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Minnesota Pollution Control Agency

May 2, 1996

copy to Pete

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FOR
CE 001
CE 002
CE 004

Mr. Thomas J. Zarnke
Manager-Engineering and Maintenance
Northern Castings Corporation
555 West 25th Street
P.O. Box 98
Hibbing, Minnesota 55746

RE: April 2, 1996, Test Plan Submittal for the May 1-3, 1996, Performance Test on Emission Point 001, 001A and 002, To Demonstrate Compliance With Applicable Emission Limits For An Alternate Pressure Drop Operating Scenario Formal Letter Following April 26, 1996, Facsimile Draft

Dear Mr. Zarnke:

This letter and its enclosures conclude the pretest requirements for the Northern Castings Company (Company) located in Hibbing, Minnesota, as discussed during our telephone conversation of April 26, 1996. Please discuss and provide your consultant with a copy of this letter.

The Air Quality Division (AQD) staff of the Minnesota Pollution Control Agency (MPCA) has reviewed the submittal, and has approved the test plan with the following provisions:

1. PM/PM10 results are to be reported as: Results shall be reported as filterable particulate plus organic condensibles for compliance purposes, and filterable particulate plus organic and inorganic condensibles for PM_{10}.

2. Replace reference to PM testing on 004, 005 in Part VI.2., with PM and Opacity Testing on 002.

3. As discussed, the following applies, as during your last performance test:

   Note that opacity observations should be conducted concurrent to a particulate test run. Inclement weather may results in a rescheduling the opacity portion of the testing. when rescheduling the test be sure to conduct the testing at or near the same conditions as the particulate testing for emission point no. 2. Please notify me of rescheduling.

4. This test may be defined as a Voluntary Test For Data Submittal

These provisions are modifications to the test plan, and are to be incorporated into the proposed test.

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Copies of the Operating Data Summary For Process Sources, Certifications Required For Performance Test Reports, and Microfiche Submittal forms are enclosed. These forms will help you to comply with the submittal requirements of Minn. R. 7017.2035 and 7017.2040. A copy of the test plan, including this letter, should be included as part of the performance test report.

Please remember that it is not the testing consultant's responsibility to submit the test report or microfiche copy of the test report or to certify that the microfiche submitted is an exact copy of the original test report by the deadlines specified in the applicable compliance document (i.e. permit, stipulation agreement, administrative penalty order, etc.). The responsibility for these submittals lies solely with the Company.

Please be aware that enforcement action, which may include a monetary penalty assessment, will be taken for performance test failures. Escalated enforcement action will result following noncompliance with a retest. Action will not normally be initiated until the results of the first retest are reviewed. Upon written notice of a second performance test failure, the Company shall voluntarily shut down the noncompliant unit(s) unless the Company meets the requirements of Minn. R. 7017.2025 Subp. 5. For the purposes of enforcing an emission limit, the period of noncompliance begins at the date of the initial noncompliant performance test. Results of a performance test are not final until AQD staff provides written compliance determination.

If you have any questions regarding this letter or the enclosures, please contact me at (612)296-8374.

Sincerely,

Yolanda Hernandez

Yolanda Hernandez
Performance Test Coordinator
Compliance Determination Unit
Compliance and Enforcement Section
Air Quality Division

YH:jeh

Enclosures

cc: Bob Beresford, Duluth Regional Office
AQD File No. 1187

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Braun Intertec Report Number CMXX-96-0292

CERTIFICATIONS

Team Leader Certification

I certify under penalty of law that the sampling procedures were performed in accordance with the approved test plan and that the data presented in this test report are, to the best of my knowledge and belief, true, accurate , and complete.

Signed: Jeffrey Fox [signature] Date: June 3 96

Jeffrey Fax

Laboratory Analyst Certification

I certify under penalty of law that the analytical procedures were performed in accordance with the requirements of the test methods and that the data presented for use in the test report were, to the best of my knowledge and belief, true, accurate, and complete.

Signed: [signature] (for) Date: 6/3/96

Jason Olson

Test Report Certification

I certify under penalty of law that this test report and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the test information submitted. Based on my inquiry of the person or persons who performed sampling and analysis relating to the performance test, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete.

Signed: [signature] Date: 6/3/96

Bruce Randall
Manager, Source Testing

Facility Owner or Operator Certification

I certify under penalty of law that the information submitted in this test report accurately reflects the operating conditions at the emission facility during this performance test and describes the date and nature of all operational and maintenance activities that were performed on process and control equipment during the month prior to the performance test. Based on my inquiry of the person or persons who performed the operational and maintenance activities, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete.

Signed: Thomas J Zanke [signature] Date: 6/8/96

Title: MGR - MTC & ENG

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INTRODUCTION

This report presents the results of several EPA Method 5 source tests and one Method 9 Visual Emissions determination performed by Braun Intertec Corporation, on May 2, 1996, at the Northern Castings facility located in Hibbing Minnesota. The testing was performed at the exhaust stacks of the Sand System and the Induction Furnace exhausts labeled 001 & 001A. The tests were conducted voluntarily in order to redemonstrate compliance after a new type of low pressure bags were installed in the baghouse and changes were made to the Sand Systems scrubber, and to comply with draft permit # 13700082-003 dated 1/20/95.

All source sampling, laboratory analysis, data reduction and report preparation was performed by the Braun Intertec test team. The test team consisted of:

Team Leader:	Jeffrey Jax
Sampling Technician:	Jayson Olson & Jarred Marske
Laboratory Analyst:	Jayson Olson & Jarred Marske
Northern Castings Rep:	Tom Zarnke

DESCRIPTION OF TEST PROGRAM

Sampling was performed following EPA required procedures, as referenced in Code of Federal Regulations, Title 40 Part 60, Appendix A, Methods 1-5 & 9, and Part 51, Appendix M. Method 202, July, 1992. The test methods utilized are presented in Table 1.

Method #	Purpose
1	Determination of Traverse Point Locations, Verification of Absence of Cyclonic Flow Conditions
2	Determination of Duct Velocity and Volume Flow Rate
3	Determination of Duct Fixed Gas Content
4	Determination of Duct Moisture Content
5	Determination of Particulate Matter Emissions
9	Determination of The Opacity of Visual Emissions
202	Determination of Condensible PM Emissions

Table 1: Test Methods

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RESULTS

The results of the test program are presented in a series of tables. Table 2 presents three run average results. Tables 3 through 5 present individual run results for each source. A discussion of results is presented following Table 5.

	Unit	TSP Emissions		Opacity of Emissions	
		Permitted Limit (gr/dscf)	Measured (gr/dscf)	Permitted Limit	Maximum Six Minute Average
CE 004	Sand System Exhaust	0.05	0.0047	20%	4.2%
CE 001	Electric Induction Furnace 001A	0.005	0.0030	Not Mearsured.	
CE 002	Electric Induction Furnaces 001	0.005	0.0014		

Table 2: Summary of Results

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Table 3: Sand System Results

PLANT: Northern Castings, Hibbing MN.

SAMPLE LOCATION: Sand System

TEST DATE: May 2, 1996

SAMPLE METHODS: EPA 1-5 & 9, 202

		Run 1	Run 2	Run 3	Avg
Run Times	:	7:56-8:59	11:00-12:02	12:42-13:45	
PROCESS CONDITIONS,					
Average Temperature (°F)	:	96	99	106	100
Average Velocity (ft/s)	:	51.9	51.2	49.9	51.0
Moisture Content (%vol.)	:	6.0	5.7	7.3	6.3
Wet Molecular Weight (g/gmole)	:	28.19	28.22	28.05	28.15
Volume Flow Rate (ACFM)	:	22,400	22,100	21,500	22,000
Volume Flow Rate (SCFM)	:	21,300	21,000	20,100	20,800
Volume Flow Rate (DSCFM)	:	20,100	19,800	18,700	19,500
PRODUCTION DATA					
Tons of Sand per Hour	:	37.9	34.3	35.9	36.0
SAMPLE VOLUME (SDCF)	:	44.562	43.852	41.923	43.446
PARTICULATE CONCENTRATION					
Filterable (gr/dscf)	:	0.0019	0.0027	0.0048	0.0031
Aqueous Condensible (gr/dscf)	:	0.0018	0.0019	0.0006	0.0014
Organic Condensible (gr/dscf)	:	0.0001	0.0002	0.0002	0.0002
Total (gr/dscf)	:	**0.0038**	**0.0048**	**0.0056**	**0.0047**
PARTICULATE EMISSION RATE					
Filterable (lb/hr)	:	0.33	0.46	0.77	0.52
Aqueous Condensible (lb/hr)	:	0.30	0.32	0.10	0.24
Organic Condensible (lb/hr)	:	0.02	0.04	0.04	0.03
Total (lb/hr)	:	**0.65**	**0.82**	**0.90**	**0.79**
% of Isokinetic Sample Rate	:	100.8	100.6	101.8	
Opacity, highest six minute avg. (%)	:			**4.2**	
Opacity, One hour avg (%)	:			2.8	
Concurrent with Run # 3					

OPERATING DATA SUMMARY FOR PROCESS SOURCES

Form OPS01
11/01/95

Test Date(s): 5/2/96

Company Name: NORTHERN CASTINGS

A. Equipment & Operating Data

1. Process Equipment No./Id.: 002
2. Process Equipment Description: WET SCRUBBER
3. Process equipment operating under normal operating conditions? (YES) NO
   If no, explain
4. Process rate during the test (amount of raw material or finished product per hour, wet or dry basis)

Process Parameter: list type and units	Run 1	Run 2	Run 3
tons per hour sand	37.9	34.3	35.9

B. Instrument Data on Process Equipment

Include copy of production records or instrumentation which indicates rate of production or operation of the equipment, i.e. units per hour, lbs. per hour, pressure, air flow, etc.

C. Air Pollution Control Equipment

Clearly identify and summarize the operating ranges documented during testing in the table below: (Refer to the operating parameters to be monitored during testing as specified in the test plan.) **THE TABLE BELOW IS NOT SUITABLE FOR ESP DATA, PLEASE SUBMIT IN AN APPROPRIATE FORMAT.**

Type of Control Equipment		Parameter monitored on control equipment.: Max. and Min. Ranges		
	Run No.:	1	2	3
Baghouse:	ΔP (in. w.c.)			
Cyclone:	ΔP (in. w.c.)			
Multi-clone:	ΔP (in. w.c.)			
Scrubber (type): Centrifugal	ΔP (in. w.c.)	7.0	7.0	7.0
water	feed rate (gpm and psi)	150	150	155
Thermal Incinerator:	(°$F_{operating\ temp}$)			
Catalytic Incinerator:	(°F_{in}, °F_{out})			
Other: FAN AMPS		100	100	100
Other:				

1. Was the control equipment operating normally? (YES) NO
   If no, explain
2. Date and procedures of last major maintenance/cleaning of control equipment 4/20/96 Replace Fan bearings 3/24/96 Speed up fan 2/16/96 cleaning & wash down 2/7/96 speed up water pump

Note: This form provides only a summary of the operating conditions during the performance test. Additional and more detailed records are required to meet the requirements of Minn. R. 7017.2035, subp. 3. This form is to be submitted as part of the performance test report.

Table 4: Furnace 001A (East) Results

PLANT: Northern Castings, Hibbing MN.

SAMPLE LOCATION: Furnace 001A (East)

TEST DATE: May 2, 1996

SAMPLE METHODS: EPA 1-5, 202

		Run 1	Run 2	Run 3	Avg
Run Times	:	10:17-11:23	12:20-13:23	13:47-14:50	
PROCESS CONDITIONS,					
Average Temperature (°F)	:	105	104	111	107
Average Velocity (ft/s)	:	53.0	50.7	52.6	52.1
Moisture Content (%vol.)	:	0.4	0.4	0.3	0.4
Wet Molecular Weight (g/gmole)	:	28.80	28.79	28.81	28.80
Volume Flow Rate (ACFM)	:	15,600	14,900	15,500	15,300
Volume Flow Rate (SCFM)	:	14,700	14,100	14,400	14,400
Volume Flow Rate (DSCFM)	:	14,700	14,000	14,400	14,400
PRODUCTION DATA					
Tons Charged	:	5.7	5.6	5.6	5.6
	tph	5.2	5.3	5.3	
SAMPLE VOLUME (SDCF)	:	60.175	58.002	57.951	58.709
PARTICULATE CONCENTRATION					
Filterable (gr/dscf)	:	0.0009	0.0016	0.0028	0.0018
Aqueous Condensible (gr/dscf)	:	0.0001	0.0003	0.0001	0.0002
Organic Condensible (gr/dscf)	:	0.0000	0.0000	0.0000	0.0000
Total (gr/dscf)	:	**0.0038**	**0.0017**	**0.0034**	**0.0030**
PARTICULATE EMISSION RATE					
Filterable (lb/hr)	:	0.11	0.19	0.35	0.22
Aqueous Condensible (lb/hr)	:	0.01	0.04	0.01	0.02
Organic Condensible (lb/hr)	:	0.00	0.00	0.00	0.00
Total (lb/hr)	:	**0.12**	**0.22**	**0.36**	**0.23**
% of Isokinetic Sample Rate	:	98.5	100.9	96.5	

OPERATING DATA SUMMARY FOR PROCESS SOURCES

Form OPS01
11/01/93

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Test Date(s): 5/2/96

Company Name: NORTHERN CASTINGS

A. Equipment & Operating Data

1. Process Equipment No./Id.: 001
2. Process Equipment Description: Melter Baghouse (EAST)
3. Process equipment operating under normal operating conditions? (YES) NO
   If no, explain
4. Process rate during the test (amount of raw material or finished product per hour, wet or dry basis)

Process Parameter: list type and units	Run 1	Run 2	Run 3
tons of metal charged	5.7	5.6	5.6

B. Instrument Data on Process Equipment

Include copy of production records or instrumentation which indicates rate of production or operation of the equipment, i.e. units per hour, lbs. per hour, pressure, air flow, etc.

C. Air Pollution Control Equipment

Clearly identify and summarize the operating ranges documented during testing in the table below: (Refer to the operating parameters to be monitored during testing as specified in the test plan.) **THE TABLE BELOW IS NOT SUITABLE FOR ESP DATA, PLEASE SUBMIT IN AN APPROPRIATE FORMAT.**

Type of Control Equipment		Parameter monitored on control equipment.: Max. and Min. Ranges		
	Run No.:	1	2	3
Baghouse:	ΔP (in. w.c.)	.8	1.2	.2
Cyclone:	ΔP (in. w.c.)			
Multi-clone:	ΔP (in. w.c.)			
Scrubber (type):______	ΔP (in. w.c.)			
______	feed rate (gpm and psi)			
Thermal Incinerator:	(°F operating temp)			
Catalytic Incinerator:	(°F in, °F out)			
Other: Fan amps		117	114	115
Other:				

1. Was the control equipment operating normally? (YES) NO
   If no, explain
2. Date and procedures of last major maintenance/cleaning of control equipment New bags installed 4/27/96

Note: This form provides only a summary of the operating conditions during the performance test. Additional and more detailed records are required to meet the requirements of Minn. R. 7017.2035, subp. 3. This form is to be submitted as part of the performance test report.

04/26/96 11:15 ☐ :04/08 NO:285 MN PCA

OPERATING DATA SUMMARY FOR PROCESS SOURCES Form OPS01 11/01/95

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Test Date(s): 5/2/96

Company Name: NORTHERN CASTINGS

A. Equipment & Operating Data

1. Process Equipment No./Id.: 001 A
2. Process Equipment Description: Melter Baghouse (West)
3. Process equipment operating under normal operating conditions? (YES) NO
   If no, explain
4. Process rate during the test (amount of raw material or finished product per hour, wet or dry basis)

Process Parameter: list type and units	Run 1	Run 2	Run 3
tons of metal Charged	5.6	5.6	5.6

B. Instrument Data on Process Equipment

Include copy of production records or instrumentation which indicates rate of production or operation of the equipment, i.e. units per hour, lbs. per hour, pressure, air flow, etc.

C. Air Pollution Control Equipment

Clearly identify and summarize the operating ranges documented during testing in the table below: (Refer to the operating parameters to be monitored during testing as specified in the test plan.) **THE TABLE BELOW IS NOT SUITABLE FOR ESP DATA, PLEASE SUBMIT IN AN APPROPRIATE FORMAT.**

Type of Control Equipment		Parameter monitored on control equipment.: Max. and Min. Ranges		
	Run No.:	1	2	3
Baghouse:	ΔP (in. w.c.)	1.5	.5	1.5
Cyclone:	ΔP (in. w.c.)			
Multi-clone:	ΔP (in. w.c.)			
Scrubber (type): ________	ΔP (in. w.c.)			
________	feed rate (gpm and psi)			
Thermal Incinerator:	(°F operating temp)			
Catalytic Incinerator:	(°F in, °F out)			
Other: Fan amps		114	118	114
Other:				

1. Was the control equipment operating normally? (YES) NO
   If no, explain
2. Date and procedures of last major maintenance/cleaning of control equipment New bags installed 4/27/96

Note: This form provides only a summary of the operating conditions during the performance test. Additional and more detailed records are required to meet the requirements of Minn. R. 7017.2035, subp. 3. This form is to be submitted as part of the performance test report.

Table 5: Furnace 001 (West) Results

PLANT: Northern Castings, Hibbing MN.

SAMPLE LOCATION: Furnace 001 (West)

TEST DATE: May 2, 1996

SAMPLE METHODS: EPA 1-5, 202

		Run 1	Run 2	Run 3	Avg
Run Times	:	7:42-8:49	9:09-10:13	14:28-15:31	
PROCESS CONDITIONS,					
Average Temperature (°F)	:	105	89	95	96
Average Velocity (ft/s)	:	50.1	49.9	48.1	49.4
Moisture Content (%vol.)	:	0.6	0.5	0.3	0.5
Wet Molecular Weight (g/gmole)	:	28.77	28.79	28.81	28.79
Volume Flow Rate (ACFM)	:	14,700	14,700	14,200	14,500
Volume Flow Rate (SCFM)	:	13,900	14,300	13,600	13,900
Volume Flow Rate (DSCFM)	:	13,800	14,200	13,500	13,800
PRODUCTION DATA					
Tons Charged	:	5.6	5.6	5.6	5.6
	tpl	5.1	5.3	5.3	
SAMPLE VOLUME (SDCF)	:	56.701	57.722	55.946	56.790
PARTICULATE CONCENTRATION					
Filterable (gr/dscf)	:	0.0005	0.0006	0.0019	0.0013
Aqueous Condensible (gr/dscf)	:	0.0002	0.0004	0.0014	0.0007
Organic Condensible (gr/dscf)	:	0.0000	0.0002	0.0000	0.0001
Total (gr/dscf)	:	0.0007	0.0012	0.0033	0.0014
PARTICULATE EMISSION RATE					
Filterable (lb/hr)	:	0.06	0.07	0.22	0.12
Aqueous Condensible (lb/hr)	:	0.03	0.05	0.16	0.08
Organic Condensible (lb/hr)	:	0.00	0.02	0.00	0.01
Total (lb/hr)	:	0.09	0.14	0.38	0.20
% of Isokinetic Sample Rate	:	98.5	99.2	99.1	

DISCUSSION OF RESULTS

The data contained in this report demonstrates that the changes made did not increase particulate concentrations at any of the three sites tested. The Induction Furnace is a single source with two exhaust stacks (E.P.#'s 001& 001A).

EPA Method 3 " Duct Fixed Gas Content" analysis was not performed on any on the tested sites. Each of these sites uses electric heat and there are no combustion sources. The gas was assumed to have an oxygen content of 20.9%. Both of the induction furnace sites tested contained a very small amount of moisture. The low water content is not unexpected considering the desiccating type atmosphere the gas passes through prior to the exhaust ducts. No other incidents of note occurred.

SAMPLING PROCEDURE

Determination of Particulate Concentration and Emission Rate (Mass Flow Rate)

REF:Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 1-5 & 9, July, 1991.
Code of Federal Regulations, Title 40, Part 51, Appendix M, Method 202

Apparatus:

A "goose-neck" nozzle constructed of stainless steel was connected via a "Swage-Lok" fitting to a heated glass probe liner. The probe liner was attached to a heated glass filter holder containing a glass fiber mat filter. The back half of the filter holder was connected via a length of Teflon tubing to the impinger train which consisted of a set of pre-weighed impinger/absorbers connected in series and immersed in an ice bath. The absorption train was followed in series by a carbon vane pump, a dry test meter and calibrated orifice connected to an inclined manometer. When sampling a combustion source, the pressure side of the calibrated orifice was connected to a Tedlar bag via a "T" and pinch clamp. Type K thermocouple were used to measure the following temperatures: probe heater, filter heater, impinger outlet, and dry test meter inlet and outlet.

A combination Stausscheibe (Type S) pitot tube and type K thermocouple were used to measure duct velocity head and temperature. The pitot tube was connected via flexible tubing to an inclined manometer. The thermocouple was connected to a digital potentiometer.

Sampling Procedure:

Prior to sampling, traverse points were selected based on Method 1 requirements. The locations of the traverse points are presented in the reduced field data sheets. A preliminary traverse of the duct was performed to determine duct velocity head and temperature distributions, as well as duct static pressure. Initial duct moisture and fixed gas content were assumed based on previous test data. Based on this information, a sample nozzle of appropriate inside diameter was selected, and the impinger train charged as presented in the reduced field data sheets. Traverse points were marked on the probe using a permanent marking pen. Sample time per traverse point was estimated in order that a minimum of 32 SDCF of sample would be collected.

The apparatus was assembled as completely as possible in the staging area and transported to the sample site. Potential contamination of the sample train was prevented by sealing all openings with aluminum foil. Once in the sampling area, the probe and filter heaters were brought to temperatures of 250 ± 25°F, and the apparatus was leak checked. Upon successful completion of the leak check, the initial dry test meter reading was recorded, and the probe inserted at the first traverse point.

Sampling Procedure:

The duct temperature, dry test meter temperature and duct velocity head were measured and recorded on the data sheet. The isokinetic sampling rate in terms of pressure drop across the calibrated orifice was calculated and recorded on the data sheet. The pump and timer were turned on, and the sample rate adjusted to correspond to the calculated isokinetic rate. Once the sample rate was set, the following data was recorded:

- Dry test meter outlet temperature
- Sample vacuum
- Probe heater temperature
- Filter heater temperature
- Impinger outlet temperature

After all data was recorded, the line to the Tedlar bag was opened, and the bag allowed to fill for five seconds. Thus, an integrated sample was collected for duct fixed gas content analysis.

At the end of the sample time for the first point, the probe was moved to the next point, and the measurements, calculations and recording of data was repeated. Upon completion of sampling from a port, the pump was turned off and the dry test meter reading recorded. The probe was removed from the duct, and placed in the next sample port. The previously described procedure was repeated for each sample port.

When the sample run was completed, the final dry test meter reading was recorded and the probe removed from the port. A post-test leak check was performed at a vacuum at least 5"Hg higher than the highest sample vacuum measured during the sample run. The final leak rate was recorded on the data sheet. The sample line was detached from the back of the filter holder, and rinsed into the first impinger using a known volume of distilled water. The sample train was sealed from contamination and transported to the staging area for recovery.

Sample Recovery:

Sample was recovered in two fractions: filterable and condensible. The filterable fraction consisted of the filter itself as well as acetone rinses and brushings of: the nozzle and connector to the probe liner; the probe liner; and the front half of the filter holder. The filter was recovered to either a glass or plastic labeled petri dish. Acetone rinses were recovered to a labeled, clean polyethylene bottle. The liquid level in the polyethylene bottle was marked upon completion of recovery.

Prior to recovery of the condensible fraction, the exterior of each impinger/absorber was cleaned and dried, and the net weight gain of each was determined to the nearest 0.5 gram. The condensible fraction consisted of the liquid impinger catches and rinses of the impingers and all connecting glassware. Glassware rinses were recovered to a clean polyethylene bottle. The liquid level of the polyethylene bottle was marked upon completion of recovery.

At the conclusion of each day of sampling, reagent and recovery solvent blanks were collected into the same types of containers as were used for sample recovery. The blank containers were clearly labeled, and the liquid levels marked.

Analytical Procedure:

The filterable fraction and rinse blank were analyzed gravimetrically. Filters were placed in a 105°C oven for two to three hours, then cooled in a desiccator. Filter weighings were repeated until two consecutive weighings agreed to within 0.5 mg. Prior to analysis, the filterable rinses were checked for liquid loss, and the liquid volume of each sample bottle determined. The liquid samples from each run and blanks were transferred to individual tared weighing dishes, and the liquid allowed to evaporate at ambient temperature and pressure. The weighing dishes were then desiccated for twenty four hours and weighed until consecutive weighings agreed to within 0.5 mg.

The condensible fraction and blank were extracted with methylene chloride and analyzed gravimetrically. Prior to analysis, condensible fractions and blanks were checked for liquid loss, and the liquid volume of each sample bottle determined. Each sample was extracted three times with 25 ml of methylene chloride in a separatory funnel. After each extraction, the organic (methylene chloride) fraction was decanted. The organic fractions were placed in individual tared weighing dishes, and evaporated at ambient temperature and pressure. After evaporation, the sample weighing dishes were desiccated for 24 hours, and weighed hourly until consecutive weighings agreed to within 0.5 mg. The aqueous fractions were retained in the event that additional analysis is required.

EQUATIONS

Equation 1a - Dry Molecular Weight:

$$MW_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

Equation 1b - Wet Molecular Weight:

$$MW_w = MW_d(1-B_{ws}) + 18.0(B_{ws})$$

Equation 2a - Meter Volume at Standard Conditions:

$$V_{m(std)} = V_m Y \frac{(T_{std})(P_{bar} + \Delta H/13.6)}{(T_m)(P_{std})}$$

Equation 2b - Volume of Water Vapor Condensed:

$$V_{wc(std)} = K_1(W_f - W_i)$$

Equation 2c - Moisture Content:

$$B_{ws} = V_{wc(std)}/(V_{wc(std)} + V_{m(std)})$$

Equation 3a - Velocity at a Traverse Point:

$$V_d = K_p C_p (T_s \Delta P / P_s MW_w)^{1/2}$$

Equation 3b - Volumetric Flow Rate (Actual Basis):

$$Q = V_{d(avg)} A_d \, 60$$

Equation 3c - Volumetric Flow Rate (Standard Basis):

$$Q_{std} = \frac{Q(T_{std})(P_s)}{(T_s)(P_{std})}$$

Equation 3d - Volumetric Flow Rate (Standard Dry Basis):

$$Q_{std(dry)} = Q_{std}(1 - B_{ws})$$

Equation 4a - Isokinetic Sampling Nozzle Inside Diameter:

$$D_n = \left(\frac{(0.0358)Q_m P_m}{T_m C_p (1 - B_{ws})} \left(\frac{T_s MW_w}{P_s \Delta P} \right)^{0.5} \right)^{0.5}$$

Equation 4b - Isokinetic Sampling "X" Factor:

$$X = 846.72 \times D_n^4 \times \Delta H@i \times C_p^2 \times (1 - B_{ws})^2 \times \frac{(MW_d \times P_s)}{(MW_w \times P_m)}$$

Equation 4c - Orifice Pressure Drop at Isokinetic Sampling Rate:

$$\Delta H = X \times \Delta P \times \frac{(T_m)}{(T_s)}$$

Equation 4d - Sample Percentage of Isokinetic:

$$\%ISO = \frac{(T_{savg} V_{mstd} P_{std} 100)}{(T_{std} V_{davg} \theta A_n P_s 60 (1 - B_{ws}))}$$

Equation 4e - Particulate Concentration:

$$Co = \frac{M \times 0.0154}{V_{mstd}}$$

Equation 4f - Particulate Emission Rate (Mass Flow Rate):

$$ER = Co \times 0.00858 \times Q_{std(dry)}$$

SYMBOL IDENTIFICATION

A_n	=	Nozzle area (ft^2)
A_d	=	Area of duct (ft^2)
B_{ws}	=	Water vapor in gas stream, proportional by volume
Co	=	Total suspended particulate matter concentration (grains/DSCF)
C_p	=	Pitot tube calibration factor (unitless)
D_n	=	Inside diameter of sample nozzle (inches)
ER	=	Total suspended particulate matter emission rate (lb/hr)
K_1	=	Constant (0.04715 ft^3/g)
K_p	=	Constant (85.49)
M	=	Net mass of total suspended particulate matter collected (mg)
MW_d	=	Duct gas dry molecular weight (lb/lb-mole)
MW_w	=	Duct gas wet molecular weight (lb/lb-mole)
P_{bar}	=	Barometric pressure ("Hg)
P_m	=	Meter pressure (assumed to be 30"Hg)
P_s	=	Absolute stack pressure ("Hg)
P_{std}	=	Standard pressure (29.92"Hg)
Q	=	Duct volumetric flow rate (actual cfm)
Q_m	=	Assumed sampling rate (cfm)
Q_{std}	=	Duct volumetric flow rate (scfm)
$Q_{std(dry)}$	=	Duct volumetric flow rate (dscfm)
T_m	=	Absolute temperature at meter (°R)
T_s	=	Absolute temperature of duct gas (°R)
T_{std}	=	Standard temperature (528°R)
V_d	=	Duct velocity at a traverse point (ft/s)
V_m	=	Dry test meter volume (cf)
$V_{m(std)}$	=	Dry test meter volume at standard conditions (scf)
$V_{wc(std)}$	=	Volume of water vapor condensed at standard conditions (scf)
W_f	=	Final weight of impinger/absorber train (g)
W_i	=	Initial weight of impinger/absorber train (g)
X	=	Isokinetic orifice pressure drop sampling coefficient
Y	=	Dry test meter calibration factor (unitless)
$\%CO_2$	=	Duct gas carbon dioxide content (%volume)
%CO	=	Duct gas carbon monoxide content (%volume)

Symbol Identification (Continued)

%ISO	=	Sample percentage of isokinetic (must be 100±10%)
$\%N_2$	=	Duct gas nitrogen content (%volume)
$\%O_2$	=	Duct gas oxygen content (%volume)
%R	=	TSP percent removal
a	=	Flow angle (degrees)
θ	=	Total sample time (minutes)
ΔH	=	Pressure drop across orifice ("H_2O)
ΔH@i	=	Orifice calibration coefficient ("H_2O)
ΔP	=	Pressure drop across pitot tube ("H_2O)

National Emission Standards for Hazardous Air Pollutants (NESHAP) for Iron and Steel Foundries - Background Information for Proposed Standards

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National Emission Standards for Hazardous Air Pollutants (NESHAP) for Iron and Steel Foundries-- Background Information for Proposed Standards

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APPENDIX E

SOURCE TEST PARTICULATE MATTER DATA FOR ELECTRIC INDUCTION FURNACE FILTERS

E.1 INTRODUCTION

This appendix presents the individual sampling run data for the source tests available to characterize the control performance for fabric and cartridge filters applied to EIF (Chapter 4). Summary test data are given in Table E-1 along with information on furnace melting rates and capacities and a description of the filters and the processes they serve.

The data in Table E-1 represent a range of furnace sizes and types of filters. The design furnace melting rates range from 0.8 to 15 tons per hour, and ventilation rates range from 6,500 to 225,000 acfm. All of the foundries produce iron in the furnaces tested. The filters include both negative and positive pressure operating modes and employ both shaker and pulse jet cleaning systems. Some were installed about 20 to 25 years ago, and some are relatively new (rebuilt). The design air-to-cloth ratios cover a range of 1.7 to 11.8 ft/min. No information is available on the ages of the bags in service when the tests were conducted.

The reported results were checked to ensure the weights of PM from the filter and the probe catch were above detection limits. When the reported catch was less than 3 mg, a detection limit value of 3 mg and the sample volume were used to estimate the detection limit in gr/dscf. Values calculated in this manner are reported as “less than” (<).

TABLE E-1. PM TEST RESULTS FOR FILTERS SERVING EIF AND SCRAP PREHEATERS

Foundry MI-04 (tested August 1994)								
Run	PM* (gr/dscf)	PM* (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	<0.0006	<0.027					4.1	Negative pressure, pulse jet cleaning Fabric: polyester Design gas flow rate: 50,000 acfm Design operating temperature: 80°F Design air-to-cloth ratio: 6 ft/min Serves 3 EIF, 1.5 tons/hr design melt rate for each
2	<0.0006	<0.027						
3	<0.0006	<0.027						
Avg	<0.0006	<0.027						
* The results were reported as <0.0002 gr/dscf and were adjusted to <0.0006 gr.dscf based on the best estimate of the detection limit.								
Foundry CA-01 (tested March 1996)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	<0.0002	<0.05	41,000	43,110	90	2.56	1.3	Positive pressure, shaker cleaning; in series with 2 prefilters and a HEPA filter Fabric: polyester Design gas flow rate: 49,600 acfm Design operating temperature: 81°F Design air-to-cloth ratio: 2.95 ft/min Serves 8 EIF, (0.5 to 1.75 tons/hr design melt rate), 4 casting stations, 4 mold spray/coating stations, 1 Hawley system

Foundry IN-13 (tested October 1996)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	<0.0006	<0.34	66,943	71,590	95	2.91	33.8	Negative pressure, pulse jet cleaning Fabric: polyester Design gas flow rate: 72,500 acfm Design operating temperature: 150°F Design air-to-cloth ratio: 2.95 ft/min Installed 1995 Serves 3 EIF, 10.7 tons/hr design melt rate for each; controls charging, melting, holding furnaces, ladle metallurgy
2	<0.0006	<0.34	66,453	72,190	102	2.94		
3	<0.0006	<0.34	67,590	73,100	100	2.97		
Avg	<0.0006	<0.34	66,995	72,290	99	2.94		
Foundry WI-43 (tested November 1997)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	<0.0010	<0.6	60,236	66,964	111	4.0	112	Negative pressure, pulse jet cleaning Fabric: polyester Design gas flow rate: 110,000 acfm Design operating temperature: 100°F Design air-to-cloth ratio: 6.5 ft/min Installed 1995 Serves 10 EIF, 11 tons/hr design melt rate each; controls charging, melting, magnesium treatment
2	<0.0011	<0.6	59,491	66,543	115	3.9	114	
3	<0.0011	<0.6	58,117	65,870	122	3.9	137	
Avg	<0.0011	<0.6	59,281	66,459	116	3.9	121	

Foundry WI-43: scrap preheater only (tested November 1997)

Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Preheat rate (tph)	Baghouse design and service data
1	<0.0007	<0.4	71,594	88,045	169	7.8	56	Negative pressure, pulse jet cleaning Fabric: fiberglass Design gas flow rate: 80,000 acfm Design operating temperature: 310°F Design air-to-cloth ratio: 7.1 ft/min Installed 1995 Serves 3 scrap preheaters, 33 tons/hr design rate each
2	<0.0007	<0.4	72,303	88,649	167	7.9	69	
3	<0.0007	<0.4	73,230	87,282	149	7.7	58	
Avg	<0.0007	<0.4	72,376	87,992	162	7.8	61	

Foundry MN-7 (tested August 1996)

Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	<0.0010	<1.0	110,900	118,500	99	3.9	7.55	Negative pressure, pulse jet cleaning Fabric: polyester (Dacron) felt (16 oz) singed finish Design gas flow rate: 119,300 acfm Design operating temperature: 103°F Design air-to-cloth ratio: 3.9 ft/min Installed 1991; Serves one EIF, 15.2 tons/hr design melt rate; controls charging, melting, tapping, holding furnaces, ladle metallurgy, pouring/cooling
2	<0.0013	<1.2	111,900	120,600	103	3.9		
3	0.0014	1.3	109,600	118,800	107	3.9		
Avg	<0.0012	<1.2	110,800	119,300	103	3.9		

Foundry WI-47 (tests of 3 systems)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Design and service data
Avg	0.0011	0.4	44,052				3.0	Negative pressure, pulse jet cleaning Fabric: polyester Design gas flow rate: 50,000 acfm Design air-to-cloth ratio: 7 ft/min Installed 1991 Serves preheater and one EIF, 3.5 tons/hr design melt rate; controls charging, melting
Avg	0.0006	0.22	46,032				2.8	Negative pressure, pulse jet cartridge cleaning Fabric: cartridge collector Design gas flow rate: 40,000 acfm Design air-to-cloth ratio: 1.3 ft/min Installed 1991 Serves two EIFs, 5 tons/hr design melt rate for each; controls charging, melting; also controls inoculation and cast cooling
Avg	0.0052	2.92	65,132				4.4	Venturi scrubber with <13 in water pressure drop; 73,500 acfm Serves two EIF for melting (5 tph each); also pouring and cooling

Foundry IN-24 (tested December 1996)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Cartridge filter design and service data
1	0.0017	0.34	23,050	23,111	62	1.55	4.4	Negative pressure, pulse jet cartridge cleaning Fabric: cellulose cartridge Design gas flow rate: 25,000 acfm Design operating temperature: 180°F Design air-to-cloth ratio: 1.68 ft/min Installed 1996 Serves two EIF, 4.5 tons/hr design melt rate controls charging, melting, tapping
2	0.0014	0.28	23,171	23,074	59	1.55		
3	0.0026	0.50	22,909	22,842	60	1.53		
Avg	0.0019	0.37	23,043	23,009	61	1.55		

Foundry CA-09 (tested October 1987)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0015	0.076	5,906	6,503	102	1.4	0.8	Negative pressure, shaker cleaning Fabric: polyester Design gas flow rate: 9,600 acfm Design operating temperature: 130°F Design air-to-cloth ratio: 2 ft/min Installed 1997 Serves three EIFs, two at 0.8 tph and one at 1.5 tph design melt rate each; controls melting, charging, preheater, and sand reclaimer
2	0.0023	0.113	5,727	6,427	113	1.3		
3	0.003	0.145	5,630	6,426	121	1.3		
Avg	0.0023	0.11	5,754	6,452	112	1.3		

Foundry MN-12 (tested March 1995 and May 1996)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0034	0.38	13,200	13,500	86	2.54	5.8	Positive pressure, shaker cleaning Fabric: felt Design gas flow rate: 29,800 acfm Design operating temperature: 100°F Design air-to-cloth ratio: 2.8 ft/min Installed 1980 Serves two EIF, 4.7 tons/hr design melt rate each; controls charging, melting, tapping, ladle metallurgy; two stacks on baghouse
2	0.0014	0.14	11,700	12,200	90	2.29	6.0	
3	0.0024	0.21	10,300	11,000	78	2.07	6.3	
4	0.0022	0.24	12,700	13,100	86	2.46	5.8	
5	0.0026	0.31	13,700	14,100	82	2.65	6.4	
6	0.0012	0.14	13,800	14,200	84	2.67	6.4	
Avg	0.0022	0.47 *	25,100 *	26,000 *	84	2.45	6.1	
1	0.0009	0.11	14,700	15,600	105	2.93	5.2	
2	0.0016	0.19	14,000	14,900	104	2.80	5.3	
3	0.0028	0.35	14,400	15,500	111	2.91	5.3	
4	0.0005	0.06	13,800	14,700	105	2.76	5.1	
5	0.0006	0.07	14,200	14,700	89	2.76	5.3	
6	0.0019	0.22	13,500	14,200	95	2.67	5.3	
Avg	0.0014	0.33 *	28,200 *	29,900 *	102	2.80	5.2	

* The baghouse has two stacks; Runs 1-3 are for one stack and Runs 4-6 are for the other stack.

Foundry PA-06 (tested July 1995; one of two baghouses in parallel)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0022	0.71	37,936	41,151	106		8.0	Negative pressure, reverse pulse cleaning (two baghouses in parallel) Fabric: polyester Design gas flow rate: 95,094acfm for two baghouses Design operating temperature: 120°F Design air-to-cloth ratio: 4.38 ft/min Installed 1996 Serves one EIF at10 tons/hr design melt rate each; also controls inoculation and carbon/silicon adjustment
2	0.00124	0.39	36,578	40,150	108			
3	0.00064	0.2	36,267	39,414	104			
Avg	0.0014	0.43	36,927	40,238	106			

Foundry PA-06 (tested July 1995; one of two stacks; doubled flow and emission rate to estimate for both stacks)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.00225	1.32	68,464	75,040	97		8.0	Negative pressure, reverse pulse cleaning (two baghouses in parallel) Fabric: polyester Design gas flow rate: 95,094acfm for two baghouses Design operating temperature: 120°F Design air-to-cloth ratio: 4.57 ft/min Installed 1996 Serves one EIF at10 tons/hr design melt rate each; also controls inoculation and carbon/silicon adjustment
2	0.00116	0.68	68,402	75,204	95			
3	0.00117	0.68	68,094	74,434	93			
Avg	0.0015	0.89	68,320	74,893	95			

Foundry OH-43 (tested October 1997)

Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph) [2]	Baghouse design and service data
1	0.0038	2.25	69,695	74,979	83	6.04	9.4	Negative pressure, pulse jet cleaning Fabric: polyester Design gas flow rate: 65,000 acfm Design operating temperature: 90-110°F Design air-to-cloth ratio: 5.24 ft/min Installed 1996 Serves two EIF, 15 tons/hr design melt rate each; controls melting, grinding, shot blasting, pouring
2	0.0013	0.81	71,174	76,590	83	6.17	5.9	
3	0.0018	1.09	71,568	78,190	93	6.30	12.2	
Avg	0.0023	1.38	70,812	76,586	86	6.34	9.2	

[2] Tons per hour transferred; both furnaces were operating, but there was only one charge during the test. Test includes both melting and holding.

Foundry TX-11 (tested October 1993)

Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0030	2.29	81,362	93,159	95	3.11	3.85	Negative pressure, shaker cleaning Fabric: Nomex Design gas flow rate: 90,000 acfm Design operating temperature: 100°F Design air-to-cloth ratio: 3 ft/min Installed 1977 Serves one EIF, 3.75 tons/hr design melt rate; controls charging, melting, tapping, ladle metallurgy
2	0.0021	1.74	77,351	90,950	111	3.03		
3	0.0020	1.71	76,379	90,057	112	3.00		
Avg	0.0024	1.91	78,364	91,389	106	3.05		

Foundry MI-28 (tested March 1996)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0031	1.03	38,480			2.10	5.20	Negative pressure, pulse jet cleaning Fabric: Polyester Design gas flow rate: 70,000 acfm Design operating temperature: 135°F Design air-to-cloth ratio: 3.9 ft/min Installed 1995 Serves 3 EIFs, 9 tons/hr design melt rate and 2 scrap preheaters; controls charging, melting, tapping
2	0.0028	0.94	39,512			2.20		
3	0.0027	0.96	41,190			2.30		
Avg	0.0029	1.03	39,728			2.20		

Foundry IN-11 (tested September 1990)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0032	1.435	52,383	61,842	143	2.14	Unknown	Negative pressure, pulse jet cleaning Fabric: polyester (Dacron) Design gas flow rate: 100,000 acfm Design operating temperature: unknown Design air-to-cloth ratio: 3.46 ft/min Installed 1990 Two identical baghouses serving three EIF each, 10 tons/hr design melt rate each; controls preheater, charging, melting, tapping
2	0.0050	2.217	52,200	62,017	143	2.15		
3	0.0026	1.140	52,100	61,534	142	2.13		
Avg	0.0036	1.597	52,228	61,798	143	2.14		
1	0.0019	1.456	89,280	103,143	135	3.57		
2	0.0037	2.827	88,683	102,427	136	3.54		
3	0.0017	1.303	89,633	104,083	139	3.60		
Avg	0.0024	1.862	89,199	103,218	137	3.57		

Foundry IN-29 (tested February 1997)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0025	0.85	40,367	42,354	86	12.5	24	Positive pressure, pulse jet cleaning Fabric: polyester felt Design gas flow rate: 40,000 acfm Design operating temperature: 175°F Design air-to-cloth ratio: 11.8 ft/min Installed 1996 Serves two EIF, 10.5 tons/hr design melt rate; controls preheating, melting
2	0.0017	0.59	39,694	41,609	85	12.3	20	
3	0.0076	2.56	39,033	41,037	86	12.1	23	
Avg	0.0039	1.33	39,698	41,667	86	12.3	23	
Foundry IN-12 (tested March 1990)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.0056	2.38	49,122	51,817	99		15	Uncontrolled induction furnaces (3 at 5 tph)
2	0.0068	2.86	49,247	51,865	99			
Avg	0.0062	2.62	49,185	51,841	99			
Foundry PA-46 (tested October 1995)								
Run	PM (gr/dscf)	PM (lb/hr)	Flow (dscfm)	Flow (acfm)	Temp (°F)	Air-cloth ratio (ft/min)	Melt rate (tph)	Baghouse design and service data
1	0.008	10.76	155,000				15	Negative pressure, pulse jet cleaning Fabric: polyester Design gas flow rate: 225,000 acfm Design operating temperature: 100°F Design air-to-cloth ratio: 6.8 ft/min Installed 1995 Serves five EIF, 3.3, 3.3, 4.1, 6.8, and 12.7 tons/hr design melt rate; controls charging, melting, tapping
2	0.009	11.25	150,000					
3	0.008	10.55	155,000					
Avg	0.008	10.85	153,000					