Background Report Reference

AP-42 Section Number: 12.20

Background Chapter: 4

Reference Number: 68

Title: Nickel Compliance Emission Determination of the Packed Tower Evaporator, Compliance Testing for Nicle Emissions

American Nickeloid Company

June 1988

AP-42 Section 12.20
Reference
Report Sect. 4
Reference 68

BTD-801 1-84

COMMONWEALTH OF PENNSYLVANIA

July 13, 1988

SUBJECT: AMERICAN NICKELOID COMPANY
Walnutport
Northampton County

TO: L. Blaine DeHaven, Chief
Source Testing & Monitoring Section

THRU: Thomas A. DiLazaro
District Engineer

FROM: Ronald D. Mordosky
Air Quality Specialist

On April 14, 1988, SCM conducted a test for nickel emissions on a plating solution evaporator at American Nickeloid Company, Walnutport, Northampton County.

Please review the test report to determine if the test methods used comply with the Department's requirements.

RDM/bas

AP-42 Section 12.20
Reference
Report Sect. 4
Reference 68

BTD-501 1-84

COMMONWEALTH OF PENNSYLVANIA

July 13, 1988

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Walnutport
Northampton County

TO: L. Blaine DeHaven, Chief
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RDM/bas

NICKEL COMPLIANCE EMISSION DETERMINATION OF THE PACKED TOWER EVAPORATOR

COMPLIANCE TESTING FOR NICKEL EMISSIONS

FOR

AMERICAN NICKELOID COMPANY
WALNUTPORT, PENNSYLVANIA

JUNE 1988

BCM PROJECT NO. 00-6030-01

PREPARED BY

PHILIP C. BURG
SCIENTIST IV

APPROVED BY

ASHOK K. SONI, P.E.
ASSISTANT VICE PRESIDENT

BCM
Engineers, Planners and Scientists
One Plymouth Meeting • Plymouth Meeting, PA 19462 • Phone: (215) 825-3800

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TABLES

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1.0 EXECUTIVE SUMMARY

American Nickelold Company, (American Nickelold) recently installed a packed tower evaporation unit at its facility in Walnutport, Pennsylvania. The packed tower unit was installed to concentrate the amount of nickel contained in the ~~nitric acid bath~~ solution of plating system Number 1. Discharge air from this unit passes through a de-mister before being released.

The Pennsylvania Department of Environmental Resources (PADER) has established that nickel emissions from the evaporation unit can not exceed 0.0017 pound per hour and has required American Nickelold to demonstrate compliance with these guidelines by source sampling. Both of these conditions were set forth in PADER's Temporary Operating Permit No. 48-318-113.

BCM Engineers (BCM) conducted three emission test runs at the evaporator exhaust stack in accordance with EPA and PADER methodology on April 15, 1988. Test results show the average emission rate of nickel from the evaporator exhaust stack was 0.0011 lb/hr. This represents 64.7 percent of the 0.0017 lb/hr allowable emission rate.

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2.0 SCOPE AND OBJECTIVES

Sampling was conducted to determine the following parameters at the evaporator exhaust stack:

- Gas flow - acfm and scfm
- Gas temperature - F°
- Gas moisture content - percent by volume
- Gas velocity - fpm
- Nickel emissions - grain/dscf and lb/hr

All field samples were returned to the BCM laboratory in Norristown, Pennsylvania, for subsequent analyses.

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3.0 PROCEDURES

3.1 FIELD WORK

Field testing of the process exhaust was conducted on April 15, 1988. The BCM sampling team consisted of the following personnel:

Philip C. Burg - Scientist IV
Pete Wilking - Technician

Mr. John Fischl acted as liaison between American Nickeloid and BCM and ensured that the process was operating normally during the test periods. Mr. Ronald Mordasky of the PADER witnessed the testing procedures and the process operating conditions.

The following methods of sampling were employed in the test program:

1. Sampling and traverse locations were determined in accordance with Method 1 of the Federal Register, Volume 42, Number 160, August 18, 1977.

2. Gas flow, gas temperature, and static pressure measurements were made in accordance with Method 2 of the Federal Register, Volume 42, Number 160, August 18, 1977.

3. Moisture content sampling was conducted in accordance with Method 4 of the Federal Register, Volume 42, Number 160, August 18, 1977.

4. Nickel sampling was conducted in accordance with Method 12 of the Federal Register, Volume 47, Number 74, April 16, 1982.

Descriptions of these methodologies are contained in Appendix A of this report.

3.2 ANALYTICAL METHODS

All samples generated during the sampling program were analyzed at the BCM laboratory in Norristown, Pennsylvania. An outline of the analytical methodologies is contained in Appendix B. Laboratory data are also presented in Appendix B.

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3.3 CALCULATIONS

All moisture content, gas flow, and molecular weight calculations were introduced into equations presented in methods 2, 3, 4, and 12, of the Federal Register, Volume 42, Number 160, August 18, 1977, as amended. This evaluation was conducted with a computer program written in Lotus 1-2-3.

3.4 EQUIPMENT CALIBRATION

In accordance with the accepted procedures published by the EPA, all gas velocity measuring equipment, volume metering equipment, temperature measuring equipment, and flow rate equipment had been calibrated prior to the test date. Calibration data are included in Appendix D.

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4.0 RESULTS

4.1 GAS FLOW RATE DATA

Gas flow rate results obtained during the nickel emission test runs are contained in Table 1 below.

4.2 NICKEL EMISSION RESULTS

Nickel emission results of test Run Nos. 1, 2 and 3 are presented in Table 1 below. Other pertinent test parameters are listed on the computer printouts in Appendix B.

Nickel emission results indicate that emissions from the packed tower evaporation unit servicing plating system No. 1 did not exceed PADER's allowable emission rate of 0.0017 lb/hr.

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TABLE 1

GAS FLOW RATE DATA

Run No.	Stack Temperature (°F)	Moisture Content (%)	Gas Velocity (ft/min)	Gas Flow Rate (acfm)	(dscfm)
1	67	2.3	1239	3892	3764
2	60	3.1	1149	3609	3495
3	65	5.1	1087	3414	3206
AVERAGE	64	3.5	1158	3638	3488

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TABLE 2

NICKEL EMISSION RESULTS

Run No.	Emission Concentration (grain/dscf)	Emission Rate (lb/hr)
1	4.3×10^{-5}	0.0014
2	1.4×10^{-5}	0.0004
3	5.6×10^{-5}	0.0015
AVERAGE	3.8×10^{-5}	0.0011

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APPENDIX A

FIELD SAMPLING PROGRAM

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APPENDIX A

FIELD SAMPLING PROGRAM

1.0 SAMPLING PROCEDURES

1.1 Test Station and Traverse Locations

The evaporation outlet stack had an internal diameter of 24 inches and had 2 to 3 inch test ports located 90° apart in the same cross-section plane. The nearest upstream and downstream flow disturbances were located 25 inches and 14 inches respectively from the test ports. Twelve traverse points per port were utilized during the testing program.

1.2 Gas Flow and Gas Temperature Determinations

The gas flow rate and temperature profile at each source was measured by conducting a simultaneous velocity and temperature traverse. Gas velocity heads were measured with a calibrated "S"-type pitot tube which was connected to an inclined manometer. A Chromel-Alumel thermocouple connected to a potentiometer was used to determine the gas temperature.

Prior to the nickel emission determinations a preliminary velocity traverse and cyclonic flow check was performed at the testing location. Results of the cyclonic flow check revealed the average flow angle of the stack gas was 7.6 degrees.

1.3 Moisture Content

Moisture sampling was conducted concurrently with nickel sampling employing the principles presented in EPA Method 4. Parameters evaluated in order to determine the gas stream's moisture content were: sample gas volume, sample gas temperature, sample gas pressure, impinger moisture gain, and silica gel moisture gain. Some minor modifications were made to the Method 4 train to allow concurrent nickel and moisture content sampling. These modifications did not deviate from sampling principles. The primary modifications were the substitution of a glass fiber filter for Pyrex wool as a filtering medium and the substitution of a calibrated orifice for a rotameter as a flow metering device.

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1.4 Molecular Weight Determinations

A Fyrite gas analyzer was used to determine the molecular weight of the exhaust gas. The following parameters were measured in order to calculate molecular weight: volume percent carbon dioxide (CO_2), volume percent oxygen (O_2), and volume percent nitrogen (N_2), determined by difference. The evaporator exhausted ambient air; therefore, there was no carbon monoxide present.

1.5 Nickel Sampling

All sampling procedures and sampling equipment employed were those outlined in Method 12 of the Federal Register, Volume 47, Number 74, April 16, 1982.

The size of the nozzle required to maintain isokinetic sampling was calculated from the results of the previously completed velocity and temperature traverses. The sampling train used a glass-lined stainless steel probe which was heated to 250°F by an internal heating element. A nozzle of the calculated size was attached to the end of the probe which was inserted into the stack. A calibrated "S"-type pitot tube and a Chromel-Alumel thermocouple were clamped to the probe and were used to monitor the velocity head and the temperature at the traverse points during the sampling period. Sampled gas passed through the nozzle and the probe to a glass fiber filter for the removal of the suspended particulates and nickel. The filter was housed in a heated chamber whose temperature was maintained at 250°F. From the filter, the stack gas passed to the impinger train. The first two impingers each contained 150 ml of 0.1 N nitric acid (HNO_3). The third impinger contained no reagents and was a knockout impinger. The fourth impinger contained approximately 200 grams of coarse silica gel that collected any moisture and/or vapors which had not been captured in the preceding impingers.

The second impinger was a 500-ml Greenburg-Smith impinger; the first, third, and fourth were 500-ml impingers of the Greenburg-Smith design, modified by replacing the tip with a 1/2-inch inside diameter (I.D.) glass tube. It should be noted that the impinger train was monitored for the entire test period in order that the exit gas temperature not exceed 70°F.

From the impinger train, the gas was conducted through an umbilical cord to the control console which contained the following pieces of equipment (listed in the order in which sampled gas passed through them): a main valve, a bypass valve for flow adjustment, an airtight vacuum pump, a dry gas meter, and a calibrated orifice. The orifice was equipped with pressure taps which were connected across the inclined manometer used to ensure that isokinetic conditions were being maintained. A schematic diagram of the EPA Method 12 sampling train can be found at the end of Appendix.

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The sampling train was subjected to a leak check prior to and after each sample run. The inlet of the nozzle was plugged and the pump vacuum was held at the highest vacuum attained during the period of testing. In all cases, the leakage rate was minimal and did not exceed the maximum allowable leakage rate of 0.02 cfm.

Upon completion of a test, the soiled glass filter was removed from its filter holder and placed in a petri dish which was subsequently sealed. The probe and nozzle were washed internally with 0.1 N HNO_3; the residual matter remaining in the probe was removed with a nylon brush attached to a polyethylene line. The front half of the glass filter holder was also rinsed with 0.1 N HNO_3 and the washings obtained were added to those collected from the nozzle and the probe. All washings were stored in sealed amber glass bottles for transfer to the laboratory. The silica gel used in the fourth impinger was removed and stored in a sealed sample bottle. The contents of the first, second, and third impingers were combined and measured volumetrically. The impingers were then rinsed with 0.1 N HNO_3 and added to the impinger solution.

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2.0 FILED DATA SHEETS

The field data sheets for the nickel testing follows.

Betz • Converse • Murdoch • Inc. BCM

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Armstrong Machinery
DATE 4/14/88
SAMPLING LOCATION Sampling Inc Outlet
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE. (DISTANCE A) _____
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE. (DISTANCE B) _____
STACK I.D., (DISTANCE A - DISTANCE B) 24"
NEAREST UPSTREAM DISTURBANCE _____
NEAREST DOWNSTREAM DISTURBANCE _____
CALCULATOR _____

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	2.1	24"	1.0		
2	6.7		1.6		
3	11.8		2.8		
4	17.7		4.2		
5	25.0		6.0		
6	35.6		8.5		
7	64.4		15.5		
8	75.0		18.0		
9	82.3		19.7		
10	88.3		21.2		
11	93.3		22.4		
12	97.9		23.0		

Betz • Converse • Murdoch • Inc. BCM

VELOCITY DETERMINATIONS

Client: American Asphalt

Location: Evaporator Outlet

Date: 4/14/83

Stack Pressure:

Barometric Pressure:

Pitot Factor: .84

Engineer:

Sample Port Locations:

Pitot/Temperature Readings

Point No.	Distance (Inches)	Port A		Port		Port B		Port		Port	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
12		.09	0			.14	+5				
11		.09	+10			.13	+15				
10		.07	+2			.10	+10	78°			
9		.06	+5	78°		.05	+8				
8		.06	+5			.02	+12				
7		.03	+5			.02	+10	78°			
6		.06	+5			.02	+5				
5		.14	+10			.02	-10				
4		.21	+12	78°		.07	-5				
3		.33	+15			.17	-5	78°			
2		.49	-15			.14	+5				
1		.38	0			.20	+8				
TOTAL						3.09	182				
AVG.						.13	7.6				

Betz • Converse • Murdoch • Inc. BCM

NOMOGRAPH DATA

PLANT American Nickeloid

DATE 4/14/88

SAMPLING LOCATION Evaporator Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.86
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	80
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	4
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	29.75
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	78°
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.13
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.49
C FACTOR	1.0	
CALCULATED NOZZLE DIAMETER, in.	.34	
ACTUAL NOZZLE DIAMETER, in.	.251	
REFERENCE Δp, in. H_2O	.46	

Set #4 D_N = .251 ; .252 , .250 = .251

BCM FIELD DATA SHEET

PLANT: American Nickeloid
DATE: 4/14/88
SAMPLING LOCATION: Evaporator Outlet
SAMPLE TYPE: Nickel
RUN NUMBER: One OPERATOR: BCB
BAROMETRIC PRESSURE: 29.25 STATIC PRESSURE: -2.5
FILTER NUMBER(S):
GEL NUMBER(S):
THIMBLE NUMBER: PLATE NUMBER:
H_2O PICKUP (ml): +12 ml H_2O +7.4 g gel

ORSAT:
CO_2: 0
O_2: 21.0
CO: 0

READ AND RECORD ALL DATA EVERY 4 MINUTES

PYROMETER NUMBER:
THERMOCOUPLE NUMBER:
PROBE NUMBER: TYPE: Glass 3'
NOZZLE NUMBER: 4 I.D. .251
METER BOX NUMBER: 285 $\Delta H_@$ 1.86
PITOT NUMBER: C_p .84
SAMPLE BOX NUMBER(S):
ASSUMED MOISTURE (%): 4
ASSUMED METER TEMPERATURE: 80
C FACTOR: 1.0 REFERENCE ΔP: .46

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	00	1515	728.471									
B-1	04	1519	730.5	.18	.71	.71	64	70	68	4	259	44
2	08	1523	732.9	.28	1.10	1.10	66	83	69	5	230	44
3	12	1527	735.0	.22	.86	.86	67	91	71	4	225	44
4	16	1531	736.1	.06	.23	.23	70	87	72	3	230	44
5	20	1535	737.7	.03	.11	.11	72	83	73	3	233	44
6	24	1539	737.8	.03	.11	.11	71	82	74	3	237	44
7	28	1543	738.4	.02	.07	.07	68	82	76	2	241	44
8	32	1547	739.2	.03	.11	.11	68	83	77	2	241	44
9	36	1551	740.3	.05	.20	.20	68	86	78	2	243	44
10	40	1555	742.0	.11	.43	.43	69	92	79	3	245	44
11	44	1559	743.7	.15	.60	.60	69	96	80	4	243	44
12	48	1603	745.530	.15	.60	.60	70	97	80	4	242	44

PLANT American Nickeloid DATE 4/14/89 RUN NUMBER one

TRAVERSE POINT NUMBER	CLOCK TIME (24 hr CLOCK) SAMPLING TIME, min		GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	AB	1606	745.530									
A 1	52	1610	748.5	-36	1.50	1.50	60	92	80	6	230	42
2	56	1614	751.2	.28	1.10	1.10	61	101	81	5	220	44
3	60	1618	753.6	.25	1.00	1.00	65	100	82	4	222	44
4	64	1622	755.7	.21	.83	.83	66	99	82	4	223	44
5	68	1626	757.6	.15	.60	.60	66	97	82	4	226	44
6	72	1630	759.3	.11	.43	.43	66	95	82	3	229	44
7	76	1634	760.1	.07	.28	.28	67	91	82	3	228	44
8	80	1638	761.3	.08	.32	.32	66	92	82	3	227	44
9	84	1642	763.0	.10	.43	.43	66	94	82	3	228	44
10	88	1646	764.9	.16	.62	.62	67	96	82	4	230	44
11	92	1650	767.0	.24	.95	.95	66	100	82	4	232	44
12	96	1654	769.058	.20	.80	.80	68	100	82	4	230	44
				Leak check at			17" Hg	= .005				
			V_m = 40.587	$\sqrt{\Delta p}$ = .362	ΔH = .583		$\bar{T}_s$ = 67	$\bar{T}_m$ = 85				

PLANT American Nickeloid

DATE 4/15/88

SAMPLING LOCATION Empanata Outlet

SAMPLE TYPE Nickel

RUN NUMBER Two OPERATOR ROB

BAROMETRIC PRESSURE 29.64 STATIC PRESSURE -2.5

FILTER NUMBER(S)

GEL NUMBER(S)

THIMBLE NUMBER PLATE NUMBER

H_2O PICKUP (ml) +20ml H_2O +5.1g silica gel

BCM FIELD DATA SHEET

ORSAT:

CO_2 0

O_2 21

CO 0

PYROMETER NUMBER

THERMOCOUPLE NUMBER

PROBE NUMBER TYPE

NOZZLE NUMBER I.D.

METER BOX NUMBER $\Delta H_@$

PITOT NUMBER C_p

SAMPLE BOX NUMBER(S)

ASSUMED MOISTURE (%)

ASSUMED METER TEMPERATURE

C FACTOR 1.0 REFERENCE Δp .46 / 1.44

READ AND RECORD ALL DATA EVERY 4 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	00	0854	769.848									
A-1	04	0858	772.3	.27	1.05	1.05	53	55	60	4	225	44
2	08	0902	774.7	.30	1.30	1.30	55	67	59	4	227	43
3	12	0906	777.0	.25	1.00	1.00	57	74	59	4	239	43
4	16	0910	779.2	.22	.92	.92	57	78	59	4	240	42
5	20	0914	781.0	.14	.58	.58	59	79	60	4	243	42
6	24	0918	782.4	.11	.45	.45	59	76	61	3	249	42
7	28	0922	783.8	.06	.25	.25	63	76	61	3	254	42
8	32	0926	785.1	.09	.37	.37	63	77	62	3	254	42
9	36	0930	786.7	.10	.42	.42	62	79	63	3	254	42
10	40	0934	788.4	.13	.54	.54	63	81	64	3	261	42
11	44	0938	790.2	.15	.63	.63	63	82	64	3	264	42
12	48	0942	792.230	.18	.75	.75	63	82	66	4	265	42

PLANT American Nickeloid DATE 4/15/88 RUN NUMBER Tube

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	48	0947	792.230									
B 1	52	0951	794.0	.11	.45	.45	52	66	63	3	270	42
2	56	0955	795.7	.18	.50	.50	54	78	65	3	267	41
3	60	0959	797.1	.12	.50	.50	54	80	65	3	262	41
4	64	1003	798.2	.06	.24	.24	57	72	65	3	263	41
5	68	1007	799.1	.03	.12	.12	62	75	65	3	262	41
6	72	1011	799.9	.03	.12	.12	62	71	65	2	261	41
7	76	1015	800.7	.03	.12	.12	63	70	65	2	263	41
8	80	1019	801.7	.04	.16	.16	64	72	65	2	256	41
9	84	1023	803.0	.07	.28	.28	64	75	65	2	254	41
10	88	1027	804.5	.11	.45	.45	63	80	66	3	253	41
11	92	1031	806.3	.14	.58	.58	63	83	66	4	256	41
12	96	1035	808.120	.15	.64	.64	62	85	66	4	254	41
			Leak check		at	15"	H_g = .015 cfm					
			V_m = 38.272	$\overline{\Delta p}$ = .338	$\overline{\Delta H}$ = 0.513		T_s = 60°	T_m = 69				

PLANT American Rockwool

DATE 4/15/88

SAMPLING LOCATION Evaporator Outlet

SAMPLE TYPE Nickel

RUN NUMBER Three OPERATOR RGB

BAROMETRIC PRESSURE 29.62 STATIC PRESSURE -2.5

FILTER NUMBER(S)

CEL NUMBER(S)

THIMBLE NUMBER PLATE NUMBER

H_2O PICKUP (ml) 433.2 H_2O +46.0 gel

BCM

FIELD DATA SHEET

ORSAT:

CO_2

O_2

CO

PYROMETER NUMBER

THERMOCOUPLE NUMBER

PROBE NUMBER TYPE

NOZZLE NUMBER I.D.

METER BOX NUMBER $\Delta H_@$

PITOT NUMBER C_p

SAMPLE BOX NUMBER(S)

ASSUMED MOISTURE (%)

ASSUMED METER TEMPERATURE

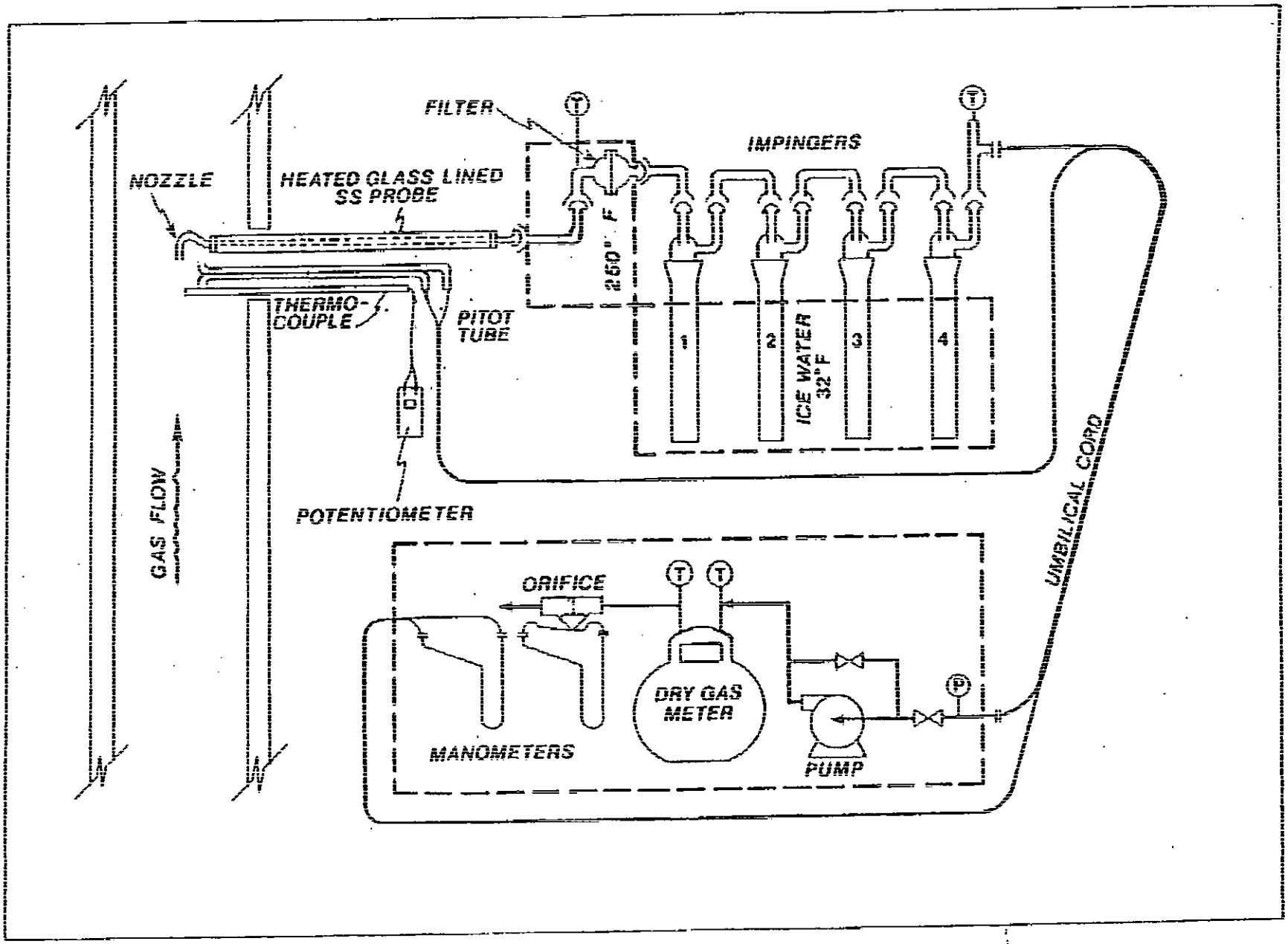
C FACTOR REFERENCE ΔP

READ AND RECORD ALL DATA EVERY 4 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	00	1200	808.665									
6-1	04	1204	810.0	.08	.32	.32	64	66	61	3	220	38
2	08	1208	811.3	.11	.45	.45	63	79	63	4	226	38
3	12	1212	812.8	.09	.37	.37	63	81	64	6	224	38
4	16	1216	813.9	.05	.20	.20	65	85	66	8	231	38
5	20	1220	814.8	.03	.12	.12	67	82	68	5	232	38
6	24	1224	815.6	.03	.12	.12	68	81	70	3	234	38
7	28	1228	816.3	.02	.07	.07	67	79	71	2	232	38
8	32	1232	817.1	.03	.12	.12	67	78	72	2	236	38
9	36	1236	818.2	.04	.16	.16	66	82	73	3	241	39
10	40	1240	819.6	.10	.46	.40	66	88	73	4	247	38
11	44	1244	821.3	.13	.54	.54	66	92	75	4	254	38
12	48	1248	823.048	.14	.58	.53	65	94	76	5	259	39

PLANT American Nickeloid DATE 4/18/88 RUN NUMBER Three

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	48	1254	823.048									
A-1	52	1258	825.7	.31	1.30	1.30	56	83	76	6	266	38
2	56	1302	828.1	.26	1.10	1.10	58	101	79	6	274	38
3	60	1306	830.6	.26	1.10	1.10	59	102	80	6	272	38
4	64	1310	832.9	.22	.93	.98	62	102	81	5	269	38
5	68	1314	834.6	.14	.58	.58	65	99	88	4	271	38
6	72	1318	835.9	.08	.32	.32	64	96	83	4	270	38
7	76	1322	836.9	.04	.16	.16	68	93	83	3	270	38
8	80	1326	838.1	.06	.24	.24	68	92	84	3	270	38
9	84	1330	839.5	.09	.37	.37	67	95	84	4	266	38
10	88	1334	841.0	.10	.41	.41	68	96	84	4	266	38
11	92	1338	842.8	.14	.58	.58	67	99	84	5	267	38
12	96	1342	844.700	.16	.66	.66	67	101	85	5	260	38
			Leak check at		13"	H_g =	.015 cfm					
			V_m = 36.035	ΔP = .316	ΔH =	.469	T_s = 66°	T_m = 83				



EPA METHOD 12

BCM

APPENDIX B

LABORATORY ANALYSIS AND DATA EVALUATION

BCM

APPENDIX B

LABORATORY ANALYSIS AND DATA EVALUATION

1.0 ANALYTICAL METHODS

All field samples were stored on ice in glass amber bottles for transportation to the BCM Laboratory, in Norristown, Pennsylvania. Analyses were conducted in accordance with procedures similar to those outlined in EPA Method 12. Appropriate chain-of-custody forms were used to ensure sample integrity.

1.1 Inorganic Nickel Samples

For each sample run, the glass fiber filter was cut into strips and combined with the probe wash and impinger solution following volume determinations. Care is taken to assure complete transferral of all sample so as not to bias the analysis. The combined sample was then acid digested and analyzed by absorption spectroscopy following spectrophotometer calibration. Mandatory checks for matrix effects on the nickel results were performed using the Method of Additions to detect any sensitivity of the atomic absorption analysis to the chemical composition and to the physical properties of the sample.

Both filter and nitric acid blanks were analyzed to determine a blank value to be used as a correction factor. The laboratory results are presented at the end of Appendix B.

1.2 Moisture Content

Silica gel had been tare-weighted prior to its use in the field. After each run, the silica gel was reweighed. The entire weight gain was considered to be due to water vapor. The total volume of the impinger solutions minus the original volume of nitric acid in the impingers, plus the volume of moisture and/or vapors collected by the silica gel, equaled the total moisture gain of the sampling train. This volume was used to calculate percent moisture by volume. The results of the moisture analyses appear on the field data sheets which are presented in Appendix A.

BCM

2.0 DATA EVALUATION

Data necessary to determine the emission rate of nickel was recorded on field data sheets. This data was evaluated using the equations listed on the pages following the laboratory results. These equations were entered in a computer program written in LOTUS 1-2-3. The complete program input and output sheets for each run follow the list of equations.

BCM Laboratory Division
1850 Gravers Road
Norristown, PA 19401
(215) 275-0281

PLEASE REMIT CHECKS TO:
BCM Eastern Inc.
1 PLYMOUTH MEETING
PLYMOUTH MEETING, PA 19462
215-825-3600

FINAL REPORT

PAGE : 1

This is a final report.
The results have been checked and authorized for release.

CLIENT

AMERICAN NICKELOID
Attn: Phil Burg
BCM MAIL/DEPT 31

Date : 05/06/88
BCM # : - -
P.O.# :
Order# : 20940

BCM Number : 811718
Location : EVAPORATOR
Client ID : Sample Run 1

Date Sampled : 04/14/88
Date Received : 04/15/88

Test Description	Results	Units	Test Method
Metal Digestion	4/25/88	M/D/Y	EPA - METALS
Nickel	0.108	mg	EPA # 6010
Sample Volume	588	ml	

Comment: ANALYSIS PERFORMED USING METHOD OF STANDARD ADDITION

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CLIENT

AMERICAN NICKELOID
Attn: Phil Burg
BCM MAIL/DEPT 31

Date : 05/06/88
BCM # : - -
P.O.# :
Order# : 20940

BCM Number : B11719
Location : EVAPORATOR
Client ID : Sample Run 2

Date Sampled : 04/15/88
Date Received : 04/15/88

Test Description	Results	Units	Test Method
Metal Digestion	4/25/88	M/D/Y	EPA - METALS
Nickel	0.0336	mg	EPA # 6010
Sample Volume	780	ml	

Comment: ANALYSIS PERFORMED USING METHOD OF STANDARD ADDITION

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T e results have been checked and authorized for release.

CLIENT

AMERICAN NICKELOID
Attn: Phil Burg
BCM MAIL/DEPT 31

Date : 05/06/88
BCM # : - -
P.O.# :
Order# : 20940

BCM Number : 811720
Location : EVAPORATOR
Client ID : Sample Run 3

Date Sampled : 04/15/88
Date Received : 04/15/88

Test Description	Results	Units	Test Method
Metal Digestion	4/25/88	M/D/Y	EPA - METALS
Nickel	0.124	mg	EPA # 6010
Sample Volume	693	ml	

Comment: ANALYSIS PERFORMED USING METHOD OF STANDARD ADDITION

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Norristown, PA 19401
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AMERICAN NICKELOID
Attn: Phil Burg
BCM MAIL/DEPT 31

Date : 05/06/88
BCM # : - -
P.O.# :
Order# : 20940

BCM Number : 811721
Location : EVAPORATOR
Client ID : BLANK

Date Sampled : 04/15/88
Date Received : 04/15/88

Test Description	Results	Units	Test Method
Metal Digestion	4/25/88	M/D/Y	EPA - METALS
Nickel	< 0.004	mg	EPA # 6010
Sample Volume	342	ml	

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FINAL REPORT

This is a final report.
The results have been checked and authorized for release.

CLIENT

AMERICAN NICKELOID
Attn: Phil Burg
BCM MAIL/DEPT 31

Date : 05/06/88
BCM # : " "
P.O.# :
Order# : 20940

BCM Number : 811721
Location : EVAPORATOR
Client ID : BLANK

Date Sampled : 04/15/88
Date Received : 04/15/88

Test Description	Results	Units	Test Method

End of Report

Certified by : _____
BCM Laboratory Director

Lab Certifications:

PA - 46-007 NJ - 77175 EPA BULK ASBESTOS QC - 3339
AL - 40300 MD - 136 AIHA/NIOSH - 241/19401

EQUATIONS FOR PARTICULATE, MOISTURE, AND FLOW CALCULATIONS

(BASED ON STANDARD CONDITIONS OF 68°F AND 29.92"Hg)

1. $V_{w(std)} = 0.0471\ V_{wc}$

2. $V_{m(std)} = 17.64\ V_m \dfrac{P_{bar} + .07355\ \Delta H}{T_m + 460}\ \gamma$

3. $B_{wo} = \dfrac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$

4. $M_d = 0.44(\%CO_2) + 0.28(\%CO) + 0.32(\%O_2) + 0.28(\%N_2)$

5. $M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

6. $EA = \dfrac{(\%O_2) - 0.5(\%CO)}{0.264(\%N_2) - (\%O_2) + 0.5(\%CO)}\ 100$

7. $V_s = (85.49)(60)(C_p)\sqrt{\Delta P}\sqrt{\dfrac{T_s + 460}{(P_s)(M_s)}}$

8. $Q_s = \dfrac{(V_s)(A_s)}{144}$

9. $Q_{s(std)} = Q_s(1 - B_{wo})\ 17.64\ \dfrac{P_s}{T_s + 460}$

10. $C'_s = 0.0154\ \dfrac{W_t}{V_{m(std)}}$

11. $C'_w = 0.0154\ \dfrac{W_t}{V_{m(std)} + V_{w(std)}}$

12. $C'_c = \dfrac{12\ C'_s}{\%CO_2}$

13. $C'_a = W_w\ \dfrac{(T_s + 460)(29.92)}{(528)(P_s)}$

14. $E = 0.00857\ Q_{s(std)}\ C'_s$

15. $A_n = \dfrac{(\pi)(D_n)^2}{(144)(4)}$

16. $I = \dfrac{(60)(1.667)(T_s + 460)(0.00267\ V_{wc} + V_{m(std)}/17.64)}{(\theta)(V_s)(P_s)(A_n)}$

LEGEND

A_n	=	Area of nozzle, ft^2
A_s	=	Area of stack, in^2
B_{wo}	=	Moisture content of gas stream, dimensionless
C_p	=	Pitot correction factor, dimensionless
C'_a	=	Particulate concentration (stack conditions), gr/ft^3
C'_c	=	Particulate concentration at 12% CO_2 (dry), gr/dscf
C'_s	=	Particulate concentration (dry), gr/dscf
C'_w	=	Particulate concentration (wet), gr/scf
D_n	=	Diameter of nozzle, in.
E	=	Particulate emission rate, lb/hr
EA	=	Excess air, percent
ΔH	=	Orifice pressure drop, in. H_2O
I	=	Isokinetic ratio, percent
M_d	=	Dry molecular weight of stack gas, lb/lb-mole
M_s	=	Molecular weight of stack gas, lb/lb-mole
P_{bar}	=	Barometric pressure, in. Hg
P_s	=	Stack pressure (absolute), in. Hg
$\sqrt{\Delta P}$	=	Average of square roots of pitot pressure differential, in. H_2O
Q_s	=	Stack gas flow, acfm
$Q_{s(std)}$	=	Stack gas flow, scfm
T_m	=	Average dry gas meter temperarure, ^oF
T_s	=	Average stack temperature, ^oF
V_m	=	Dry sample volume (meter conditions), ft^3
$V_{m(std)}$	=	Dry sample volume (standard conditions), ft^3

V_s = Stack velocity, ft/min

V_{wc} = Volume of liquid collected in impingers and silica gel, ml

$V_{w(std)}$ = Volume of liquid collected, ft^3

W_t = Total weight of particulates collected, mg

θ = Duration of test, min.

Sampling Method:	USEPA Method 12
Pollutant:	Nickel
Client:	American Nickeloid
BCM Job Number:	00-6030-01
Location:	Walnutport, Pennsylvania
Source:	Evaporator Outlet
Sample Run:	1
Sampled by:	Phillip C. Burg
Sample date:	April 14, 1988

SOURCE SAMPLING INPUT PARAMETERS

Average Stack Temperature (deg. f):	66.9
Average Dry Gas Meter Temperature (deg. f):	84.7
Average Square Root of Pitot Pressure (inches H20):	0.3624
Orifice Pressure Drop (inches H20):	0.5829
Duct Diameter (inches):	24.00
Duct Height (inches):	0.00
Duct Width (inches):	0.00
Duct Area (sq.ft.):	3.142
Pitot Factor:	0.84
Meter Box Calibration Factor:	0.98
Nozzle Diameter (inches):	0.251
Static Pressure (inches H20):	-2.50
Barometric Pressure (inches Hg):	29.75
Stack Pressure (inches Hg):	29.57
Dry Sample Volume (acfm):	40.59
Dry Sample Volume (scfm):	38.37
Volume of Moisture Collected (ml):	19.40
Volume of Moisture Collected (scfm):	0.914
Moisture Content (%):	2.326
Volume of Carbon Dioxide (%):	0.0
Volume of Carbon Monoxide (%):	0.0
Volume of Oxygen (%):	21.0
Dry Molecular Weight (lb/lb mole):	28.84
Molecular Weight (lb/lb mole):	28.59
Amount Pollutant Collated (mg):	0.108
Test Duration (min):	96

Sampling Method:	USEPA Method 12
Pollutant:	Nickel
Client:	American Nickeloid
BCM Job Number:	00-6030-01
Location:	Walnutport, Pennsylvania
Source:	Evaporator Outlet
Sample Run:	1
Sampled by:	Phillip C. Burg
Sample date:	April 14, 1988

SOURCE SAMPLING RESULTS

Velocity (ft/min):	1239
Mass Flow Rate (lb/hr):	17124
Volumetric Flowrate (dscfm):	3764
Volumetric Flowrate (scfm):	3853
Volumetric Flowrate (acfm):	3892
Excess Air (%):	-145.8
Isokinetic Ratio (%):	97
Pollutant Conc. @12% CO2 (gr/dscf):	ERR
Pollutant Concentration (gr/dscf):	0.000043
Pollutant Concentration (gr/scf):	0.000042
Pollutant Emission Rate (lb/hr):	0.00140

Sampling Method:	USEPA Method 12
Pollutant:	Nickel
Client:	American Nickeloid
BCM Job Number:	00-6030-01
Location:	Walnutport, Pennsylvania
Source:	Evaporator Outlet
Sample Run:	2
Sampled by:	Phillip C. Burg
Sample date:	April 15, 1988

SOURCE SAMPLING INPUT PARAMETERS

Average Stack Temperature (deg. F):	59.9
Average Dry Gas Meter Temperature (deg. F):	69.4
Average Square Root of Pitot Pressure (inches H20):	0.3372
Orifice Pressure Drop (inches H20):	0.5133
Duct Diameter (inches):	24.00
Duct Height (inches):	0.00
Duct Width (inches):	0.00
Duct Area (sq.ft.):	3.14
Pitot Factor:	0.84
Meter Box Calibration Factor:	0.98
Nozzle Diameter (inches):	0.251
Static Pressure (inches H20):	-2.50
Barometric Pressure (inches Hg):	29.64
Stack Pressure (inches Hg):	29.46
Dry Sample Volume (acfm):	38.27
Dry Sample Volume (scfm):	37.09
Volume of Moisture Collected (ml):	25.60
Volume of Moisture Collected (scfm):	1.206
Moisture Content (%):	3.148
Volume of Carbon Dioxide (%):	0.0
Volume of Carbon Monoxide (%):	0.0
Volume of Oxygen (%):	21.0
Dry Molecular Weight (lb/lb mole):	28.84
Molecular Weight (lb/lb mole):	28.50
Amount Pollutant Colleted (mg):	0.034
Test Duration (min):	96

Sampling Method: USEPA Method 12
Pollutant: Nickel
Client: American Nickeloid
BCM Job Number: 00-6030-01
Location: Walnutport, Pennsylvania
Source: Evaporator Outlet
Sample Run: 2
Sampled by: Phillip C. Burg
Sample date: April 15, 1988

SOURCE SAMPLING RESULTS

Velocity (ft/min):	1149
Mass Flow Rate (lb/hr):	15985
Volumetric Flowrate (dscfm):	3495
Volumetric Flowrate (scfm):	3608
Volumetric Flowrate (acfm):	3609
Excess Air (%):	-145.8
Isokinetic Ratio (%):	101
Pollutant Conc. @12% CO2 (gr/dscf):	ERR
Pollutant Concentration (gr/dscf):	0.000014
Pollutant Concentration (gr/scf):	0.000014
Pollutant Emission Rate (lb/hr):	0.00042

Sampling Method:	USEPA Method 12
Pollutant:	Nickel
Client:	American Nickeloid
BCM Job Number:	00-6030-01
Location:	Walnutport, Pennsylvania
Source:	Evaporator Outlet
Sample Run:	3
Sampled by:	Phillip C. Burg
Sample date:	April 15, 1988

SOURCE SAMPLING INPUT PARAMETERS

Average Stack Temperature (deg. f):	64.8
Average Dry Gas Meter Temperature (deg. f):	86.2
Average Square Root of Pitot Pressure (inches H20):	0.3162
Orifice Pressure Drop (inches H20):	0.4688
Duct Diameter (inches):	24.00
Duct Height (inches):	0.00
Duct Width (inches):	0.00
Duct Area (sq.ft.):	3.14
Pitot Factor:	0.84
Meter Box Calibration Factor:	0.98
Nozzle Diameter (inches):	0.251
Static Pressure (inches H20):	-2.50
Barometric Pressure (inches Hg):	29.62
Stack Pressure (inches Hg):	29.44
Dry Sample Volume (acfm):	36.04
Dry Sample Volume (scfm):	33.83
Volume of Moisture Collected (ml):	39.00
Volume of Moisture Collected (scfm):	1.837
Moisture Content (%):	5.151
Volume of Carbon Dioxide (%):	0.0
Volume of Carbon Monoxide (%):	0.0
Volume of Oxygen (%):	21.0
Dry Molecular Weight (lb/lb mole):	28.84
Molecular Weight (lb/lb mole):	28.28
Amount Pollutant Colleted (mg):	0.124
Test Duration (min):	96

Sampling Method:	USEPA Method 12
Pollutant:	Nickel
Client:	American Nickeloid
BCM Job Number:	00-6030-01
Location:	Walnutport, Pennsylvania
Source:	Evaporator Outlet
Sample Run:	3
Sampled by:	Phillip C. Burg
Sample date:	April 15, 1988

SOURCE SAMPLING RESULTS

Velocity (ft/min):	1087
Mass Flow Rate (lb/hr):	14857
Volumetric Flowrate (dscfm):	3206
Volumetric Flowrate (scfm):	3380
Volumetric Flowrate (acfm):	3414
Excess Air (%):	-145.8
Isokinetic Ratio (%):	101
Pollutant Conc. @12% CO2 (gr/dscf):	ERR
Pollutant Concentration (gr/dscf):	0.000056
Pollutant Concentration (gr/scf):	0.000054
Pollutant Emission Rate (lb/hr):	0.00155

BCM

APPENDIX C

EQUIPMENT CALIBRATION

1.0 DRY GAS METER AND ORIFICE METER

The dry gas meter and orific were calibrated using a wet test meter. Gases were moved through the dry gas meter at orifice pressure differentials (ΔH's) of 0.5, 1.0, and 2.0 inches of water. With the information obtained, γ, the ratio of accuracy of wet test meter to dry test meter; and $\Delta H_@$, the orifice pressure differential that gives 0.75 cfm of air at 68°F and 29.92 inches of mercury, were calculated. The γ has a tolerance of 1.00 ±0.01 and the $\Delta H_@$ has a tolerance of 1.84 +0.26 -0.24. The γ and $\Delta H_@$ are determined as follows:

$$\gamma = \frac{V_w P_b (t_d + 460)}{V_d [P_b + .07353 (\Delta H)] (t_w + 460)}$$

$$\Delta H_@ = \frac{0.0317 (\Delta H)}{P_b (t_d + 460)} \left(\frac{(T_w + 460)\ \theta}{V_w} \right)^2$$

Where:

ΔH = Orifice pressure differential, in H_2O

P_b = Barometric pressure, in Hg

t_d = Average temperature of dry gas meter, °F

t_w = Average temperature of wet test meter, °F

θ = Duration of test, min.

V_d = Dry gas meter volume, ft^3

V_w = Wet test meter volume, ft^3

2.0 POTENTIOMETER CALIBRATION

The Thermo - Electron potentiometers were calibrated by using a known voltage source as an input to the potentiometer.

3.0 PROBE CALIBRATION

The probes were calibrated by measuring the outlet temperatures at various variable transformer settings while passing air through at approximately 0.75 cubic feet per minute.

BOM METER BOX CALIBRATION SHEET

Date 3-20-00 Box No. 285 Inspector NJC

Pump ✓ Oil ✓ Vick ✓ Pump Serial No. _____

Manometers ✓ Knobs ✓ Oil ✓ Tubing ✓

Quick Connects ✓ Vacuum Gage ✓ Valves ✓

Dry Gas Meter ✓ Volume _____ ft³ Serial No. _____

Thermometers _____ In _____ °F Out _____ °F Ambient _____ °F

Amphenol ✓ Lights ✓ Switches ✓ Variac ✓

Leak Check - Max. Vacuum 30" in. Hg Leak Rate .001 CFM

Remarks _____

	Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	T_d	Time θ
30.29	0.5	5.005	5.19	64.0	92.7	70.0	75.6	13.13
	1.0	5.007	5.213	64.0	91.4	71.0	75.5	9.26
30.54	2.0	10.004	10.493	62.0	98.4	70.1	76.8	13.55

Tolerances: $1.6 \leq \Delta H_@ \leq 2.1$ $0.99 \leq \gamma \leq 1.01$

$$\Delta H_@ = \frac{(0.0317)(\Delta H)}{(P_b)(OT_d+460)}\left[\frac{(T_w+460)(\theta)}{(CF_w)}\right]^2 \qquad \gamma = \frac{(CF_w)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_w+460)}$$

$\Delta H_@$		γ	
1.87	$\frac{(0.0317)(0.5)}{(30.25)(72+460)}\left[\frac{(64+460)(13.13)}{(5.005)}\right]^2$	.985	$\frac{(5.005)(30.29)(75.6+460)}{(5.19)(30.25+0.0368)(64+460)}$
1.86	$\frac{(0.0317)(1.0)}{(30.25)(71+460)}\left[\frac{(64+460)(9.26)}{(5.007)}\right]^2$	.98	$\frac{(5.007)(30.25)(75.5+460)}{(5.213)(30.25+0.0737)(64+460)}$
1.96	$\frac{(0.0317)(2.0)}{(30.54)(70.1+460)}\left[\frac{(62+460)(13.55)}{(10.004)}\right]^2$	.975	$\frac{(10.004)(30.54)(76.8+460)}{(10.493)(30.54+0.147)(62+460)}$