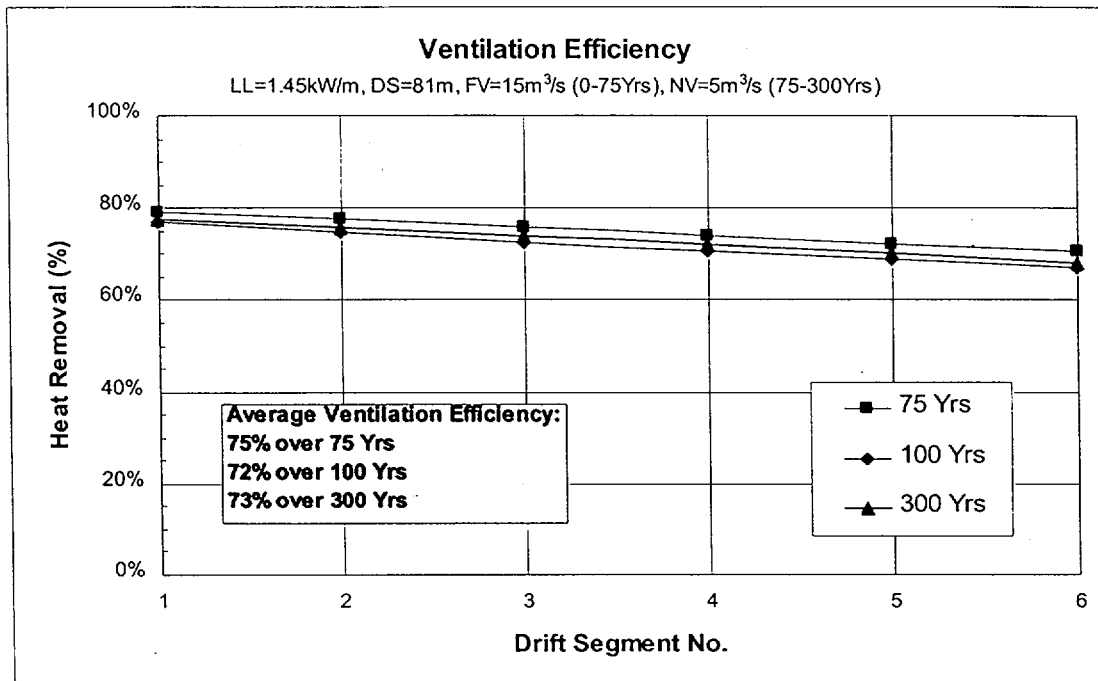
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
 For obliterated numbers, see Table XIV-3, p. XIV-4.

Figure XIV-3. Average Waste Package Surface Temperatures for Case 13: HF7N5C8



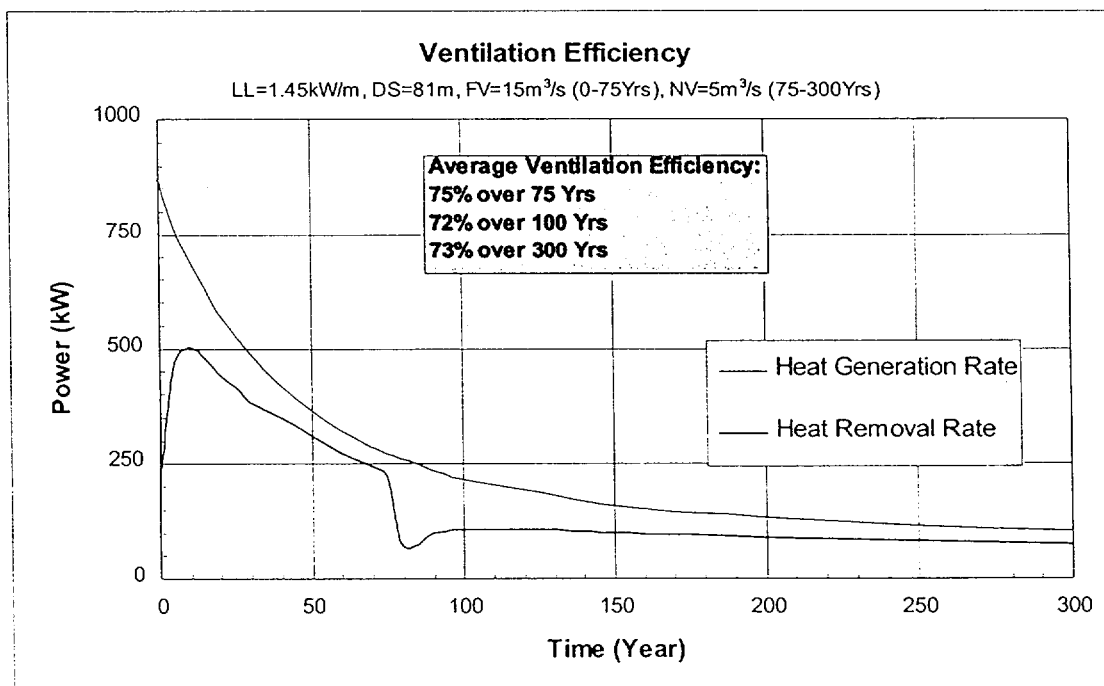
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIV-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 13: HF7N5C8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIV-5. Average Heat Removal Rates at Different Drift Segments for Case 13: HF7N5C8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIV-6. Overall Heat Generation and Removal Rates at Different Time for Case 13: HF7N5C8

ATTACHMENT XV

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 14: HF5N3V8

ATTACHMENT XV

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 14: HF5N3V8

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 3 m³/s from 50 to 100 years and 1.5 m³/s from 100 to 300 years. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XV-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.22	25.22	25.22	25.22	25.22
1.00	46.13	49.92	53.10	55.75	57.97	59.83
5.00	45.44	51.65	57.34	62.51	67.16	71.37
10.00	43.77	49.80	55.63	61.24	66.61	71.70
15.00	42.19	47.78	53.26	58.62	63.84	68.91
20.00	40.86	46.04	51.14	56.14	61.04	65.85
26.00	39.42	44.21	48.91	53.56	58.13	62.61
30.00	38.54	42.99	47.39	51.71	55.98	60.17
40.00	36.70	40.74	44.75	48.71	52.63	56.50
50.00	35.20	38.75	42.29	45.82	49.33	52.83
60.00	52.38	58.24	63.32	67.80	71.84	75.52
70.00	52.57	60.53	67.43	73.43	78.70	83.35
80.00	50.58	58.56	65.79	72.31	78.16	83.42
90.00	48.79	56.40	63.41	69.84	75.73	81.12
100.00	47.24	54.47	61.17	67.38	73.13	78.43
125.00	53.31	61.15	67.98	73.99	79.35	84.16
150.00	51.00	59.40	66.69	73.06	78.64	83.57
200.00	48.01	56.07	63.28	69.70	75.41	80.49
250.00	46.04	53.60	60.48	66.72	72.36	77.44
300.00	44.57	51.74	58.33	64.36	69.86	74.87

Source: DTN: MO0010MWDANS03.005

Table XV-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.88	33.97	37.39	40.25	42.64	44.64
5.00	32.05	38.53	44.44	49.79	54.62	58.95
10.00	31.61	38.04	44.25	50.22	55.90	61.27
15.00	31.06	37.02	42.86	48.57	54.14	59.55
20.00	30.58	36.08	41.49	46.80	52.02	57.14
26.00	30.13	35.18	40.17	45.09	49.93	54.70
30.00	29.74	34.43	39.05	43.61	48.11	52.55
40.00	29.29	33.55	37.77	41.95	46.08	50.17
50.00	28.73	32.46	36.19	39.90	43.60	47.28
60.00	32.88	39.58	45.39	50.53	55.15	59.38
70.00	35.94	45.39	53.55	60.63	66.81	72.24
80.00	35.51	45.06	53.68	61.42	68.35	74.55
90.00	34.75	43.76	52.05	59.66	66.62	72.97
100.00	34.08	42.53	50.38	57.65	64.38	70.59
125.00	36.34	46.06	54.52	61.97	68.61	74.57
150.00	37.02	47.39	56.35	64.13	70.93	76.91
200.00	35.81	45.52	54.18	61.88	68.71	74.76
250.00	34.70	43.59	51.69	59.03	65.67	71.65
300.00	33.93	42.19	49.79	56.77	63.15	68.96

Source: DTN: MO0010MWDANS03.005

Table XV-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.02	68.02	68.02	68.02	68.02
1.00	74.51	77.86	80.67	83.03	85.00	86.65
5.00	71.27	76.70	81.70	86.26	90.37	94.10
10.00	67.48	72.76	77.91	82.89	87.68	92.24
15.00	64.11	69.05	73.92	78.70	83.38	87.95
20.00	61.25	65.87	70.43	74.92	79.34	83.69
26.00	58.14	62.45	66.70	70.90	75.05	79.14
30.00	56.25	60.27	64.26	68.19	72.08	75.92
40.00	52.18	55.88	59.56	63.21	66.83	70.41
50.00	48.85	52.13	55.41	58.69	61.96	65.22
60.00	65.54	70.98	75.69	79.86	83.61	87.04
70.00	64.13	71.61	78.13	83.80	88.78	93.19
80.00	61.09	68.63	75.48	81.67	87.25	92.27
90.00	58.47	65.69	72.35	78.48	84.11	89.27
100.00	56.22	63.10	69.49	75.43	80.93	86.03
125.00	61.20	68.71	75.26	81.04	86.19	90.83
150.00	57.72	65.83	72.90	79.06	84.47	89.25
200.00	53.67	61.49	68.50	74.75	80.33	85.28
250.00	51.07	58.42	65.13	71.22	76.73	81.70
300.00	49.15	56.14	62.57	68.46	73.85	78.77

Source: DTN: MO0010MWDANS03.005

Table XV-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

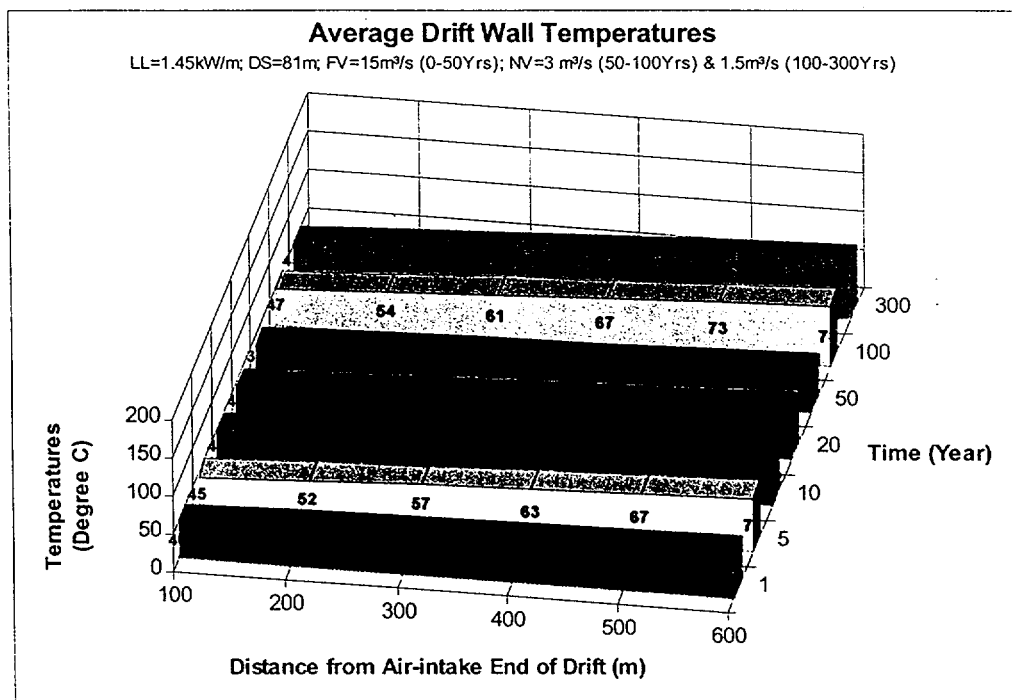
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.80	35.80	35.80	35.80	35.80
1.00	67.58	56.52	47.28	39.54	33.07	27.66
5.00	97.57	89.60	81.73	74.09	66.79	59.96
10.00	91.39	88.99	86.00	82.48	78.58	74.41
15.00	83.89	82.39	80.79	79.00	77.04	74.86
20.00	77.25	76.03	74.82	73.55	72.21	70.81
26.00	70.92	69.98	69.01	68.02	67.00	65.94
30.00	65.62	64.80	63.96	63.12	62.26	61.38
40.00	59.35	58.88	58.38	57.82	57.23	56.59
50.00	51.62	51.61	51.53	51.39	51.17	50.90
60.00	20.56	17.49	15.16	13.40	12.06	11.03
70.00	28.55	24.65	21.30	18.48	16.12	14.17
80.00	27.42	24.93	22.50	20.20	18.08	16.16
90.00	25.44	23.51	21.64	19.86	18.16	16.56
100.00	23.70	22.05	20.48	18.97	17.55	16.20
125.00	14.30	12.25	10.66	9.39	8.37	7.51
150.00	15.15	13.06	11.29	9.81	8.57	7.53
200.00	13.63	12.24	10.92	9.70	8.60	7.63
250.00	12.22	11.20	10.21	9.26	8.36	7.53
300.00	11.25	10.41	9.59	8.79	8.04	7.33

Source: DTN: MO0010MWDANS03.005

Table XV-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

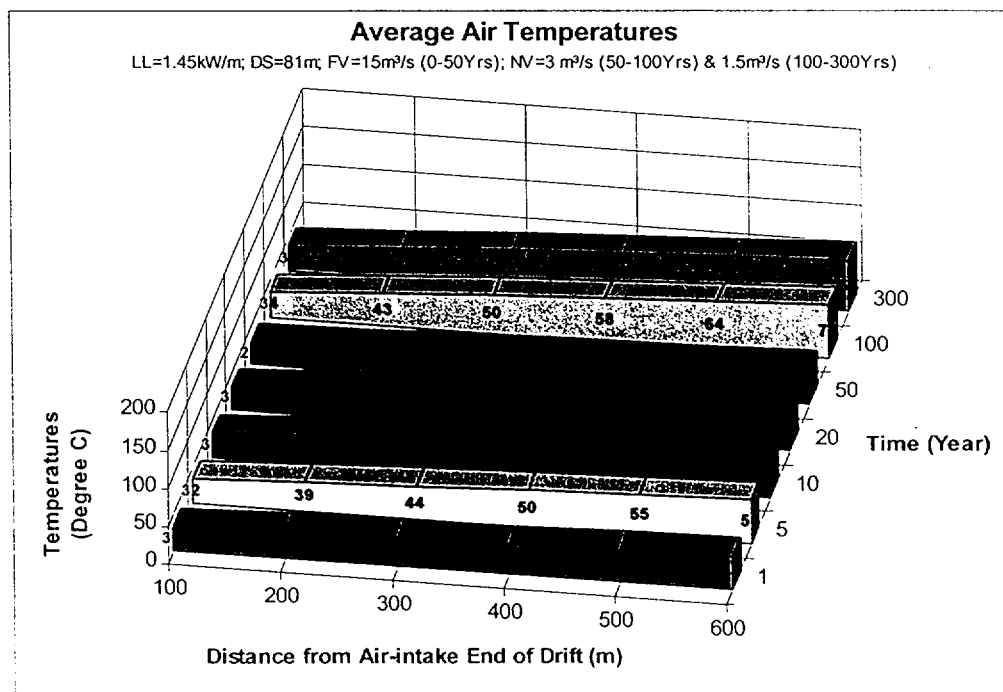
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)	
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.82	107.41	0.34	
1.00	96.99%	843.84	856.92	27021.20	1.00	271.66	243.24	7670.07	
5.00	87.93%	764.96	804.40	101470.60	5.00	469.74	370.70	46761.31	
10.00	79.35%	690.37	727.67	114738.26	10.00	501.84	485.79	76599.37	
15.00	72.23%	628.43	659.40	103973.79	15.00	477.97	489.91	77248.24	
20.00	66.23%	576.22	602.32	94974.15	20.00	444.67	461.32	72740.48	
26.00	59.89%	521.01	548.62	103807.02	26.00	410.86	427.76	80939.32	
30.00	56.11%	488.18	504.60	63651.70	30.00	381.14	396.00	49952.75	
40.00	48.24%	419.68	453.93	143151.62	40.00	348.25	364.69	115009.73	
50.00	41.94%	364.89	392.29	123711.69	50.00	308.23	328.24	103513.19	
60.00	36.88%	320.81	342.85	108121.88	60.00	89.70	198.96	62745.18	
70.00	32.81%	285.42	303.12	95590.81	70.00	123.26	106.48	33579.91	
80.00	29.47%	256.40	270.91	85434.15	80.00	129.28	126.27	39821.71	
90.00	26.76%	232.84	244.62	77142.91	90.00	125.18	127.23	40123.27	
100.00	24.52%	213.32	223.08	70349.62	100.00	118.95	122.06	38493.67	
125.00	21.21%	184.50	198.91	156819.84	125.00	62.48	90.71	71518.35	
150.00	17.89%	155.68	170.09	134098.48	150.00	65.42	63.95	50415.54	
200.00	14.85%	129.19	142.43	224589.03	200.00	62.71	64.06	101016.39	
250.00	13.03%	113.33	121.26	191201.22	250.00	58.79	60.75	95789.35	
300.00	11.76%	102.34	107.84	170036.07	300.00	55.41	57.10	90029.43	
Total heat generated in 50 years (GJ)				876502.77	Total heat removed in 50 years (GJ)				630434.80
Total heat generated in 100 years (GJ)				1313142.14	Total heat removed in 100 years (GJ)				845198.54
Total heat generated in 300 years (GJ)				2189886.77	Total heat removed in 300 years (GJ)				1253967.61
Percentage of total heat removal in 50 years = 72%									
Percentage of total heat removal in 100 years = 64%									
Percentage of total heat removal in 300 years = 57%									

Source: DTN: MO0010MWDANS03.005



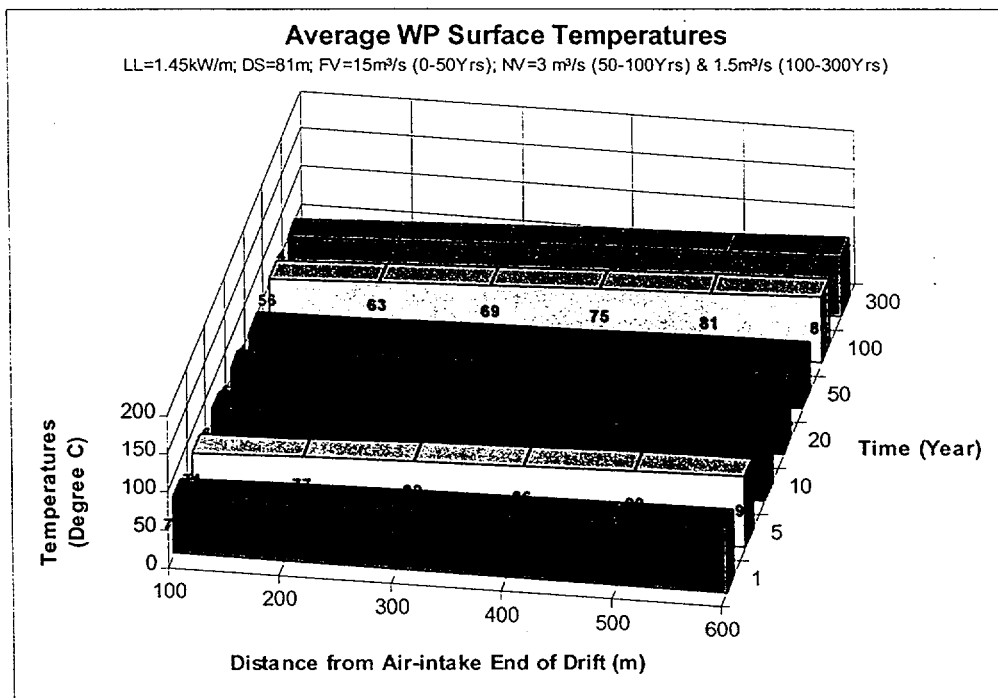
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XV-1, p. XV-2.

Figure XV-1. Average Drift Wall Temperatures for Case 14: HF5N3V8



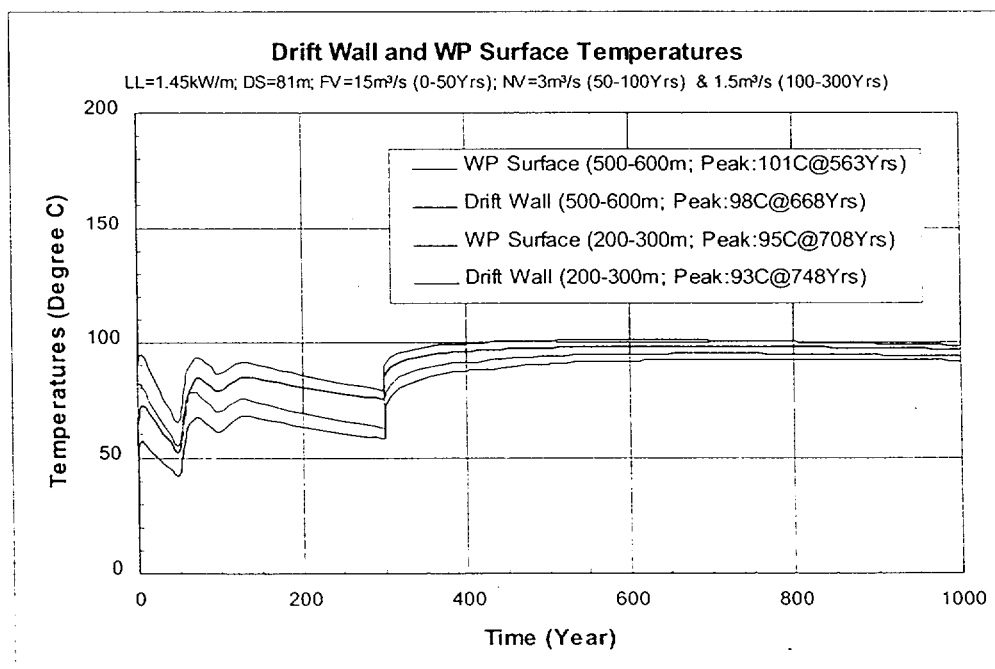
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XV-2, p. XV-3.

Figure XV-2. Average Air Temperatures for Case 14: HF5N3V8



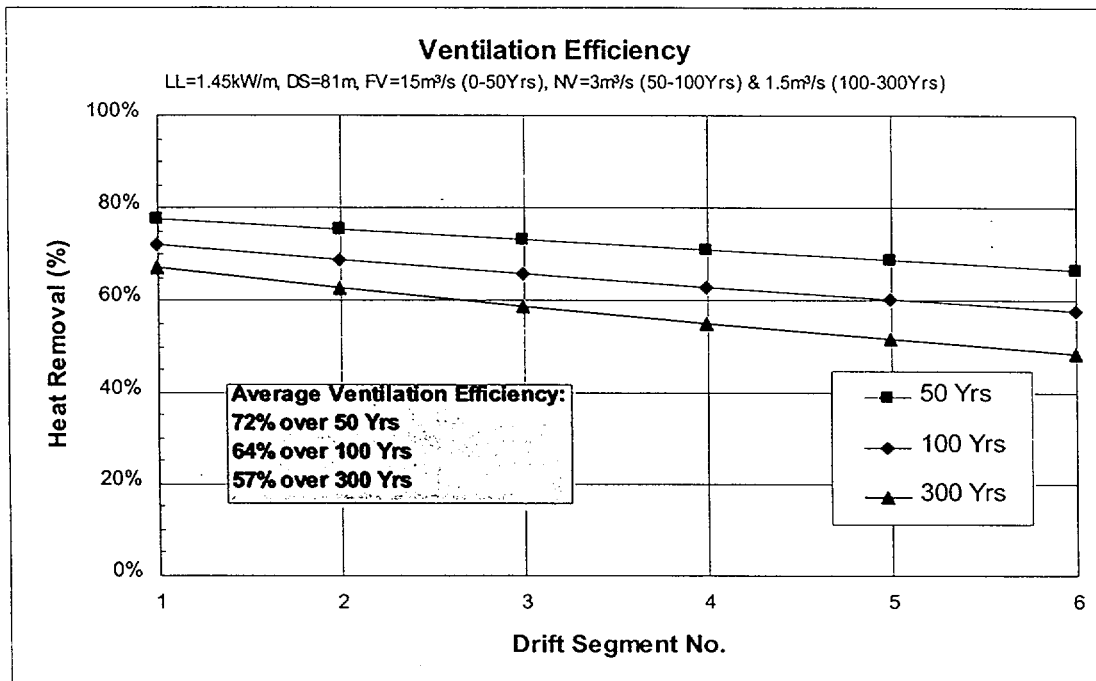
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XV-3, p. XV-4.

Figure XV-3. Average Waste Package Surface Temperatures for Case 14: HF5N3V8



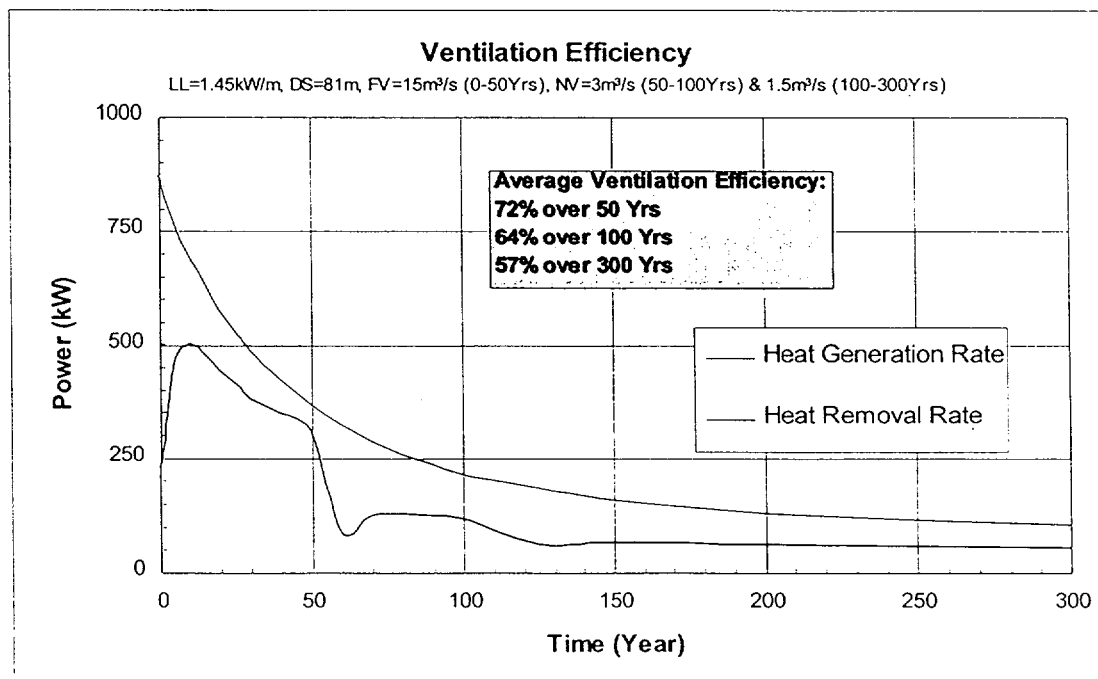
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XV-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 14: HF5N3V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XV-5. Average Heat Removal Rates at Different Drift Segments for Case 14: HF5N3V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XV-6. Overall Heat Generation and Removal Rates at Different Time for Case 14: HF5N3V8

ATTACHMENT XVI

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 15: HF5N5V8

ATTACHMENT XVI

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 15: HF5N5V8

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XVI-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.22	25.22	25.22	25.22	25.22
1.00	46.13	49.92	53.10	55.75	57.97	59.83
5.00	45.44	51.65	57.34	62.51	67.16	71.37
10.00	43.77	49.80	55.63	61.24	66.61	71.70
15.00	42.19	47.78	53.26	58.62	63.84	68.91
20.00	40.86	46.04	51.14	56.14	61.04	65.85
26.00	39.42	44.21	48.91	53.56	58.13	62.61
30.00	38.54	42.99	47.39	51.71	55.98	60.17
40.00	36.70	40.74	44.75	48.71	52.63	56.50
50.00	35.20	38.75	42.29	45.82	49.33	52.83
60.00	45.39	50.37	54.90	59.06	62.94	66.58
70.00	44.51	50.65	56.26	61.39	66.10	70.44
80.00	42.88	48.79	54.39	59.66	64.62	69.27
90.00	41.50	47.02	52.31	57.37	62.19	66.78
100.00	40.33	45.50	50.48	55.27	59.87	64.26
125.00	45.83	51.67	56.96	61.80	66.28	70.45
150.00	43.87	50.19	55.93	61.15	65.91	70.28
200.00	41.43	47.33	52.86	58.03	62.84	67.30
250.00	39.86	45.27	50.41	55.29	59.91	64.26
300.00	38.72	43.76	48.58	53.18	57.57	61.75

Source: DTN: MO0010MWDANS03.005

Table XVI-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.88	33.97	37.39	40.25	42.64	44.64
5.00	32.05	38.53	44.44	49.79	54.62	58.95
10.00	31.61	38.04	44.25	50.22	55.90	61.27
15.00	31.06	37.02	42.86	48.57	54.14	59.55
20.00	30.58	36.08	41.49	46.80	52.02	57.14
26.00	30.13	35.18	40.17	45.09	49.93	54.70
30.00	29.74	34.43	39.05	43.61	48.11	52.55
40.00	29.29	33.55	37.77	41.95	46.08	50.17
50.00	28.73	32.46	36.19	39.90	43.60	47.28
60.00	31.03	36.45	41.39	45.96	50.21	54.22
70.00	32.49	39.32	45.54	51.22	56.43	61.21
80.00	31.99	38.63	44.90	50.81	56.34	61.51
90.00	31.42	37.58	43.49	49.13	54.51	59.62
100.00	30.94	36.66	42.18	47.48	52.56	57.44
125.00	32.51	39.25	45.36	50.97	56.16	60.99
150.00	33.09	40.40	47.02	53.02	58.49	63.50
200.00	32.16	38.91	45.23	51.11	56.57	61.62
250.00	31.34	37.40	43.18	48.67	53.85	58.73
300.00	30.78	36.34	41.67	46.77	51.64	56.27

Source: DTN: MO0010MWDANS03.005

Table XVI-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.02	68.02	68.02	68.02	68.02
1.00	74.51	77.86	80.67	83.03	85.00	86.65
5.00	71.27	76.70	81.70	86.26	90.37	94.10
10.00	67.48	72.76	77.91	82.89	87.68	92.24
15.00	64.11	69.05	73.92	78.70	83.38	87.95
20.00	61.25	65.87	70.43	74.92	79.34	83.69
26.00	58.14	62.45	66.70	70.90	75.05	79.14
30.00	56.25	60.27	64.26	68.19	72.08	75.92
40.00	52.18	55.88	59.56	63.21	66.83	70.41
50.00	48.85	52.13	55.41	58.69	61.96	65.22
60.00	58.51	63.14	67.34	71.21	74.83	78.22
70.00	56.18	61.94	67.23	72.07	76.51	80.62
80.00	53.49	59.06	64.35	69.34	74.06	78.48
90.00	51.25	56.48	61.49	66.31	70.90	75.28
100.00	49.35	54.27	59.01	63.58	67.96	72.17
125.00	53.89	59.47	64.54	69.18	73.48	77.48
150.00	50.72	56.82	62.37	67.42	72.03	76.26
200.00	47.19	52.91	58.28	63.31	67.98	72.33
250.00	44.97	50.22	55.23	59.98	64.49	68.73
300.00	43.36	48.27	52.97	57.46	61.75	65.83

Source: DTN: MO0010MWDANS03.005

Table XVI-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

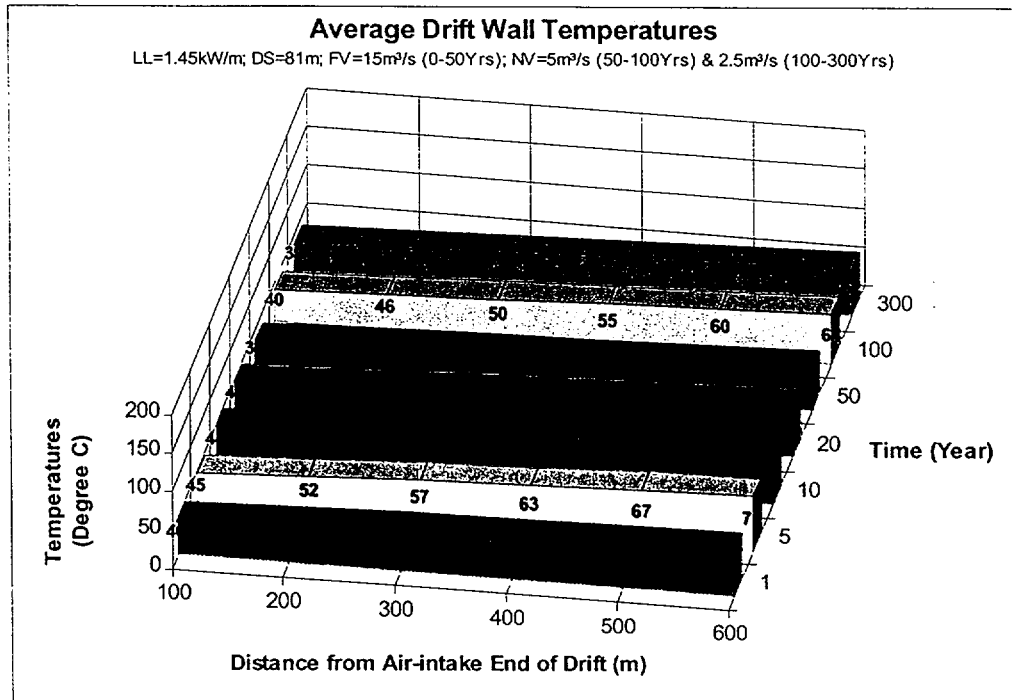
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.80	35.80	35.80	35.80	35.80
1.00	67.58	56.52	47.28	39.54	33.07	27.66
5.00	97.57	89.60	81.73	74.09	66.79	59.96
10.00	91.39	88.99	86.00	82.48	78.58	74.41
15.00	83.89	82.39	80.79	79.00	77.04	74.86
20.00	77.25	76.03	74.82	73.55	72.21	70.81
26.00	70.92	69.98	69.01	68.02	67.00	65.94
30.00	65.62	64.80	63.96	63.12	62.26	61.38
40.00	59.35	58.88	58.38	57.82	57.23	56.59
50.00	51.62	51.61	51.53	51.39	51.17	50.90
60.00	26.73	24.05	21.92	20.23	18.88	17.79
70.00	33.22	30.27	27.59	25.19	23.08	21.22
80.00	30.98	29.45	27.83	26.16	24.52	22.93
90.00	28.46	27.33	26.18	25.01	23.84	22.66
100.00	26.34	25.38	24.44	23.50	22.56	21.62
125.00	16.19	14.52	13.18	12.09	11.19	10.42
150.00	17.43	15.76	14.27	12.95	11.80	10.79
200.00	15.44	14.55	13.62	12.68	11.77	10.90
250.00	13.66	13.08	12.46	11.83	11.18	10.52
300.00	12.46	11.98	11.49	11.00	10.49	9.98

Source: DTN: MO0010MWDANS03.005

Table XVI-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

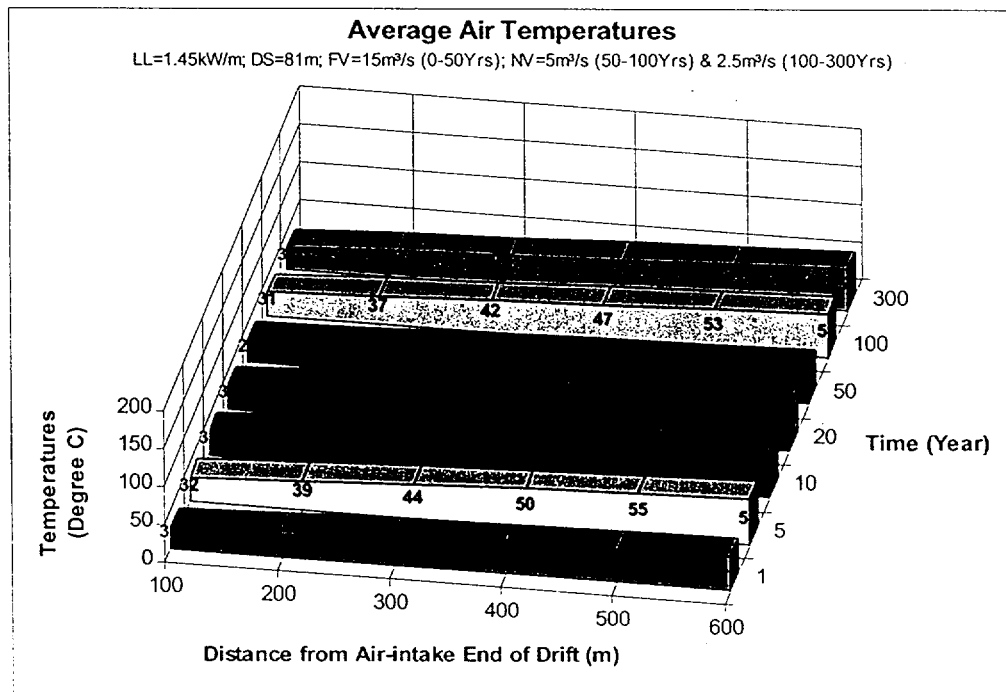
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)	
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.82	107.41	0.34	
1.00	96.99%	843.84	856.92	27021.20	1.00	271.66	243.24	7670.07	
5.00	87.93%	764.96	804.40	101470.60	5.00	469.74	370.70	46761.31	
10.00	79.35%	690.37	727.67	114738.26	10.00	501.84	485.79	76599.37	
15.00	72.23%	628.43	659.40	103973.79	15.00	477.97	489.91	77248.24	
20.00	66.23%	576.22	602.32	94974.15	20.00	444.67	461.32	72740.48	
26.00	59.89%	521.01	548.62	103807.02	26.00	410.86	427.76	80939.32	
30.00	56.11%	488.18	504.60	63651.70	30.00	381.14	396.00	49952.75	
40.00	48.24%	419.68	453.93	143151.62	40.00	348.25	364.69	115009.73	
50.00	41.94%	364.89	392.29	123711.69	50.00	308.23	328.24	103513.19	
60.00	36.88%	320.81	342.85	108121.88	60.00	129.58	218.90	69033.77	
70.00	32.81%	285.42	303.12	95590.81	70.00	160.57	145.08	45751.71	
80.00	29.47%	256.40	270.91	85434.15	80.00	161.87	161.22	50843.16	
90.00	26.76%	232.84	244.62	77142.91	90.00	153.49	157.68	49725.69	
100.00	24.52%	213.32	223.08	70349.62	100.00	143.84	148.67	46883.25	
125.00	21.21%	184.50	198.91	156819.84	125.00	77.60	110.72	87292.74	
150.00	17.89%	155.68	170.09	134098.48	150.00	83.01	80.30	63310.14	
200.00	14.85%	129.19	142.43	224589.03	200.00	78.96	80.98	127693.79	
250.00	13.03%	113.33	121.26	191201.22	250.00	72.73	75.84	119591.31	
300.00	11.76%	102.34	107.84	170036.07	300.00	67.41	70.07	110488.47	
Total heat generated in 50 years (GJ)				876502.77	Total heat removed in 50 years (GJ)				630434.80
Total heat generated in 100 years (GJ)				1313142.14	Total heat removed in 100 years (GJ)				892672.39
Total heat generated in 300 years (GJ)				2189886.77	Total heat removed in 300 years (GJ)				1401048.83
Percentage of total heat removal in 50 years = 72%									
Percentage of total heat removal in 100 years = 68%									
Percentage of total heat removal in 300 years = 64%									

Source: DTN: MO0010MWDANS03.005



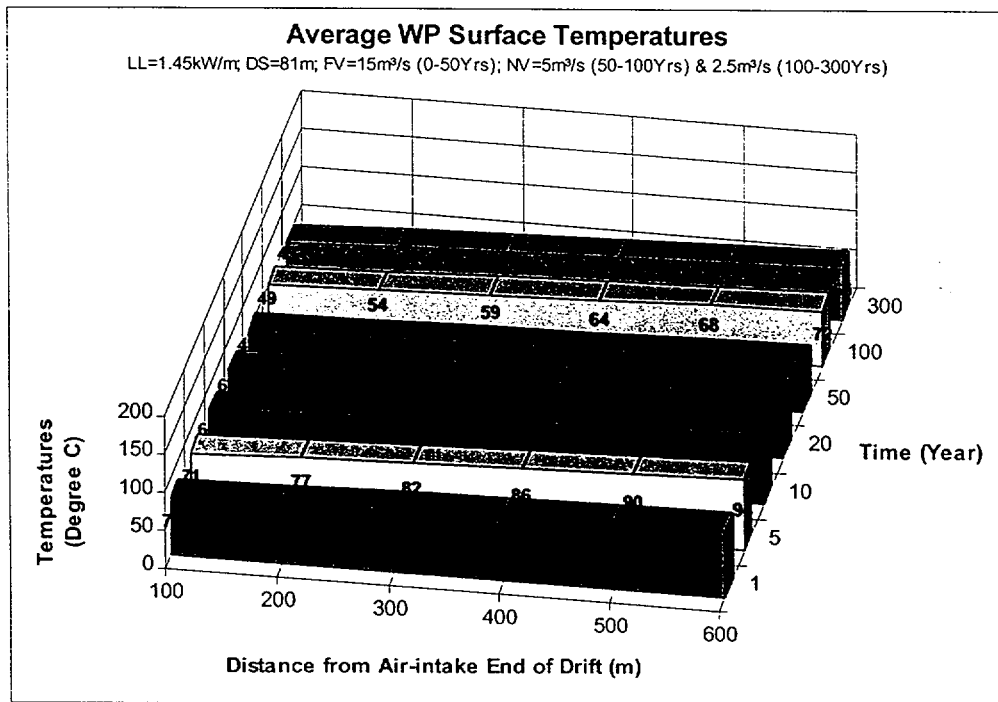
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XVI-1, p. XVI-2.

Figure XVI-1. Average Drift Wall Temperatures for Case 15: HF5N5V8



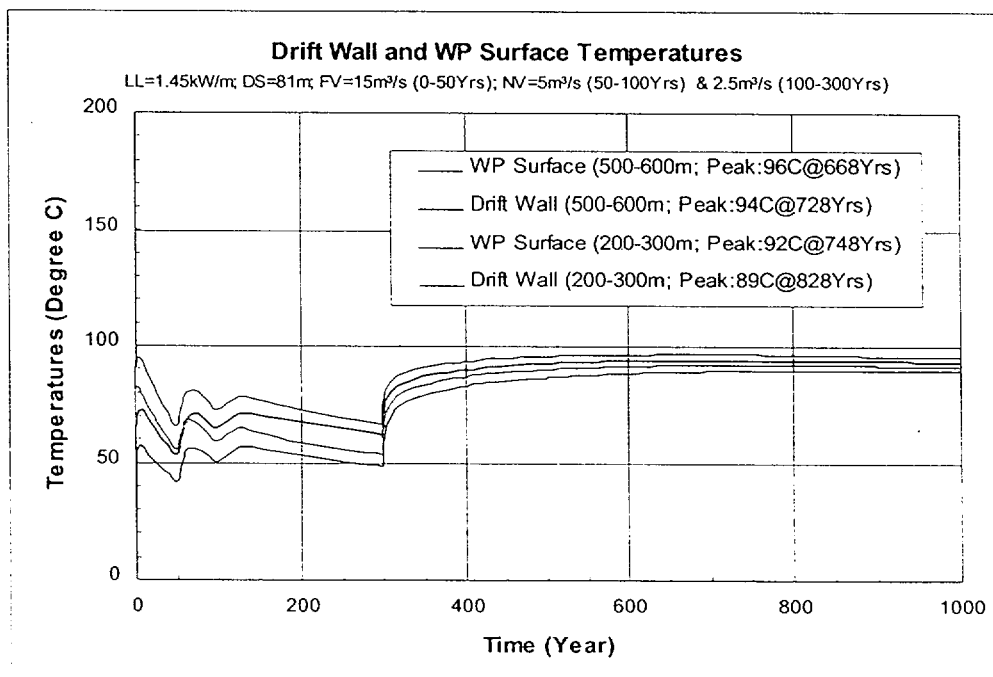
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XVI-2, p. XVI-3.

Figure XVI-2. Average Air Temperatures for Case 15: HF5N5V8



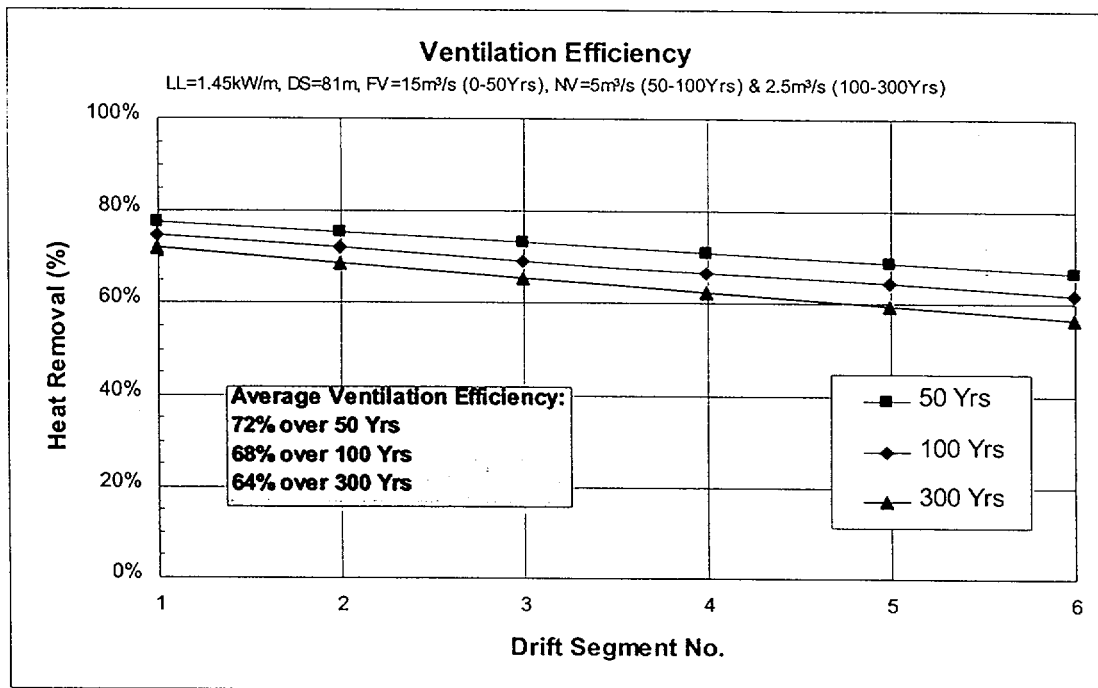
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XVI-3, p. XVI-4.

Figure XVI-3. Average Waste Package Surface Temperatures for Case 15: HF5N5V8



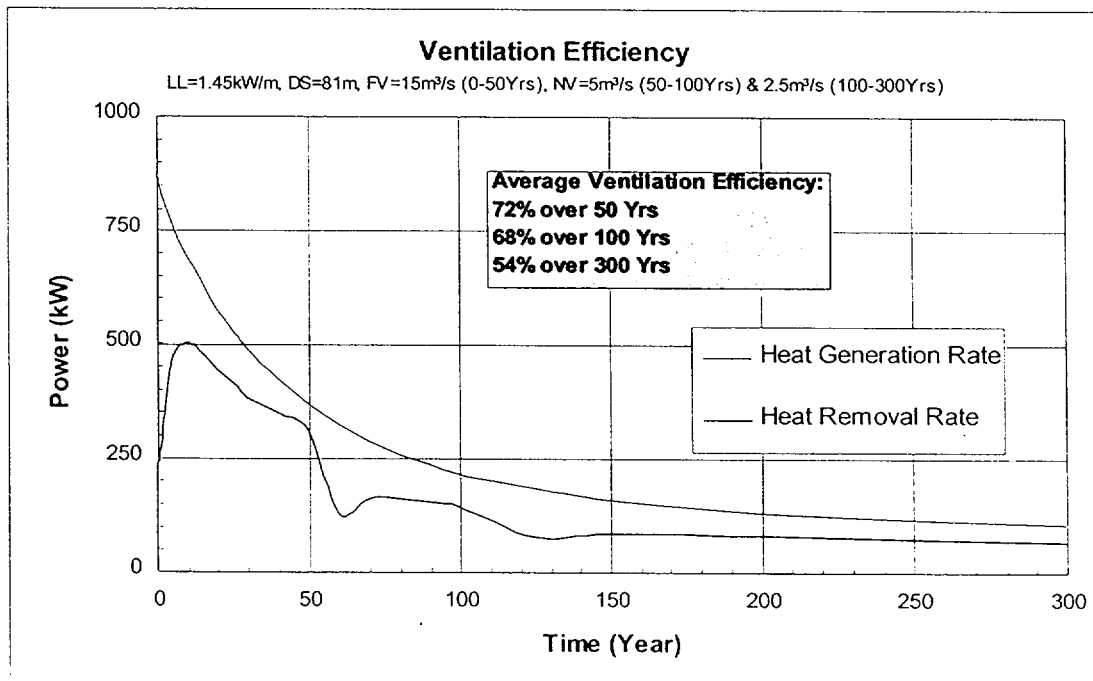
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVI-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 15: HF5N5V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVI-5. Average Heat Removal Rates at Different Drift Segments for Case 15: HF5N5V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVI-6. Overall Heat Generation and Removal Rates at Different Time for Case 15: HF5N5V8

ATTACHMENT XVII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 16: LF5N3V8

ATTACHMENT XVII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 16: LF5N3V8

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.0 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 3 m³/s from 50 to 100 years and 1.5 m³/s from 100 to 300 years. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XVII-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	39.31	42.36	44.80	46.85	48.56	49.98
5.00	38.82	43.10	47.07	50.69	53.99	56.97
10.00	37.69	41.81	45.81	49.67	53.37	56.90
15.00	36.70	40.53	44.29	47.96	51.55	55.04
20.00	35.78	39.33	42.83	46.27	49.63	52.94
26.00	34.77	38.05	41.28	44.46	47.60	50.68
30.00	34.18	37.22	40.23	43.19	46.11	48.99
40.00	32.95	35.72	38.46	41.18	43.86	46.51
50.00	31.96	34.39	36.81	39.23	41.64	44.04
60.00	43.72	47.75	51.23	54.32	57.08	59.62
70.00	43.90	49.36	54.10	58.24	61.87	65.07
80.00	42.54	48.04	53.01	57.49	61.53	65.15
90.00	41.30	46.53	51.35	55.78	59.84	63.56
100.00	40.23	45.20	49.80	54.07	58.03	61.68
125.00	44.42	49.81	54.50	58.64	62.33	65.64
150.00	42.86	48.64	53.66	58.05	61.89	65.28
200.00	40.84	46.39	51.36	55.78	59.72	63.22
250.00	39.48	44.69	49.44	53.74	57.63	61.13
300.00	38.47	43.41	47.95	52.10	55.90	59.36

Source: DTN: MO0010MWDANS03.005

Table XVII-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	28.77	31.94	34.60	36.82	38.67	40.23
5.00	29.87	34.41	38.58	42.38	45.83	48.95
10.00	29.55	33.99	38.29	42.43	46.38	50.13
15.00	29.19	33.30	37.33	41.28	45.13	48.87
20.00	28.86	32.66	36.40	40.07	43.68	47.22
26.00	28.53	32.02	35.46	38.86	42.20	45.49
30.00	28.26	31.49	34.67	37.81	40.91	43.97
40.00	27.95	30.88	33.79	36.66	39.51	42.33
50.00	27.57	30.14	32.71	35.27	37.82	40.35
60.00	30.44	35.06	39.07	42.61	45.80	48.71
70.00	32.55	39.07	44.71	49.60	53.87	57.61
80.00	32.26	38.86	44.81	50.16	54.95	59.23
90.00	31.73	37.95	43.68	48.93	53.74	58.13
100.00	31.26	37.09	42.50	47.52	52.16	56.45
125.00	32.82	39.52	45.35	50.49	55.07	59.19
150.00	33.29	40.44	46.63	52.00	56.69	60.81
200.00	32.47	39.17	45.15	50.47	55.18	59.36
250.00	31.70	37.84	43.44	48.51	53.10	57.22
300.00	31.17	36.87	42.12	46.94	51.35	55.36

Source: DTN: MO0010MWDANS03.005

Table XVII-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	67.93	67.95	67.95	67.95	67.95	67.95
1.00	60.29	63.08	65.36	67.26	68.85	70.18
5.00	57.91	61.82	65.45	68.78	71.82	74.57
10.00	55.09	58.86	62.53	66.08	69.50	72.76
15.00	52.79	56.32	59.78	63.17	66.49	69.73
20.00	50.65	53.94	57.18	60.37	63.51	66.59
26.00	48.32	51.37	54.39	57.36	60.30	63.19
30.00	46.96	49.80	52.62	55.39	58.13	60.84
40.00	44.08	46.69	49.28	51.85	54.39	56.91
50.00	41.72	44.03	46.34	48.64	50.94	53.23
60.00	53.58	57.41	60.72	63.65	66.28	68.68
70.00	52.55	57.81	62.38	66.37	69.86	72.94
80.00	50.38	55.68	60.48	64.81	68.72	72.22
90.00	48.47	53.53	58.19	62.49	66.42	70.02
100.00	46.84	51.65	56.13	60.27	64.11	67.66
125.00	50.32	55.57	60.14	64.16	67.75	70.98
150.00	47.87	53.53	58.45	62.74	66.51	69.83
200.00	45.03	50.48	55.36	59.71	63.59	67.03
250.00	43.18	48.30	52.97	57.21	61.04	64.50
300.00	41.81	46.68	51.15	55.25	58.99	62.41

Source: DTN: MO0010MWDANS03.005

Table XVII-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

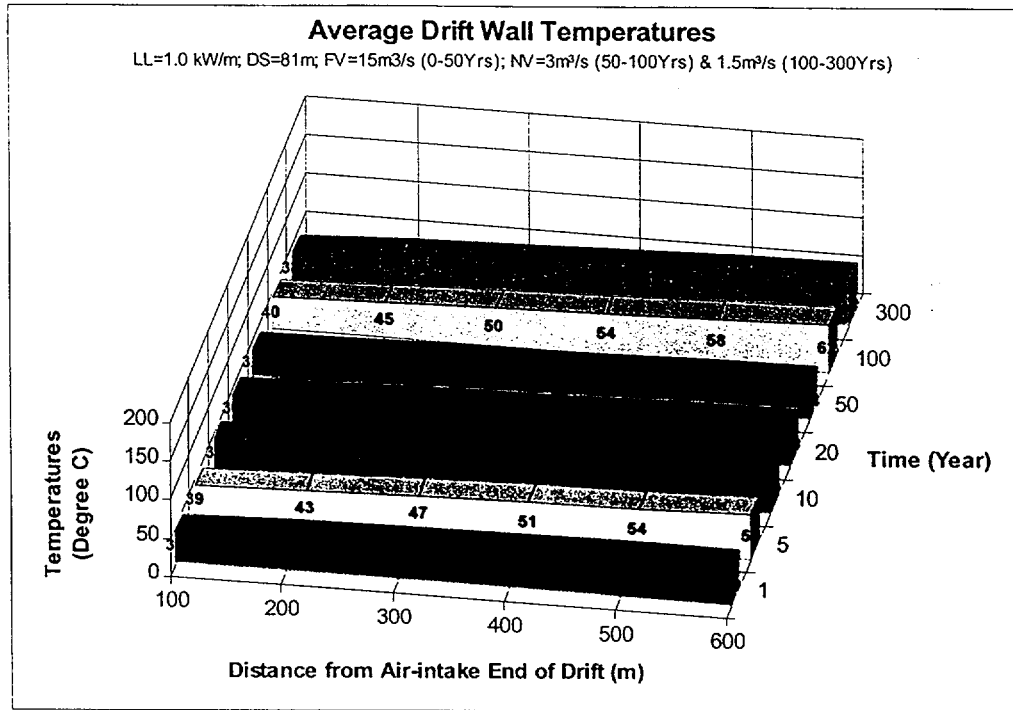
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.76	35.79	35.79	35.79	35.79	35.79
1.00	52.14	43.89	36.72	30.72	25.69	21.48
5.00	67.39	62.74	57.69	52.65	47.75	43.07
10.00	63.00	61.41	59.48	57.22	54.68	51.94
15.00	57.92	56.89	55.78	54.58	53.27	51.81
20.00	53.41	52.58	51.72	50.84	49.92	48.96
26.00	48.88	48.26	47.61	46.95	46.26	45.54
30.00	45.13	44.58	44.05	43.47	42.91	42.31
40.00	40.84	40.52	40.19	39.81	39.40	38.98
50.00	35.57	35.56	35.50	35.41	35.25	35.07
60.00	14.18	12.07	10.46	9.24	8.32	7.61
70.00	19.71	17.01	14.71	12.76	11.13	9.78
80.00	18.94	17.22	15.54	13.95	12.49	11.17
90.00	17.56	16.23	14.95	13.72	12.54	11.45
100.00	16.34	15.21	14.12	13.09	12.11	11.18
125.00	9.85	8.45	7.35	6.48	5.77	5.18
150.00	10.45	9.01	7.79	6.77	5.91	5.20
200.00	9.41	8.45	7.54	6.70	5.94	5.27
250.00	8.44	7.74	7.05	6.40	5.78	5.20
300.00	7.77	7.19	6.62	6.07	5.55	5.06

Source: DTN: MO0010MWDANS03.005

Table XVII-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

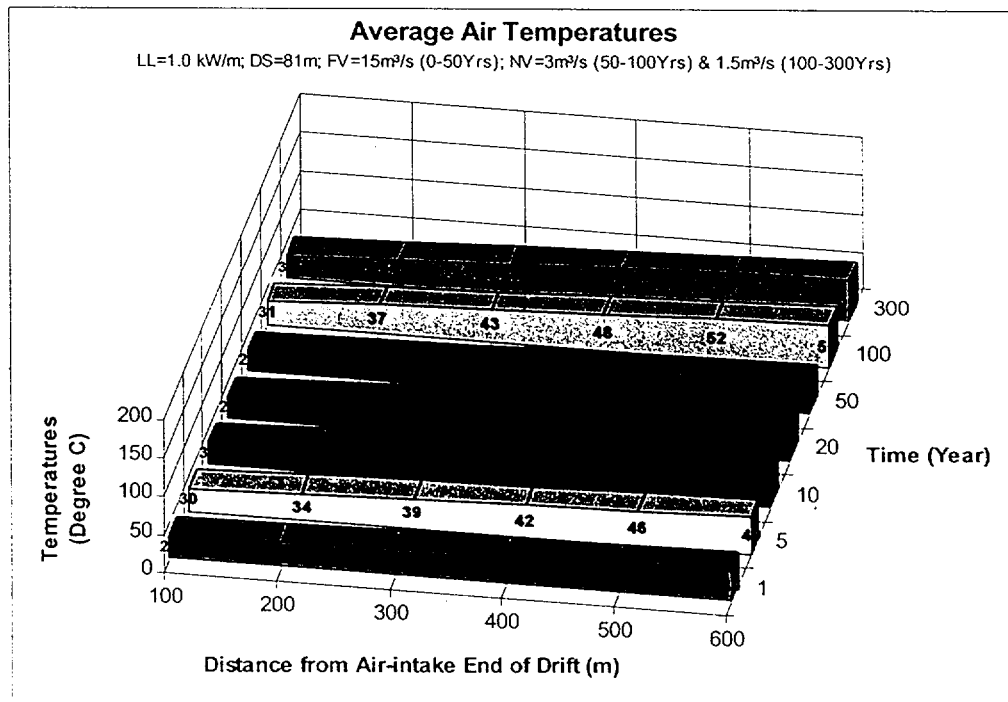
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.0E-4	100.00%	600.00	600.00	1.89	1.0E-4	214.72	107.36	0.34
1.00	96.99%	581.96	590.98	18635.31	1.00	210.64	212.68	6706.45
5.00	87.93%	527.56	554.76	69979.72	5.00	331.30	270.97	34181.26
10.00	79.35%	476.12	501.84	79129.84	10.00	347.72	339.51	53534.15
15.00	72.23%	433.40	454.76	71706.06	15.00	330.25	338.98	53451.14
20.00	66.23%	397.39	415.39	65499.41	20.00	307.43	318.84	50274.84
26.00	59.89%	359.32	378.36	71591.05	26.00	283.50	295.47	55907.16
30.00	56.11%	336.67	348.00	43897.73	30.00	262.45	272.98	34434.37
40.00	48.24%	289.44	313.06	98725.25	40.00	239.74	251.10	79185.74
50.00	41.94%	251.65	270.54	85318.40	50.00	212.37	226.05	71287.86
60.00	36.88%	221.25	236.45	74566.81	60.00	61.88	137.12	43242.66
70.00	32.81%	196.84	209.05	65924.69	70.00	85.10	73.49	23176.08
80.00	29.47%	176.83	186.83	58920.10	80.00	89.31	87.21	27501.94
90.00	26.76%	160.58	168.70	53202.00	90.00	86.44	87.88	27713.00
100.00	24.52%	147.12	153.85	48516.98	100.00	82.06	84.25	26569.12
125.00	21.21%	127.24	137.18	108151.61	125.00	43.08	62.57	49330.59
150.00	17.89%	107.37	117.30	92481.71	150.00	45.13	44.11	34774.89
200.00	14.85%	89.09	98.23	154888.99	200.00	43.30	44.22	69722.60
250.00	13.03%	78.16	83.63	131862.91	250.00	40.61	41.96	66156.76
300.00	11.76%	70.58	74.37	117266.25	300.00	38.26	39.44	62185.18
Total heat generated in 50 years (GJ)				604484.67	Total heat removed in 50 years (GJ)			438963.30
Total heat generated in 100 years (GJ)				905615.27	Total heat removed in 100 years (GJ)			587166.10
Total heat generated in 300 years (GJ)				1510266.74	Total heat removed in 300 years (GJ)			869336.13
Percentage of total heat removal in 50 years = 73%								
Percentage of total heat removal in 100 years = 65%								
Percentage of total heat removal in 300 years = 58%								

Source: DTN: MO0010MWDANS03.005



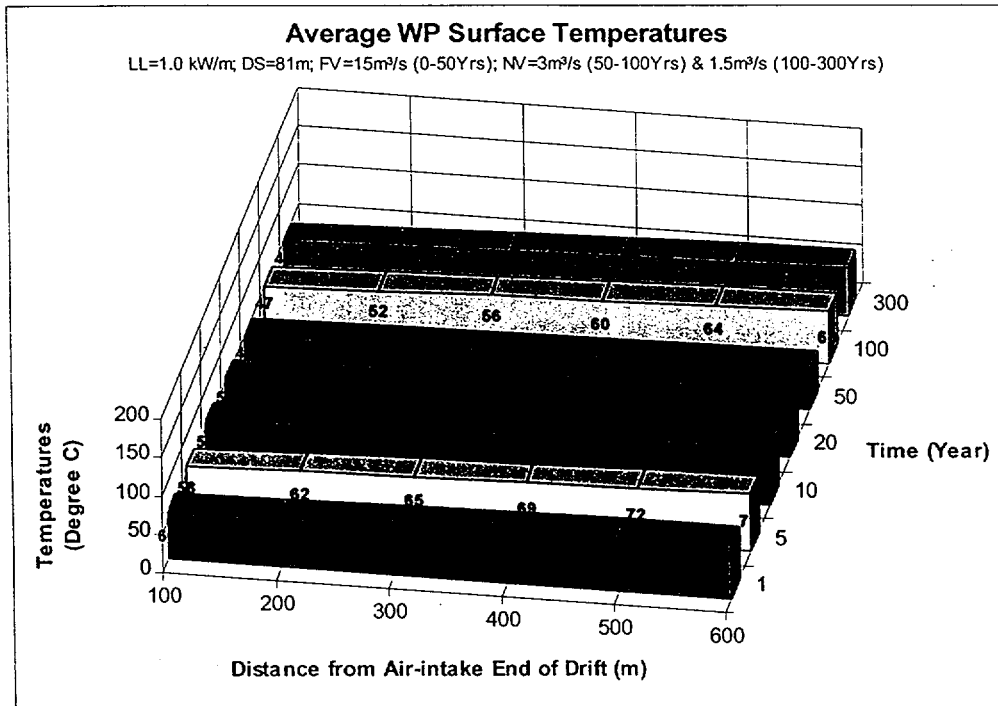
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XVII-1, p. XVII-2.

Figure XVII-1. Average Drift Wall Temperatures for Case 16: LF5N3V8



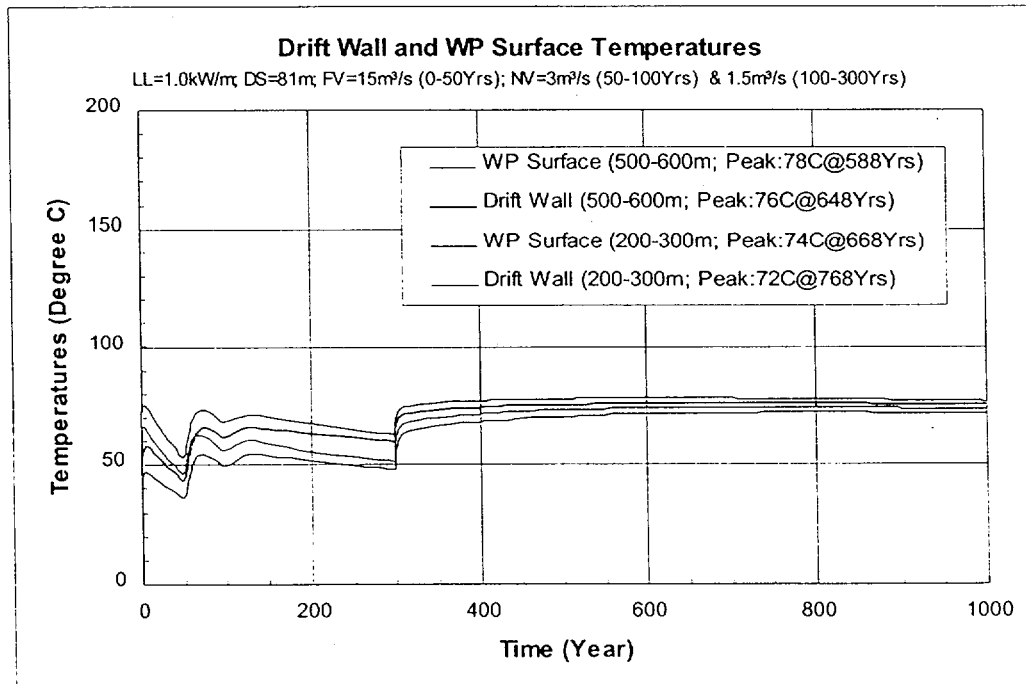
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XVII-2, p. XVII-3.

Figure XVII-2. Average Air Temperatures for Case 16: LF5N3V8



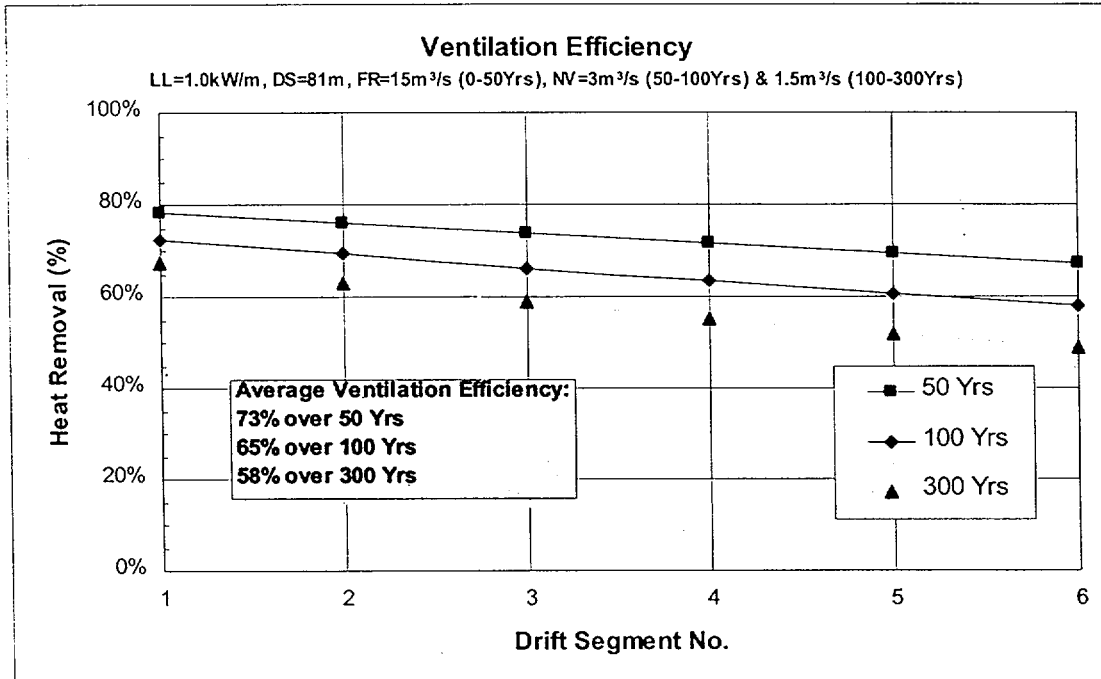
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XVII-3, p. XVII-4.

Figure XVII-3. Average Waste Package Surface Temperatures for Case 16: LF5N3V8



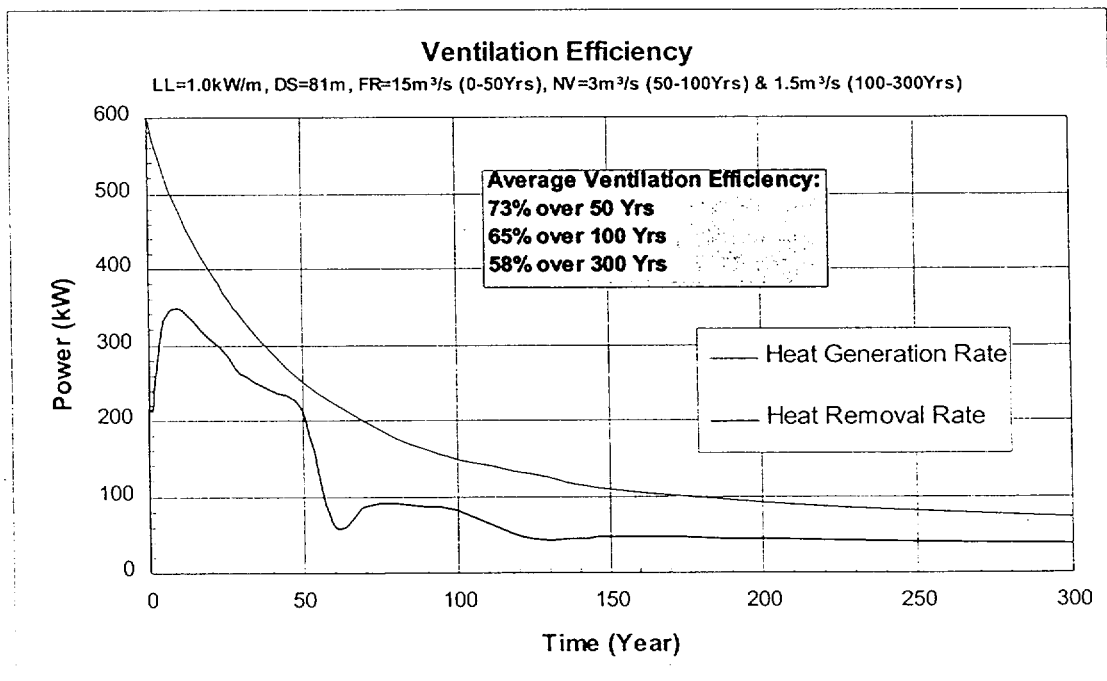
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVII-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 16: LF5N3V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVII-5. Average Heat Removal Rates at Different Drift Segments for Case 16: LF5N3V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVII-6. Overall Heat Generation and Removal Rates at Different Time for Case 16: LF5N3V8

ATTACHMENT XVIII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 17: LF5N5V8

ATTACHMENT XVIII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 17: LF5N5V8

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.0 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XVIII-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	39.31	42.36	44.80	46.85	48.56	49.98
5.00	38.82	43.10	47.07	50.69	53.99	56.97
10.00	37.69	41.81	45.81	49.67	53.37	56.90
15.00	36.70	40.53	44.29	47.96	51.55	55.04
20.00	35.78	39.33	42.83	46.27	49.63	52.94
26.00	34.77	38.05	41.28	44.46	47.60	50.68
30.00	34.18	37.22	40.23	43.19	46.11	48.99
40.00	32.95	35.72	38.46	41.18	43.86	46.51
50.00	31.96	34.39	36.81	39.23	41.64	44.04
60.00	38.93	42.35	45.46	48.32	50.97	53.48
70.00	38.35	42.57	46.42	49.96	53.19	56.17
80.00	37.25	41.31	45.16	48.79	52.20	55.40
90.00	36.30	40.10	43.73	47.21	50.52	53.69
100.00	35.49	39.04	42.46	45.75	48.91	51.94
125.00	39.28	43.28	46.93	50.25	53.33	56.20
150.00	37.96	42.30	46.25	49.84	53.12	56.13
200.00	36.31	40.37	44.19	47.74	51.05	54.12
250.00	35.23	38.95	42.50	45.86	49.04	52.04
300.00	34.44	37.91	41.23	44.40	47.43	50.30

Source: DTN: MO0010MWDANS03.005

Table XVIII-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	28.77	31.94	34.60	36.82	38.67	40.23
5.00	29.87	34.41	38.58	42.38	45.83	48.95
10.00	29.55	33.99	38.29	42.43	46.38	50.13
15.00	29.19	33.30	37.33	41.28	45.13	48.87
20.00	28.86	32.66	36.40	40.07	43.68	47.22
26.00	28.53	32.02	35.46	38.86	42.20	45.49
30.00	28.26	31.49	34.67	37.81	40.91	43.97
40.00	27.95	30.88	33.79	36.66	39.51	42.33
50.00	27.57	30.14	32.71	35.27	37.82	40.35
60.00	29.16	32.90	36.31	39.45	42.39	45.15
70.00	30.17	34.88	39.18	43.10	46.69	49.99
80.00	29.82	34.41	38.74	42.82	46.64	50.21
90.00	29.43	33.68	37.76	41.65	45.37	48.89
100.00	29.09	33.04	36.84	40.50	44.01	47.37
125.00	30.17	34.82	39.03	42.90	46.48	49.81
150.00	30.58	35.62	40.18	44.33	48.10	51.55
200.00	29.95	34.61	38.97	43.03	46.79	50.28
250.00	29.38	33.57	37.56	41.35	44.93	48.30
300.00	28.99	32.83	36.51	40.03	43.39	46.59

Source: DTN: MO0010MWDANS03.005

Table XVIII-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	67.93	67.95	67.95	67.95	67.95	67.95
1.00	60.29	63.08	65.36	67.26	68.85	70.18
5.00	57.91	61.82	65.45	68.78	71.82	74.57
10.00	55.09	58.86	62.53	66.08	69.50	72.76
15.00	52.79	56.32	59.78	63.17	66.49	69.73
20.00	50.65	53.94	57.18	60.37	63.51	66.59
26.00	48.32	51.37	54.39	57.36	60.30	63.19
30.00	46.96	49.80	52.62	55.39	58.13	60.84
40.00	44.08	46.69	49.28	51.85	54.39	56.91
50.00	41.72	44.03	46.34	48.64	50.94	53.23
60.00	48.58	51.84	54.80	57.52	60.05	62.44
70.00	46.92	50.98	54.69	58.09	61.20	64.07
80.00	45.01	48.92	52.63	56.14	59.44	62.53
90.00	43.38	47.05	50.56	53.93	57.14	60.21
100.00	42.01	45.45	48.77	51.96	55.03	57.97
125.00	45.20	49.10	52.64	55.88	58.87	61.66
150.00	42.97	47.23	51.09	54.61	57.83	60.77
200.00	40.50	44.49	48.23	51.73	54.99	58.00
250.00	38.92	42.58	46.07	49.38	52.51	55.46
300.00	37.78	41.19	44.46	47.59	50.57	53.41

Source: DTN: MO0010MWDANS03.005

Table XVIII-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

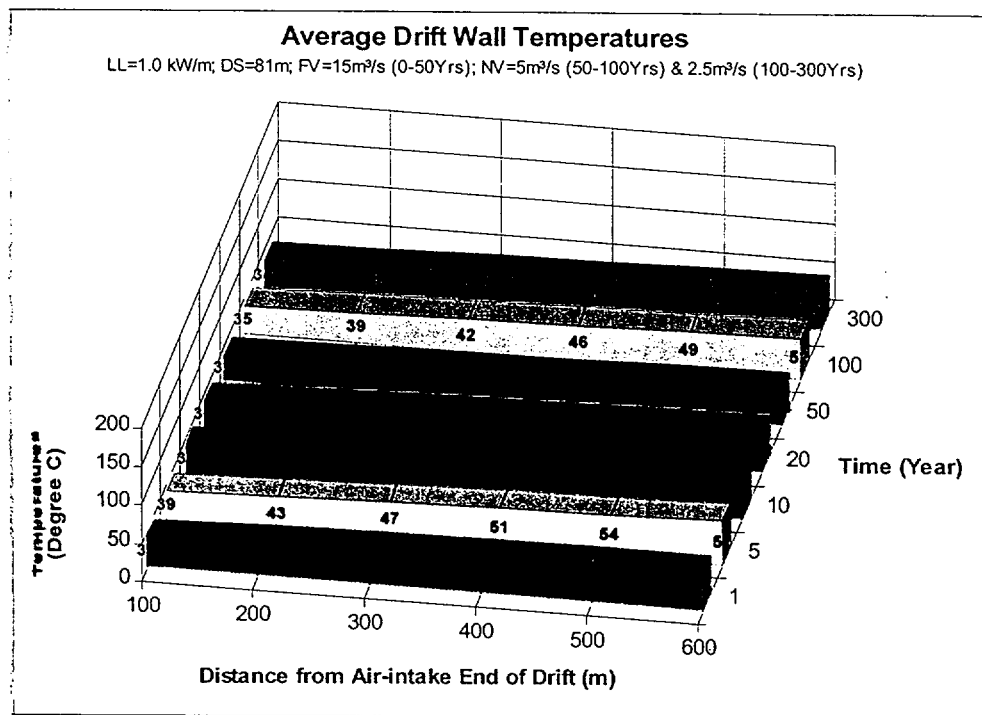
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.76	35.79	35.79	35.79	35.79	35.79
1.00	52.14	43.89	36.72	30.72	25.69	21.48
5.00	67.39	62.74	57.69	52.65	47.75	43.07
10.00	63.00	61.41	59.48	57.22	54.68	51.94
15.00	57.92	56.89	55.78	54.58	53.27	51.81
20.00	53.41	52.58	51.72	50.84	49.92	48.96
26.00	48.88	48.26	47.61	46.95	46.26	45.54
30.00	45.13	44.58	44.05	43.47	42.91	42.31
40.00	40.84	40.52	40.19	39.81	39.40	38.98
50.00	35.57	35.56	35.50	35.41	35.25	35.07
60.00	18.43	16.58	15.12	13.95	13.01	12.27
70.00	22.92	20.89	19.04	17.39	15.92	14.64
80.00	21.39	20.33	19.21	18.07	16.93	15.83
90.00	19.64	18.86	18.07	17.27	16.46	15.65
100.00	18.15	17.50	16.85	16.21	15.56	14.93
125.00	11.16	10.01	9.09	8.34	7.72	7.19
150.00	12.02	10.87	9.84	8.93	8.14	7.45
200.00	10.67	10.05	9.40	8.75	8.12	7.52
250.00	9.44	9.04	8.61	8.17	7.72	7.26
300.00	8.60	8.27	7.94	7.59	7.24	6.89

Source: DTN: MO0010MWDANS03.005

Table XVIII-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m)

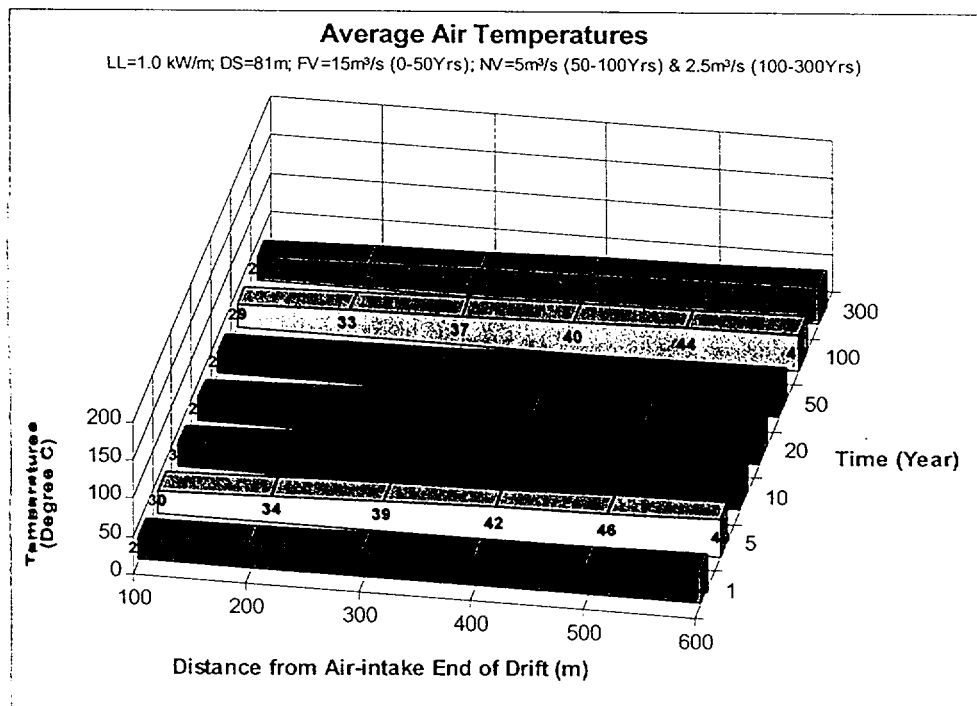
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.0E-4	100.00%	600.00	600.00	1.89	1.0E-4	214.72	107.36	0.34
1.00	96.99%	581.96	590.98	18635.31	1.00	210.64	212.68	6706.45
5.00	87.93%	527.56	554.76	69979.72	5.00	331.30	270.97	34181.26
10.00	79.35%	476.12	501.84	79129.84	10.00	347.72	339.51	53534.15
15.00	72.23%	433.40	454.76	71706.06	15.00	330.25	338.98	53451.14
20.00	66.23%	397.39	415.39	65499.41	20.00	307.43	318.84	50274.84
26.00	59.89%	359.32	378.36	71591.05	26.00	283.50	295.47	55907.16
30.00	56.11%	336.67	348.00	43897.73	30.00	262.45	272.98	34434.37
40.00	48.24%	289.44	313.06	98725.25	40.00	239.74	251.10	79185.74
50.00	41.94%	251.65	270.54	85318.40	50.00	212.37	226.05	71287.86
60.00	36.88%	221.25	236.45	74566.81	60.00	89.36	150.86	47576.54
70.00	32.81%	196.84	209.05	65924.69	70.00	110.81	100.09	31563.33
80.00	29.47%	176.83	186.83	58920.10	80.00	111.77	111.29	35095.73
90.00	26.76%	160.58	168.70	53202.00	90.00	105.95	108.86	34328.92
100.00	24.52%	147.12	153.85	48516.98	100.00	99.20	102.57	32347.29
125.00	21.21%	127.24	137.18	108151.61	125.00	53.49	76.35	60191.28
150.00	17.89%	107.37	117.30	92481.71	150.00	57.25	55.37	43655.42
200.00	14.85%	89.09	98.23	154888.99	200.00	59.83	58.54	92307.14
250.00	13.03%	78.16	83.63	131862.91	250.00	50.23	55.03	86774.79
300.00	11.76%	70.58	74.37	117266.25	300.00	46.55	48.39	76301.50
Total heat generated in 50 years (GJ)				604484.67	Total heat removed in 50 years (GJ)			438963.30
Total heat generated in 100 years (GJ)				905615.27	Total heat removed in 100 years (GJ)			619875.11
Total heat generated in 300 years (GJ)				1510266.74	Total heat removed in 300 years (GJ)			979105.26
Percentage of total heat removal in 50 years = 73%								
Percentage of total heat removal in 100 years = 68%								
Percentage of total heat removal in 300 years = 65%								

Source: DTN: MO0010MWDANS03.005



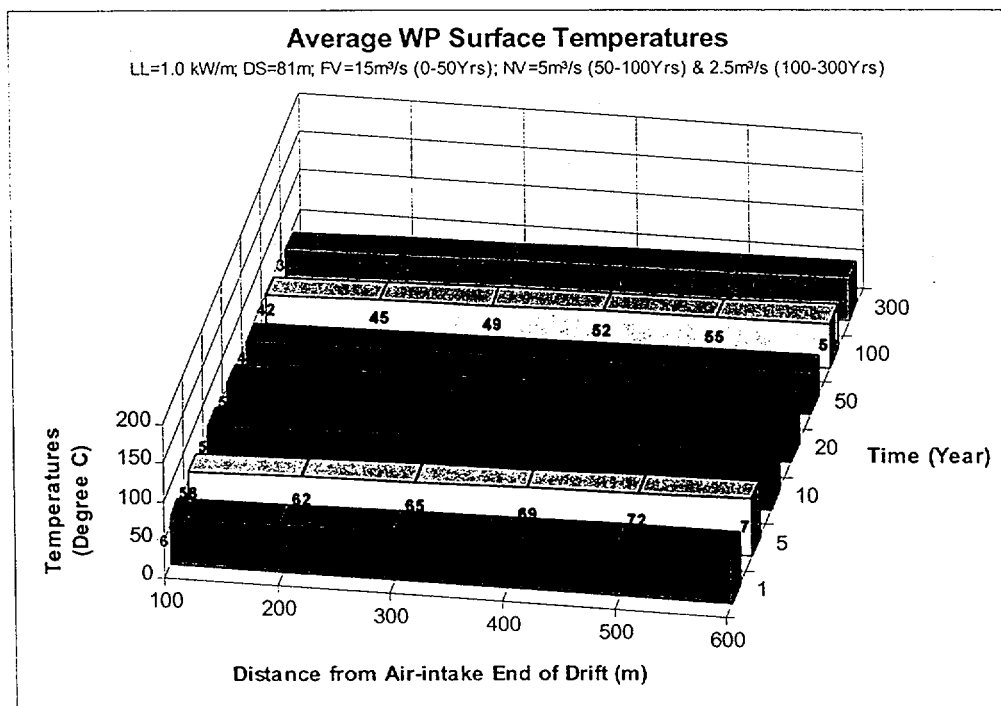
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XVIII-1, p. XVIII-2.

Figure XVIII-1. Average Drift Wall Temperatures for Case 17: LF5N5V8



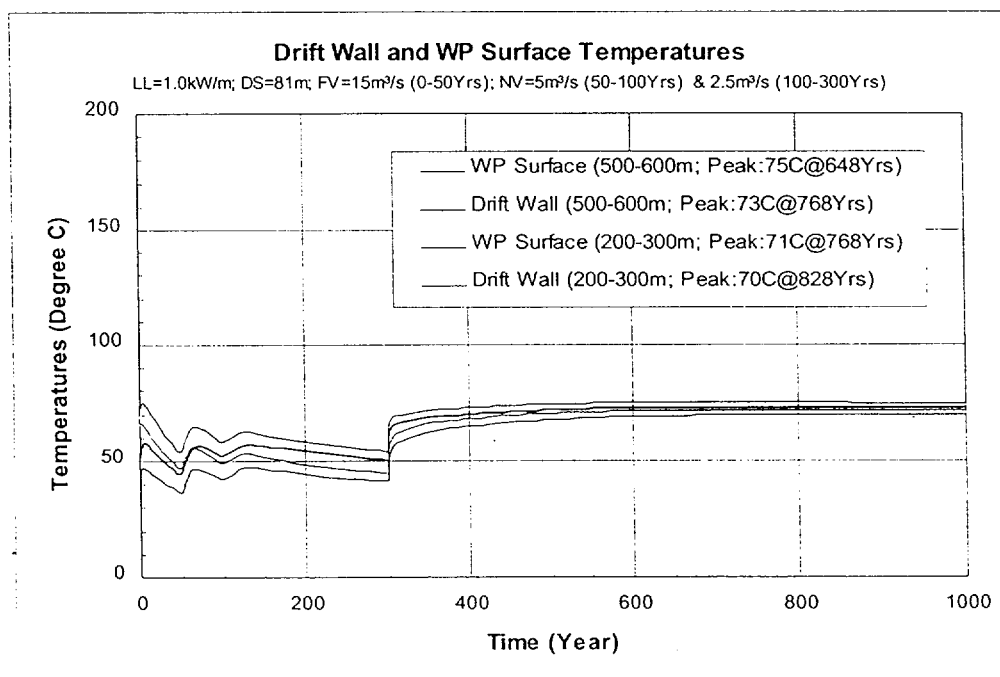
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XVIII-2, p. XVIII-3.

Figure XVIII-2. Average Air Temperatures for Case 17: LF5N5V8



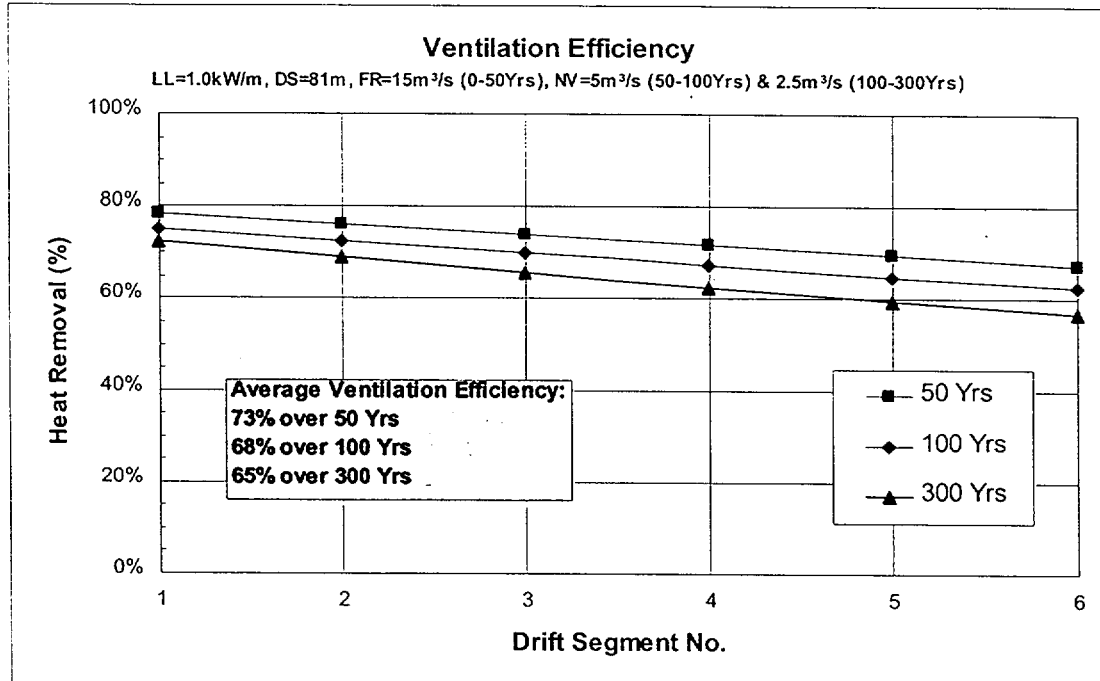
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
 For obliterated numbers, see Table XVIII-3, p. XVIII-4.

Figure XVIII-3. Average Waste Package Surface Temperatures for Case 17: LF5N5V8



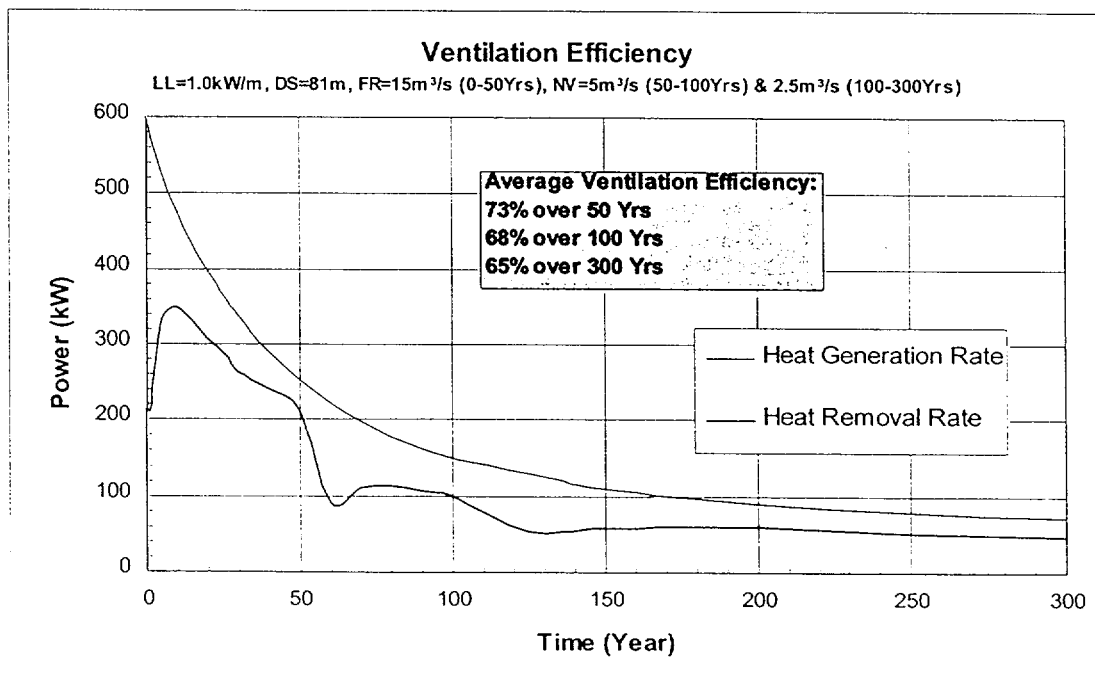
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVIII-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 17: LF5N5V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVIII-5. Average Heat Removal Rates at Different Drift Segments for Case 17: LF5N5V8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XVIII-6. Overall Heat Generation and Removal Rates at Different Time for Case 17: LF5N5V8

ATTACHMENT XIX

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 18: HF5N5V4

ATTACHMENT XIX

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 18: HF5N5V4

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Drift spacing for this case is reduced to 40.5 m. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XIX-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	46.13	50.11	53.30	55.96	58.20	60.06
5.00	45.52	51.76	57.48	62.68	67.37	71.61
10.00	44.03	50.16	56.09	61.79	67.24	72.42
15.00	42.57	48.33	53.99	59.52	64.91	70.16
20.00	41.30	46.70	52.02	57.26	62.40	67.46
26.00	39.89	44.92	49.88	54.80	59.66	64.44
30.00	39.01	43.71	48.37	52.99	57.56	62.09
40.00	37.14	41.42	45.69	49.95	54.18	58.40
50.00	35.60	39.37	43.17	46.98	50.80	54.62
60.00	46.13	51.50	56.44	61.04	65.38	69.51
70.00	45.53	52.19	58.34	64.03	69.33	74.26
80.00	44.02	50.55	56.80	62.75	68.40	73.77
90.00	42.63	48.82	54.82	60.62	66.22	71.61
100.00	41.41	47.24	52.94	58.49	63.90	69.14
125.00	47.44	54.17	60.40	66.22	71.71	76.91
150.00	45.73	53.11	59.96	66.32	72.25	77.81
200.00	43.03	50.02	56.74	63.16	69.25	75.03
250.00	41.17	47.55	53.79	59.87	65.76	71.44
300.00	39.81	45.68	51.47	57.15	62.72	68.16

Source: DTN: MO0010MWDANS03.005

Table XIX-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.89	34.00	37.43	40.31	42.71	44.72
5.00	32.06	38.57	44.51	49.89	54.75	59.11
10.00	31.65	38.13	44.39	50.41	56.14	61.57
15.00	31.14	37.19	43.13	48.95	54.63	60.16
20.00	30.68	36.30	41.85	47.32	52.71	58.00
26.00	30.24	35.43	40.58	45.69	50.73	55.72
30.00	29.86	34.69	39.48	44.24	48.97	53.65
40.00	29.40	33.80	38.19	42.57	46.94	51.28
50.00	28.83	32.70	36.59	40.50	44.42	48.35
60.00	31.21	36.85	42.04	46.89	51.46	55.81
70.00	32.77	39.93	46.53	52.63	58.28	63.54
80.00	32.33	39.38	46.13	52.54	58.63	64.38
90.00	31.78	38.39	44.82	51.04	57.04	62.82
100.00	31.29	37.46	43.50	49.41	55.15	60.74
125.00	33.00	40.33	47.12	53.47	59.46	65.14
150.00	33.72	41.79	49.26	56.19	62.65	68.68
200.00	32.80	40.34	47.58	54.48	61.03	67.24
250.00	31.87	38.65	45.30	51.78	58.07	64.13
300.00	31.22	37.39	43.48	49.48	55.37	61.12

Source: DTN: MO0010MWDANS03.005

Table XIX-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.04	68.04	68.04	68.04	68.04
1.00	74.51	77.98	80.81	83.18	85.16	86.82
5.00	71.32	76.77	81.80	86.39	90.53	94.30
10.00	67.65	73.01	78.23	83.29	88.15	92.79
15.00	64.35	69.43	74.44	79.37	84.20	88.92
20.00	61.54	66.33	71.07	75.77	80.40	84.97
26.00	58.45	62.95	67.41	71.84	76.24	80.59
30.00	56.56	60.78	64.98	69.16	73.31	77.44
40.00	52.47	56.37	60.27	64.16	68.05	71.93
50.00	49.12	52.58	56.07	59.59	63.12	66.66
60.00	59.11	64.06	68.63	72.89	76.92	80.75
70.00	57.01	63.23	69.00	74.36	79.35	84.00
80.00	54.42	60.54	66.42	72.05	77.40	82.49
90.00	52.18	57.99	63.66	69.16	74.48	79.60
100.00	50.24	55.74	61.13	66.41	71.56	76.56
125.00	55.29	61.70	67.64	73.21	78.46	83.45
150.00	52.36	59.45	66.04	72.18	77.91	83.29
200.00	48.60	55.35	61.84	68.06	73.98	79.60
250.00	46.14	52.29	58.34	64.24	69.97	75.51
300.00	44.33	50.02	55.63	61.16	66.59	71.89

Source: DTN: MO0010MWDANS03.005

Table XIX-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

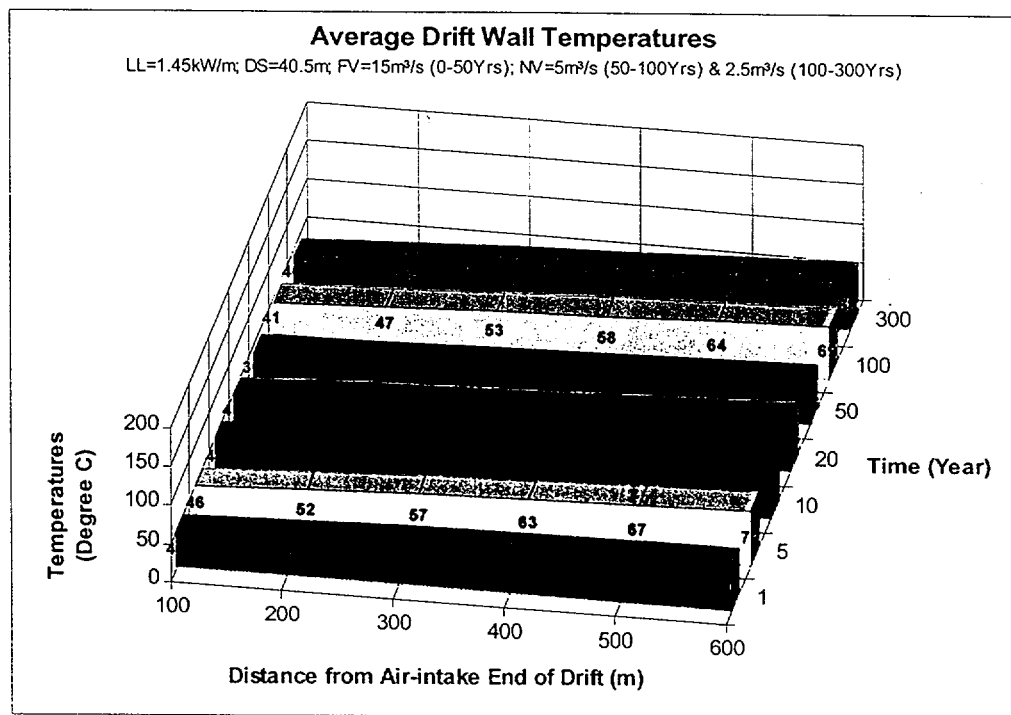
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.83	35.83	35.83	35.83	35.83
1.00	67.59	56.86	47.55	39.76	33.27	27.82
5.00	97.70	90.06	82.16	74.48	67.17	60.31
10.00	91.95	89.64	86.70	83.22	79.33	75.17
15.00	84.96	83.66	82.19	80.50	78.60	76.45
20.00	78.63	77.73	76.76	75.70	74.53	73.26
26.00	72.44	71.89	71.26	70.58	69.83	69.00
30.00	67.19	66.81	66.36	65.87	65.35	64.77
40.00	60.88	60.87	60.77	60.60	60.37	60.11
50.00	53.05	53.47	53.81	54.06	54.24	54.35
60.00	27.52	25.01	23.04	21.48	20.27	19.30
70.00	34.46	31.75	29.26	27.03	25.06	23.32
80.00	32.49	31.28	29.91	28.45	26.97	25.51
90.00	30.06	29.32	28.48	27.59	26.62	25.62
100.00	27.90	27.37	26.79	26.16	25.49	24.78
125.00	17.25	15.79	14.64	13.70	12.92	12.25
150.00	18.80	17.40	16.11	14.95	13.92	13.01
200.00	16.81	16.27	15.61	14.88	14.13	13.38
250.00	14.81	14.62	14.34	13.98	13.55	13.07
300.00	13.41	13.30	13.14	12.94	12.69	12.40

Source: DTN: MO0010MWDANS03.005

Table XIX-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

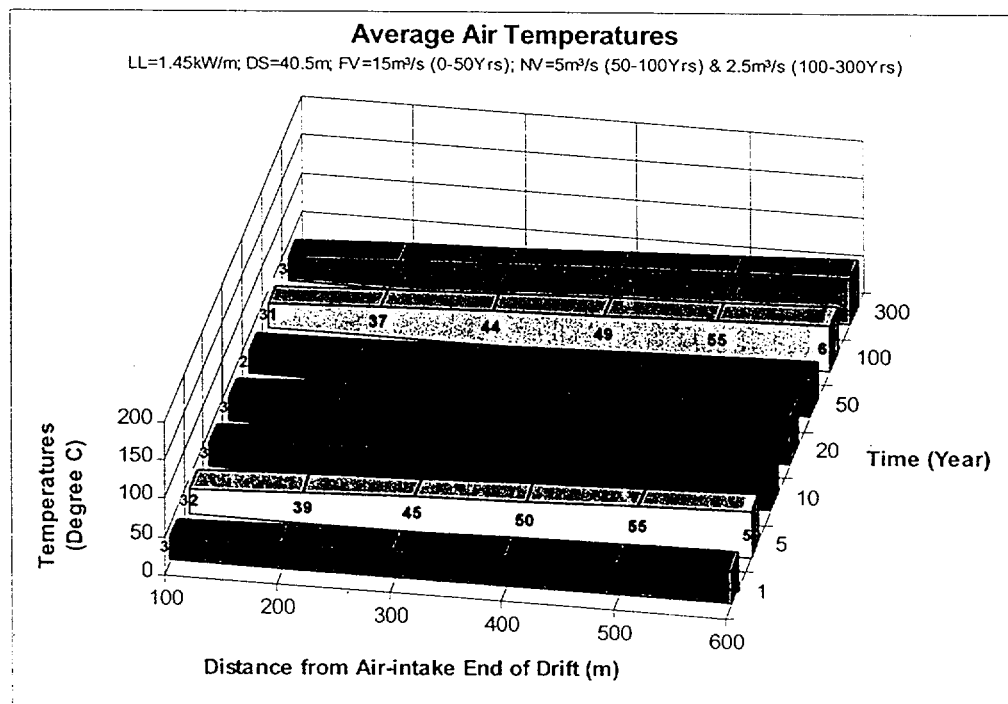
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)	
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.96	107.48	0.34	
1.00	96.99%	843.84	856.92	27021.20	1.00	272.85	243.90	7690.95	
5.00	87.93%	764.96	804.40	101470.60	5.00	471.88	372.36	46971.24	
10.00	79.35%	690.37	727.67	114738.26	10.00	505.99	488.93	77095.25	
15.00	72.23%	628.43	659.40	103973.79	15.00	486.37	496.18	78237.66	
20.00	66.23%	576.22	602.32	94974.15	20.00	456.61	471.49	74343.89	
26.00	59.89%	521.01	548.62	103807.02	26.00	425.01	440.81	83407.56	
30.00	56.11%	488.18	504.60	63651.70	30.00	396.36	410.68	51805.28	
40.00	48.24%	419.68	453.93	143151.62	40.00	363.59	379.98	119829.88	
50.00	41.94%	364.89	392.29	123711.69	50.00	322.98	343.29	108259.47	
60.00	36.88%	320.81	342.85	108121.88	60.00	136.61	229.80	72468.82	
70.00	32.81%	285.42	303.12	95590.81	70.00	170.87	153.74	48483.30	
80.00	29.47%	256.40	270.91	85434.15	80.00	174.62	172.74	54476.24	
90.00	26.76%	232.84	244.62	77142.91	90.00	167.68	171.15	53974.33	
100.00	24.52%	213.32	223.08	70349.62	100.00	158.48	163.08	51429.87	
125.00	21.21%	184.50	198.91	156819.84	125.00	86.55	122.51	96590.00	
150.00	17.89%	155.68	170.09	134098.48	150.00	94.18	90.36	71240.69	
200.00	14.85%	129.19	142.43	224589.03	200.00	91.07	92.62	146044.54	
250.00	13.03%	113.33	121.26	191201.22	250.00	84.37	87.72	138311.46	
300.00	11.76%	102.34	107.84	170036.07	300.00	77.88	81.12	127912.68	
Total heat generated in 50 years (GJ)				876502.77	Total heat removed in 50 years (GJ)				647641.52
Total heat generated in 100 years (GJ)				1313142.14	Total heat removed in 100 years (GJ)				928474.08
Total heat generated in 300 years (GJ)				2189886.77	Total heat removed in 300 years (GJ)				1508573.45
Percentage of total heat removal in 50 years = 74%									
Percentage of total heat removal in 100 years = 71%									
Percentage of total heat removal in 300 years = 69%									

Source: DTN: MO0010MWDANS03.005



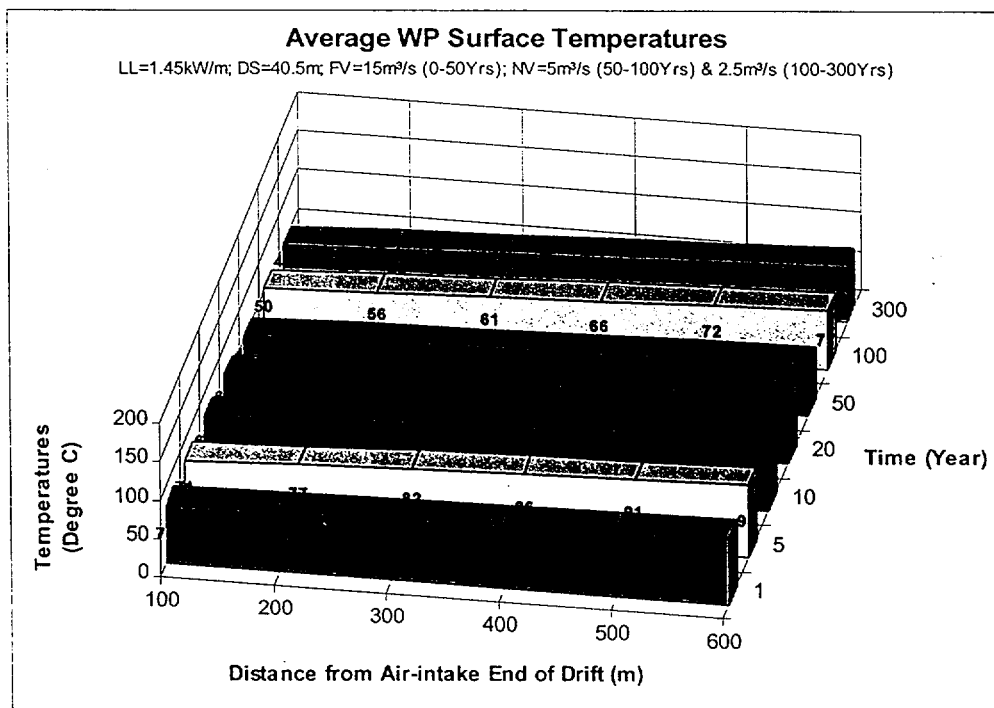
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XIX-1, p. XIX-2.

Figure XIX-1. Average Drift Wall Temperatures for Case 18: HF5N5V4



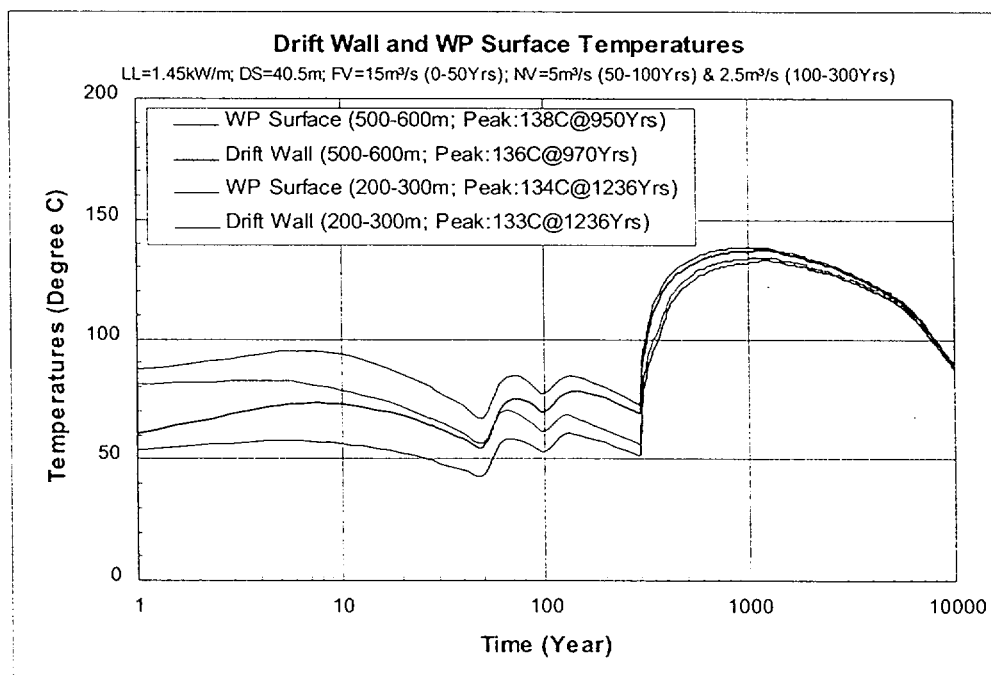
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XIX-2, p. XIX-3.

Figure XIX-2. Average Air Temperatures for Case 18: HF5N5V4



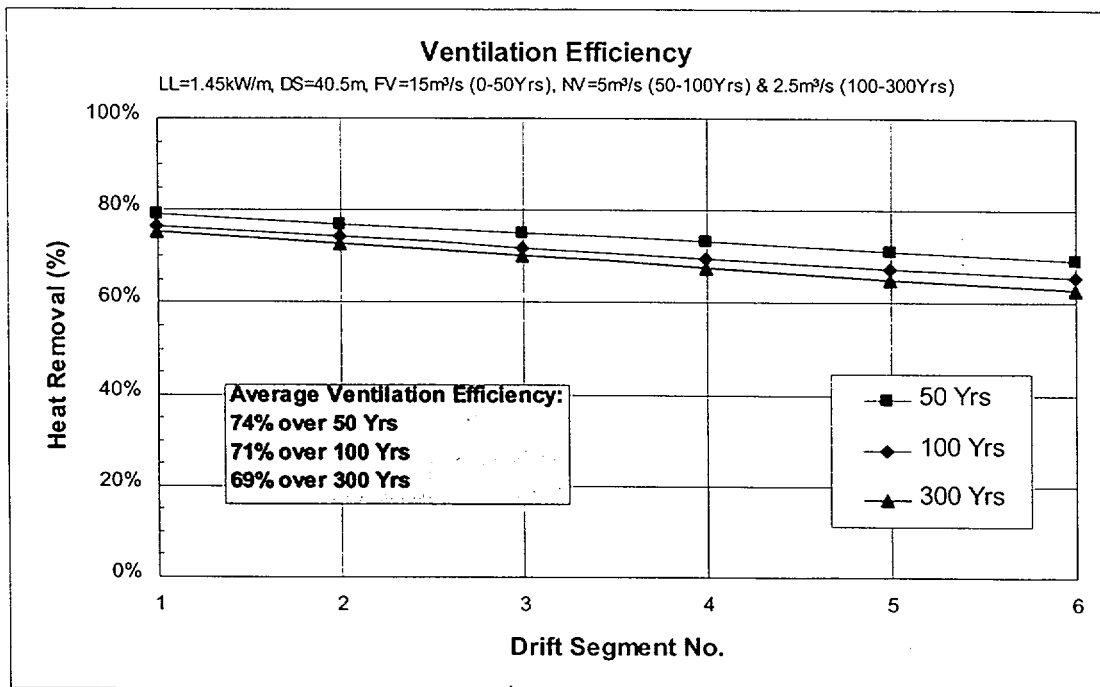
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XIX-3, p. XIX-4.

Figure XIX-3. Average Waste Package Surface Temperatures for Case 18: HF5N5V4



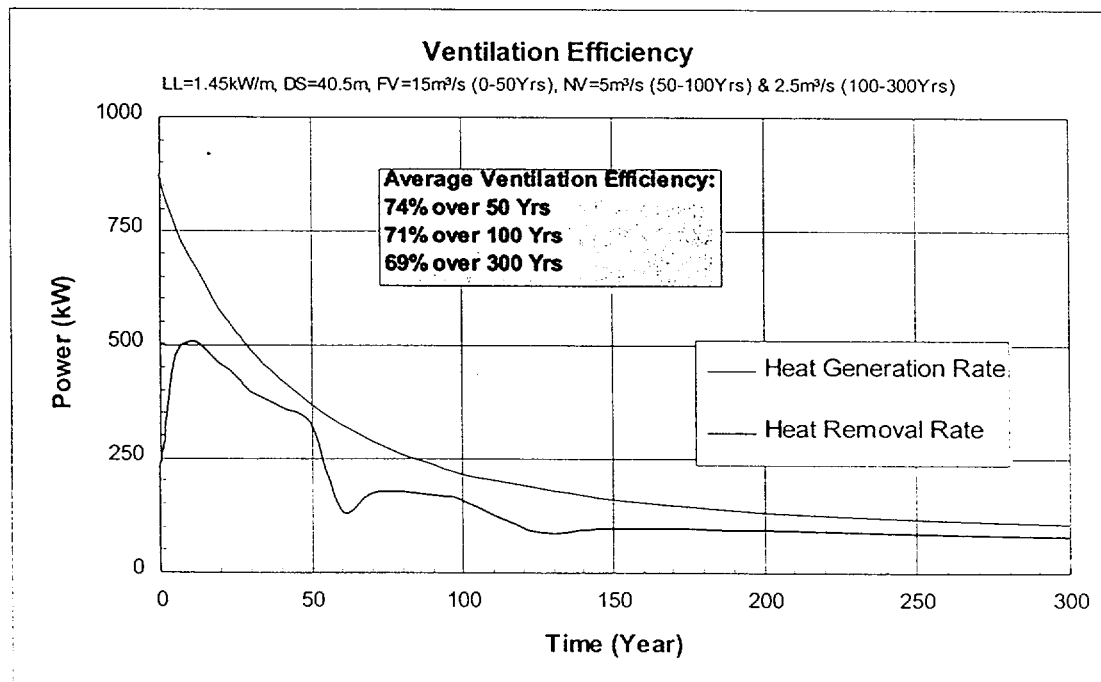
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIX-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 18: HF5N5V4



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIX-5. Average Heat Removal Rates at Different Drift Segments for Case 18: HF5N5V4



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XIX-6. Overall Heat Generation and Removal Rates at Different Time for Case 18: HF5N5V4

ATTACHMENT XX

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 19: LF5N3V4

ATTACHMENT XX

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 19: LF5N3V4

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.0 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 3 m³/s from 50 to 100 years and 1.5 m³/s from 100 to 300 years. Drift spacing for this case is 40.5 m. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XX-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	39.31	42.36	44.81	46.85	48.56	49.98
5.00	38.88	43.17	47.14	50.78	54.10	57.09
10.00	37.86	42.05	46.12	50.04	53.80	57.38
15.00	36.95	40.90	44.77	48.57	52.27	55.89
20.00	36.07	39.78	43.43	47.03	50.57	54.04
26.00	35.09	38.53	41.93	45.30	48.63	51.93
30.00	34.50	37.71	40.90	44.05	47.19	50.29
40.00	33.25	36.19	39.10	42.02	44.92	47.81
50.00	32.23	34.81	37.41	40.02	42.63	45.25
60.00	44.39	48.75	52.59	56.04	59.19	62.11
70.00	45.05	51.04	56.31	60.98	65.14	68.86
80.00	43.96	50.17	55.86	61.06	65.79	70.09
90.00	42.79	48.84	54.51	59.79	64.69	69.23
100.00	41.70	47.53	53.03	58.23	63.12	67.70
125.00	46.51	53.06	58.92	64.23	69.08	73.54
150.00	45.27	52.42	58.82	64.56	69.74	74.44
200.00	43.00	50.01	56.49	62.45	67.90	72.89
250.00	41.32	47.89	54.11	59.96	65.42	70.50
300.00	40.05	46.20	52.10	57.73	63.06	68.09

Source: DTN: MO0010MWDANS03.005

Table XX-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	28.77	31.94	34.60	36.82	38.67	40.23
5.00	29.88	34.42	38.60	42.41	45.87	48.99
10.00	29.58	34.05	38.38	42.55	46.54	50.33
15.00	29.24	33.41	37.51	41.53	45.46	49.28
20.00	28.93	32.81	36.65	40.43	44.15	47.81
26.00	28.61	32.19	35.74	39.26	42.75	46.19
30.00	28.34	31.66	34.96	38.24	41.49	44.72
40.00	28.03	31.05	34.08	37.09	40.10	43.09
50.00	27.64	30.30	32.98	35.67	38.37	41.08
60.00	30.60	35.41	39.63	43.41	46.85	50.04
70.00	32.87	39.75	45.77	51.07	55.75	59.93
80.00	32.71	39.82	46.32	52.24	57.61	62.48
90.00	32.24	39.06	45.45	51.41	56.94	62.06
100.00	31.78	38.24	44.37	50.16	55.61	60.73
125.00	33.55	41.09	47.83	53.94	59.52	64.64
150.00	34.22	42.43	49.75	56.31	62.21	67.55
200.00	33.40	41.24	48.48	55.12	61.20	66.76
250.00	32.52	39.72	46.56	52.99	59.01	64.60
300.00	31.87	38.51	44.90	51.01	56.81	62.29

Source: DTN: MO0010MWDANS03.005

Table XX-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	67.93	67.95	67.95	67.95	67.95	67.95
1.00	60.29	63.08	65.36	67.27	68.86	70.18
5.00	57.95	61.87	65.50	68.84	71.90	74.66
10.00	55.21	59.03	62.75	66.36	69.82	73.14
15.00	52.96	56.58	60.13	63.63	67.05	70.40
20.00	50.85	54.26	57.63	60.96	64.24	67.47
26.00	48.54	51.72	54.88	58.01	61.12	64.19
30.00	47.17	50.15	53.12	56.06	58.99	61.89
40.00	44.28	47.03	49.77	52.51	55.24	57.96
50.00	41.90	44.34	46.79	49.26	51.73	54.22
60.00	54.15	58.28	61.91	65.17	68.15	70.91
70.00	53.54	59.29	64.35	68.83	72.81	76.39
80.00	51.60	57.56	63.04	68.04	72.61	76.77
90.00	49.76	55.58	61.04	66.13	70.88	75.27
100.00	48.12	53.73	59.04	64.07	68.80	73.25
125.00	52.22	58.56	64.24	69.39	74.10	78.43
150.00	50.06	57.03	63.28	68.88	73.95	78.54
200.00	47.01	53.86	60.20	66.04	71.39	76.29
250.00	44.87	51.29	57.38	63.13	68.49	73.49
300.00	43.27	49.30	55.08	60.61	65.85	70.80

Source: DTN: MO0010MWDANS03.005

Table XX-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

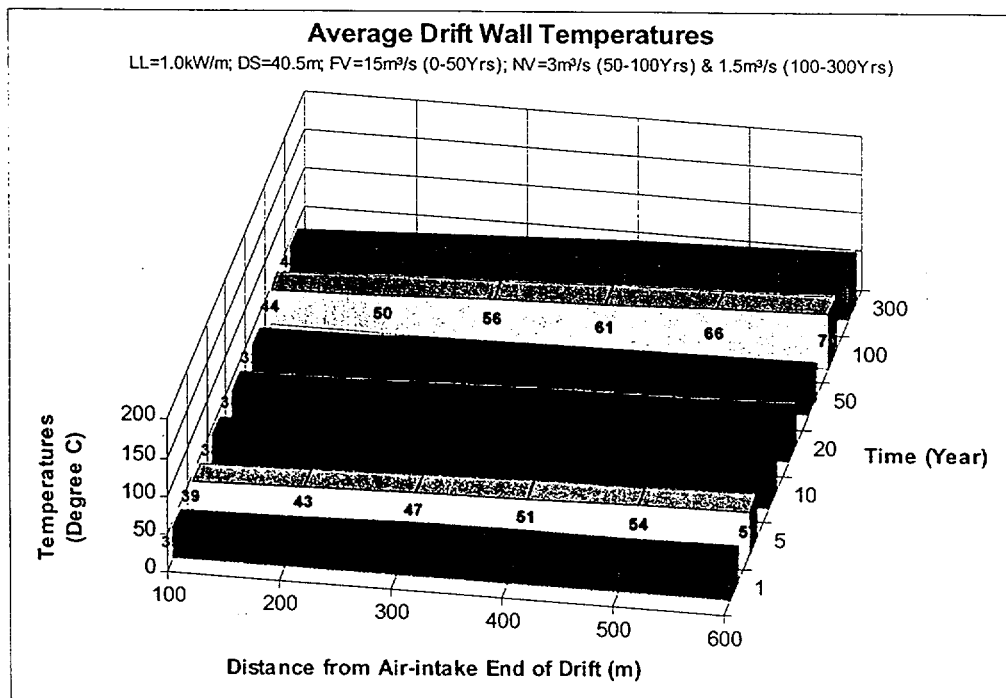
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.76	35.79	35.79	35.79	35.79	35.79
1.00	52.14	43.90	36.72	30.72	25.70	21.48
5.00	67.48	62.84	57.77	52.75	47.85	43.17
10.00	63.38	61.84	59.92	57.67	55.14	52.41
15.00	58.64	57.74	56.73	55.59	54.32	52.91
20.00	54.35	53.73	53.04	52.31	51.51	50.64
26.00	49.92	49.57	49.15	48.70	48.19	47.64
30.00	46.20	45.96	45.67	45.35	45.01	44.64
40.00	41.89	41.88	41.80	41.71	41.56	41.37
50.00	36.54	36.83	37.04	37.23	37.34	37.42
60.00	14.61	12.56	11.02	9.85	8.98	8.31
70.00	20.54	17.95	15.71	13.81	12.23	10.91
80.00	20.12	18.55	16.97	15.44	14.01	12.70
90.00	18.89	17.79	16.67	15.54	14.43	13.36
100.00	17.70	16.85	15.99	15.11	14.23	13.36
125.00	10.77	9.50	8.50	7.70	7.03	6.46
150.00	11.62	10.35	9.23	8.26	7.44	6.73
200.00	10.59	9.87	9.12	8.38	7.66	7.00
250.00	9.48	9.07	8.61	8.11	7.58	7.06
300.00	8.66	8.37	8.05	7.70	7.31	6.91

Source: DTN: MO0010MWDANS03.005

Table XX-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.0 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), and 1.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

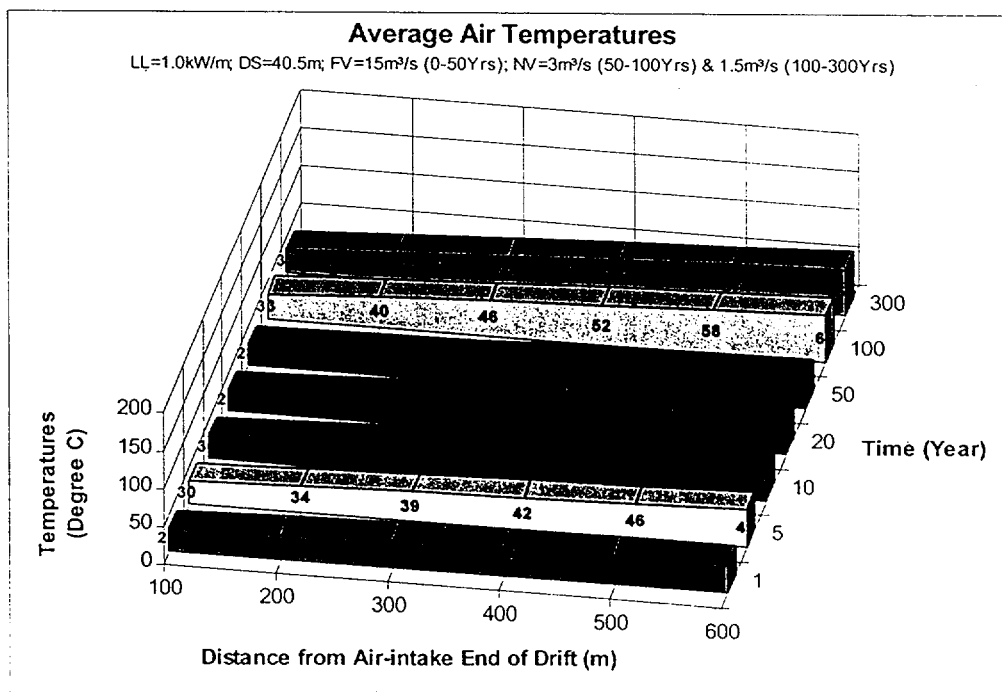
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.0E-4	100.00%	600.00	600.00	1.89	1.0E-4	214.72	107.36	0.34
1.00	96.99%	581.96	590.98	18635.31	1.00	210.67	212.69	6706.86
5.00	87.93%	527.56	554.76	69979.72	5.00	331.85	271.26	34217.85
10.00	79.35%	476.12	501.84	79129.84	10.00	350.37	341.11	53786.26
15.00	72.23%	433.40	454.76	71706.06	15.00	335.94	343.15	54108.31
20.00	66.23%	397.39	415.39	65499.41	20.00	315.58	325.76	51365.92
26.00	59.89%	359.32	378.36	71591.05	26.00	293.18	304.38	57593.51
30.00	56.11%	336.67	348.00	43897.73	30.00	272.83	283.00	35699.05
40.00	48.24%	289.44	313.06	98725.25	40.00	250.21	261.52	82472.76
50.00	41.94%	251.65	270.54	85318.40	50.00	222.42	236.31	74524.24
60.00	36.88%	221.25	236.45	74566.81	60.00	65.33	143.87	45372.19
70.00	32.81%	196.84	209.05	65924.69	70.00	91.15	78.24	24673.52
80.00	29.47%	176.83	186.83	58920.10	80.00	97.79	94.47	29791.86
90.00	26.76%	160.58	168.70	53202.00	90.00	96.70	97.24	30666.48
100.00	24.52%	147.12	153.85	48516.98	100.00	93.24	94.97	29949.06
125.00	21.21%	127.24	137.18	108151.61	125.00	49.96	71.60	56448.30
150.00	17.89%	107.37	117.30	92481.71	150.00	53.62	51.79	40830.81
200.00	14.85%	89.09	98.23	154888.99	200.00	52.63	53.12	83766.94
250.00	13.03%	78.16	83.63	131862.91	250.00	49.91	51.27	80842.75
300.00	11.76%	70.58	74.37	117266.25	300.00	46.99	48.45	76402.46
Total heat generated in 50 years (GJ)				604484.67	Total heat removed in 50 years (GJ)			450475.10
Total heat generated in 100 years (GJ)				905615.27	Total heat removed in 100 years (GJ)			610928.20
Total heat generated in 300 years (GJ)				1510266.74	Total heat removed in 300 years (GJ)			949219.45
Percentage of total heat removal in 50 years = 75%								
Percentage of total heat removal in 100 years = 67%								
Percentage of total heat removal in 300 years = 63%								

Source: DTN: MO0010MWDANS03.005



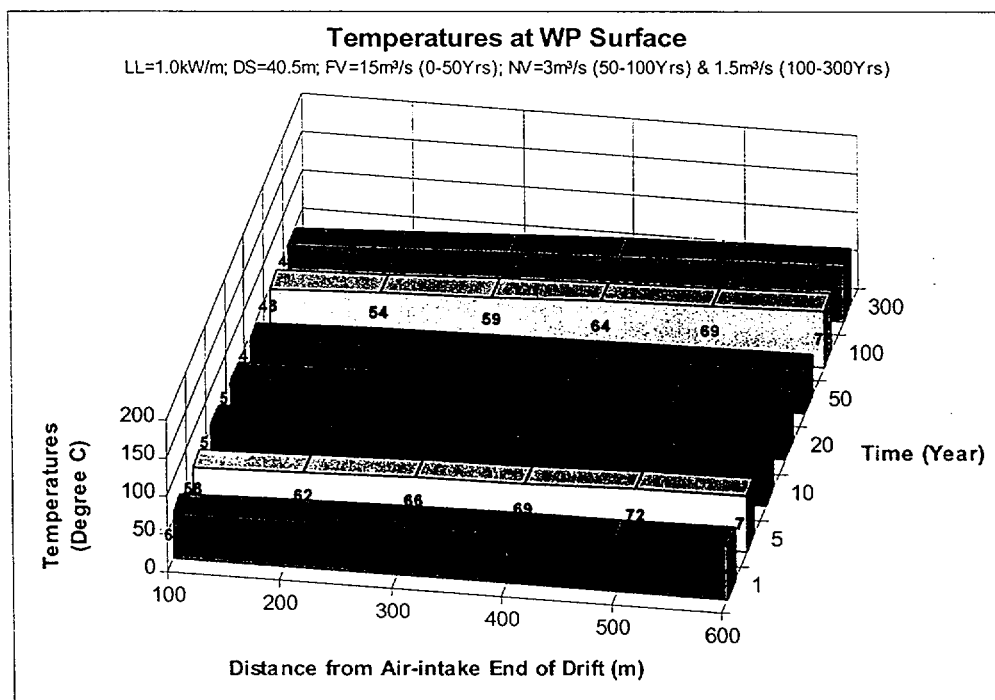
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XX-1, p. XX-2.

Figure XX-1. Average Drift Wall Temperatures for Case 19: LF5N3V4



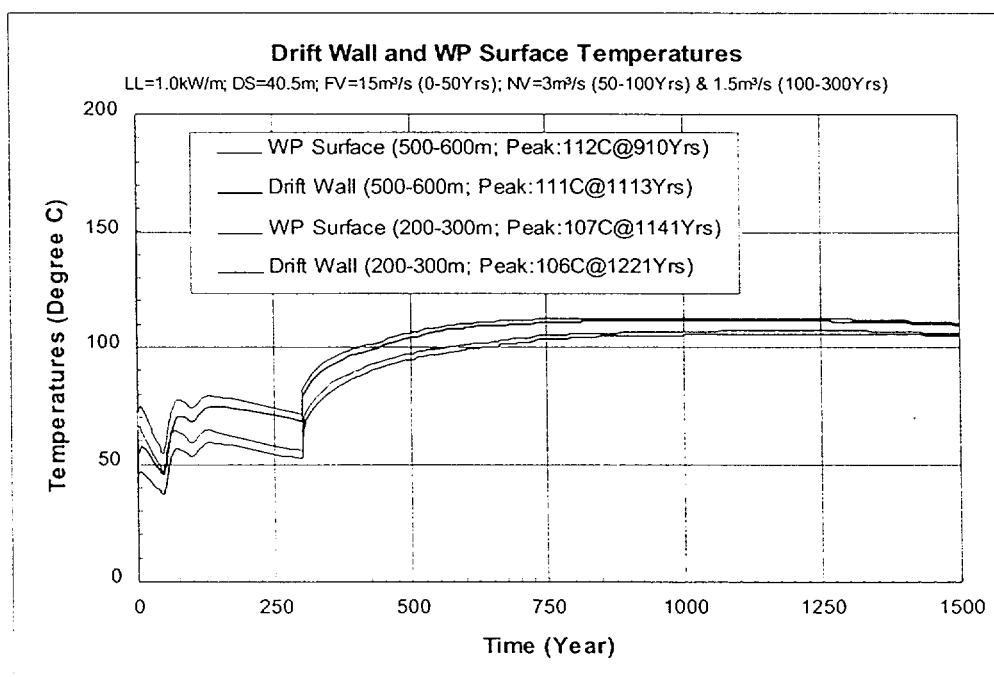
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XX-2, p. XX-3.

Figure XX-2. Average Air Temperatures for Case 19: LF5N3V4



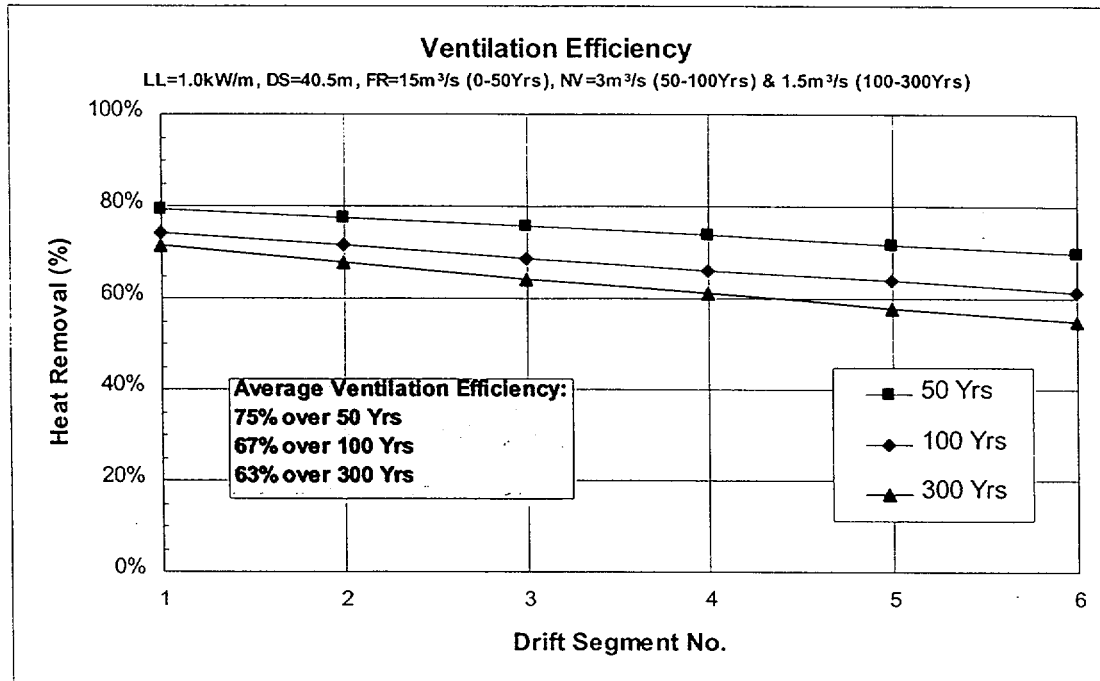
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XX-3, p. XX-4.

Figure XX-3. Average Waste Package Surface Temperatures for Case 19: LF5N3V4



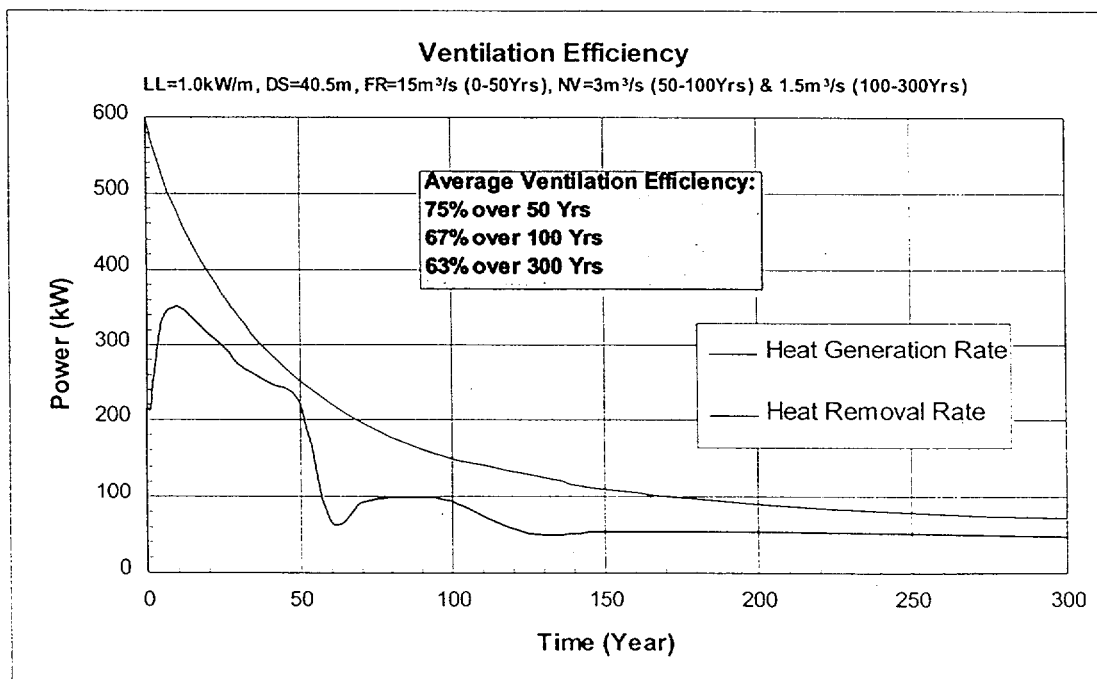
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XX-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 19: LF5N3V4



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XX-5. Average Heat Removal Rates at Different Drift Segments for Case 19: LF5N3V4



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XX-6. Overall Heat Generation and Removal Rates at Different Time for Case 19: LF5N3V4

ATTACHMENT XXI

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 20: LF5N5V4

ATTACHMENT XXI

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 20: LF5N5V4

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.0 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Drift spacing for this case is 40.5 m. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XXI-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	39.31	42.36	44.81	46.85	48.56	49.98
5.00	38.88	43.17	47.14	50.78	54.10	57.09
10.00	37.86	42.05	46.12	50.04	53.80	57.38
15.00	36.95	40.90	44.77	48.57	52.27	55.89
20.00	36.07	39.78	43.43	47.03	50.57	54.04
26.00	35.09	38.53	41.93	45.30	48.63	51.93
30.00	34.50	37.71	40.90	44.05	47.19	50.29
40.00	33.25	36.19	39.10	42.02	44.92	47.81
50.00	32.23	34.81	37.41	40.02	42.63	45.25
60.00	39.43	43.12	46.51	49.66	52.64	55.46
70.00	39.05	43.62	47.84	51.76	55.39	58.78
80.00	38.03	42.52	46.81	50.90	54.79	58.47
90.00	37.07	41.33	45.45	49.43	53.28	56.99
100.00	36.23	40.23	44.15	47.96	51.67	55.27
125.00	40.38	45.00	49.28	53.28	57.05	60.63
150.00	39.24	44.31	49.01	53.09	57.43	61.26
200.00	37.41	42.22	46.85	51.22	55.41	59.39
250.00	36.13	40.52	44.82	48.99	53.05	56.96
300.00	35.18	39.22	43.21	47.12	50.96	54.70

Source: DTN: MO0010MWDANS03.005

Table XXI-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	28.77	31.94	34.60	36.82	38.67	40.23
5.00	29.88	34.42	38.60	42.41	45.87	48.99
10.00	29.58	34.05	38.38	42.55	46.54	50.33
15.00	29.24	33.41	37.51	41.53	45.46	49.28
20.00	28.93	32.81	36.65	40.43	44.15	47.81
26.00	28.61	32.19	35.74	39.26	42.75	46.19
30.00	28.34	31.66	34.96	38.24	41.49	44.72
40.00	28.03	31.05	34.08	37.09	40.10	43.09
50.00	27.64	30.30	32.98	35.67	38.37	41.08
60.00	29.28	33.17	36.75	40.09	43.23	46.23
70.00	30.36	35.30	39.85	44.05	47.95	51.57
80.00	30.06	34.93	39.58	44.01	48.20	52.17
90.00	29.68	34.24	38.67	42.96	47.10	51.09
100.00	29.33	33.59	37.75	41.82	45.78	49.63
125.00	30.51	35.56	40.24	44.61	48.74	52.66
150.00	31.01	36.57	41.72	46.45	50.91	55.08
200.00	30.38	35.59	40.58	45.28	49.81	54.09
250.00	29.75	34.43	39.02	43.48	47.81	51.99
300.00	29.29	33.55	37.76	41.89	45.95	49.92

Source: DTN: MO0010MWDANS03.005

Table XXI-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	67.93	67.95	67.95	67.95	67.95	67.95
1.00	60.29	63.08	65.36	67.27	68.86	70.18
5.00	57.95	61.87	65.50	68.84	71.90	74.66
10.00	55.21	59.03	62.75	66.36	69.82	73.14
15.00	52.96	56.58	60.13	63.63	67.05	70.40
20.00	50.85	54.26	57.63	60.96	64.24	67.47
26.00	48.54	51.72	54.88	58.01	61.12	64.19
30.00	47.17	50.15	53.12	56.06	58.99	61.89
40.00	44.28	47.03	49.77	52.51	55.24	57.96
50.00	41.90	44.34	46.79	49.26	51.73	54.22
60.00	48.99	52.48	55.69	58.68	61.50	64.17
70.00	47.50	51.87	55.91	59.66	63.14	66.40
80.00	45.65	49.94	54.07	58.00	61.74	65.29
90.00	44.02	48.10	52.06	55.90	59.61	63.19
100.00	42.62	46.47	50.24	53.92	57.51	60.99
125.00	46.17	50.64	54.78	58.66	62.31	65.77
150.00	44.10	49.04	53.63	57.60	61.85	65.58
200.00	41.48	46.17	50.69	54.97	59.07	62.98
250.00	39.73	44.02	48.22	52.31	56.28	60.12
300.00	38.45	42.40	46.30	50.14	53.90	57.58

Source: DTN: MO0010MWDANS03.005

Table XXI-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

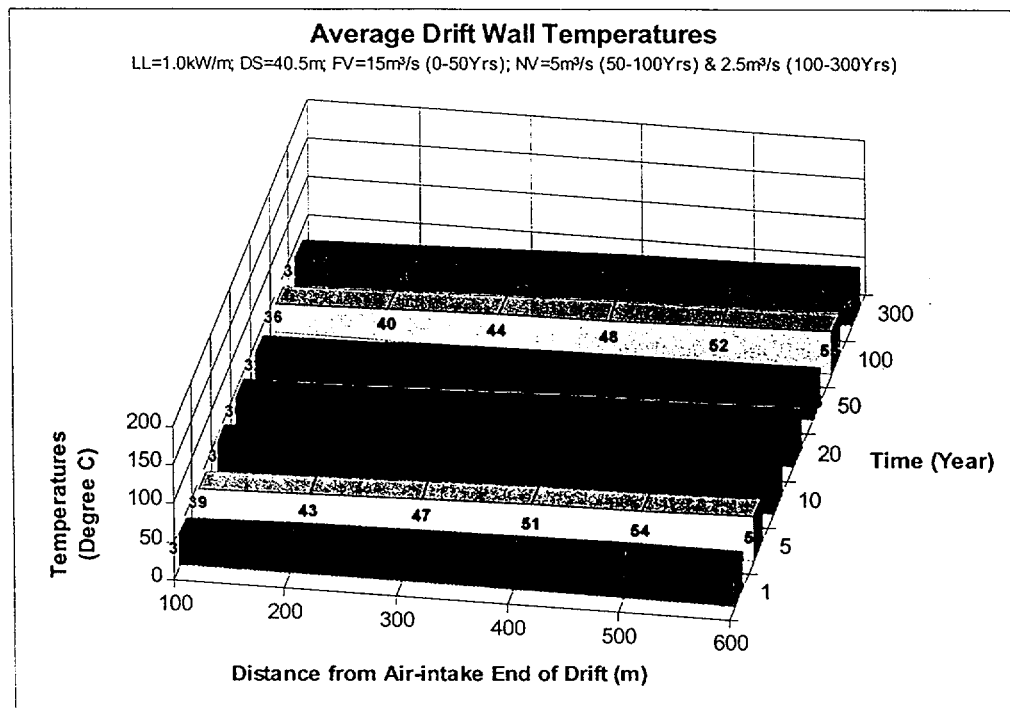
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.76	35.79	35.79	35.79	35.79	35.79
1.00	52.14	43.90	36.72	30.72	25.70	21.48
5.00	67.48	62.84	57.77	52.75	47.85	43.17
10.00	63.38	61.84	59.92	57.67	55.14	52.41
15.00	58.64	57.74	56.73	55.59	54.32	52.91
20.00	54.35	53.73	53.04	52.31	51.51	50.64
26.00	49.92	49.57	49.15	48.70	48.19	47.64
30.00	46.20	45.96	45.67	45.35	45.01	44.64
40.00	41.89	41.88	41.80	41.71	41.56	41.37
50.00	36.54	36.83	37.04	37.23	37.34	37.42
60.00	18.97	17.24	15.88	14.81	13.96	13.29
70.00	23.76	21.89	20.18	18.64	17.27	16.07
80.00	22.42	21.59	20.64	19.63	18.61	17.60
90.00	20.74	20.23	19.65	19.03	18.36	17.66
100.00	19.22	18.86	18.47	18.03	17.57	17.08
125.00	11.88	10.88	10.09	9.44	8.90	8.44
150.00	12.96	11.99	11.10	10.18	9.62	8.99
200.00	11.60	11.22	10.77	10.12	9.76	9.24
250.00	10.23	10.10	9.90	9.62	9.33	9.01
300.00	9.26	9.18	9.07	8.92	8.75	8.55

Source: DTN: MO0010MWDANS03.005

Table XXI-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.0 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 40.5 m)

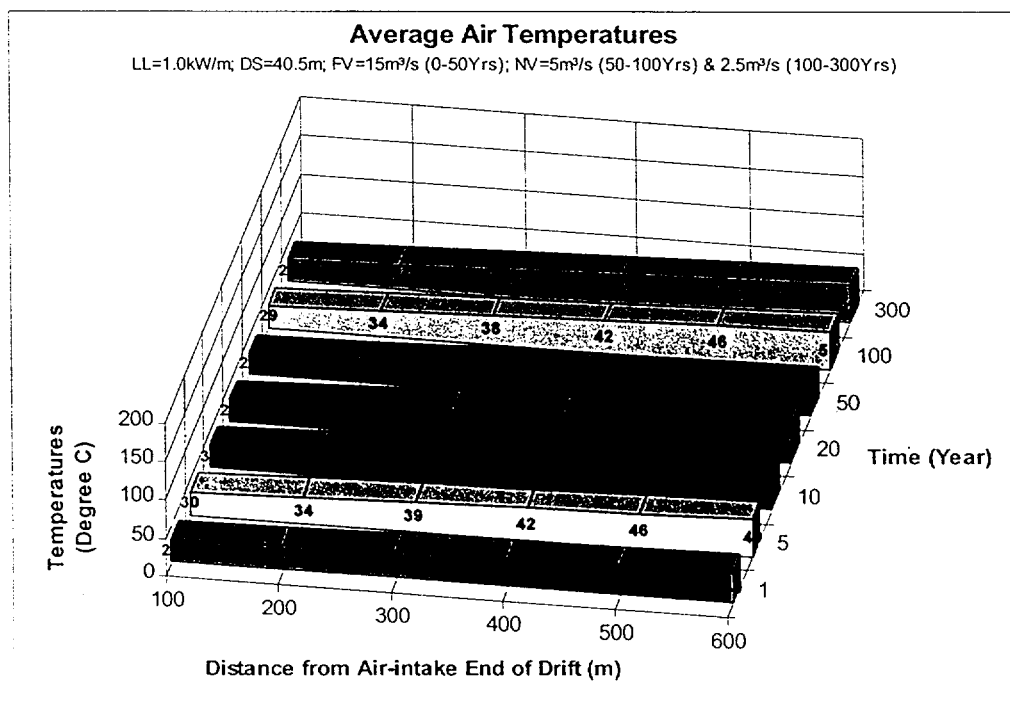
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.0E-4	100.00%	600.00	600.00	1.89	1.0E-4	214.72	107.36	0.34
1.00	96.99%	581.96	590.98	18635.31	1.00	210.67	212.69	6706.86
5.00	87.93%	527.56	554.76	69979.72	5.00	331.85	271.26	34217.85
10.00	79.35%	476.12	501.84	79129.84	10.00	350.37	341.11	53786.26
15.00	72.23%	433.40	454.76	71706.06	15.00	335.94	343.15	54108.31
20.00	66.23%	397.39	415.39	65499.41	20.00	315.58	325.76	51365.92
26.00	59.89%	359.32	378.36	71591.05	26.00	293.18	304.38	57593.51
30.00	56.11%	336.67	348.00	43897.73	30.00	272.83	283.00	35699.05
40.00	48.24%	289.44	313.06	98725.25	40.00	250.21	261.52	82472.76
50.00	41.94%	251.65	270.54	85318.40	50.00	222.42	236.31	74524.24
60.00	36.88%	221.25	236.45	74566.81	60.00	94.14	158.28	49915.53
70.00	32.81%	196.84	209.05	65924.69	70.00	117.83	105.99	33423.80
80.00	29.47%	176.83	186.83	58920.10	80.00	120.48	119.15	37576.41
90.00	26.76%	160.58	168.70	53202.00	90.00	115.67	118.07	37235.95
100.00	24.52%	147.12	153.85	48516.98	100.00	109.23	112.45	35461.67
125.00	21.21%	127.24	137.18	108151.61	125.00	59.63	84.43	66562.55
150.00	17.89%	107.37	117.30	92481.71	150.00	64.85	62.24	49067.24
200.00	14.85%	89.09	98.23	154888.99	200.00	62.72	63.78	100572.61
250.00	13.03%	78.16	83.63	131862.91	250.00	58.19	60.45	95324.48
300.00	11.76%	70.58	74.37	117266.25	300.00	53.72	55.96	88231.44
Total heat generated in 50 years (GJ)				604484.67	Total heat removed in 50 years (GJ)			450475.10
Total heat generated in 100 years (GJ)				905615.27	Total heat removed in 100 years (GJ)			644088.46
Total heat generated in 300 years (GJ)				1510266.74	Total heat removed in 300 years (GJ)			1043846.77
Percentage of total heat removal in 50 years = 75%								
Percentage of total heat removal in 100 years = 71%								
Percentage of total heat removal in 300 years = 69%								

Source: DTN: MO0010MWDANS03.005



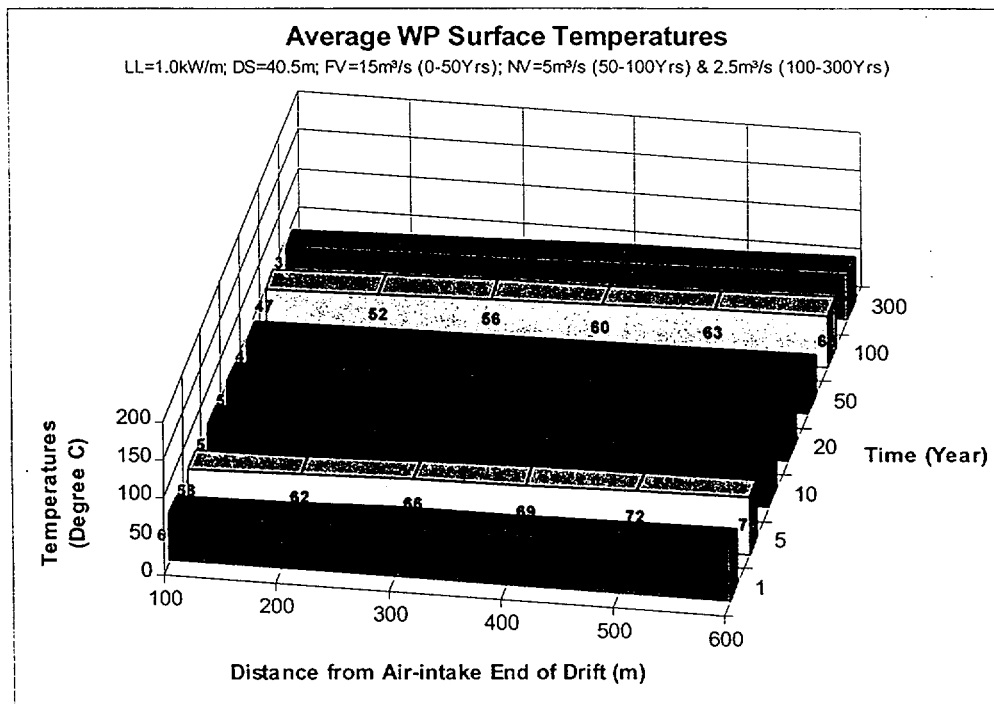
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXI-1, p. XXI-2.

Figure XXI-1. Average Drift Wall Temperatures for Case 20: LF5N5V4



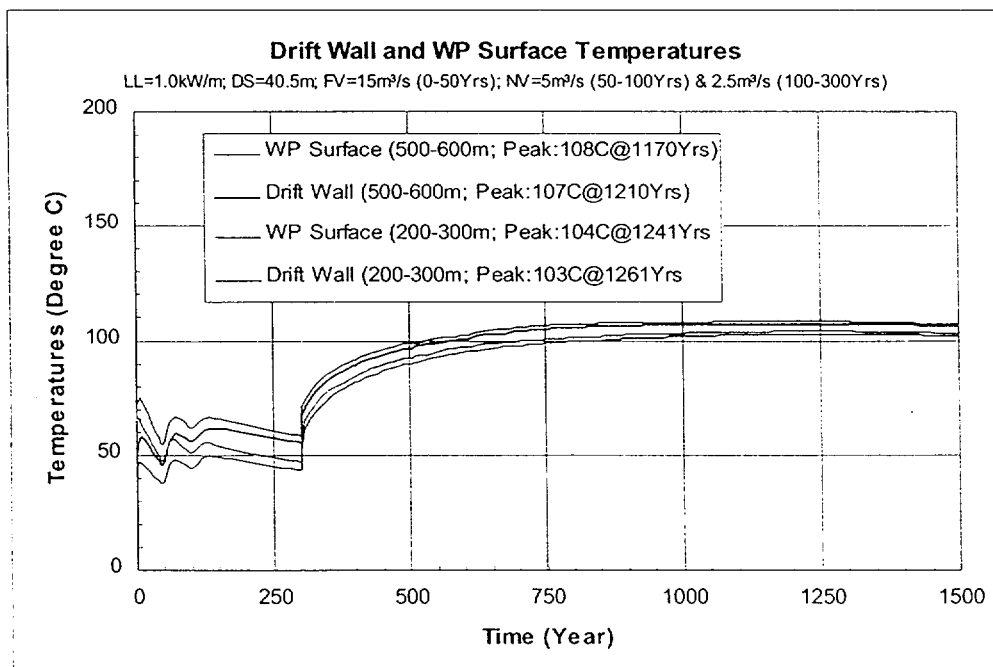
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXI-2, p. XXI-3.

Figure XXI-2. Average Air Temperatures for Case 20: LF5N5V4



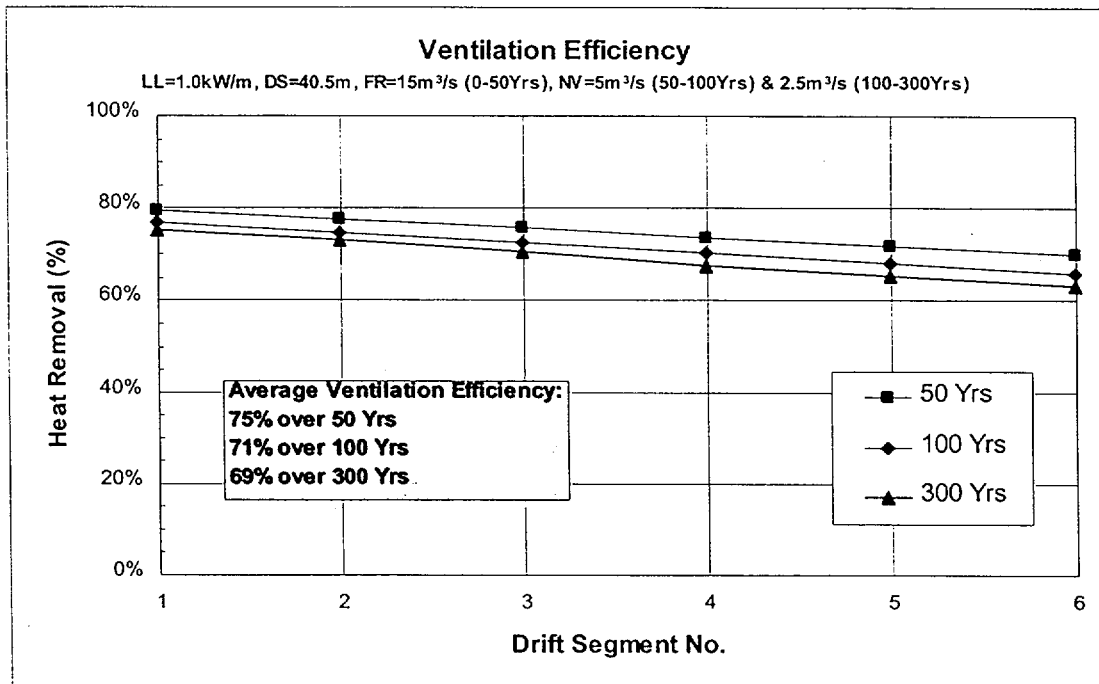
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXI-3, p. XXI-4.

Figure XXI-3. Average Waste Package Surface Temperatures for Case 20: LF5N5V4



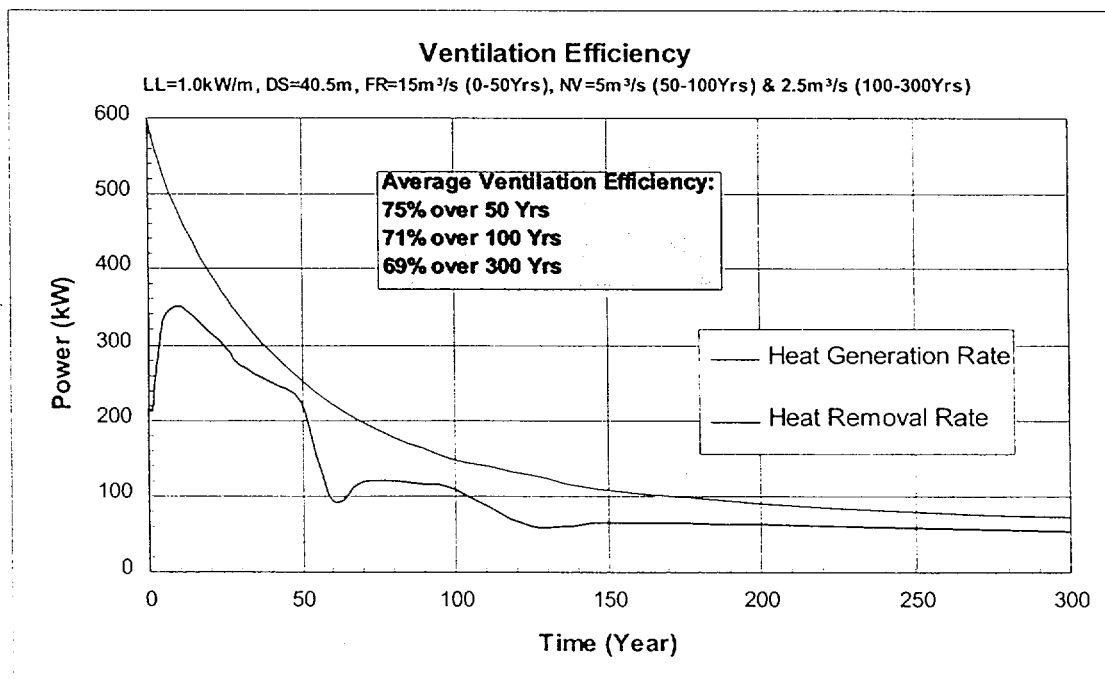
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXI-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 20: LF5N5V4



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXI-5. Average Heat Removal Rates at Different Drift Segments for Case 20: LF5N5V4



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXI-6. Overall Heat Generation and Removal Rates at Different Time for Case 20: LF5N5V4

ATTACHMENT XXII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 21: HF5N5V2

ATTACHMENT XXII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 21: HF5N5V2

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Drift spacing for this case is 25 m. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XXII-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 25 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	46.16	50.14	53.33	56.00	58.24	60.10
5.00	46.05	52.46	58.33	63.67	68.50	72.85
10.00	44.65	51.08	57.32	63.33	69.08	74.56
15.00	43.14	49.22	55.21	61.09	66.87	72.50
20.00	41.80	47.48	53.12	58.71	64.23	69.69
26.00	40.31	45.58	50.83	56.06	61.26	66.44
30.00	39.39	44.30	49.22	54.12	59.00	63.87
40.00	37.42	41.88	46.36	50.85	55.35	59.85
50.00	35.81	39.72	43.68	47.67	51.70	55.76
60.00	46.78	52.46	57.71	62.65	67.32	71.80
70.00	46.53	53.68	60.33	66.54	72.33	77.78
80.00	44.90	51.99	58.83	65.41	71.70	77.71
90.00	43.38	50.07	56.63	63.05	69.32	75.42
100.00	42.03	48.30	54.51	60.63	66.65	72.57
125.00	48.66	56.03	62.95	69.50	75.74	81.73
150.00	46.92	55.09	62.78	70.02	76.85	83.33
200.00	43.80	51.47	58.97	66.25	73.28	80.05
250.00	41.72	48.58	55.43	62.23	68.94	75.51
300.00	40.21	46.44	52.70	58.95	65.19	71.37

Source: DTN: MO0010MWDANS03.005

Table XXII-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 25 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.89	34.00	37.44	40.32	42.72	44.74
5.00	32.13	38.71	44.72	50.18	55.10	59.53
10.00	31.79	38.43	44.87	51.07	57.00	62.63
15.00	31.29	37.52	43.67	49.74	55.68	61.49
20.00	30.81	36.60	42.36	48.07	53.74	59.34
26.00	30.35	35.69	41.03	46.35	51.66	56.93
30.00	29.95	34.91	39.87	44.83	49.78	54.72
40.00	29.48	33.99	38.52	43.07	47.63	52.20
50.00	28.89	32.84	36.84	40.88	44.96	49.07
60.00	31.34	37.14	42.52	47.57	52.37	56.97
70.00	33.03	40.49	47.43	53.88	59.91	65.57
80.00	32.63	40.05	47.22	54.10	60.68	66.96
90.00	32.04	38.99	45.83	52.54	59.08	65.43
100.00	31.51	37.98	44.39	50.73	56.99	63.14
125.00	33.33	41.07	48.34	55.23	61.81	68.13
150.00	34.16	42.77	50.86	58.48	65.67	72.48
200.00	33.16	41.20	49.05	56.65	63.99	71.04
250.00	32.11	39.26	46.40	53.48	60.46	67.32
300.00	31.39	37.83	44.29	50.76	57.21	63.63

Source: DTN: MO0010MWDANS03.005

Table XXII-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 25 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.04	68.04	68.04	68.04	68.04
1.00	74.52	78.00	80.83	83.20	85.19	86.85
5.00	71.66	77.24	82.40	87.11	91.37	95.23
10.00	68.05	73.65	79.12	84.43	89.55	94.45
15.00	64.73	70.05	75.33	80.56	85.72	90.77
20.00	61.87	66.88	71.88	76.87	81.82	86.74
26.00	58.73	63.42	68.11	72.81	77.50	82.19
30.00	56.81	61.20	65.60	70.02	74.44	78.86
40.00	52.66	56.70	60.76	64.86	68.98	73.11
50.00	49.26	52.82	56.45	60.12	63.84	67.59
60.00	59.63	64.85	69.70	74.26	78.59	82.75
70.00	57.82	64.48	70.70	76.53	81.98	87.12
80.00	55.13	61.75	68.18	74.38	80.33	86.03
90.00	52.78	59.05	65.23	71.30	77.25	83.04
100.00	50.75	56.64	62.50	68.30	74.02	79.67
125.00	56.36	63.36	69.95	76.20	82.18	87.92
150.00	53.41	61.24	68.63	75.60	82.20	88.46
200.00	49.29	56.67	63.90	70.95	77.76	84.34
250.00	46.62	53.23	59.86	66.45	72.96	79.37
300.00	44.69	50.72	56.78	62.85	68.91	74.94

Source: DTN: MO0010MWDANS03.005

Table XXII-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 25 m)

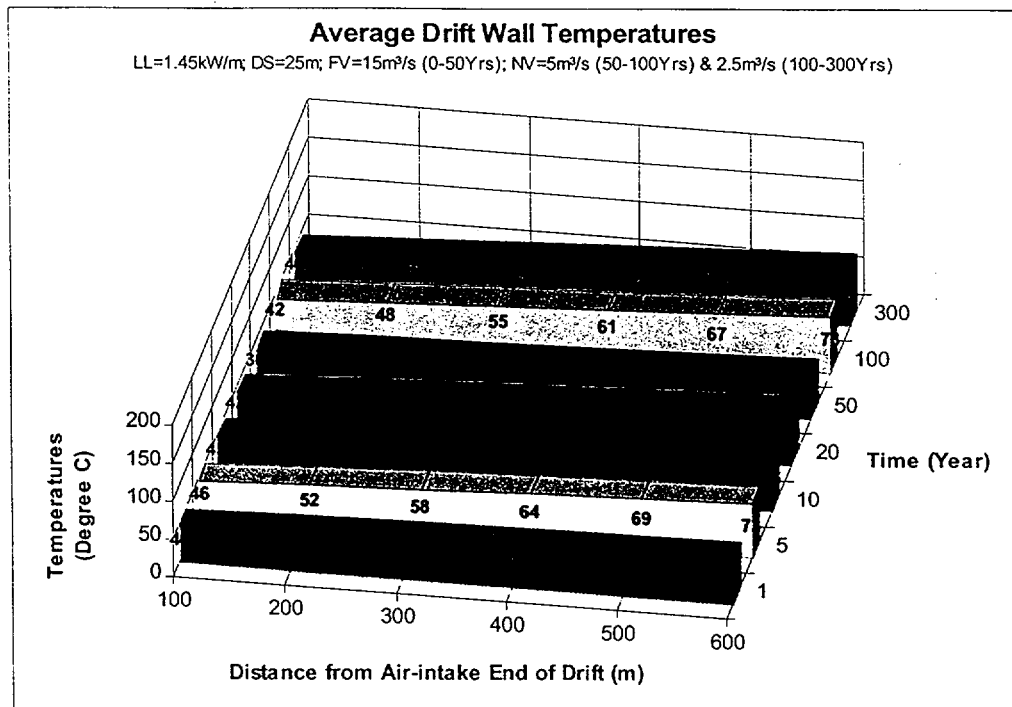
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.83	35.83	35.83	35.83	35.83
1.00	67.63	56.89	47.58	39.80	33.29	27.84
5.00	98.63	91.04	83.15	75.47	68.15	61.23
10.00	93.88	91.87	89.14	85.81	82.01	77.88
15.00	86.96	86.20	85.18	83.87	82.29	80.39
20.00	80.43	80.09	79.64	79.06	78.35	77.48
26.00	73.99	73.95	73.83	73.64	73.35	73.00
30.00	68.53	68.60	68.61	68.59	68.51	68.39
40.00	61.99	62.36	62.67	62.92	63.11	63.23
50.00	53.87	54.62	55.30	55.91	56.44	56.90
60.00	28.12	25.72	23.85	22.40	21.27	20.40
70.00	35.61	33.09	30.74	28.63	26.73	25.07
80.00	33.81	32.91	31.79	30.53	29.18	27.83
90.00	31.20	30.84	30.34	29.72	28.99	28.18
100.00	28.85	28.68	28.44	28.12	27.74	27.28
125.00	17.97	16.68	15.66	14.85	14.19	13.64
150.00	19.75	18.56	17.45	16.42	15.50	14.69
200.00	17.58	17.34	16.92	16.40	15.81	15.20
250.00	15.33	15.41	15.39	15.27	15.06	14.77
300.00	13.79	13.87	13.93	13.95	13.91	13.83

Source: DTN: MO0010MWDANS03.005

Table XXII-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 25 m)

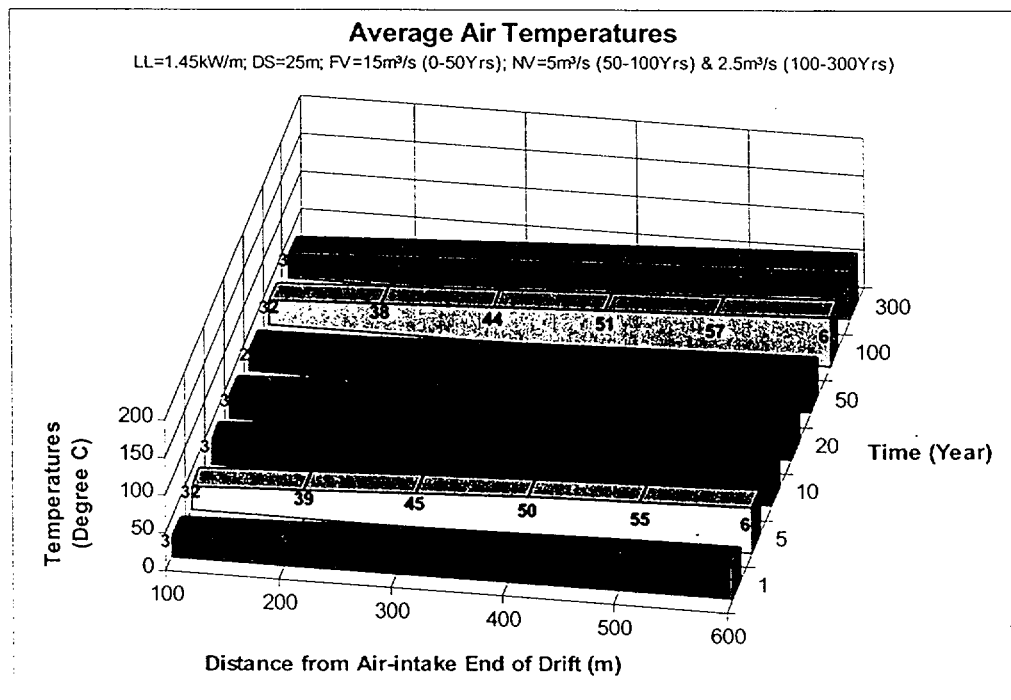
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.96	107.48	0.34
1.00	96.99%	843.84	856.92	27021.20	1.00	273.04	244.00	7693.98
5.00	87.93%	764.96	804.40	101470.60	5.00	477.79	375.42	47356.46
10.00	79.35%	690.37	727.67	114738.26	10.00	520.72	499.26	78722.95
15.00	72.23%	628.43	659.40	103973.79	15.00	504.91	512.81	80860.63
20.00	66.23%	576.22	602.32	94974.15	20.00	475.05	489.98	77259.69
26.00	59.89%	521.01	548.62	103807.02	26.00	441.77	458.41	86738.23
30.00	56.11%	488.18	504.60	63651.70	30.00	411.23	426.50	53800.44
40.00	48.24%	419.68	453.93	143151.62	40.00	376.27	393.75	124174.16
50.00	41.94%	364.89	392.29	123711.69	50.00	333.03	354.65	111843.60
60.00	36.88%	320.81	342.85	108121.88	60.00	141.75	237.39	74864.05
70.00	32.81%	285.42	303.12	95590.81	70.00	179.87	160.81	50712.85
80.00	29.47%	256.40	270.91	85434.15	80.00	186.06	182.96	57699.04
90.00	26.76%	232.84	244.62	77142.91	90.00	179.27	182.66	57604.61
100.00	24.52%	213.32	223.08	70349.62	100.00	169.11	174.19	54933.06
125.00	21.21%	184.50	198.91	156819.84	125.00	92.99	131.05	103322.17
150.00	17.89%	155.68	170.09	134098.48	150.00	102.38	97.68	77013.81
200.00	14.85%	129.19	142.43	224589.03	200.00	99.26	100.82	158965.99
250.00	13.03%	113.33	121.26	191201.22	250.00	91.23	95.24	150180.51
300.00	11.76%	102.34	107.84	170036.07	300.00	83.28	87.25	137582.34
Total heat generated in 50 years (GJ)				876502.77	Total heat removed in 50 years (GJ)			668450.46
Total heat generated in 100 years (GJ)				1313142.14	Total heat removed in 100 years (GJ)			964264.07
Total heat generated in 300 years (GJ)				2189886.77	Total heat removed in 300 years (GJ)			1591328.89
Percentage of total heat removal in 50 years = 76%								
Percentage of total heat removal in 100 years = 73%								
Percentage of total heat removal in 300 years = 73%								

Source: DTN: MO0010MWDANS03.005



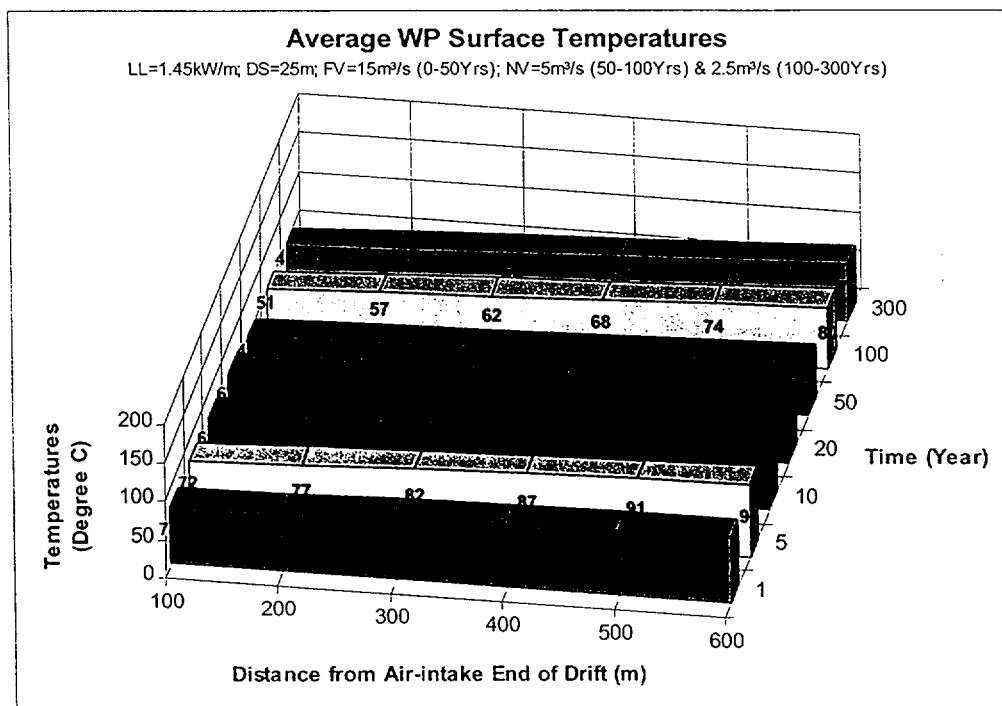
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXII-1, p. XXII-2.

Figure XXII-1. Average Drift Wall Temperatures for Case 21: HF5N5V2



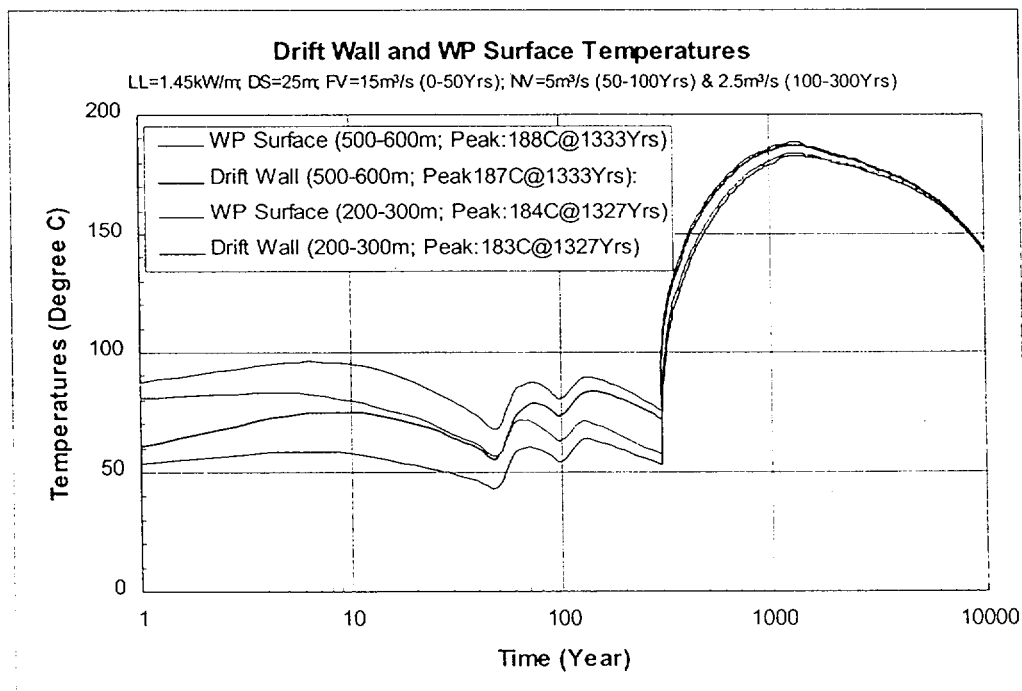
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXII-2, p. XXII-3.

Figure XXII-2. Average Air Temperatures for Case 21: HF5N5V2



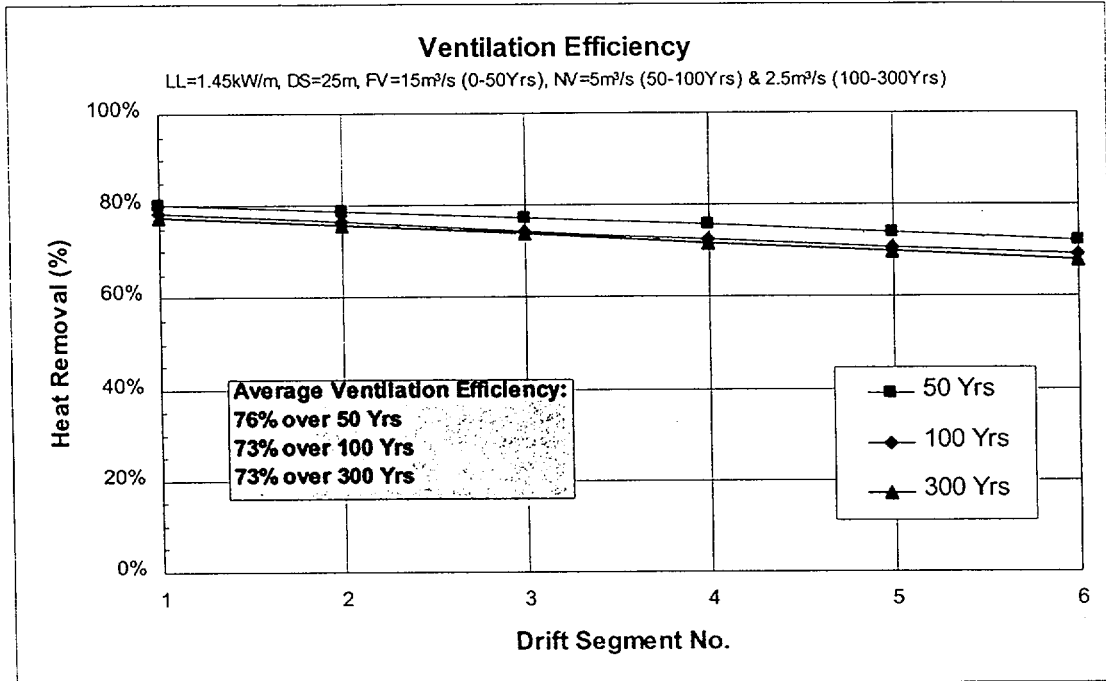
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXII-3, p. XXII-4.

Figure XXII-3. Average Waste Package Surface Temperatures for Case 21: HF5N5V2



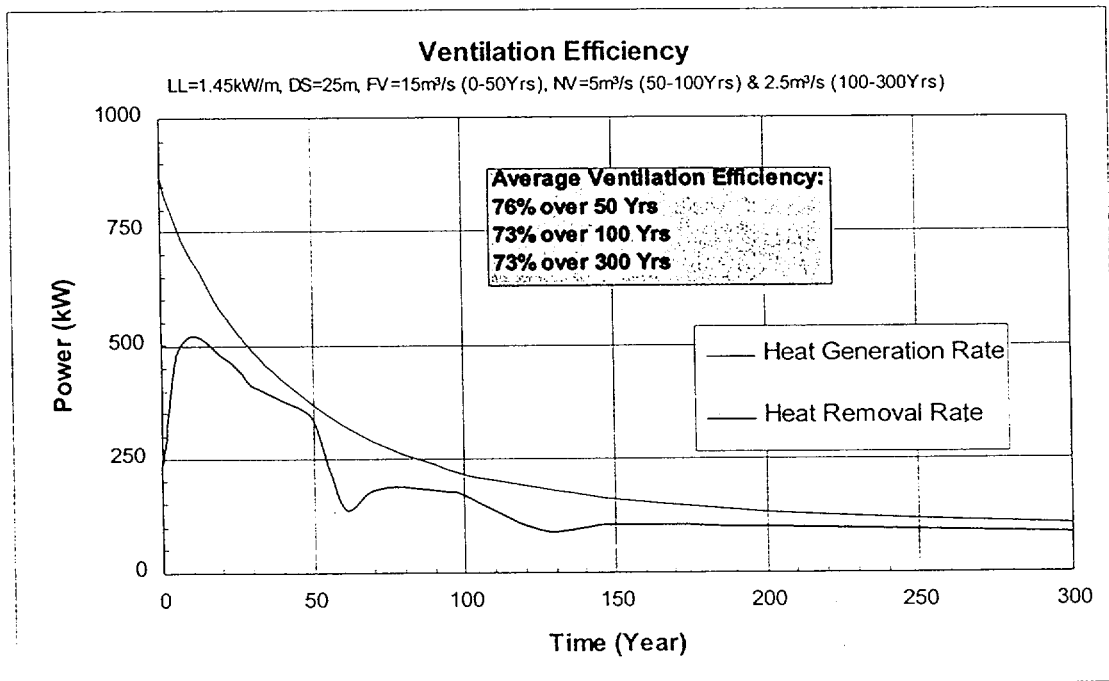
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXII-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 21: HF5N5V2



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXII-5. Average Heat Removal Rates at Different Drift Segments for Case 21: HF5N5V2



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXII-6. Overall Heat Generation and Removal Rates at Different Time for Case 21: HF5N5V2

ATTACHMENT XXIII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 22: HF5N5V8KD

ATTACHMENT XXIII

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 22: HF5N5V8KD

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Thermal conductivity (*k*) values for stratigraphic units are reduced by 25 percent. Drift spacing for this case is 81 m. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XXIII-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Reduced by 25%)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	46.89	51.11	54.53	57.40	59.82	61.85
5.00	45.97	52.53	58.59	64.12	69.16	73.71
10.00	44.18	50.47	56.64	62.60	68.33	73.82
15.00	42.54	48.36	54.09	59.73	65.28	70.71
20.00	41.15	46.52	51.84	57.08	62.26	67.37
26.00	39.65	44.59	49.49	54.34	59.13	63.88
30.00	38.74	43.33	47.87	52.37	56.83	61.25
40.00	36.82	40.97	45.10	49.21	53.28	57.34
50.00	35.29	38.91	42.54	46.17	49.80	53.43
60.00	46.23	51.51	56.31	60.73	64.86	68.75
70.00	45.17	51.74	57.78	63.34	68.47	73.20
80.00	43.40	49.67	55.67	61.37	66.79	71.89
90.00	41.91	47.73	53.36	58.78	64.00	69.02
100.00	40.65	46.07	51.33	56.43	61.36	66.14
125.00	46.76	53.01	58.70	63.96	68.84	73.41
150.00	44.51	51.31	57.54	63.25	68.51	73.36
200.00	41.82	48.06	53.99	59.60	64.87	69.81
250.00	40.12	45.77	51.21	56.43	61.42	66.18
300.00	38.90	44.12	49.16	54.04	58.72	63.23

Source: DTN: MO0010MWDANS03.005

Table XXIII-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Reduced by 25%)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.98	34.19	37.72	40.70	43.20	45.30
5.00	32.21	38.90	45.04	50.64	55.72	60.31
10.00	31.72	38.32	44.74	50.95	56.90	62.57
15.00	31.16	37.25	43.25	49.17	54.98	60.66
20.00	30.66	36.27	41.82	47.31	52.73	58.08
26.00	30.19	35.34	40.45	45.51	50.52	55.48
30.00	29.80	34.56	39.28	43.96	48.61	53.21
40.00	29.33	33.65	37.95	42.22	46.48	50.71
50.00	28.76	32.53	36.31	40.10	43.89	47.68
60.00	31.18	36.76	41.86	46.59	51.02	55.21
70.00	32.73	39.84	46.36	52.35	57.87	62.98
80.00	32.18	39.07	45.65	51.90	57.80	63.36
90.00	31.57	37.94	44.10	50.04	55.76	61.24
100.00	31.06	36.95	42.67	48.22	53.60	58.80
125.00	32.74	39.74	46.15	52.07	57.59	62.78
150.00	33.38	41.03	48.03	54.44	60.33	65.77
200.00	32.35	39.37	46.03	52.29	58.16	63.66
250.00	31.46	37.71	43.73	49.51	55.04	60.30
300.00	30.86	36.55	42.06	47.38	52.51	57.45

Source: DTN: MO0010MWDANS03.005

Table XXIII-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Reduced by 25%)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.04	68.04	68.04	68.04	68.04
1.00	75.01	78.66	81.66	84.19	86.32	88.11
5.00	71.66	77.35	82.64	87.51	91.93	95.96
10.00	67.80	73.28	78.68	83.94	89.04	93.94
15.00	64.37	69.49	74.56	79.57	84.53	89.40
20.00	61.48	66.24	70.98	75.67	80.33	84.93
26.00	58.33	62.75	67.15	71.53	75.87	80.18
30.00	56.41	60.54	64.64	68.72	72.77	76.81
40.00	52.29	56.08	59.86	63.62	67.37	71.11
50.00	48.93	52.27	55.62	58.98	62.36	65.73
60.00	59.22	64.10	68.55	72.65	76.49	80.12
70.00	56.75	62.89	68.56	73.79	78.62	83.10
80.00	53.95	59.83	65.48	70.87	76.00	80.85
90.00	51.61	57.10	62.42	67.57	72.53	77.31
100.00	49.64	54.78	59.77	64.62	69.32	73.88
125.00	54.73	60.69	66.13	71.16	75.84	80.23
150.00	51.31	57.86	63.86	69.38	74.46	79.15
200.00	47.56	53.59	59.34	64.78	69.90	74.71
250.00	45.22	50.70	55.98	61.06	65.92	70.56
300.00	43.54	48.61	53.52	58.27	62.84	67.24

Source: DTN: MO0010MWDANS03.005

Table XXIII-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Reduced by 25%)

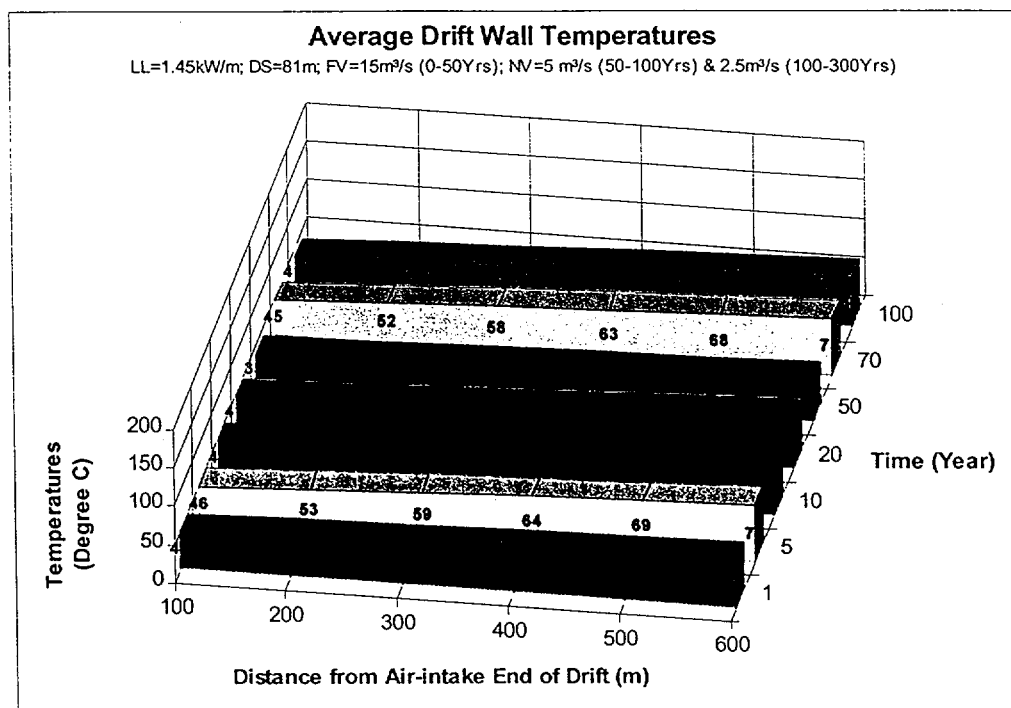
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.83	35.83	35.83	35.83	35.83
1.00	68.87	58.21	48.95	41.15	34.60	29.09
5.00	99.76	92.53	84.96	77.49	70.30	63.48
10.00	93.00	91.24	88.85	85.85	82.36	78.51
15.00	85.20	84.21	83.13	81.83	80.35	78.61
20.00	78.35	77.57	76.77	75.91	75.01	74.02
26.00	71.81	71.24	70.64	70.02	69.36	68.66
30.00	66.35	65.85	65.33	64.80	64.24	63.69
40.00	59.91	59.72	59.47	59.18	58.84	58.51
50.00	52.00	52.20	52.33	52.40	52.40	52.38
60.00	27.38	24.75	22.64	20.97	19.64	18.58
70.00	34.28	31.50	28.92	26.58	24.48	22.63
80.00	31.82	30.58	29.18	27.69	26.16	24.64
90.00	29.13	28.24	27.32	26.35	25.35	24.31
100.00	26.86	26.12	25.37	24.61	23.84	23.07
125.00	16.69	15.09	13.81	12.77	11.91	11.18
150.00	18.06	16.51	15.09	13.82	12.70	11.71
200.00	15.86	15.14	14.34	13.50	12.66	11.84
250.00	13.92	13.47	12.99	12.46	11.91	11.34
300.00	12.64	12.26	11.88	11.48	11.06	10.64

Source: DTN: MO0010MWDANS03.005

Table XXIII-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Reduced by 25%)

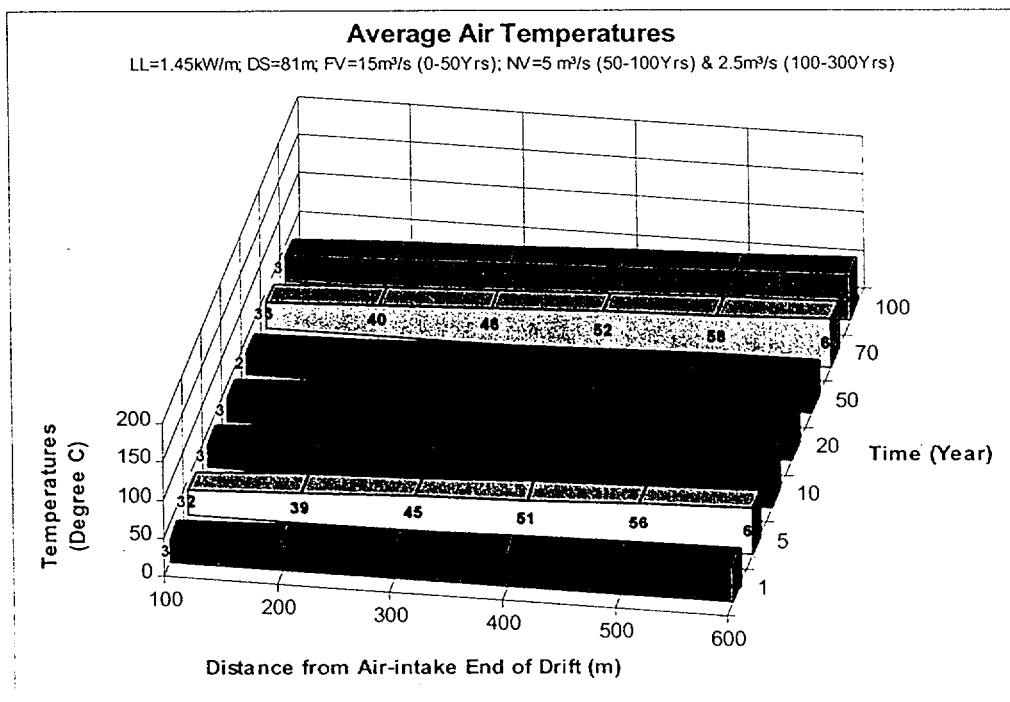
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)	
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.82	107.41	0.34	
1.00	96.99%	843.84	856.92	27021.20	1.00	271.66	243.24	7670.07	
5.00	87.93%	764.96	804.40	101470.60	5.00	469.74	370.70	46761.31	
10.00	79.35%	690.37	727.67	114738.26	10.00	501.84	485.79	76599.37	
15.00	72.23%	628.43	659.40	103973.79	15.00	477.97	489.91	77248.24	
20.00	66.23%	576.22	602.32	94974.15	20.00	444.67	461.32	72740.48	
26.00	59.89%	521.01	548.62	103807.02	26.00	410.86	427.76	80939.32	
30.00	56.11%	488.18	504.60	63651.70	30.00	381.14	396.00	49952.75	
40.00	48.24%	419.68	453.93	143151.62	40.00	348.25	364.69	115009.73	
50.00	41.94%	364.89	392.29	123711.69	50.00	308.23	328.24	103513.19	
60.00	36.88%	320.81	342.85	108121.88	60.00	129.58	218.90	69033.77	
70.00	32.81%	285.42	303.12	95590.81	70.00	160.57	145.08	45751.71	
80.00	29.47%	256.40	270.91	85434.15	80.00	161.87	161.22	50843.16	
90.00	26.76%	232.84	244.62	77142.91	90.00	153.49	157.68	49725.69	
100.00	24.52%	213.32	223.08	70349.62	100.00	143.84	148.67	46883.25	
125.00	21.21%	184.50	198.91	156819.84	125.00	77.60	110.72	87292.74	
150.00	17.89%	155.68	170.09	134098.48	150.00	83.01	80.30	63310.14	
200.00	14.85%	129.19	142.43	224589.03	200.00	78.96	80.98	127693.79	
250.00	13.03%	113.33	121.26	191201.22	250.00	72.73	75.84	119591.31	
300.00	11.76%	102.34	107.84	170036.07	300.00	67.41	70.07	110488.47	
Total heat generated in 50 years (GJ)				876502.77	Total heat removed in 50 years (GJ)				630434.80
Total heat generated in 100 years (GJ)				1313142.14	Total heat removed in 100 years (GJ)				892672.39
Total heat generated in 300 years (GJ)				2189886.77	Total heat removed in 300 years (GJ)				1401048.83
Percentage of total heat removal in 50 years = 72%									
Percentage of total heat removal in 100 years = 68%									
Percentage of total heat removal in 300 years = 64%									

Source: DTN: MO0010MWDANS03.005



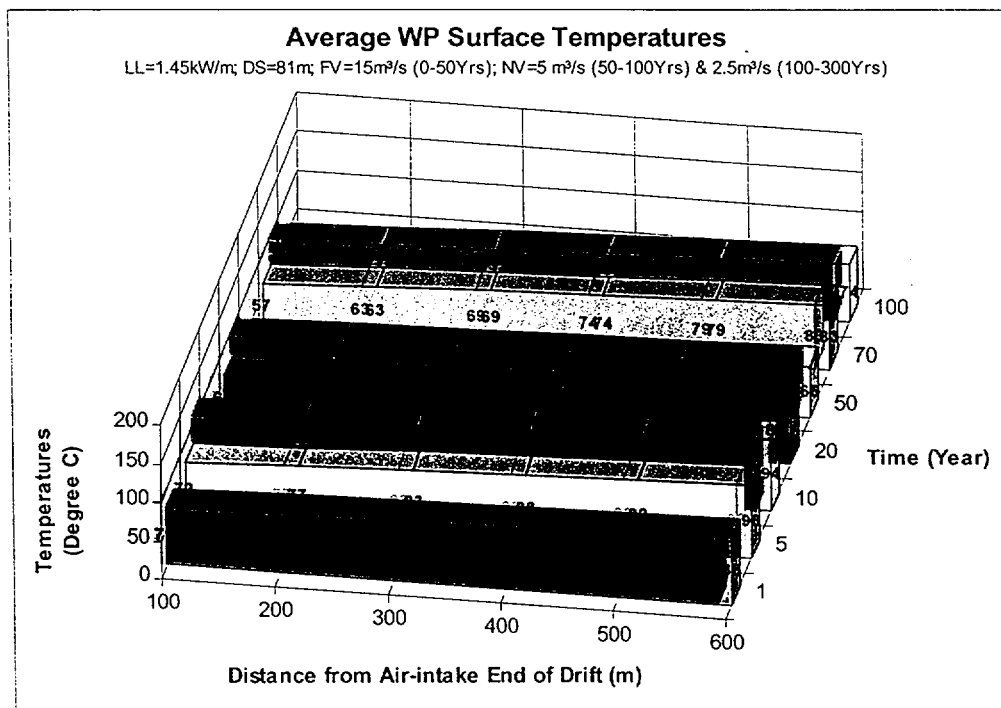
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXIII-1, p. XXIII-2.

Figure XXIII-1. Average Drift Wall Temperatures for Case 22: HF5N5V8KD



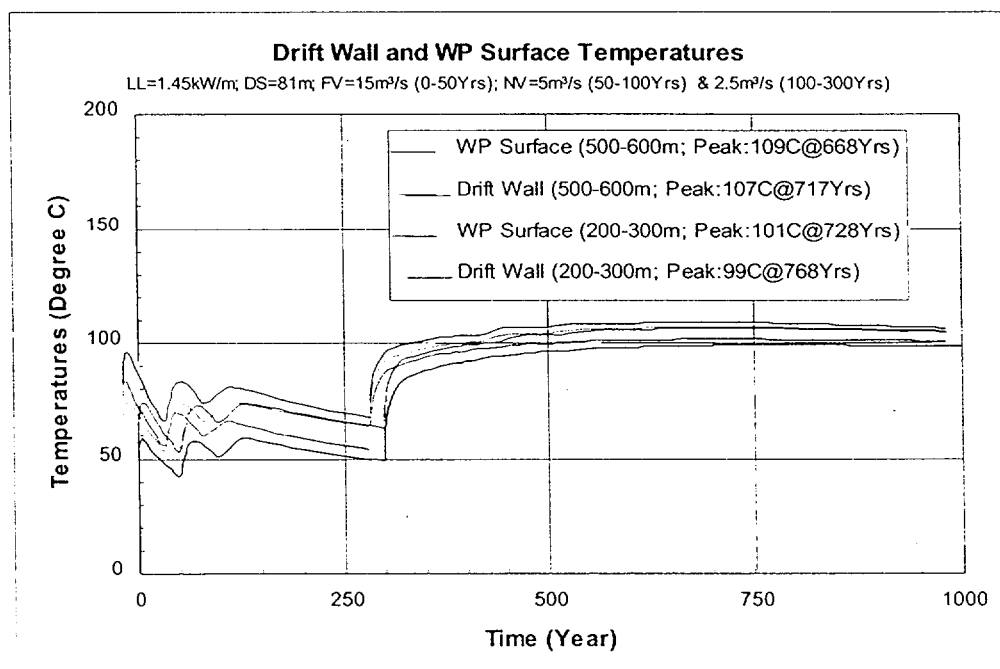
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXIII-2, p. XXIII-3.

Figure XXIII-2. Average Air Temperatures for Case 22: HF5N5V8KD



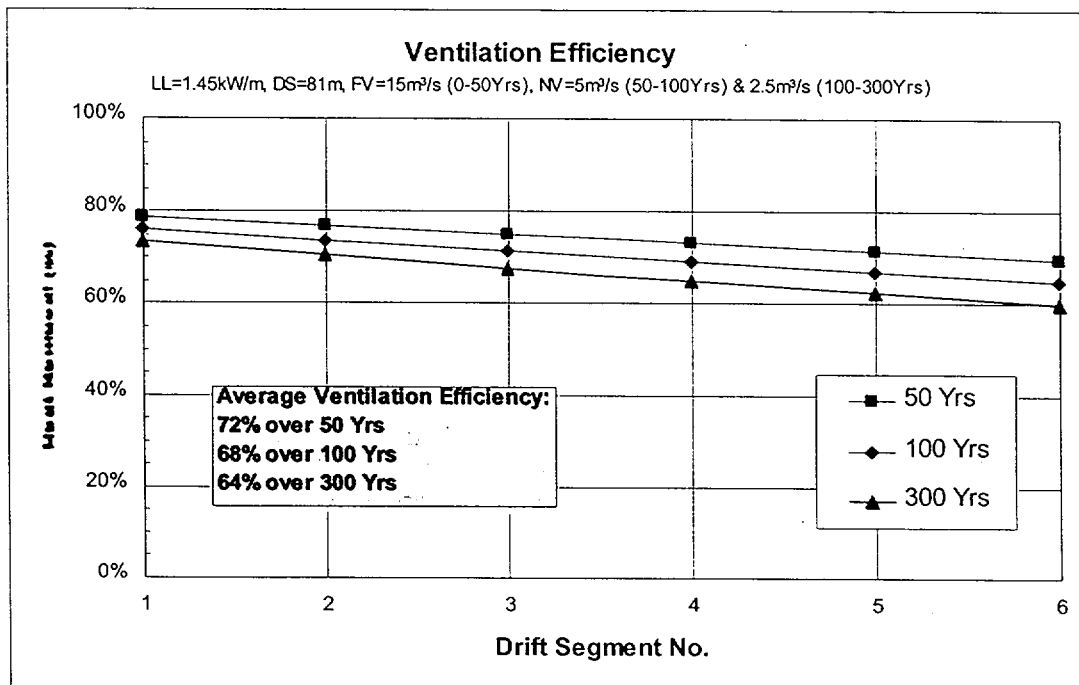
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXIII-3, p. XXIII-4.

Figure XXIII-3. Average Waste Package Surface Temperatures for Case 22: HF5N5V8KD



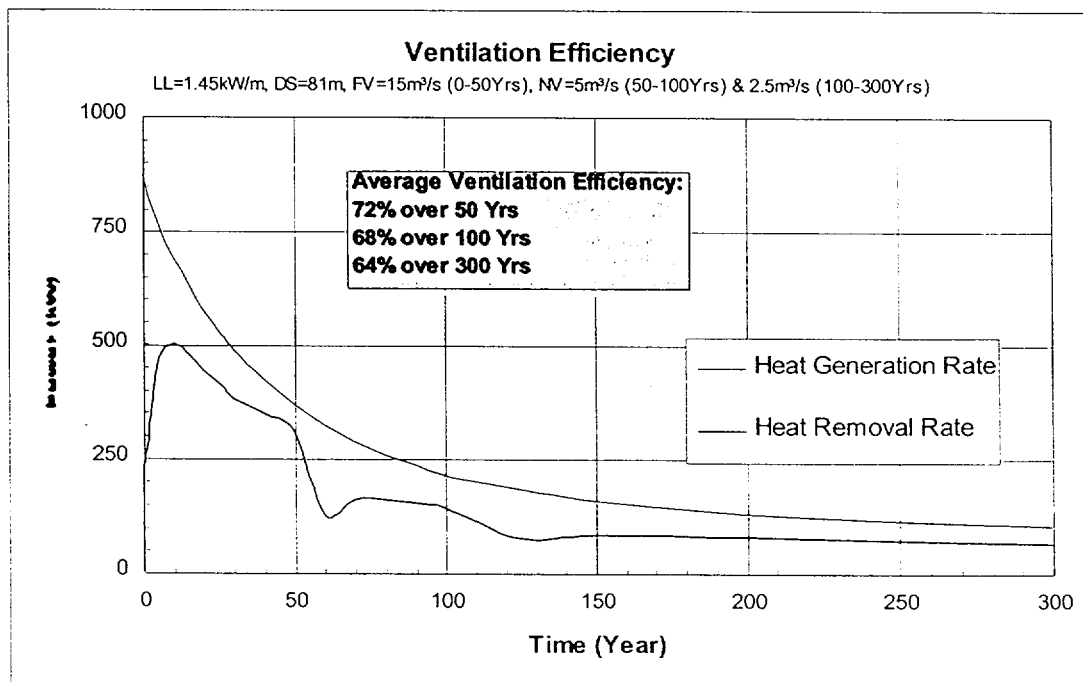
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXIII-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 22: HF5N5V8KD



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXIII-5. Average Heat Removal Rates at Different Drift Segments for Case 22: HF5N5V8KD



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXIII-6. Overall Heat Generation and Removal Rates at Different Time for Case 22: HF5N5V8KD

ATTACHMENT XXIV

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 23: HF5N5V8KU

ATTACHMENT XXIV

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 23: HF5N5V8KU

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Thermal conductivity values for stratigraphic units are raised by 25 percent. Drift spacing for this case is 81 m. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XXIV-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Raised by 25%)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
1.00	45.48	49.22	52.22	54.71	56.78	58.51
5.00	44.96	50.88	56.28	61.16	65.54	69.46
10.00	43.38	49.17	54.73	60.05	65.10	69.87
15.00	41.88	47.27	52.52	57.62	62.56	67.33
20.00	40.60	45.62	50.52	55.30	59.97	64.52
26.00	39.22	43.87	48.43	52.88	57.25	61.53
30.00	38.38	42.72	46.97	51.14	55.24	59.26
40.00	36.59	40.54	44.44	48.28	52.06	55.79
50.00	35.13	38.62	42.08	45.53	48.94	52.31
60.00	44.69	49.43	53.75	57.70	61.38	64.83
70.00	43.94	49.74	55.00	59.80	64.19	68.21
80.00	42.45	48.06	53.34	58.27	62.87	67.17
90.00	41.16	46.44	51.47	56.23	60.73	64.98
100.00	40.06	45.04	49.79	54.33	58.65	62.75
125.00	45.08	50.60	55.58	60.11	64.28	68.14
150.00	43.35	49.29	54.66	59.50	63.90	67.91
200.00	41.12	46.75	51.97	56.80	61.25	65.35
250.00	39.66	44.87	49.78	54.40	58.71	62.75
300.00	38.58	43.47	48.11	52.51	56.66	60.57

Source: DTN: MO0010MWDANS03.005

Table XXIV-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Raised by 25%)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.81	33.83	37.18	39.96	42.28	44.22
5.00	31.91	38.24	43.99	49.17	53.81	57.96
10.00	31.50	37.78	43.82	49.58	55.04	60.17
15.00	30.98	36.81	42.50	48.03	53.39	58.57
20.00	30.51	35.91	41.19	46.36	51.40	56.31
26.00	30.07	35.05	39.93	44.72	49.42	54.01
30.00	29.70	34.31	38.85	43.31	47.69	51.98
40.00	29.25	33.46	37.61	41.70	45.74	49.71
50.00	28.71	32.40	36.08	39.73	43.35	46.94
60.00	30.90	36.20	41.01	45.43	49.55	53.42
70.00	32.29	38.89	44.87	50.30	55.25	59.78
80.00	31.83	38.26	44.29	49.91	55.15	60.01
90.00	31.29	37.29	42.99	48.39	53.49	58.30
100.00	30.84	36.43	41.77	46.87	51.72	56.34
125.00	32.32	38.85	44.73	50.09	55.02	59.57
150.00	32.85	39.89	46.21	51.90	57.05	61.73
200.00	32.01	38.54	44.60	50.18	55.32	60.05
250.00	31.24	37.16	42.75	48.00	52.92	57.51
300.00	30.72	36.17	41.36	46.29	50.94	55.33

Source: DTN: MO0010MWDANS03.005

Table XXIV-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Raised by 25%)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.04	68.04	68.04	68.04	68.04
1.00	74.08	77.37	80.05	82.29	84.15	85.70
5.00	70.92	76.13	80.90	85.24	89.14	92.62
10.00	67.19	72.29	77.22	81.96	86.49	90.78
15.00	63.87	68.66	73.34	77.91	82.36	86.68
20.00	61.05	65.54	69.95	74.26	78.49	82.62
26.00	57.98	62.18	66.31	70.36	74.34	78.25
30.00	56.11	60.05	63.92	67.73	71.48	75.17
40.00	52.08	55.71	59.31	62.86	66.36	69.82
50.00	48.78	52.01	55.23	58.44	61.62	64.78
60.00	57.92	62.34	66.35	70.04	73.46	76.68
70.00	55.70	61.16	66.13	70.67	74.81	78.62
80.00	53.11	58.42	63.42	68.11	72.49	76.58
90.00	50.95	55.96	60.74	65.28	69.58	73.64
100.00	49.10	53.85	58.39	62.72	66.86	70.80
125.00	53.22	58.50	63.28	67.63	71.64	75.34
150.00	50.25	56.00	61.19	65.88	70.15	74.04
200.00	46.90	52.37	57.44	62.15	66.49	70.49
250.00	44.78	49.85	54.63	59.14	63.35	67.30
300.00	43.23	48.00	52.52	56.82	60.88	64.71

Source: DTN: MO0010MWDANS03.005

Table XXIV-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Raised by 25%)

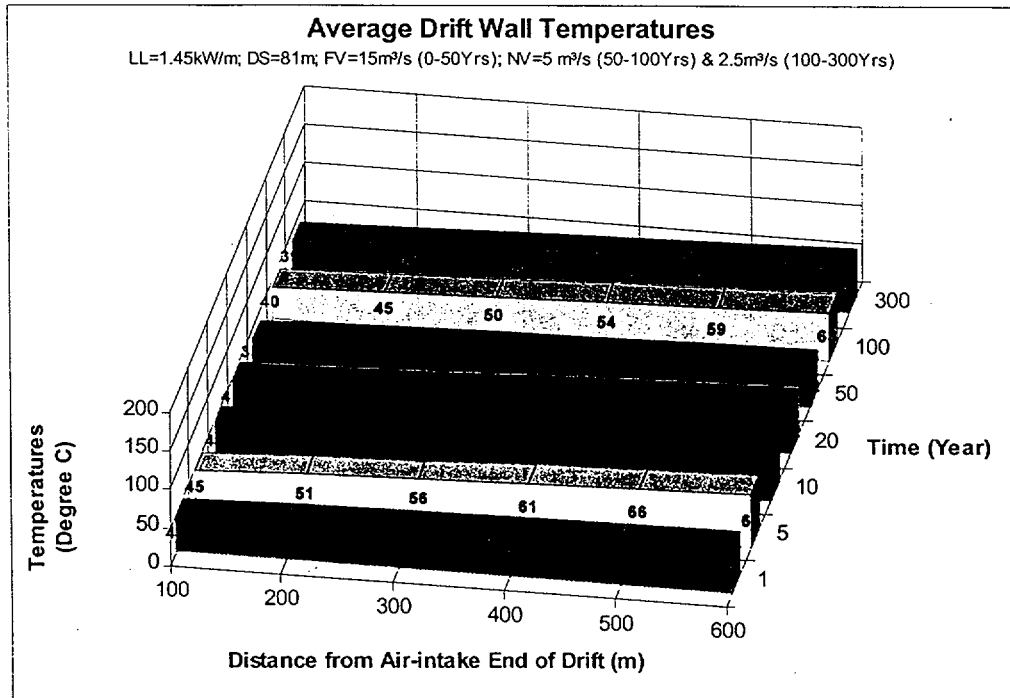
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.83	35.83	35.83	35.83	35.83
1.00	66.49	55.65	46.32	38.57	32.10	26.72
5.00	95.64	87.60	79.44	71.64	64.25	57.37
10.00	89.89	86.98	83.53	79.67	75.47	71.06
15.00	82.67	80.75	78.69	76.51	74.16	71.64
20.00	76.26	74.68	73.07	71.44	69.76	68.02
26.00	70.12	68.86	67.59	66.27	64.95	63.60
30.00	64.97	63.89	62.78	61.67	60.55	59.43
40.00	58.85	58.17	57.43	56.65	55.83	54.99
50.00	51.30	51.11	50.85	50.52	50.11	49.65
60.00	26.18	23.47	21.32	19.62	18.25	17.15
70.00	32.32	29.26	26.52	24.08	21.95	20.10
80.00	30.27	28.52	26.73	24.95	23.21	21.57
90.00	27.91	26.58	25.26	23.94	22.63	21.35
100.00	25.90	24.78	23.68	22.60	21.53	20.48
125.00	15.79	14.07	12.68	11.56	10.62	9.83
150.00	16.93	15.17	13.63	12.27	11.10	10.09
200.00	15.11	14.09	13.05	12.04	11.08	10.18
250.00	13.46	12.76	12.05	11.33	10.60	9.90
300.00	12.32	11.76	11.19	10.62	10.04	9.47

Source: DTN: MO0010MWDANS03.005

Table XXIV-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Thermal Conductivity Values Raised by 25%)

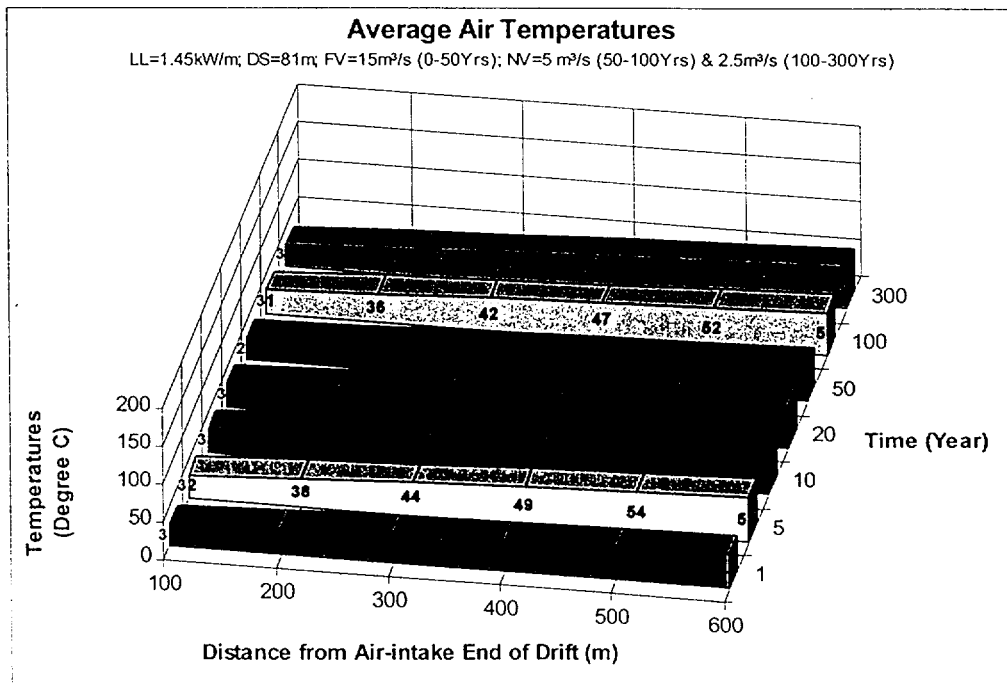
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)	
1.0E-4	100.00%	870.00	870.00	2.74	1.0E-4	214.82	107.41	0.34	
1.00	96.99%	843.84	856.92	27021.20	1.00	271.66	243.24	7670.07	
5.00	87.93%	764.96	804.40	101470.60	5.00	469.74	370.70	46761.31	
10.00	79.35%	690.37	727.67	114738.26	10.00	501.84	485.79	76599.37	
15.00	72.23%	628.43	659.40	103973.79	15.00	477.97	489.91	77248.24	
20.00	66.23%	576.22	602.32	94974.15	20.00	444.67	461.32	72740.48	
26.00	59.89%	521.01	548.62	103807.02	26.00	410.86	427.76	80939.32	
30.00	56.11%	488.18	504.60	63651.70	30.00	381.14	396.00	49952.75	
40.00	48.24%	419.68	453.93	143151.62	40.00	348.25	364.69	115009.73	
50.00	41.94%	364.89	392.29	123711.69	50.00	308.23	328.24	103513.19	
60.00	36.88%	320.81	342.85	108121.88	60.00	129.58	218.90	69033.77	
70.00	32.81%	285.42	303.12	95590.81	70.00	160.57	145.08	45751.71	
80.00	29.47%	256.40	270.91	85434.15	80.00	161.87	161.22	50843.16	
90.00	26.76%	232.84	244.62	77142.91	90.00	153.49	157.68	49725.69	
100.00	24.52%	213.32	223.08	70349.62	100.00	143.84	148.67	46883.25	
125.00	21.21%	184.50	198.91	156819.84	125.00	77.60	110.72	87292.74	
150.00	17.89%	155.68	170.09	134098.48	150.00	83.01	80.30	63310.14	
200.00	14.85%	129.19	142.43	224589.03	200.00	78.96	80.98	127693.79	
250.00	13.03%	113.33	121.26	191201.22	250.00	72.73	75.84	119591.31	
300.00	11.76%	102.34	107.84	170036.07	300.00	67.41	70.07	110488.47	
Total heat generated in 50 years (GJ)				876502.77	Total heat removed in 50 years (GJ)				630434.80
Total heat generated in 100 years (GJ)				1313142.14	Total heat removed in 100 years (GJ)				892672.39
Total heat generated in 300 years (GJ)				2189886.77	Total heat removed in 300 years (GJ)				1401048.83
Percentage of total heat removal in 50 years = 72%									
Percentage of total heat removal in 100 years = 68%									
Percentage of total heat removal in 300 years = 64%									

Source: DTN: MO0010MWDANS03.005



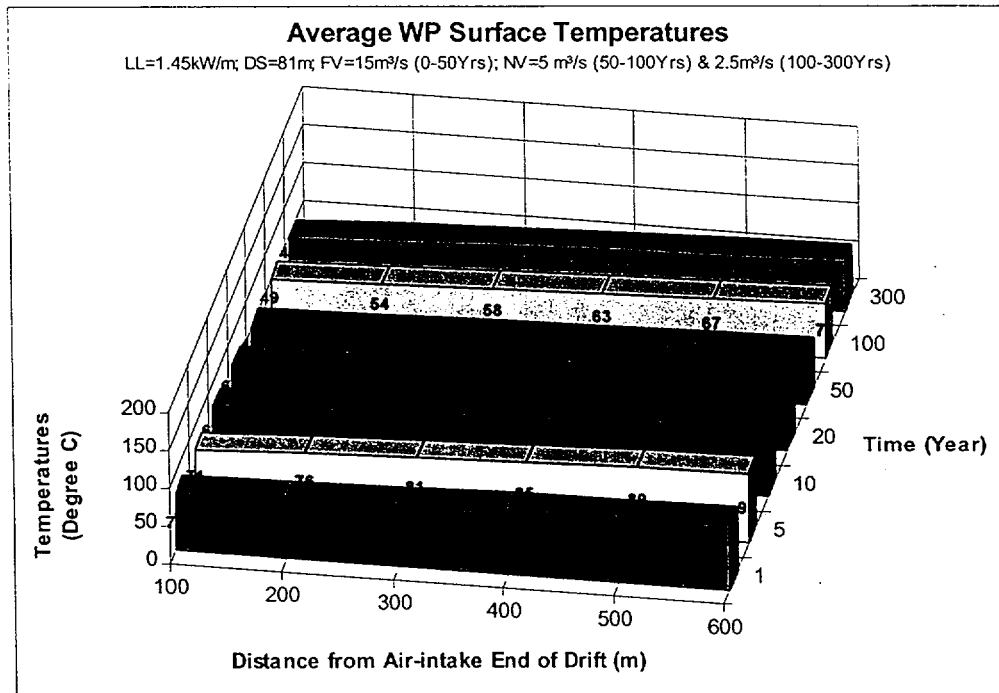
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XXIV-1, p. XXIV-2.

Figure XXIV-1. Average Drift Wall Temperatures for Case 23: HF5N5V8KU



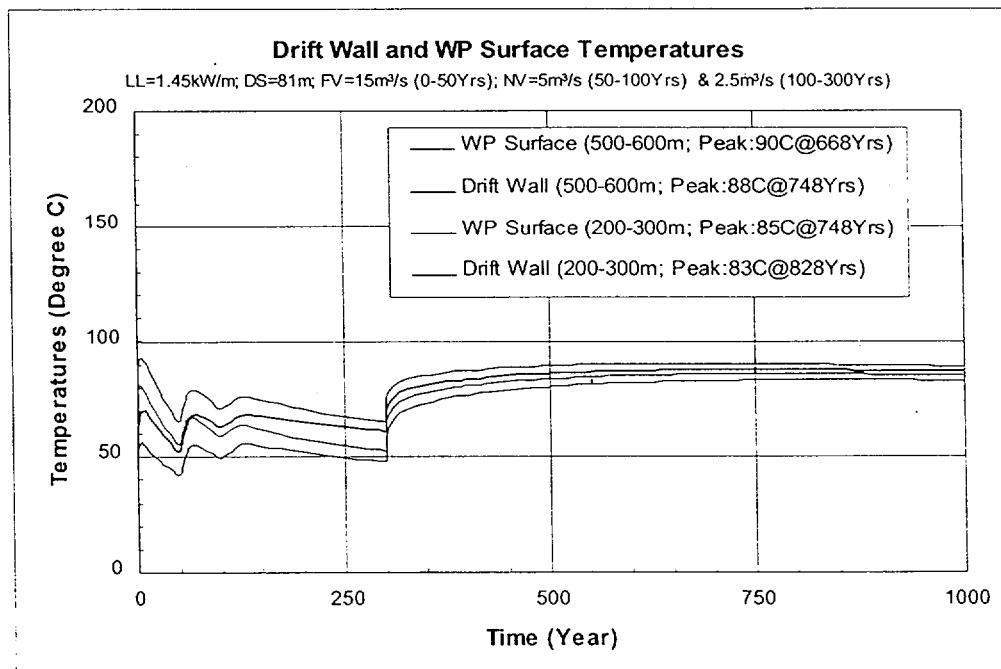
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XXIV-2, p. XXIV-3.

Figure XXIV-2. Average Air Temperatures for Case 23: HF5N5V8KU



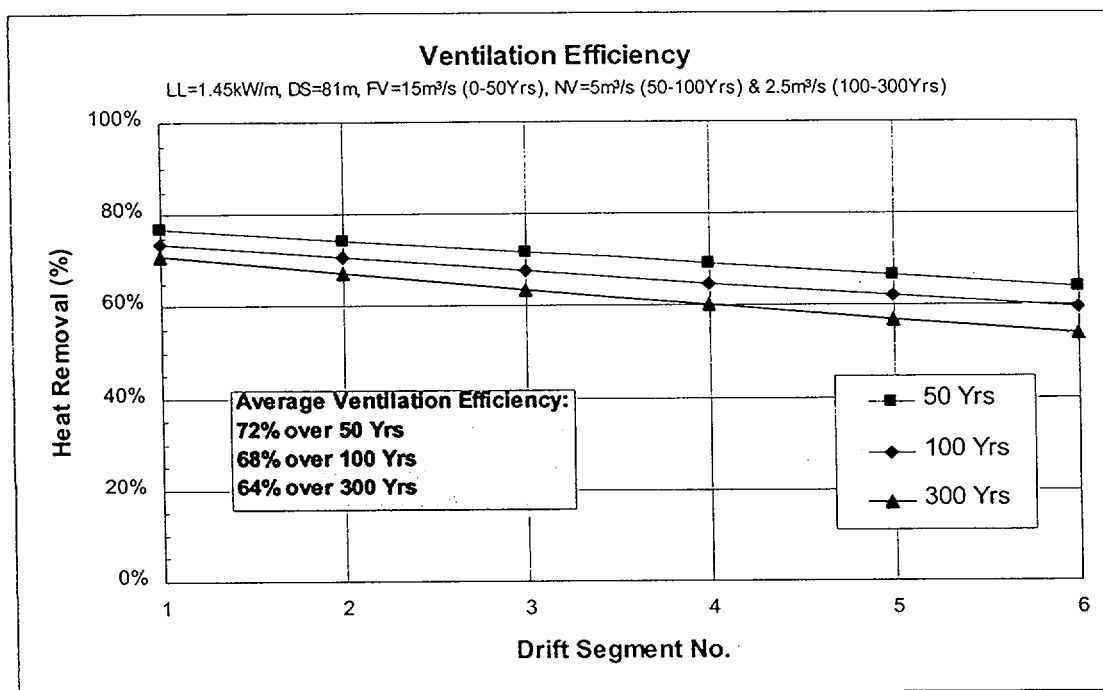
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXIV-3, p. XXIV-4.

Figure XXIV-3. Average Waste Package Surface Temperatures for Case 23: HF5N5V8KU



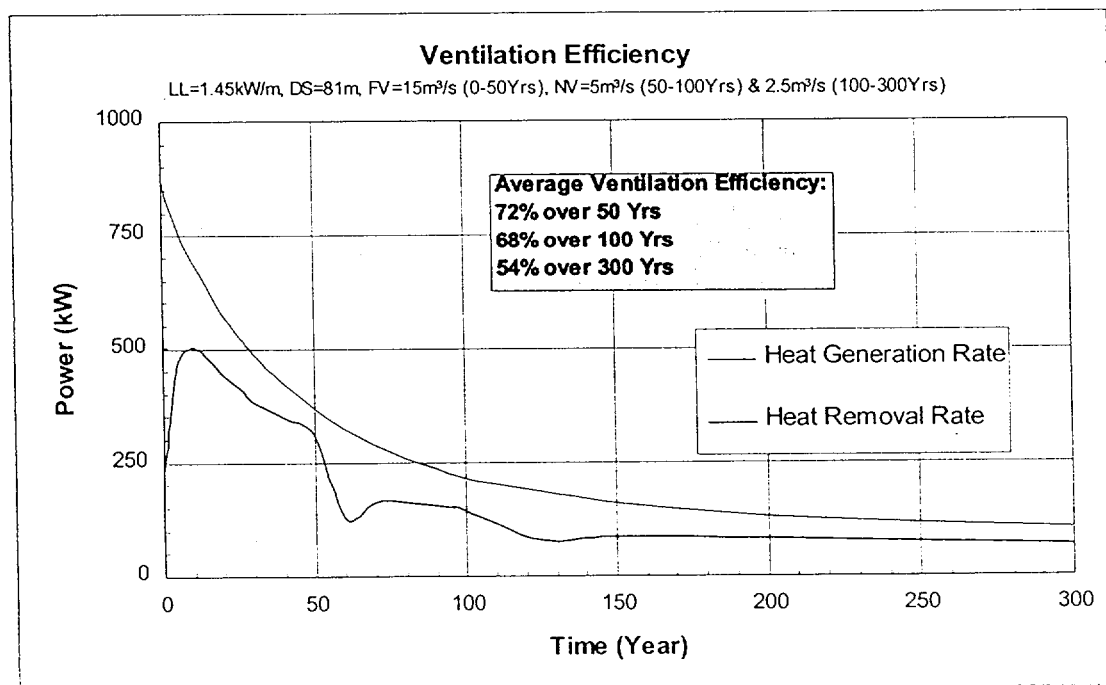
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXIV-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 23: HF5N5V8KU



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXIV-5. Average Heat Removal Rates at Different Drift Segments for Case 23: HF5N5V8KU



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXIV-6. Overall Heat Generation and Removal Rates at Different Time for Case 23: HF5N5V8KU

ATTACHMENT XXV

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 24: HF5N5V8A

ATTACHMENT XXV

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 24: HF5N5V8A

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 5 m³/s from 50 to 100 years and 2.5 m³/s from 100 to 300 years. Waste is aged for additional 18 years. Drift spacing for this case is 81 m. Ventilation efficiency is calculated for up to 300 years. All data presented in this attachment are obtained from DTN: MO0010MWDANS03.005.

Table XXV-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Waste Aged for Additional 18 Years)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.23	25.23	25.23	25.23	25.23
2.00	39.68	42.91	45.51	47.71	49.56	51.12
7.00	39.04	43.42	47.50	51.24	54.67	57.78
12.00	38.13	42.37	46.47	50.44	54.24	57.87
17.00	37.23	41.22	45.12	48.93	52.64	56.25
22.00	36.40	40.14	43.81	47.41	50.94	54.39
27.00	35.65	39.16	42.62	46.00	49.34	52.61
32.00	34.97	38.27	41.52	44.72	47.87	50.95
42.00	33.83	36.86	39.85	42.82	45.74	48.63
50.00	33.24	36.02	38.76	41.49	44.19	46.87
57.00	41.69	45.71	49.34	52.66	55.73	58.60
62.00	41.96	47.03	51.63	55.79	59.59	63.07
72.00	40.88	46.00	50.80	55.27	59.44	63.30
82.00	39.82	44.69	49.32	53.71	57.87	61.79
100.00	38.81	43.43	47.85	52.08	56.12	59.96
107.00	44.49	49.71	54.42	58.71	62.65	66.31
132.00	43.30	49.20	54.48	59.24	63.53	67.43
182.00	41.06	46.70	51.94	56.78	61.23	65.32
232.00	39.58	44.80	49.73	54.36	58.71	62.77
300.00	38.20	43.05	47.68	52.08	56.26	60.20

Source: DTN: MO0010MWDANS03.005

Table XXV-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Waste Aged for Additional 18 Years)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
2.00	28.81	32.03	34.75	37.03	38.95	40.57
7.00	29.94	34.57	38.83	42.75	46.31	49.54
12.00	29.66	34.20	38.60	42.84	46.90	50.76
17.00	29.35	33.61	37.78	41.86	45.84	49.71
22.00	29.05	33.03	36.95	40.79	44.56	48.25
27.00	28.78	32.51	36.17	39.78	43.33	46.81
32.00	28.54	32.03	35.47	38.86	42.19	45.48
42.00	28.23	31.43	34.60	37.73	40.83	43.89
50.00	27.94	30.85	33.75	36.62	39.47	42.29
57.00	29.95	34.38	38.38	42.05	45.44	48.62
62.00	31.37	37.12	42.31	47.01	51.28	55.17
72.00	31.18	36.98	42.40	47.44	52.11	56.45
82.00	30.76	36.25	41.47	46.41	51.09	55.49
100.00	30.37	35.51	40.44	45.15	49.64	53.92
107.00	31.96	38.13	43.68	48.73	53.37	57.66
132.00	32.74	39.64	45.81	51.34	56.34	60.86
182.00	31.99	38.51	44.54	50.09	55.19	59.87
232.00	31.22	37.13	42.71	47.97	52.89	57.49
300.00	30.63	36.02	41.17	46.08	50.73	55.13

Source: DTN: MO0010MWDANS03.005

Table XXV-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Waste Aged for Additional 18 Years)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	67.93	67.94	67.94	67.94	67.94	67.94
2.00	60.39	63.34	65.72	67.76	69.46	70.90
7.00	58.20	62.18	65.91	69.33	72.48	75.34
12.00	55.98	59.84	63.59	67.22	70.72	74.08
17.00	53.90	57.55	61.13	64.63	68.06	71.40
22.00	51.98	55.43	58.81	62.14	65.41	68.62
27.00	50.26	53.51	56.71	59.85	62.96	66.01
32.00	48.69	51.76	54.79	57.77	60.71	63.60
42.00	46.04	48.88	51.69	54.48	57.23	59.95
50.00	44.67	47.28	49.87	52.44	54.99	57.52
57.00	53.16	56.94	60.37	63.49	66.38	69.08
62.00	52.75	57.57	61.93	65.90	69.50	72.80
72.00	50.75	55.61	60.18	64.45	68.42	72.12
82.00	48.93	53.57	57.99	62.19	66.17	69.94
100.00	47.22	51.64	55.87	59.92	63.80	67.49
107.00	52.73	57.73	62.23	66.35	70.13	73.64
132.00	50.23	55.93	61.04	65.65	69.80	73.58
182.00	46.86	52.34	57.43	62.14	66.47	70.46
232.00	44.72	49.80	54.60	59.11	63.36	67.33
300.00	42.74	47.48	51.99	56.29	60.38	64.24

Source: DTN: MO0010MWDANS03.005

Table XXV-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Waste Aged for Additional 18 Years)

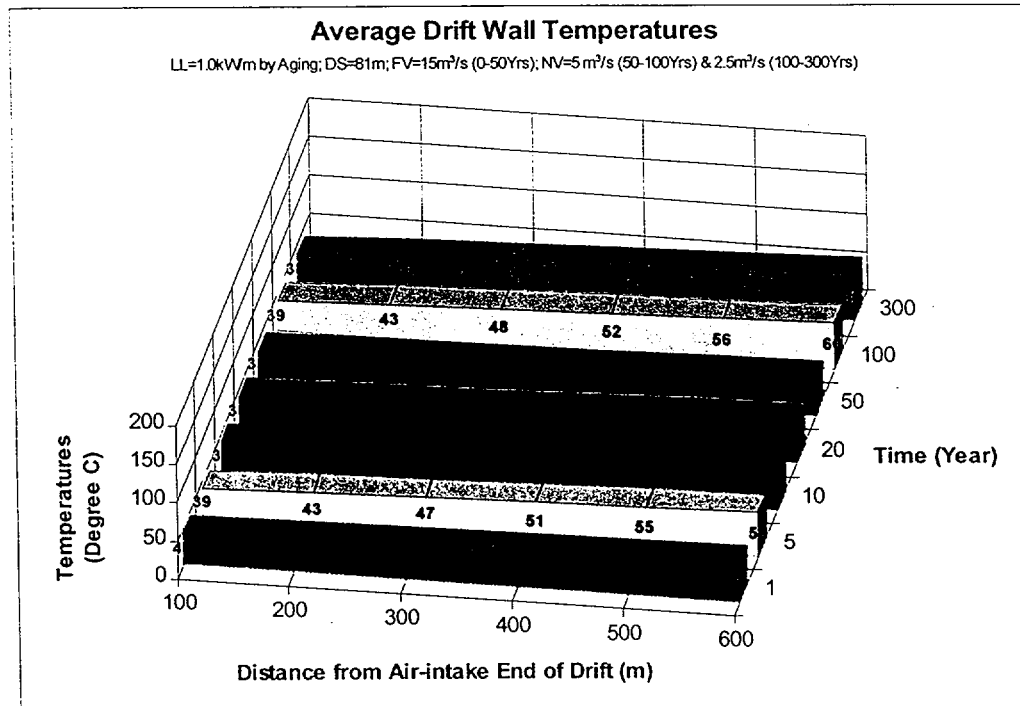
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.76	35.79	35.79	35.79	35.79	35.79
2.00	52.71	44.62	37.52	31.59	26.58	22.37
7.00	68.38	63.95	59.05	54.14	49.33	44.69
12.00	64.41	62.83	60.90	58.64	56.14	53.42
17.00	60.11	58.97	57.75	56.44	55.04	53.52
22.00	56.05	55.11	54.13	53.14	52.12	51.06
27.00	52.34	51.53	50.72	49.89	49.05	48.20
32.00	48.98	48.29	47.59	46.87	46.15	45.42
42.00	44.70	44.29	43.83	43.35	42.84	42.30
50.00	40.62	40.36	40.04	39.73	39.38	39.02
57.00	21.96	19.62	17.75	16.26	15.06	14.09
62.00	28.24	25.49	23.02	20.84	18.93	17.26
72.00	27.38	25.72	24.03	22.36	20.74	19.21
82.00	25.54	24.35	23.14	21.93	20.72	19.53
100.00	23.79	22.82	21.84	20.88	19.93	18.99
107.00	15.00	13.31	11.97	10.89	10.00	9.25
132.00	16.68	14.88	13.30	11.94	10.76	9.75
182.00	15.07	14.05	13.00	11.98	10.99	10.08
232.00	13.40	12.74	12.04	11.33	10.62	9.91
300.00	12.13	11.63	11.11	10.57	10.04	9.49

Source: DTN: MO0010MWDANS03.005

Table XXV-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 5 m³/s (50-100 Years), and 2.5 m³/s (100-300 Years) (Drift Spacing = 81 m, Waste Aged for Additional 18 Years)

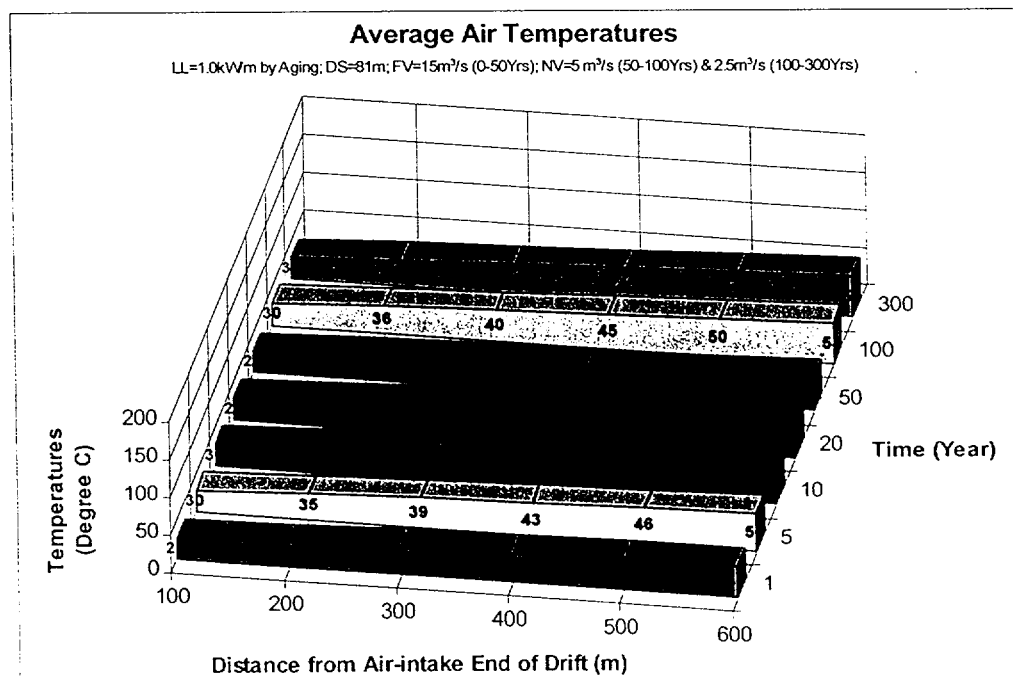
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.00E-04	68.63%	597.08	597.08	1.88	1.00E-04	214.72	107.36	0.34
2.00	66.23%	576.22	586.65	36999.34	2.00	215.39	215.05	13563.19
7.00	60.83%	529.22	552.72	87153.06	7.00	339.54	277.46	43750.50
12.00	56.11%	488.18	508.70	80211.84	12.00	356.34	347.94	54863.12
17.00	51.98%	452.19	470.18	74138.40	17.00	341.83	349.08	55043.39
22.00	48.24%	419.68	435.94	68738.45	22.00	321.61	331.72	52305.55
27.00	44.88%	390.42	405.05	63868.36	27.00	301.73	311.67	49144.59
32.00	41.94%	364.89	377.65	59548.34	32.00	283.30	292.52	46124.03
42.00	36.88%	320.81	342.85	108121.88	42.00	261.31	272.31	85874.62
50.00	34.32%	298.60	309.71	78135.62	50.00	239.16	250.24	63131.54
57.00	31.03%	269.93	284.27	62752.22	57.00	104.74	171.95	37957.96
62.00	29.47%	256.40	263.17	41495.98	62.00	133.77	119.26	18804.26
72.00	26.76%	232.84	244.62	77142.91	72.00	139.44	136.60	43079.70
82.00	24.52%	213.32	223.08	70349.62	82.00	135.19	137.31	43303.23
100.00	22.50%	195.73	204.52	116096.67	100.00	128.25	131.72	74770.82
107.00	21.21%	184.50	190.11	41967.72	107.00	70.42	99.33	21927.86
132.00	17.89%	155.68	170.09	134098.48	132.00	77.31	73.86	58233.99
182.00	14.85%	129.19	142.43	224589.03	182.00	75.18	76.24	120220.86
232.00	13.03%	113.33	121.26	191201.22	232.00	70.05	72.61	114494.89
300.00	11.44%	99.51	106.42	228211.77	300.00	64.97	67.51	144767.51
Total heat generated in 50 years (GJ)				656917.17	Total heat removed in 50 years (GJ)			463800.88
Total heat generated in 100 years (GJ)				1024754.57	Total heat removed in 100 years (GJ)			681716.84
Total heat generated in 300 years (GJ)				1844822.79	Total heat removed in 300 years (GJ)			1141361.94
Percentage of total heat removal in 50 years = 71%								
Percentage of total heat removal in 100 years = 67%								
Percentage of total heat removal in 300 years = 62%								

Source: DTN: MO0010MWDANS03.005



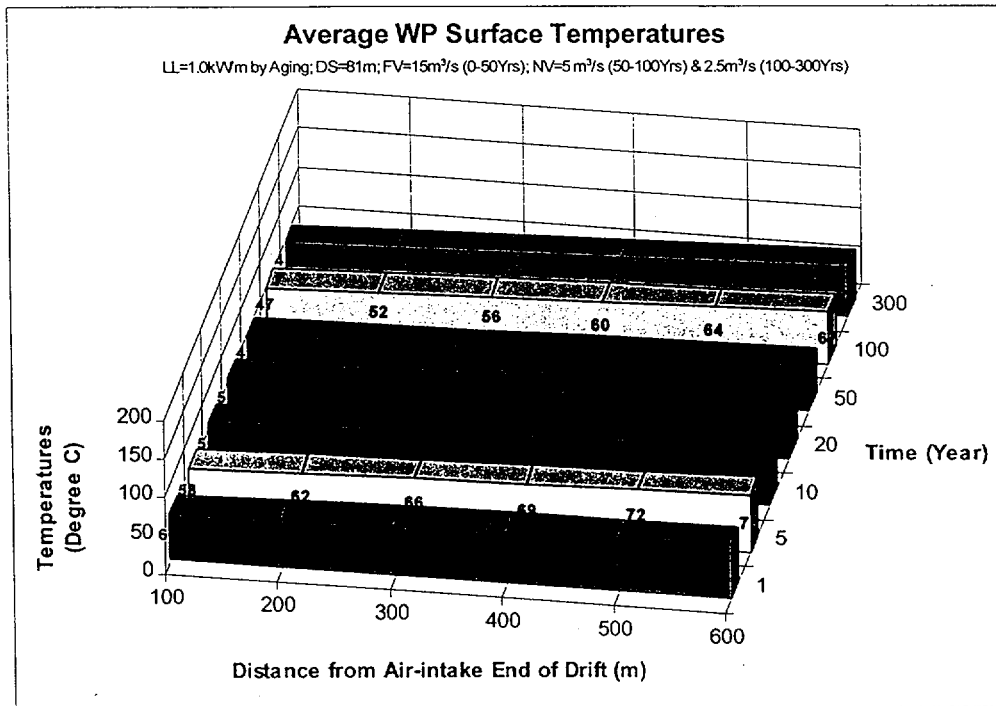
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXV-1, p. XXV-2.

Figure XXV-1. Average Drift Wall Temperatures for Case 24: HF5N5V8A



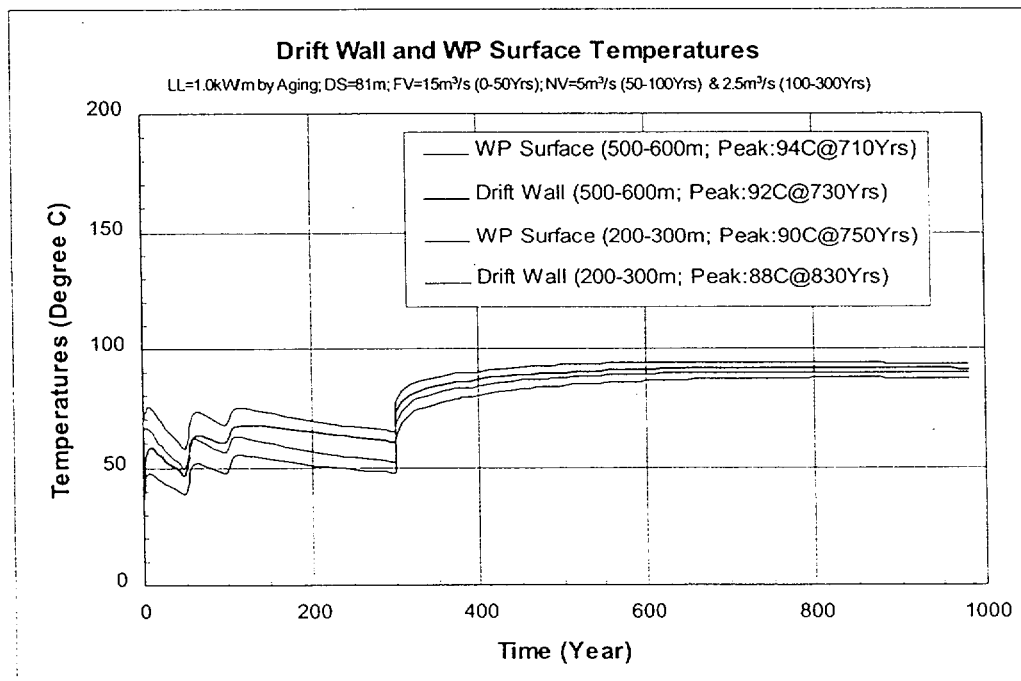
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXV-2, p. XXV-3.

Figure XXV-2. Average Air Temperatures for Case 24: HF5N5V8A



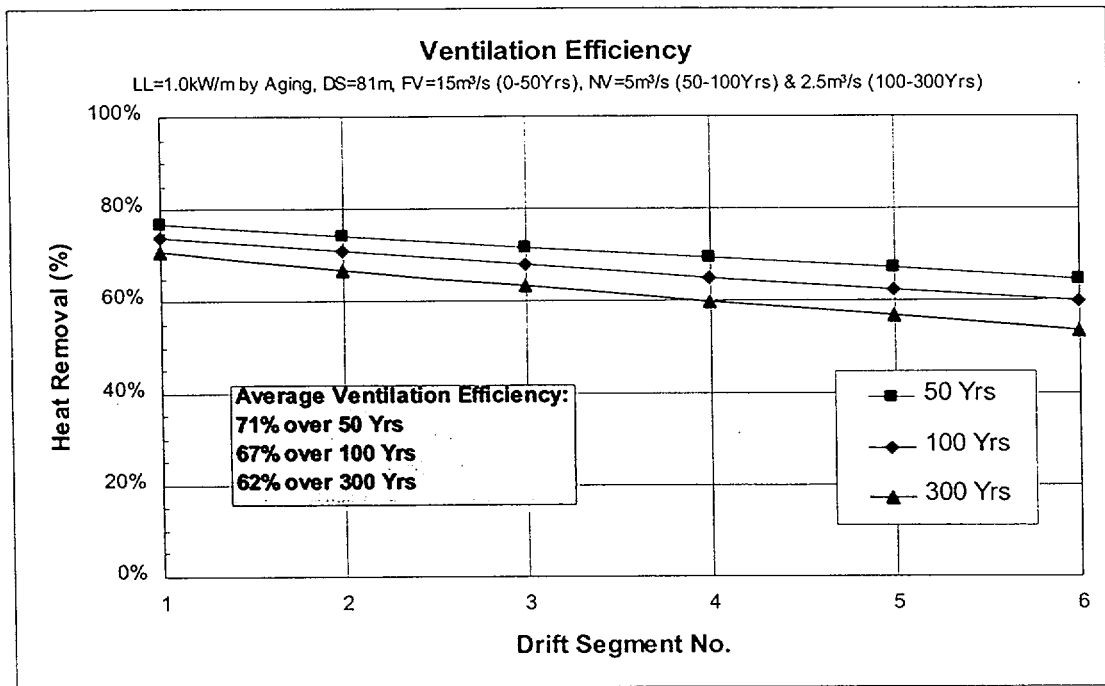
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.
For obliterated numbers, see Table XXV-3, p. XXV-4.

Figure XXV-3. Average Waste Package Surface Temperatures for Case 24: HF5N5V8A



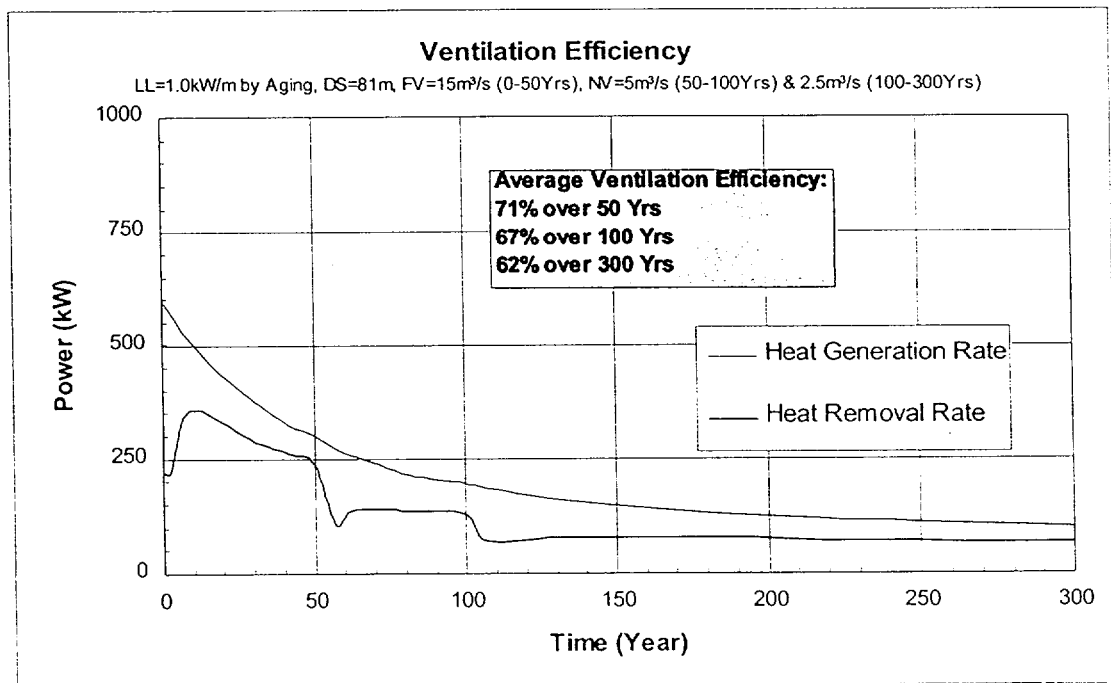
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXV-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 24: HF5N5V8A



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXV-5. Average Heat Removal Rates at Different Drift Segments for Case 24: HF5N5V8A



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXV-6. Overall Heat Generation and Removal Rates at Different Time for Case 24: HF5N5V8A

ATTACHMENT XXVI

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 25: HF5N3VI8

ATTACHMENT XXVI

TEMPERATURES AND HEAT REMOVAL RATES FOR CASE 25: HF5N3VI8

This attachment provides the results of calculations of temperatures and ventilation efficiency (heat removed) for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 3 m³/s from 50 to 100 years, 1.5 m³/s from 100 to 300 years, and 1.0 m³/s from 300 to 10,000 years. Drift spacing for this case is 81 m. Ventilation efficiency is calculated for up to 10,000 years. All data presented in this attachment are obtained from DTN: MO0103MWDTEM00.007.

Table XXVI-1. Average Drift Wall Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), 1.5 m³/s (100-300 Years), and 1.0 m³/s (300-10,000 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	25.22	25.22	25.22	25.22	25.22	25.22
1.00	46.13	49.92	53.10	55.75	57.97	59.83
5.00	45.44	51.65	57.34	62.51	67.16	71.37
10.00	43.77	49.80	55.63	61.24	66.61	71.70
15.00	42.19	47.78	53.26	58.62	63.84	68.91
20.00	40.86	46.04	51.14	56.14	61.04	65.85
26.00	39.42	44.21	48.91	53.56	58.13	62.61
30.00	38.54	42.99	47.39	51.71	55.98	60.17
40.00	36.70	40.74	44.75	48.71	52.63	56.50
50.00	35.20	38.75	42.29	45.82	49.33	52.83
60.00	52.38	58.24	63.32	67.80	71.84	75.52
70.00	52.57	60.53	67.43	73.43	78.70	83.35
80.00	50.58	58.56	65.79	72.31	78.16	83.42
90.00	48.79	56.40	63.41	69.84	75.73	81.12
100.00	47.24	54.47	61.17	67.38	73.13	78.43
125.00	53.31	61.15	67.98	73.99	79.35	84.16
150.00	51.00	59.40	66.69	73.06	78.64	83.57
200.00	48.01	56.07	63.28	69.70	75.41	80.49
250.00	46.04	53.60	60.48	66.72	72.36	77.44
300.00	44.57	51.74	58.33	64.36	69.86	74.87
400.00	46.07	53.43	59.96	65.81	71.06	75.80
500.00	44.66	52.14	58.80	64.74	70.06	74.81
600.00	43.19	50.41	56.95	62.87	68.20	73.01
700.00	41.88	48.77	55.10	60.89	66.16	70.96
800.00	40.62	47.17	53.25	58.87	64.04	68.77
900.00	39.50	45.71	51.53	56.96	61.98	66.63
1000.00	38.56	44.45	50.01	55.23	60.11	64.64
1500.00	35.02	40.10	45.04	49.81	54.37	58.68
2000.00	32.95	37.01	41.12	45.20	49.22	53.12
3000.00	31.04	34.14	37.34	40.59	43.87	47.14
4000.00	30.25	32.74	35.27	37.85	40.47	43.13
5000.00	29.78	31.94	34.09	36.24	38.39	40.56
6000.00	29.45	31.42	33.33	35.21	37.07	38.92
7000.00	29.15	30.96	32.72	34.43	36.09	37.71
8000.00	28.90	30.60	32.22	33.80	35.32	36.80
9000.00	28.68	30.27	31.79	33.26	34.68	36.04
10000.00	28.47	29.97	31.40	32.78	34.11	35.38

Source: DTN: MO0103MWDTEM00.007

Table XXVI-2. Average Air Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), 1.5 m³/s (100-300 Years), and 1.0 m³/s (300-10,000 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	25.00	25.00	25.00	25.00	25.00	25.00
1.00E-04	27.59	27.59	27.59	27.59	27.59	27.59
1.00	29.88	33.97	37.39	40.25	42.64	44.64
5.00	32.05	38.53	44.44	49.79	54.62	58.95
10.00	31.61	38.04	44.25	50.22	55.90	61.27
15.00	31.06	37.02	42.86	48.57	54.14	59.55
20.00	30.58	36.08	41.49	46.80	52.02	57.14
26.00	30.13	35.18	40.17	45.09	49.93	54.70
30.00	29.74	34.43	39.05	43.61	48.11	52.55
40.00	29.29	33.55	37.77	41.95	46.08	50.17
50.00	28.73	32.46	36.19	39.90	43.60	47.28
60.00	32.88	39.58	45.39	50.53	55.15	59.38
70.00	35.94	45.39	53.55	60.63	66.81	72.24
80.00	35.51	45.06	53.68	61.42	68.35	74.55
90.00	34.75	43.76	52.05	59.66	66.62	72.97
100.00	34.08	42.53	50.38	57.65	64.38	70.59
125.00	36.34	46.06	54.52	61.97	68.61	74.57
150.00	37.02	47.39	56.35	64.13	70.93	76.91
200.00	35.81	45.52	54.18	61.88	68.71	74.76
250.00	34.70	43.59	51.69	59.03	65.67	71.65
300.00	33.93	42.19	49.79	56.77	63.15	68.96
400.00	34.78	43.38	51.03	57.88	64.04	69.60
500.00	34.74	43.40	51.09	57.95	64.07	69.56
600.00	34.03	42.27	49.75	56.51	62.60	68.08
700.00	33.35	41.10	48.23	54.77	60.74	66.16
800.00	32.73	39.99	46.76	53.03	58.81	64.12
900.00	32.16	38.96	45.36	51.35	56.92	62.08
1000.00	31.67	38.04	44.10	49.81	55.17	60.17
1500.00	30.60	36.14	41.54	46.75	51.73	56.45
2000.00	29.26	33.66	38.12	42.55	46.92	51.17
3000.00	28.32	31.76	35.29	38.89	42.50	46.11
4000.00	27.69	30.42	33.21	36.06	38.95	41.88
5000.00	27.39	29.75	32.10	34.45	36.82	39.21
6000.00	27.20	29.34	31.42	33.48	35.51	37.53
7000.00	27.05	29.02	30.94	32.79	34.60	36.38
8000.00	26.92	28.76	30.53	32.25	33.90	35.51
9000.00	26.80	28.53	30.19	31.79	33.33	34.81
10000.00	26.70	28.33	29.89	31.39	32.83	34.21

Source: DTN: MO0103MWDTEM00.007

Table XXVI-3. Average Waste Package Surface Temperatures (°C) at Different Time and Locations during Ventilation for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), 1.5 m³/s (100-300 Years), and 1.0 m³/s (300-10,000 Years) (Drift Spacing = 81 m)

Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	70.00	70.00	70.00	70.00	70.00	70.00
1.00E-04	68.02	68.02	68.02	68.02	68.02	68.02
1.00	74.51	77.86	80.67	83.03	85.00	86.65
5.00	71.27	76.70	81.70	86.26	90.37	94.10
10.00	67.48	72.76	77.91	82.89	87.68	92.24
15.00	64.11	69.05	73.92	78.70	83.38	87.95
20.00	61.25	65.87	70.43	74.92	79.34	83.69
26.00	58.14	62.45	66.70	70.90	75.05	79.14
30.00	56.25	60.27	64.26	68.19	72.08	75.92
40.00	52.18	55.88	59.56	63.21	66.83	70.41
50.00	48.85	52.13	55.41	58.69	61.96	65.22
60.00	65.54	70.98	75.69	79.86	83.61	87.04
70.00	64.13	71.61	78.13	83.80	88.78	93.19
80.00	61.09	68.63	75.48	81.67	87.25	92.27
90.00	58.47	65.69	72.35	78.48	84.11	89.27
100.00	56.22	63.10	69.49	75.43	80.93	86.03
125.00	61.20	68.71	75.26	81.04	86.19	90.83
150.00	57.72	65.83	72.90	79.06	84.47	89.25
200.00	53.67	61.49	68.50	74.75	80.33	85.28
250.00	51.07	58.42	65.13	71.22	76.73	81.70
300.00	49.15	56.14	62.57	68.46	73.85	78.77
400.00	50.03	57.23	63.63	69.36	74.51	79.16
500.00	48.10	55.44	61.99	67.84	73.07	77.75
600.00	46.24	53.34	59.78	65.61	70.88	75.62
700.00	44.62	51.40	57.65	63.36	68.57	73.31
800.00	43.09	49.54	55.55	61.10	66.21	70.89
900.00	41.74	47.87	53.62	58.98	63.96	68.56
1000.00	40.62	46.44	51.93	57.10	61.93	66.42
1500.00	36.46	41.49	46.40	51.14	55.66	59.96
2000.00	34.10	38.13	42.20	46.27	50.26	54.15
3000.00	31.97	35.05	38.23	41.47	44.74	48.00
4000.00	31.10	33.58	36.10	38.66	41.28	43.92
5000.00	30.57	32.72	34.86	37.00	39.15	41.31
6000.00	30.19	32.15	34.06	35.94	37.79	39.63
7000.00	29.83	31.65	33.40	35.11	36.76	38.39
8000.00	29.54	31.24	32.87	34.44	35.96	37.43
9000.00	29.28	30.87	32.40	33.87	35.28	36.65
10000.00	29.03	30.53	31.97	33.35	34.68	35.95

Source: DTN: MO0103MWDTEM00.007

Table XXVI-4. Heat Removed (kW) by Ventilation at Different Time and Locations for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), 1.5 m³/s (100-300 Years), and 1.0 m³/s (300-10,000 Years) (Drift Spacing = 81 m)

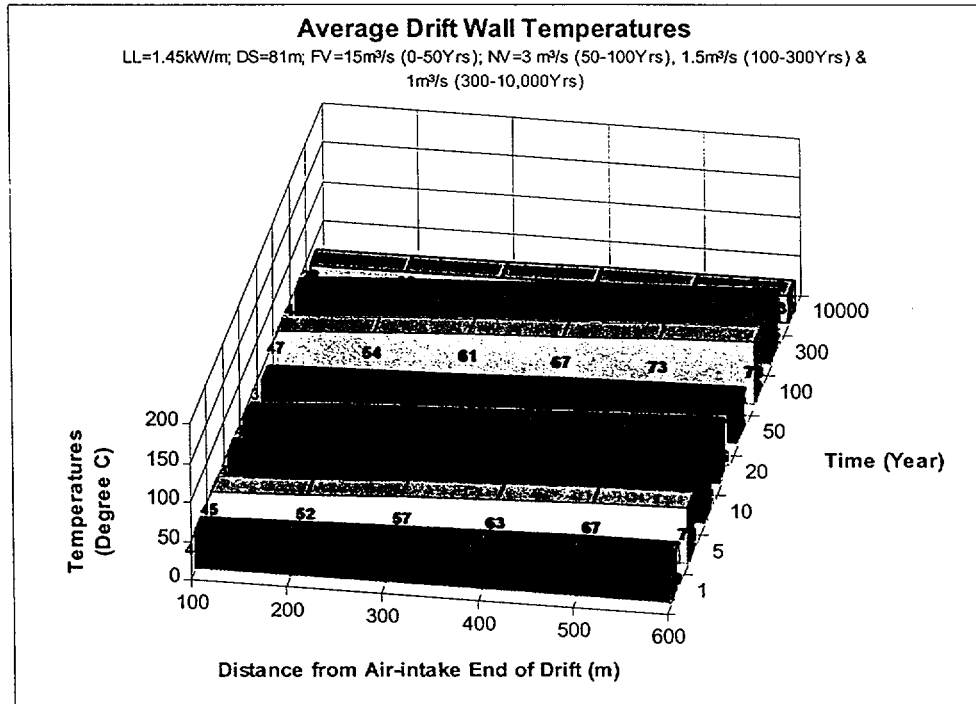
Time (Year)	Location Measured from Air-intake End (m)					
	0-100	100-200	200-300	300-400	400-500	500-600
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00E-04	35.80	35.80	35.80	35.80	35.80	35.80
1.00	67.58	56.52	47.28	39.54	33.07	27.66
5.00	97.57	89.60	81.73	74.09	66.79	59.96
10.00	91.39	88.99	86.00	82.48	78.58	74.41
15.00	83.89	82.39	80.79	79.00	77.04	74.86
20.00	77.25	76.03	74.82	73.55	72.21	70.81
26.00	70.92	69.98	69.01	68.02	67.00	65.94
30.00	65.62	64.80	63.96	63.12	62.26	61.38
40.00	59.35	58.88	58.38	57.82	57.23	56.59
50.00	51.62	51.61	51.53	51.39	51.17	50.90
60.00	20.56	17.49	15.16	13.40	12.06	11.03
70.00	28.55	24.65	21.30	18.48	16.12	14.17
80.00	27.42	24.93	22.50	20.20	18.08	16.16
90.00	25.44	23.51	21.64	19.86	18.16	16.56
100.00	23.70	22.05	20.48	18.97	17.55	16.20
125.00	14.30	12.25	10.66	9.39	8.37	7.51
150.00	15.15	13.06	11.29	9.81	8.57	7.53
200.00	13.63	12.24	10.92	9.70	8.60	7.63
250.00	12.22	11.20	10.21	9.26	8.36	7.53
300.00	11.25	10.41	9.59	8.79	8.04	7.33
400.00	8.00	7.04	6.26	5.60	5.04	4.55
500.00	7.97	7.08	6.30	5.61	5.01	4.49
600.00	7.39	6.74	6.12	5.53	4.98	4.48
700.00	6.83	6.34	5.84	5.35	4.88	4.44
800.00	6.33	5.94	5.54	5.13	4.73	4.34
900.00	5.86	5.56	5.24	4.90	4.56	4.22
1000.00	5.45	5.22	4.95	4.67	4.38	4.09
1500.00	4.58	4.53	4.42	4.26	4.07	3.86
2000.00	3.49	3.60	3.64	3.63	3.57	3.47
3000.00	2.72	2.81	2.89	2.94	2.96	2.95
4000.00	2.20	2.24	2.28	2.33	2.37	2.39
5000.00	1.95	1.93	1.92	1.93	1.94	1.95
6000.00	1.80	1.75	1.71	1.68	1.66	1.65
7000.00	1.68	1.62	1.56	1.52	1.48	1.45
8000.00	1.57	1.51	1.45	1.40	1.36	1.31
9000.00	1.48	1.42	1.36	1.31	1.26	1.21
10000.00	1.39	1.33	1.28	1.23	1.18	1.13

Source: DTN: MO0103MWDTEM00.007

Table XXVI-5. Calculation of Overall Ventilation Efficiency for 600m-long Drift for 1.45 kW/m, 15 m³/s (0-50 Years), 3 m³/s (50-100 Years), 1.5 m³/s (100-300 Years), and 1.0 m³/s (300-10,000 Years) (Drift Spacing = 81 m)

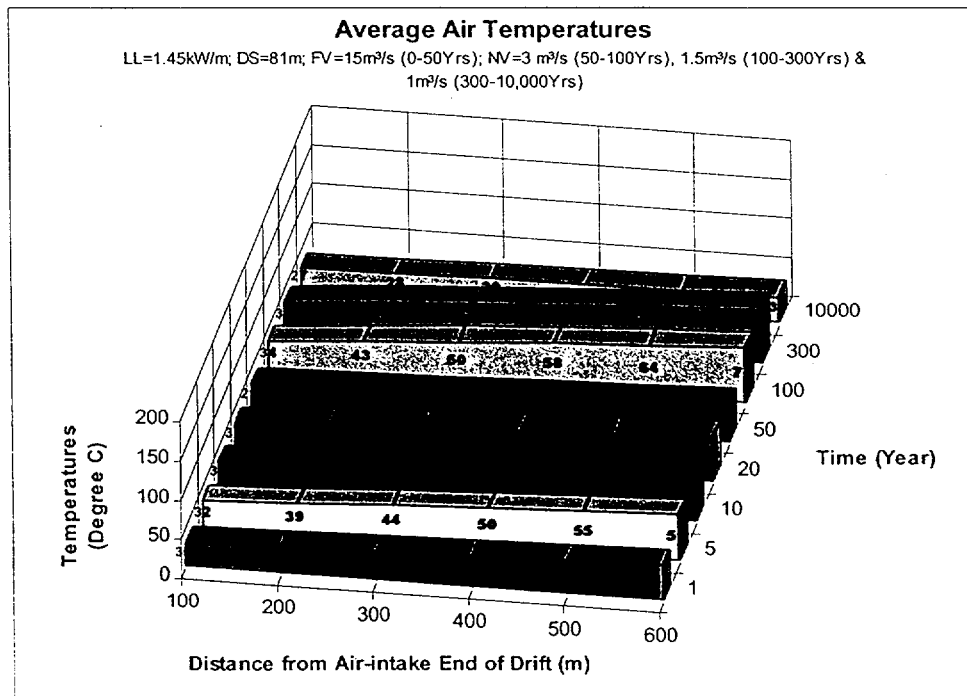
Time (year)	% of Heat Decay	Rate of Heat Generated per 600m (kW)	Average Rate of Heat Generated per 600m (kW)	Heat Generated per 600m (GJ)	Time (year)	Rate of Heat Removed per 600m (kW)	Average Rate of Heat Removed per 600m (kW)	Heat Removed per 600m (GJ)
1.00E-04	100.00%	870.00	870.00	2.74	1.00E-04	214.82	107.41	0.34
1.00	96.99%	843.84	856.92	27021.20	1.00	271.66	243.24	7670.07
5.00	87.93%	764.96	804.40	101470.60	5.00	469.74	370.70	46761.31
10.00	79.35%	690.37	727.67	114738.26	10.00	501.84	485.79	76599.37
15.00	72.23%	628.43	659.40	103973.79	15.00	477.97	489.91	77248.24
20.00	66.23%	576.22	602.32	94974.15	20.00	444.67	461.32	72740.48
26.00	59.89%	521.01	548.62	103807.02	26.00	410.86	427.76	80939.32
30.00	56.11%	488.18	504.60	63651.70	30.00	381.14	396.00	49952.75
40.00	48.24%	419.68	453.93	143151.62	40.00	348.25	364.69	115009.73
50.00	41.94%	364.89	392.29	123711.69	50.00	308.23	328.24	103513.19
60.00	36.88%	320.81	342.85	108121.88	60.00	89.70	198.96	62745.18
70.00	32.81%	285.42	303.12	95590.81	70.00	123.26	106.48	33579.91
80.00	29.47%	256.40	270.91	85434.15	80.00	129.28	126.27	39821.71
90.00	26.76%	232.84	244.62	77142.91	90.00	125.18	127.23	40123.27
100.00	24.52%	213.32	223.08	70349.62	100.00	118.95	122.06	38493.67
125.00	21.21%	184.50	198.91	156819.84	125.00	62.48	90.71	71518.35
150.00	17.89%	155.68	170.09	134098.48	150.00	65.42	63.95	50415.54
200.00	14.85%	129.19	142.43	224589.03	200.00	62.71	64.06	101016.39
250.00	13.03%	113.33	121.26	191201.22	250.00	58.79	60.75	95789.35
300.00	11.76%	102.34	107.84	170036.07	300.00	55.41	57.10	90029.43
400.00	9.97%	86.72	94.53	298108.41	400.00	36.48	45.95	144892.64
500.00	8.66%	75.37	81.04	255582.09	500.00	36.45	36.47	115000.25
600.00	7.65%	66.56	70.96	223793.02	600.00	35.24	35.84	113039.48
700.00	6.83%	59.40	62.98	198605.64	700.00	33.67	34.45	108654.57
800.00	6.14%	53.44	56.42	177916.80	800.00	32.00	32.83	103544.96
900.00	5.55%	48.29	50.86	160400.50	900.00	30.33	31.17	98285.13
1000.00	5.08%	44.19	46.24	145814.38	1000.00	28.77	29.55	93187.17
1500.00	3.50%	30.43	37.31	588256.69	1500.00	25.73	27.25	429630.68
2000.00	2.75%	23.91	27.17	428406.28	2000.00	21.40	23.57	371581.29
3000.00	2.16%	18.75	21.33	672745.04	3000.00	17.27	19.33	609740.13
4000.00	1.94%	16.87	17.81	561711.61	4000.00	13.81	15.54	489950.95
5000.00	1.78%	15.53	16.20	510817.50	5000.00	11.62	12.71	400969.74
6000.00	1.67%	14.50	15.01	473433.41	6000.00	10.25	10.93	344831.70
7000.00	1.55%	13.45	13.97	440617.49	7000.00	9.31	9.78	308361.68
8000.00	1.45%	12.60	13.02	410699.84	8000.00	8.60	8.95	282351.85
9000.00	1.36%	11.83	12.21	385200.43	9000.00	8.03	8.31	262144.98
10000.00	1.28%	11.10	11.46	361495.39	10000.00	7.54	7.78	245433.97
Total heat generated in 50 years (GJ)				876502.77	Total heat removed in 50 years (GJ)			630434.80
Total heat generated in 100 years (GJ)				1313142.14	Total heat removed in 100 years (GJ)			845198.54
Total heat generated in 300 years (GJ)				2189886.77	Total heat removed in 300 years (GJ)			1253967.61
Total heat generated in 10,000 years (GJ)				8483491.29	Total heat removed in 10,000 years (GJ)			5775568.76
Percentage of total heat removal in 50 years = 72%								
Percentage of total heat removal in 100 years = 64%								
Percentage of total heat removal in 300 years = 57%								
Percentage of total heat removal in 10,000 years = 68%								

Source: DTN: MO0103MWDTEM00.007



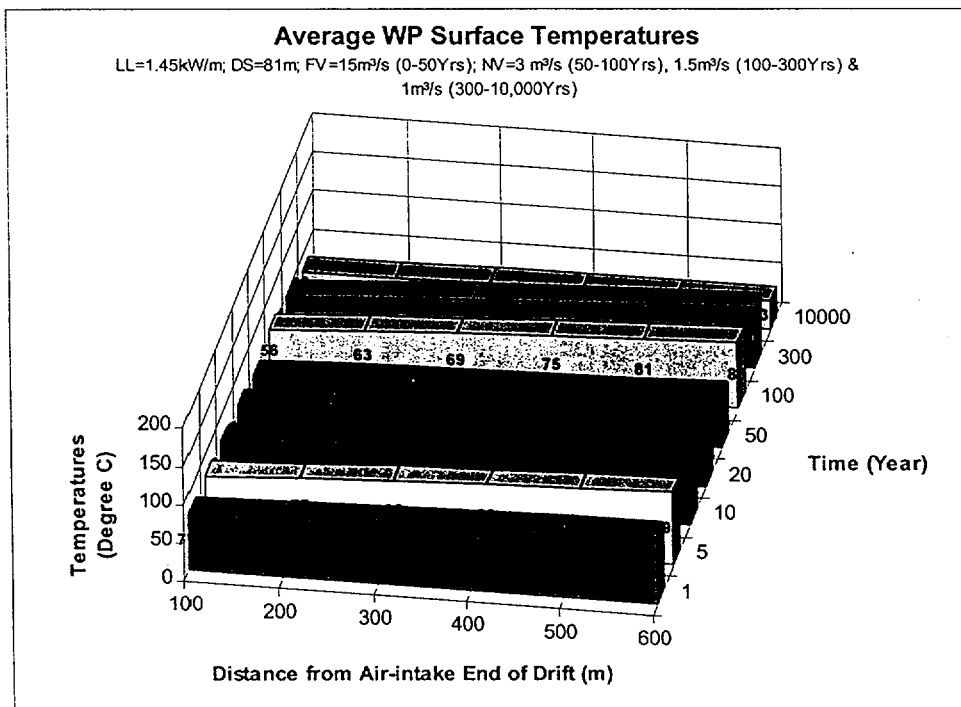
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XXVI-1, p. XXVI-3.

Figure XXVI-1. Average Drift Wall Temperatures for Case 25: HF5N3VI8



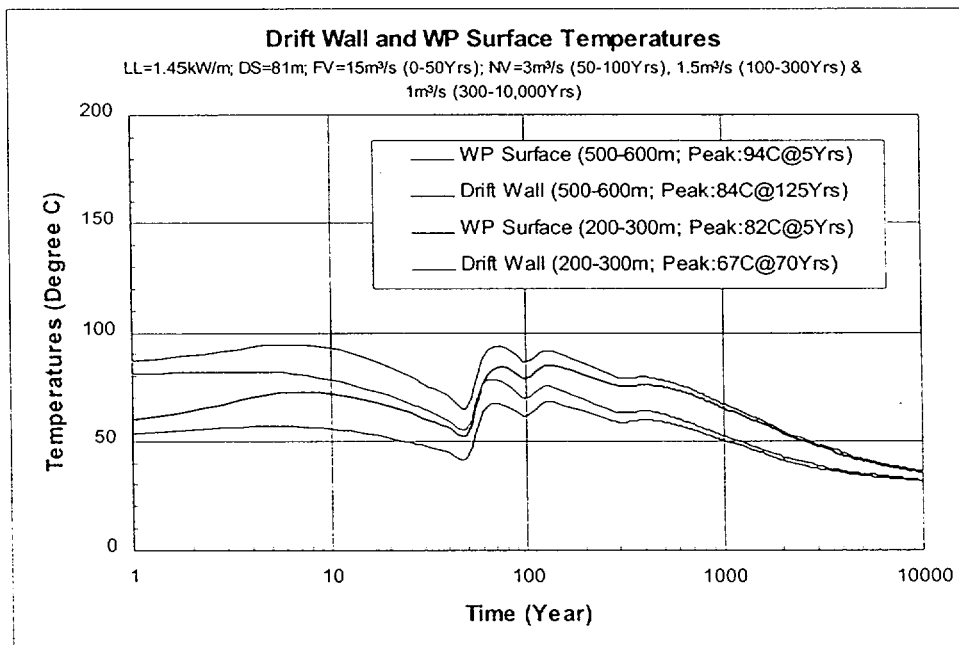
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XXVI-2, p. XXVI-4.

Figure XXVI-2. Average Air Temperatures for Case 25: HF5N3VI8



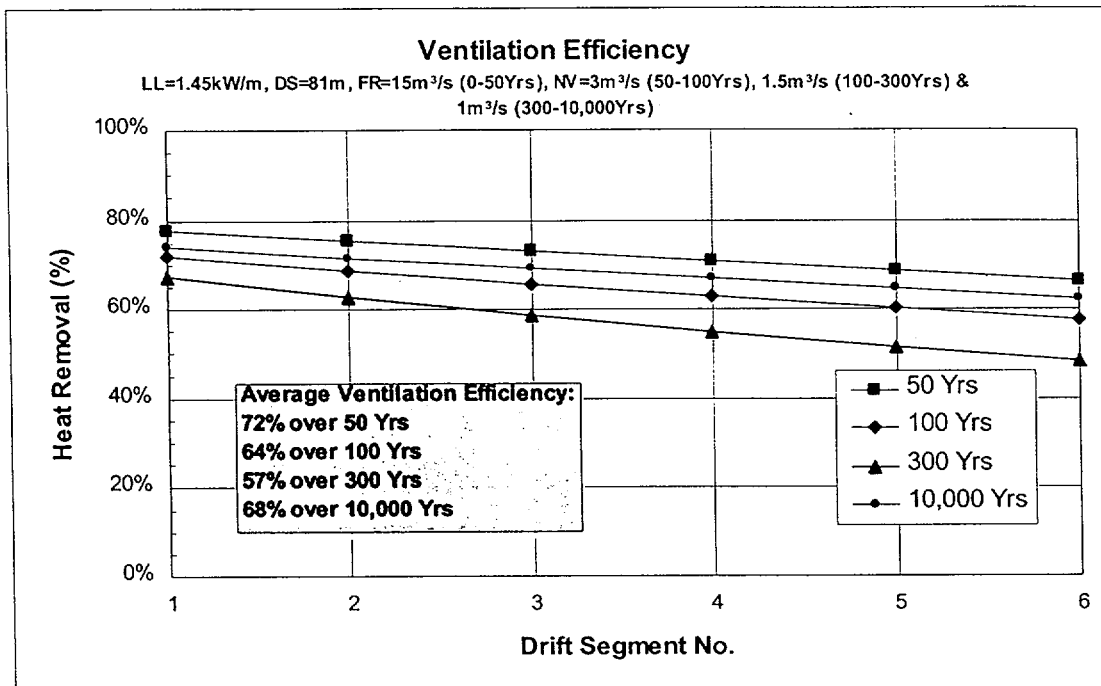
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation. For obliterated numbers, see Table XXVI-3, p. XXVI-5.

Figure XXVI-3. Average Waste Package Surface Temperatures for Case 25: HF5N3VI8



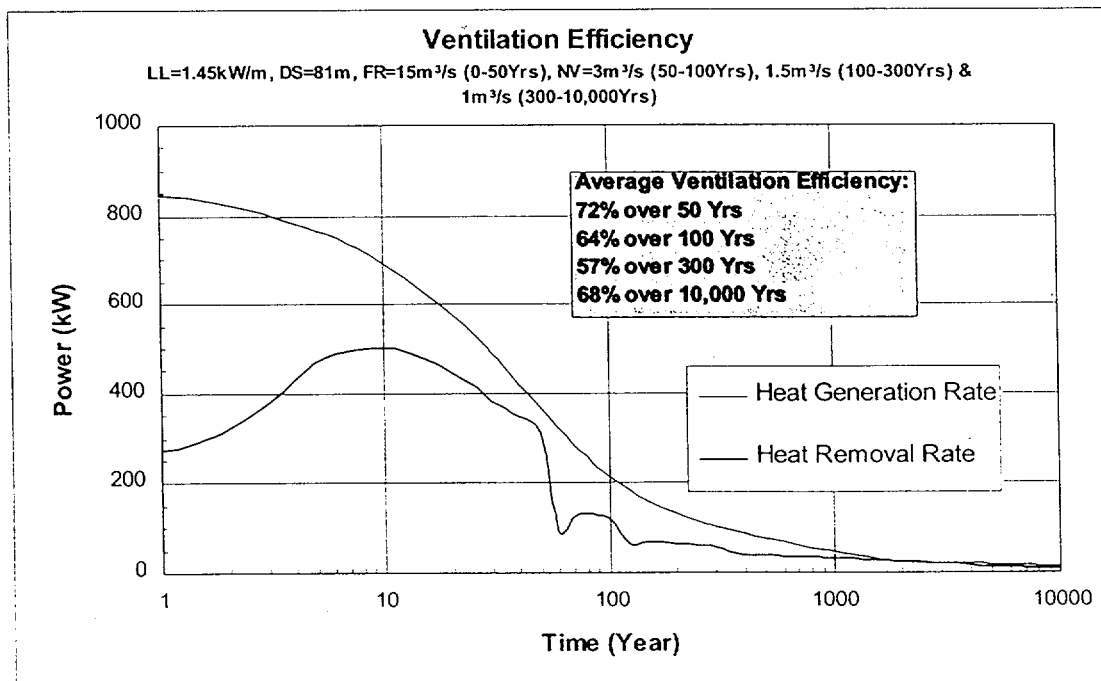
Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXVI-4. Average Drift Wall and Waste Package Surface Temperatures at Different Time and Locations for Case 25: HF5N3VI8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXVI-5. Average Heat Removal Rates at Different Drift Segments for Case 25: HF5N3VI8



Note: LL=Initial Linear Heat Load; DS=Drift Spacing; FV=Forced Ventilation; NV=Natural Ventilation.

Figure XXVI-6. Overall Heat Generation and Removal Rates at Different Time for Case 25: HF5N3VI8

ATTACHMENT XXVII

CALCULATION OF IN-DRIFT RELATIVE HUMIDITY FOR CASE 25: HF5N3VI8

ATTACHMENT XXVII

CALCULATION OF IN-DRIFT RELATIVE HUMIDITY FOR CASE 25: HF5N3VI8

This attachment provides the results of calculations of in-drift relative humidity for a linear heat load of 1.45 kW/m with a forced ventilation air flow rate of 15 m³/s from 0 to 50 years and natural ventilation air flow rates of 3 m³/s from 50 to 100 years, 1.5 m³/s from 100 to 300 years, and 1.0 m³/s from 300 to 10,000 years. Drift spacing for this case is 81 m. All data presented in this attachment are obtained from DTN: MO0103MWDTEM00.007.

The calculation used an average inlet air of 25°C dry bulb temperature at 30 percent relative humidity (see Section 5.3.2). The ventilation air is allowed to cross the emplacement drift picking up the heat of the waste packages and all the potential moisture influx of 60 mm per year, inclusive of the 600-m long emplacement drift aerial footprint.

Table XXVII-1 is a psychrometric calculation showing various potential temperatures and humidities of intake air in the emplacement drift. The table headings are described further with nomenclature and equations below. The formulas or equations used are taken from *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, pp. 12 to 18). Table XXVII-1 shows the specific psychrometric properties of the intake air at typical 25°C dry bulb temperature and 30 percent relative humidity in the repository horizon.

The same psychrometric calculation is applied to Tables XXVII-2 and XXVII-3 using various dry bulb air temperatures of ANSYS output and moisture mass present in the ventilation air as a result of water influx from the rock formation.

Calculations are converted to English Units by using the reference material equations or formulas for air psychrometry and conversion factors from *Mine Ventilation and Air Conditioning* (Hartman et al. 1997, pp. 12 to 18) and *Perry's Chemical Engineers' Handbook* (Perry and Green 1984, Table 1-5).

Calculation of water influx rate into the emplacement drift

- (1). Drift aerial configuration is 600 m × 5.5 m or approximately 2,000 ft × 18 ft for a total area of 36,000 ft².
- (2). Conversion of total water influx at 60 mm/year is 2.362 inches/yr or 0.19685 ft/yr.
- (3). Total annual water volume in emplacement drift is 36,000 ft² × 0.19685 ft/yr or 7,086.600 ft³/yr.
- (4). Total annual mass of water in emplacement drift is 7,086.600 ft³/yr × 62.4 lb/ ft³ or 442,203.84 lb/yr
- (5). Conversion rate of water influx to lb/min or grains/min at 100 percent evaporation is
442,203.84 lb/yr / 365 days/yr / 24 hr/day / 60 min/hr or 0.84133 lb/min

At 7,000 grains per pound,

Total water (moisture) influx rate to air is $0.84133 \text{ lb/min} \times 7,000 \text{ grains/lb} = 5,889.31 \text{ grains/min}$, using the conversion factor from *Perry's Chemical Engineers' Handbook* (Perry and Green 1984, Table 1-5).

Mass of Moisture in Emplacement Drift Air

- (1). The inlet air is 77°F (25°C) dry bulb temperature at 30 percent relative humidity. The calculated psychrometric properties of the inlet air is shown in Table XXVII-1. For Case 4, Column M shows the inlet air has initial moisture content of 47.25 grains/lb air.
- (2). The inlet air specific volume is 15.633 ft³/lb as shown in Table XXVII-1, Column N, for Case 4.
- (3). At an air volume conversion rate of $1 \text{ m}^3/\text{s} = 2,118.644 \text{ ft}^3/\text{min}$, the mass equivalent flow rate of air and moisture in the emplacement drift are as follows:

a) Air Quantity @ $15 \text{ m}^3/\text{s} = 2,118.644 \text{ ft}^3/\text{min}/(\text{m}^3/\text{s}) \times 15 \text{ m}^3/\text{s} = 31,779.66 \text{ ft}^3/\text{min}$

$$\text{Air Mass} = 31,779.66 \text{ ft}^3/\text{min} / 15.633 \text{ ft}^3/\text{lb} = 2032.857 \text{ lb/min}$$

$$\text{Total moisture rate added by water influx is } 5,889.31 \text{ grains/min}$$

Average distribution of added moisture in mass of air,

$$5,889.31 \text{ grains/min} / 2,032.857 \text{ lb/min} = 2.897 \text{ grains/lb}$$

New total moisture content of air = initial + water influx

$$= 47.25 \text{ grains/lb} + 2.897 \text{ grains/lb} = 50.15 \text{ grains/lb.}$$

b) Air Quantity @ $3 \text{ m}^3/\text{s} = 2,118.644 \text{ ft}^3/\text{min}/(\text{m}^3/\text{s}) \times 3 \text{ m}^3/\text{s} = 6,355.93 \text{ ft}^3/\text{min}$

$$\text{Air Mass} = 6,355.93 \text{ ft}^3/\text{min} / 15.633 \text{ ft}^3/\text{lb} = 406.571 \text{ lb/min}$$

$$\text{Total moisture rate added by water influx is } 5,889.31 \text{ grains/min}$$

Average distribution of added moisture in mass of air,

$$5,889.31 \text{ grains/min} / 406.571 \text{ lb/min} = 14.485 \text{ grains/lb}$$

New total moisture content of air = initial + water influx

$$= 47.25 \text{ grains/lb} + 14.485 \text{ grains/lb} = 61.738 \text{ grains/lb.}$$

c) Air Quantity @ $1.5 \text{ m}^3/\text{s} = 2,118.644 \text{ ft}^3/\text{min}/(\text{m}^3/\text{s}) \times 1.5 \text{ m}^3/\text{s} = 3,177.97 \text{ ft}^3/\text{min}$

$$\text{Air Mass} = 3,177.97 \text{ ft}^3/\text{min} / 15.633 \text{ ft}^3/\text{lb} = 203.286 \text{ lb/min}$$

Total moisture rate added by water influx is 5,889.31 grains/min

Average distribution of added moisture in mass of air,

$$5,889.31 \text{ grains/min} / 203.286 \text{ lb/min} = 28.971 \text{ grains/lb}$$

New total moisture content of air = initial + water influx

$$= 47.25 \text{ grains/lb} + 28.971 \text{ grains/lb} = 76.224 \text{ grains/lb.}$$

d) Air Quantity @ $1.0 \text{ m}^3/\text{s} = 2,118.644 \text{ ft}^3/\text{min} / (\text{m}^3/\text{s}) \times 1.0 \text{ m}^3/\text{s} = 2,118.64 \text{ ft}^3/\text{min}$

$$\text{Air Mass} - 2,118.64 \text{ ft}^3/\text{min} / 15.633 \text{ ft}^3/\text{lb} = 135.524 \text{ lb/min}$$

Total moisture rate added by water influx is 5,889.31 grains/min

Average distribution of added moisture in mass of air,

$$5,889.31 \text{ grains/min} / 135.524 \text{ lb/min} = 43.456 \text{ grains/lb}$$

New total moisture content of air = initial + water influx

$$= 47.25 \text{ grains/lb} + 43.456 \text{ grains/lb} = 90.709 \text{ grains/lb.}$$

- (4). Given the mass content of moisture in the exhaust air, in grains per pound, the relative humidity is calculated through the equations and formulas shown in Table XXVII-1. This is based on the calculated dry bulb temperatures using ANSYS, as shown in Column D of Tables XXVII-2 and XXVII-3.
- (5). Table XXVII-2, Column K data are calculated relative humidity predictions in the next 10,000 years of preclosure and postclosure repository ventilation. The calculation is based on the water influx of 60 mm per year into the emplacement drift.

Effects of Moisture on Predicted Thermal Response

The thermal prediction of emplacement drift climate through ANSYS simulation considers only the case when there is no moisture influx from the rock formation. ANSYS calculates the dry bulb temperature of the air in the emplacement drift. The moisture mass in the ventilation air crossing the entire 600-m long emplacement drift is constant.

Since this calculation has included the change in the moisture mass of the ventilation air because of water influx from the rock formation, the simulation of ANSYS and the calculation of relative humidity have some degree of uncertainty.

The effects of moisture on the predicted thermal response is shown by enthalpy comparison of Tables XXVII-2 and XXVII-3, which show the total heat content of the ventilation air with and without the moisture influx. The comparison of enthalpy is focused on the ventilation air after it crosses the 600-m long emplacement drift. Column P of Table XXVII-2 is the enthalpy of ventilation air, including the water influx of 60 mm per year. With the same ANSYS simulation,

Column P of Table XXVII-3 is the enthalpy of the ventilation air with a constant initial moisture mass and no water influx.

Table XXVII-4 is the enthalpy comparison of both cases. The effects of moisture on the predicted thermal response are judged in terms of the percent difference between the two outputs as follows:

- (1). For ventilation air of 15 m³/s in 0-50 years, the difference is between 1.12 to 1.68 percent.
- (2). For ventilation air of 3 m³/s in 50-100 years, the difference is between 5.01 to 5.68 percent.
- (3). For ventilation air of 1.5 m³/s in 100-300 years, the difference is between 9.69 to 10.37 percent.
- (4). For ventilation air of 1.0 m³/s in 300-10,000 years, the difference is between 15.47 to 22.89 percent.

A curve relationship of the enthalpy difference (percent) versus the air quantity for all cases (10,000 years) is shown Figure XXVII-1. The difference associated with the temperature calculations using ANSYS simulation by neglecting the effects of moisture on the thermal response is small, especially within the first few hundred years of repository ventilation when the air quantity is between 15 and 1.5 m³/s. The difference can become significant when the air quantity is 1.0 m³/s or less.

Table XXVII-1. Psychrometric Properties of Intake Ventilation Air in Emplacement Drift

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	M
		Dry Bulb	Dry Bulb	Wet Bulb	Wet Bulb	Bar.	Sat. Vapor	Sat. Vapor	Partial	Relative	Specific Humidity			Specific	Air Density	Enthalpy	
Sample Intake Ventilation Air		Temp.	Temp.	Temp	Temp	Pres. Ave.	Pres. at Td	Pres. at Tw	Vapor Pressure	Humidity	Moisture	Moisture	Volume	Moist Air	Heat Cont.	Moisture	Moisture
		Td	Td	Tw	Tw	Pb	Ps	Ps'	Pv	R	W (H2O)	W*7000	v	w	h	g/kg	W*7000
		Equiv. of	Assumed	Adjusted	Equiv. Of	Assumed	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	input
		Col D	Empl Air	to fit	Col. E	Ave Field										Col M x	
Case		Intake	Col. K			Data										0.1429	
		°F	°C	°F	°C	inch Hg	inch Hg	inch Hg	inch Hg	% Rel. Hum.	lb/lb dry air	Grains/lb air	ft³/lb dry air	lb/ft³	Btu/lb air	Gram/Kg	Grains/lb air
			Input °C	Adjusted Trial Number			Input °Hg			Desired Number							Calc Input
1		77.00	25	51.384	10.77	26.2	0.93763	0.38261	0.14064	15.00	0.00336	23.50	15.549	0.06452	22.155	3.36	23.50
2		77.00	25	53.331	11.85	26.2	0.93763	0.41107	0.18753	20.00	0.00448	31.39	15.577	0.06447	23.389	4.49	31.39
3		77.00	25	55.205	12.89	26.2	0.93763	0.44019	0.23440	25.00	0.00561	39.30	15.605	0.06443	24.626	5.62	39.30
4	Use this	77.00	25	57.011	13.90	26.2	0.93763	0.46996	0.28129	30.00	0.00675	47.25	15.633	0.06438	25.869	6.75	47.25
5		77.00	25	58.754	14.86	26.2	0.93763	0.50034	0.32817	35.00	0.00789	55.23	15.662	0.06434	27.116	7.89	55.23
6		77.00	25	60.436	15.80	26.2	0.93763	0.53128	0.37504	40.00	0.00903	63.23	15.690	0.06430	28.368	9.04	63.23
7		77.00	25	62.062	16.70	26.2	0.93763	0.56277	0.42193	45.00	0.01018	71.27	15.719	0.06425	29.624	10.18	71.27
8		77.00	25	63.634	17.57	26.2	0.93763	0.59476	0.46881	50.00	0.01133	79.33	15.747	0.06421	30.885	11.34	79.33
9		77.00	25	65.156	18.42	26.2	0.93763	0.62724	0.51569	55.00	0.01249	87.42	15.776	0.06417	32.151	12.49	87.42
10		80.00	26.668	59.150	15.08	26.2	1.03492	0.50748	0.31074	30.03	0.00747	52.26	15.739	0.06400	27.383	7.47	52.26

Note: T_d = temperature dry bulb, °F; T_w = temperature wet bulb, °F; P_b = barometric pressure, inch Hg.

Formulas used to determine characteristics of air are listed as follows (Hartman et al. 1997, pp. 12 to 18) and (Perry and Green 1984, Table 1-5):

Saturated Vapor Pressure (at T_d), $P_s = 0.18079 \times e^{(((17.27 \times T_d) - 552.64) / (T_d + 395.14))}$, inches Hg

Saturated Vapor Pressure (at T_w), $P_{s'} = 0.18079 \times e^{(((17.27 \times T_w) - 552.64) / (T_w + 395.14))}$, inches Hg

Vapor Pressure, $P_v = P_{s'} - ((P_b - P_{s'}) \times (T_d - T_w) / (2800 - 1.3 \times T_w))$, inches Hg

Relative Humidity, $R = (P_v / P_s) \times 100\%$

Specific Humidity, $W = 0.622 \times (P_v / (P_b - P_v))$, lb/lb dry air, or

Grains Specific Humidity, $W \times 7000 = 0.622 \times (P_v / (P_b - P_v)) \times 7000$, grains water vapor/lb dry air

Specific Volume, $v = 53.35 \times (460 + T_d) / ((P_b - P_v) \times 0.491 \times 144)$, ft³/lb

Moist Air density, $w = (1.325 / (460 + T_d)) \times (P_b - 0.378 \times P_v)$, lb/ft³

Enthalpy, $h = 0.24 \times T_d + W \times (1060 + 0.45 \times T_d)$, Btu/lb dry air

Table XXVII-2. Psychrometric Properties of Ventilation Air in Emplacement Drift - at 600 m with Variable Moisture

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	M
		Dry Bulb	Dry Bulb	Wet Bulb	Wet Bulb	Bar.	Sat. Vapor	Sat. Vapor	Partial	Relative	Specific Humidity		Specific	Air Density	Enthalpy		
Test Sta. & Remarks	Temp.	Temp.	Temp.	Temp.	Temp.	Pres. Ave.	Pres. at Td	Pres. at Tw	Vapor Pres.	Humidity	Moisture	Moisture	Volume	Moist Air	Heat Cont.	Moisture	Moisture
		Td	Td	Tw	Tw	Pb	Ps	Ps'	Pv	R	W (H ₂ O)	W*7000	v	w	h	g/kg	W*7000
		Equiv. of	Observed	Adjusted	Equiv. Of	Observed	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated
		Col D	Field	to fit	Col. E	Field										Col M x 0.1429	
Year	Air Quantity			Col. M													
	m ³ /s	°F	°C	°F	°C	Inch Hg	Inch Hg	Inch Hg	Inch Hg	% Rel. Hum.	lb/lb dry air	Grains/lb air	ft ³ /lb dry air	lb/ft ³	Btu/lb air	Gram/Kg	Grains/lb air
			Input °C			Input "Hg											Input
			600m														600m
0.0001	15	81.66	27.59	59.268	15.15	26.2	1.09238	0.50962	0.29834	27.31	0.00716	50.15	15.779	0.06381	27.456	7.17	50.15
1	15	112.35	44.64	68.697	20.39	26.2	2.78422	0.70887	0.29834	10.72	0.00716	50.15	16.673	0.06039	34.921	7.17	50.15
5	15	138.11	58.95	75.315	24.06	26.2	5.61866	0.88660	0.29834	5.31	0.00716	50.15	17.424	0.05779	41.186	7.17	50.15
10	15	142.29	61.27	76.299	24.61	26.2	6.25627	0.91608	0.29834	4.77	0.00716	50.15	17.545	0.05739	42.201	7.17	50.15
15	15	139.19	59.55	75.572	24.21	26.2	5.77797	0.89421	0.29834	5.16	0.00716	50.15	17.455	0.05769	41.448	7.17	50.15
20	15	134.85	57.14	74.532	23.63	26.2	5.16061	0.86372	0.29834	5.78	0.00716	50.15	17.329	0.05811	40.393	7.17	50.15
26	15	130.46	54.7	73.453	23.03	26.2	4.59399	0.83304	0.29834	6.49	0.00716	50.15	17.201	0.05854	39.325	7.17	50.15
30	15	126.59	52.55	72.479	22.49	26.2	4.13978	0.80617	0.29834	7.21	0.00716	50.15	17.088	0.05893	38.384	7.17	50.15
40	15	122.31	50.17	71.375	21.87	26.2	3.68248	0.77663	0.29834	8.10	0.00716	50.15	16.963	0.05936	37.342	7.17	50.15
50	15	117.10	47.28	69.996	21.11	26.2	3.18614	0.74106	0.29834	9.36	0.00716	50.15	16.812	0.05989	36.077	7.17	50.15
60	3	138.88	59.38	77.189	25.10	26.2	5.73245	0.94349	0.36631	6.39	0.00882	61.74	17.492	0.05766	43.232	8.82	61.74
70	3	162.03	72.24	82.165	27.87	26.2	10.17597	1.11034	0.36631	3.60	0.00882	61.74	18.168	0.05551	48.880	8.82	61.74
80	3	166.19	74.55	82.999	28.33	26.2	11.22451	1.14068	0.36631	3.26	0.00882	61.74	18.290	0.05515	49.894	8.82	61.74
90	3	163.35	72.97	82.430	28.02	26.2	10.49794	1.11992	0.36631	3.49	0.00882	61.74	18.207	0.05540	49.200	8.82	61.74
100	3	159.06	70.59	81.559	27.53	26.2	9.47899	1.08873	0.36631	3.86	0.00882	61.74	18.082	0.05578	48.155	8.82	61.74
125	1.5	166.23	74.57	84.773	29.32	26.2	11.23397	1.20761	0.45078	4.01	0.01089	76.22	18.351	0.05507	52.251	10.89	76.22
150	1.5	170.44	76.91	85.567	29.76	26.2	12.38894	1.23869	0.45078	3.64	0.01089	76.22	18.474	0.05471	53.283	10.89	76.22
200	1.5	166.57	74.76	84.838	29.35	26.2	11.32421	1.21013	0.45078	3.98	0.01089	76.22	18.361	0.05504	52.335	10.89	76.22
250	1.5	160.97	71.65	83.759	28.75	26.2	9.92191	1.16895	0.45078	4.54	0.01089	76.22	18.197	0.05554	50.964	10.89	76.22
300	1.5	156.13	68.96	82.802	28.22	26.2	8.83071	1.13346	0.45078	5.10	0.01089	76.22	18.055	0.05598	49.778	10.89	76.22
400	1	157.28	69.6	84.789	29.33	26.2	9.08060	1.20824	0.53470	5.89	0.01296	90.71	18.148	0.05580	52.400	12.96	90.71
500	1	157.21	69.56	84.775	29.32	26.2	9.06481	1.20771	0.53470	5.90	0.01296	90.71	18.146	0.05581	52.383	12.96	90.71
600	1	154.54	68.08	84.264	29.04	26.2	8.49667	1.18806	0.53470	6.29	0.01296	90.71	18.067	0.05605	51.728	12.96	90.71
700	1	151.09	66.16	83.590	28.66	26.2	7.80502	1.16263	0.53470	6.85	0.01296	90.71	17.966	0.05637	50.878	12.96	90.71
800	1	147.42	64.12	82.863	28.26	26.2	7.12327	1.13567	0.53470	7.51	0.01296	90.71	17.858	0.05671	49.975	12.96	90.71
900	1	143.74	62.08	82.122	27.85	26.2	6.49297	1.10879	0.53470	8.24	0.01296	90.71	17.750	0.05706	49.073	12.96	90.71
1000	1	140.31	60.17	81.416	27.45	26.2	5.94664	1.08370	0.53470	8.99	0.01296	90.71	17.649	0.05738	48.228	12.96	90.71
1500	1	133.61	56.45	80.006	26.67	26.2	4.99462	1.03505	0.53470	10.71	0.01296	90.71	17.452	0.05803	46.581	12.96	90.71
2000	1	124.11	51.17	77.920	25.51	26.2	3.86903	0.96655	0.53470	13.82	0.01296	90.71	17.173	0.05897	44.245	12.96	90.71
3000	1	115.00	46.11	75.819	24.34	26.2	3.00225	0.90160	0.53470	17.81	0.01296	90.71	16.905	0.05991	42.006	12.96	90.71
4000	1	107.38	41.88	73.980	23.32	26.2	2.41154	0.84791	0.53470	22.17	0.01296	90.71	16.681	0.06071	40.134	12.96	90.71
5000	1	102.58	39.21	72.778	22.65	26.2	2.09284	0.81433	0.53470	25.55	0.01296	90.71	16.540	0.06123	38.953	12.96	90.71
6000	1	99.55	37.53	72.004	22.22	26.2	1.91157	0.79333	0.53470	27.97	0.01296	90.71	16.451	0.06156	38.209	12.96	90.71
7000	1	97.48	36.38	71.466	21.93	26.2	1.79547	0.77902	0.53470	29.78	0.01296	90.71	16.390	0.06179	37.701	12.96	90.71
8000	1	95.92	35.51	71.054	21.70	26.2	1.71174	0.76823	0.53470	31.24	0.01296	90.71	16.344	0.06196	37.316	12.96	90.71
9000	1	94.66	34.81	70.721	21.51	26.2	1.64685	0.75957	0.53470	32.47	0.01296	90.71	16.307	0.06211	37.006	12.96	90.71
10000	1	93.58	34.21	70.433	21.35	26.2	1.59294	0.75217	0.53470	33.57	0.01296	90.71	16.275	0.06223	36.740	12.96	90.71

Table XXVII-3. Psychrometric Properties of Ventilation Air in Emplacement Drift - at 600 m with Constant Moisture

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	M
		Dry Bulb	Dry Bulb	Wet Bulb	Wet Bulb	Bar.	Sat. Vapor	Sat. Vapor	Partial	Relative	Specific Humidity		Specific	Air Density	Enthalpy		
Test Sta. & Remarks		Temp.	Temp.	Temp	Temp	Pres. Ave.	Pres. at Td	Pres. at Tw	Vapor Pres.	Humidity	Moisture	Moisture	Volume	Moist Air	Heat Cont.	Moisture	Moisture
		Td	Td	Tw	Tw	Pb	Ps	Ps*	Pv	R	W (H2O)	W*7000	v	w	h	g/kg	W*7000
		Equiv. of	Observed	Adjusted	Equiv. Of	Observed	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	Input
		Col D	Field	to flt	Col. E	Field										Col M x 0.1429	
Year	Air Quantity			Col. M													
	m ³ /s	°F	°C	°F	°C	Inch Hg	Inch Hg	Inch Hg	Inch Hg	% Rel. Hum.	lb/lb dry air	Grains/lb air	ft ³ /lb dry air	lb/ft ³	Btu/lb air	Gram/Kg	Grains/lb air
			Input °oC			Input "Hg											Input
			600m														600m
0 0001	15	81.66	27.59	58.648	14.80	26.2	1.09238	0.49844	0.28128	25.75	0.00675	47.25	15.769	0.06383	27.002	6.75	47.25
1	15	112.35	44.64	68.191	20.11	26.2	2.78422	0.69666	0.28127	10.10	0.00675	47.25	16.662	0.06041	34.461	6.75	47.25
5	15	138.11	58.95	74.879	23.82	26.2	5.61866	0.87380	0.28127	5.01	0.00675	47.25	17.412	0.05781	40.721	6.75	47.25
10	15	142.29	61.27	75.872	24.37	26.2	6.25627	0.90320	0.28127	4.50	0.00675	47.25	17.534	0.05740	41.736	6.75	47.25
15	15	139.19	59.55	75.138	23.97	26.2	5.77797	0.88139	0.28127	4.87	0.00675	47.25	17.444	0.05770	40.983	6.75	47.25
20	15	134.85	57.14	74.088	23.38	26.2	5.16061	0.85098	0.28127	5.45	0.00675	47.25	17.318	0.05812	39.929	6.75	47.25
26	15	130.46	54.7	72.998	22.78	26.2	4.59399	0.82039	0.28127	6.12	0.00675	47.25	17.190	0.05855	38.862	6.75	47.25
30	15	126.59	52.55	72.014	22.23	26.2	4.13978	0.79361	0.28127	6.79	0.00675	47.25	17.077	0.05894	37.921	6.75	47.25
40	15	122.31	50.17	70.898	21.61	26.2	3.68248	0.76417	0.28127	7.64	0.00675	47.25	16.952	0.05937	36.880	6.75	47.25
50	15	117.10	47.28	69.504	20.84	26.2	3.18614	0.72872	0.28127	8.83	0.00675	47.25	16.801	0.05991	35.616	6.75	47.25
60	3	138.88	59.38	75.065	23.92	26.2	5.73245	0.87924	0.28127	4.91	0.00675	47.25	17.435	0.05773	40.909	6.75	47.25
70	3	162.03	72.24	80.276	26.82	26.2	10.17597	1.04422	0.28127	2.76	0.00675	47.25	18.109	0.05558	46.535	6.75	47.25
80	3	166.19	74.55	81.147	27.30	26.2	11.22451	1.07428	0.28127	2.51	0.00675	47.25	18.230	0.05521	47.545	6.75	47.25
90	3	163.35	72.97	80.554	26.97	26.2	10.49794	1.05371	0.28127	2.68	0.00675	47.25	18.147	0.05547	46.854	6.75	47.25
100	3	159.06	70.59	79.643	26.47	26.2	9.47899	1.02282	0.28127	2.97	0.00675	47.25	18.022	0.05585	45.813	6.75	47.25
125	1.5	166.23	74.57	81.155	27.31	26.2	11.23397	1.07454	0.28127	2.50	0.00675	47.25	18.231	0.05521	47.554	6.75	47.25
150	1.5	170.44	76.91	82.019	27.79	26.2	12.38894	1.10510	0.28127	2.27	0.00675	47.25	18.354	0.05484	48.578	6.75	47.25
200	1.5	166.57	74.76	81.226	27.35	26.2	11.32421	1.07701	0.28127	2.48	0.00675	47.25	18.241	0.05518	47.637	6.75	47.25
250	1.5	160.97	71.65	80.051	26.69	26.2	9.92191	1.03656	0.28127	2.83	0.00675	47.25	18.078	0.05568	46.277	6.75	47.25
300	1.5	156.13	68.96	79.007	26.12	26.2	8.83071	1.00174	0.28127	3.19	0.00675	47.25	17.937	0.05612	45.100	6.75	47.25
400	1	157.28	69.6	79.258	26.25	26.2	9.08060	1.01001	0.28128	3.10	0.00675	47.25	17.970	0.05601	45.380	6.75	47.25
500	1	157.21	69.56	79.242	26.25	26.2	9.06481	1.00949	0.28128	3.10	0.00675	47.25	17.968	0.05602	45.363	6.75	47.25
600	1	154.54	68.08	78.660	25.92	26.2	8.49667	0.99039	0.28128	3.31	0.00675	47.25	17.891	0.05626	44.715	6.75	47.25
700	1	151.09	66.16	77.893	25.50	26.2	7.80502	0.96568	0.28128	3.80	0.00675	47.25	17.790	0.05658	43.875	6.75	47.25
800	1	147.42	64.12	77.062	25.03	26.2	7.12327	0.93954	0.28128	3.95	0.00675	47.25	17.683	0.05692	42.983	6.75	47.25
900	1	143.74	62.08	76.214	24.56	26.2	6.49297	0.91351	0.28128	4.33	0.00675	47.25	17.576	0.05727	42.090	6.75	47.25
1000	1	140.31	60.17	75.404	24.11	26.2	5.94664	0.88924	0.28128	4.73	0.00675	47.25	17.476	0.05759	41.255	6.75	47.25
1500	1	133.61	56.45	73.783	23.21	26.2	4.99462	0.84231	0.28128	5.63	0.00675	47.25	17.281	0.05824	39.627	6.75	47.25
2000	1	124.11	51.17	71.370	21.87	26.2	3.86903	0.77651	0.28127	7.27	0.00675	47.25	17.005	0.05919	37.317	6.75	47.25
3000	1	115.00	46.11	68.927	20.51	26.2	3.00225	0.71447	0.28127	9.37	0.00675	47.25	16.740	0.06013	35.104	6.75	47.25
4000	1	107.38	41.88	66.775	19.32	26.2	2.41154	0.66348	0.28127	11.66	0.00675	47.25	16.518	0.06094	33.253	6.75	47.25
5000	1	102.58	39.21	65.362	18.53	26.2	2.09284	0.63175	0.28127	13.44	0.00675	47.25	16.378	0.06146	32.085	6.75	47.25
6000	1	99.55	37.53	64.449	18.03	26.2	1.91157	0.61197	0.28127	14.71	0.00675	47.25	16.290	0.06179	31.350	6.75	47.25
7000	1	97.48	36.38	63.814	17.67	26.2	1.76547	0.59853	0.28127	15.67	0.00675	47.25	16.230	0.06202	30.847	6.75	47.25
8000	1	95.92	35.51	63.328	17.40	26.2	1.71174	0.58841	0.28127	16.43	0.00675	47.25	16.184	0.06219	30.467	6.75	47.25
9000	1	94.66	34.81	62.932	17.18	26.2	1.64685	0.58029	0.28127	17.08	0.00675	47.25	16.147	0.06233	30.160	6.75	47.25
10000	1	93.58	34.21	62.591	17.00	26.2	1.59294	0.57336	0.28127	17.66	0.00675	47.25	16.116	0.06246	29.898	6.75	47.25

Table XXVII-4. Comparison of Enthalpy with Variable or Constant Moisture

Year	Case No.	Air Flow Rate (m ³ /s)	Enthalpy Difference (%)	Enthalpy (BTU/lb)	
				With Variable Moisture	With Constant Moisture
0.0001	1	15	1.68	27.46	27.00
1	2	15	1.34	34.92	34.46
5	3	15	1.14	41.19	40.72
10	4	15	1.12	42.20	41.74
15	5	15	1.13	41.45	40.98
20	6	15	1.16	40.39	39.93
26	7	15	1.19	39.33	38.86
30	8	15	1.22	38.38	37.92
40	9	15	1.25	37.34	36.88
50	10	15	1.29	36.08	35.62
60	11	3	5.68	43.23	40.91
70	12	3	5.04	48.88	46.53
80	13	3	4.94	49.89	47.55
90	14	3	5.01	49.20	46.85
100	15	3	5.11	48.15	45.81
125	16	1.5	9.88	52.25	47.55
150	17	1.5	9.69	53.28	48.58
200	18	1.5	9.86	52.34	47.64
250	19	1.5	10.13	50.96	46.28
300	20	1.5	10.37	49.78	45.10
400	21	1	15.47	52.40	45.38
500	22	1	15.48	52.38	45.36
600	23	1	15.68	51.73	44.72
700	24	1	15.96	50.88	43.88
800	25	1	16.27	49.98	42.98
900	26	1	16.59	49.07	42.09
1000	27	1	16.90	48.23	41.25
1500	28	1	17.55	46.58	39.63
2000	29	1	18.56	44.25	37.32
3000	30	1	19.66	42.01	35.10
4000	31	1	20.69	40.13	33.25
5000	32	1	21.40	38.95	32.09
6000	33	1	21.88	38.21	31.35
7000	34	1	22.22	37.70	30.85
8000	35	1	22.48	37.32	30.47
9000	36	1	22.70	37.01	30.16
10000	37	1	22.89	36.74	29.90

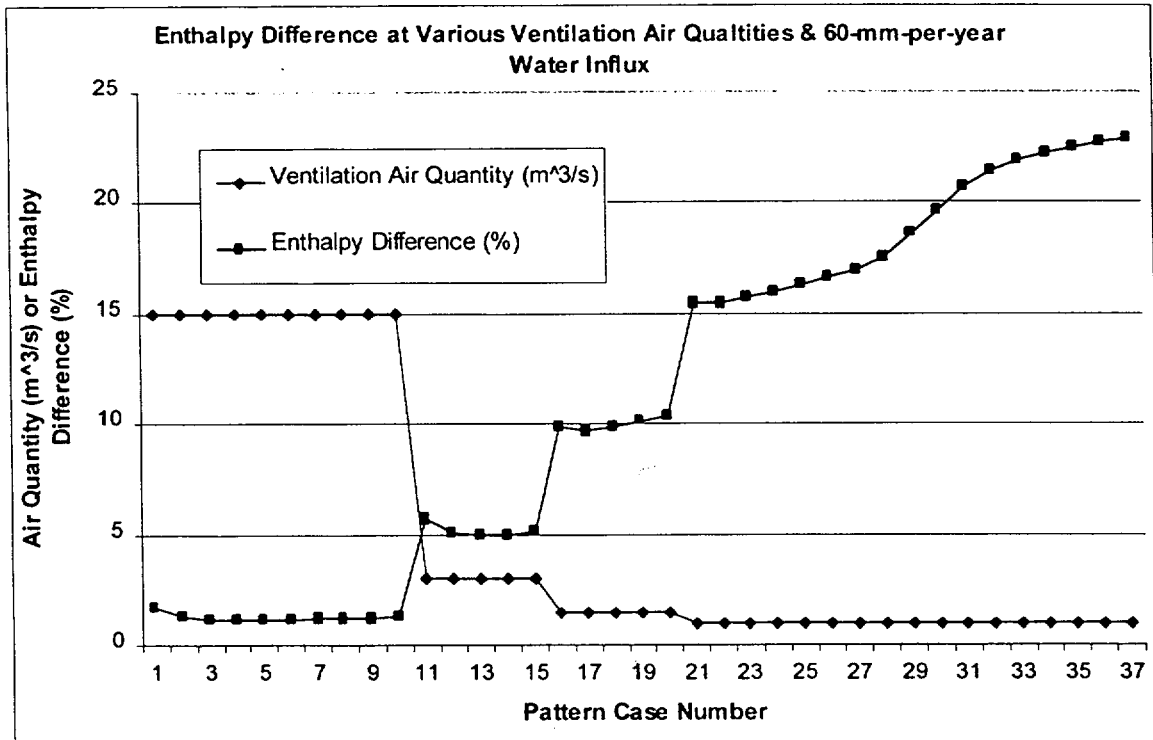


Figure XXVII-1. Enthalpy Difference at Various Ventilation Air Quantities and 60-mm per Year Water Influx