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SEP 2016
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MDEQ Jackson
AQD

September 13, 2016

VIA HAND DELIVERY AND FIRST CLASS MAIL

Mr. Edward Nam
Acting Director--Air and Radiation Division
U.S. Environmental Protection Agency ("USEPA")
Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590

Re: Response to Finding of Violation Under 42 USC 7413(a)(3) dated June 30, 2016

Dear Mr. Nam:

We are providing this letter on behalf of our client, Gerdau Specialty Steel, N. A. ("Gerdau") in response to the above referenced Finding of Violation ("FOV"). As you may know, Gerdau has been cooperatively working with USEPA since June 2015 to investigate the cause and determine the potential remedies to address the alleged violations.

With respect to the Finding of Violation, Gerdau is asserting the following to provide clarification and perspective with respect to the alleged violations:

1. Gerdau agrees that 40 C.F.R. § 63.10686(b)(2) states that a facility must not discharge or cause the discharge into the atmosphere from an EAF any gases which exit from a melt shop and, due **solely to the operations of any affected EAF(s)**, exhibit six percent opacity or greater. However, please be advised that the Gerdau facility melt shop roof monitor was closed when the canopy system was installed. The only remaining monitor still open is at the caster roof. The general ventilation pattern of the building forces any dust generated to migrate towards the caster area. "However, this dust does not appear to report directly to the caster roof vent. Rather the dust comingles with other emission sources and appears to accumulate near the caster deck. It is therefore difficult to distinguish between emissions generated at the caster from other emission sources at the roof vent elevation." (See attached **Exhibit A**--GCT Meltshop Air

> Pollution Control System Evaluation—Preliminary Report dated January 29, 2016, page 13.)

2. The caster roof monitor emission limit per the Gerdau Renewable Operating Permit ("ROP") B4306, General Condition #11 is: "11. Unless otherwise specified in this ROP, the permittee shall comply with Rule 301, which states, in part, "Except as provided in subrules 2, 3, and 4 of this rule, a person shall not cause or permit to be discharged into the outer air from a process or process equipment a visible emission of a density greater than the most stringent of the following: **(R 336.1301(1))**

   a. A 6-minute average of 20 percent opacity, except for one 6-minute average per hour of not more than 27 percent opacity.

   b. A limit specified by an applicable federal new source performance standard.

   Because 11b is inapplicable to the Gerdau Jackson plant, the limit in 11a applies. **Please be aware that Gerdau's monitor has not exceeded its ROP permit limit at any time.**

3. Therefore, while Gerdau has conceded that some EAF emissions may be exiting the caster roof monitor, because it is virtually impossible to differentiate between the caster and EAF emissions, Gerdau does not agree that the EAF emissions are exiting at 6% opacity or greater.

The purpose of the remainder of this letter is to respond to particular allegations as presented in the FOV. For ease of reference, we are listing the particular noted allegation and providing our response below.

USEPA Allegation 26. On September 4, 2015, EPA conducted Method 9 opacity observations at the open roof monitor located in the south end of the shop. EPA observed opacity in excess of a 6-minute average of 6% on five occasions, three of which occurred within one hour and one of which exceeded 10%, and two of which occurred during the second hour and one of which exceeded 10%.

Gerdau Response:

While Gerdau acknowledges that EPA did conduct Method 9 opacity observations on September 4, the readings were done incorrectly. Gerdau observed that the EPA reader was not positioned in the correct location to take an accurate reading. As discussed during a conference call with EPA on September 10, 2015 and followed up by email from Mr. Ross Bradley to Ms. Letuchy and Mr. DeLeon on September 15, 2015 (see attached **Exhibit B**), the reader was positioned horizontally to the long axis which is contrary to EPA Method 9 guidance. As a result, EPA conducted additional Method 9 readings on September 17, 2015. Therefore, Gerdau disputes the accuracy of the September 4, 2016 readings and denies the allegations of non-compliance.

USEPA Allegation 27: On September 17, 2015, EPA conducted additional Method 9 opacity observations at the open roof monitor located at the south end of the shop. EPA observed opacity in excess of a 6-minute average of 6% on three occasions, all of which occurred within one hour and one of which exceeded 10%.

Gerdau Response:

While Gerdau acknowledges that EPA conducted the readings on September 17, 2015, please be aware that the Method 9 Visible Emission Observation Form dated September 17, 2015 by observer Kushal Som noted that the estimated emission location height as 35 feet. (See **Exhibit C).** However, the roof monitor is at a height of 100 feet, 81/2 inches to the top of the monitor. Therefore, Gerdau disputes the accuracy of the observation.

In addition, please be aware that the emissions from the roof monitor reflect *caster* emissions. As stated above, ROP B4306-2015 dated February 12, 2015, general condition #11 states that the emission limit at the caster roof monitor to be "a 6 -minute average of 20 percent opacity, except for one 6-minute average per hour of not more than 27 percent opacity." Again, because it is virtually impossible for an observer to differentiate whether the emissions are due to the EAF versus the caster area, Gerdau disputes whether the EAF emissions were in excess of 6% opacity.

USEPA Allegation 28: From December 8, 2015, to December 10, 2015, Gas Cleaning Technologies, LLC (GCT) conducted a melt shop air pollution control system evaluation at the Facility and summarized its findings in a report dated January 29, 2016. GCT's evaluation included the following observations: the airflow rate of the canopy hood capturing emissions from the EAFs during charging (and tapping) was lower than design values; dampers of the same canopy hood were in incorrect positions during charging and tapping; and capture of tapping emissions from the EAFs was difficult due to the general ventilation pattern of the building forcing any dust generated at the EAFs to migrate towards the south end of the melt shop.

Gerdau Response:

Since becoming aware of the emissions drift issue identified by EPA in June 2015, Gerdau has worked diligently to determine the root cause(s) of the issue and to implement remedies as soon as possible. After working with EPA for several weeks to develop a scope of work, Gerdau hired GCT to do a Meltshop Air Pollution Control System Evaluation. GCT conducted its site work from December 8 to 10, 2016 and provided a report dated January 29, 2016. While Gerdau agrees that GCT did observe and submit several findings, Gerdau does not agree that GCT observed that "capture of tapping emissions from the EAFs was difficult due to the general ventilation pattern of the building forcing **any** dust generated at the EAFs to migrate towards the south end of the melt shop" [emphasis added]. EPA is implying that **all** dust generated from the EAFs will migrate to the south end of the melt shop, when the vast majority of the EAF dust is captured by the canopy and side draft system. Noticeable EAF drift now occurs only during hold fire and tapping and when the wind direction is from the northwest. Northwest winds are noted to occur about 20% of the time over the past 5 years. During facility operation, given a *worst case scenario* of unfavorable wind direction, noticeable EAF drift could occur at a maximum of 15 minutes every 2 hours (a typical tap-to-tap cycle) or about 3% of the time in a given year. Further, just because there is noticeable EAF emission drift does not mean that it always exceeds 6% opacity.

USEPA Allegation 29: From March 15, 2016 to March 17, 2016, GCT conducted a reevaluation of the melt shop air pollution control system at the Facility and summarized its findings in a report dated April 19, 2016. Gerdau conducted opacity readings during the reevaluation. GCT's evaluation included the following observations: average exhaust rates at the canopy hood during tapping and charging do not meet the original design exhaust rates; emissions from the EAFs escaped the side draft hoods during melting and were observed travelling towards the south end of the melt shop; and opacity readings over 6% were observed at the open roof monitor located at the south end of the shop on two occasions on March 16, 2016.

Gerdau Response:

When Gerdau received the January 29, 2016 report from GCT, Gerdau immediately began implementation of GCT's recommendation to adjust the canopy hood damper logic. Gerdau noticed considerable visual improvement in capture efficiency during charging and tapping. Gerdau then hired GCT again to verify the improvement, re-evaluate the system following the change and make recommendations for further improvements as necessary.

Upon system re-evaluation, GCT noted on page 5 of the April 19, 2016 report that "[b]ased on GCT's re-evaluation of the APC system performance, the revised damper control logic has rectified the previously identified control issue and has resulted in a significant increase in canopy hood exhaust rate during charging and tapping operations. This appears to have improved capture of charging and tapping emissions and, based on the (3) periods of Method 9 readings collected, reduced opacity at the caster roof vent below the 6% limit during these periods." (See **Exhibit D**.) However, due to the change in meltshop ventilation pattern with caster louvers open in the springtime, fugitive EAF emissions from the side draft hood during "hold fire" mode were now observed to travel towards the caster aisle. Again, as stated previously, please keep in mind that emissions are also generated at the caster and while Gerdau has conceded that some EAF emissions may be exiting the caster roof monitor, it is virtually impossible to differentiate between the caster and EAF emissions.

As you may know, Gerdau has received additional correspondence dated August 1, 2016 from the U.S. Department of Justice Environment and Natural Resources Division ("USDOJ") concerning this matter. Gerdau has requested a September 2016 meeting with USDOJ and USEPA to discuss this FOV as well as the September 2014 NOV and hopefully reach resolution.

Gerdau appreciates EPA's cooperation and Gerdau will continue to cooperate in good faith to resolve the matters discussed herein. If you have any questions concerning this response, please do not hesitate to contact me.

Very truly yours,
Dickinson Wright PLLC

By: Anna M. Maiuri
Anna M. Maiuri

Exhibits

cc: Ms. Iva Ziza, DOJ (w/exhibits)
Ms. Alexandra Letuchy, EPA (w/exhibits)
Mr. Jose DeLeon, EPA (w/exhibits)
Mr. Scott Miller, MDEQ (w/exhibits) ✓
Mr. Andre Wollman, Gerdau (w/exhibits)

Mr. Jack Skelley, Gerdau (w/exhibits)
Mr. Ross Bradley, Gerdau (w/exhibits)

Exhibit A

GCT

Gerdau Jackson

Meltshop Air Pollution Control System Evaluation

Preliminary Report

GCT Project: T4027

January 29, 2016

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Disclaimer

This report has been prepared based upon information provided by Gerdau Jackson. Gas Cleaning Technologies, LLC has relied upon this information in the preparation of this report and has not independently verified that the information is accurate or complete. This report was prepared under contract to Gerdau Jackson for their use and benefit and under the terms and conditions of that contract and cannot be used by or relied upon by any other party for any other purpose. Except with respect to the express warranties contained within the contract, GCT provides no other warranty, either express or implied, under any theory of law, for the information, conclusions or recommendations provided herein.

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PROJECT T4027 - MELTSHOP AIR POLLUTION CONTROL SYSTEM EVALUATION

REV	DESCRIPTION	ORIG	REVIEW	GCT APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Preliminary Report	F. Concha	C. Grass	N/A	1/29/2016	N/A	

CONTENTS

1. EXECUTIVE SUMMARY

Gerdau Specialty Steel N.A. (Gerdau) operates an SBQ meltshop in Jackson, Michigan equipped with (2) 52 ton Electric Arc Furnaces (EAFs). Each furnace is equipped with side draft fume collection hoods for local collection of emissions from the EAFs as well as canopy hoods located above each furnace for collection of secondary emissions generated during EAF operations. The combined gasses from the side draft hoods and secondary hoods tie into a common 828,000 ACFM baghouse system.

Gerdau is currently experiencing some drift from the EAF aisle towards the caster aisle and has contracted Gas Cleaning Technologies (GCT) to perform a meltshop Air Pollution Control (APC) system study to assess the current performance of the APC system and evaluate options to improve capture efficiency within the meltshop.

As a part of the evaluation, GCT conducted a site visit from December 8 to 10, 2015 to collect updated measurements, data, and observations of the APC system to allow GCT to conduct the evaluation of the system performance. Using the updated data collected, GCT conducted an evaluation of the APC system. The results of this evaluation are summarized as follows:

- Side Draft Hood Performance
  - 2015 Side Draft Hood exhaust rates are approximately 25 to 40% lower than in 2010
  - Capture by the side drafts is between 75-90%, depending on the phase of EAF operation
  - Emissions escaping the side draft hoods during melting generally report to the canopy hood and were not observed to travel towards the caster aisle. Therefore, although the system is operating differently, overall meltshop capture during melting is not expected to have significantly changed from 2010.
  - Increasing the side draft hood exhaust rates is not recommended as this may negatively affect EAF performance and will not lead to a significant change in overall meltshop capture.
- Canopy Hood Performance
  - 2015 Canopy Hood exhaust rates are similar to 2010 during melting, but lower than the 2010 design value during charging
  - GCT identified a damper control logic issue that may be causing the reduced canopy hood exhaust rates during charging. This should be relatively simple to rectify, resulting in a significant increase in canopy hood exhaust rate.
  - Due to meltshop ventilation patterns, capture of tapping emissions by canopy hood is difficult
- Shop Ventilation
  - The general ventilation pattern of the building forces any dust generated to migrate towards the caster area. Drift towards the caster is present even with majority of doors closed.
  - This dust does not appear to report directly to the caster roof vent. Rather the dust comingles with other emission sources and appears to accumulate near the caster deck.
  - Continuous emissions are generated from the caster ladles and the caster appears to contribute significantly towards the white haze that accumulates in the caster roof trusses.

- During GCT's visit, winds were from South. As expected, wind conditions can affect system performance.

In general, based on GCT's evaluation the baghouse system is adequately sized for the current operation, however it may be possible to operate the existing system more effectively. To this end, GCT recommends Gerdau investigate the current damper control logic to determine why several of the dampers are in incorrect positions during charging and tapping. Ensuring that all (3) dampers at the charging/tapping EAF are fully open during the entire duration of the operation should increase the ventilation rate towards the design exhaust rate of 481,000 ACFM.

Modification of the damper control logic can be implemented relatively quickly and is expected to result in improved shop cleanliness, reduced spillage from the canopy and reduced fugitive emissions from the EAF aisle to the caster area. Following modification of the damper control logic, the canopy hood exhaust rates should be retested to determine the resulting hood exhaust rates and to determine if further turning is required. The system performance should then be reevaluated to determine the impact of the new canopy hood exhaust rates on system performance.

Long term, the building ventilation pattern makes high capture of tapping emissions difficult and promotes drift into caster aisle making it difficult to distinguish between various emissions sources. A higher canopy hood exhaust rate or even a larger baghouse would not eliminate drift in the meltshop. Additional modifications may therefore be required to demonstrate regulatory compliance.

Based on feedback from Gerdau, the investigation of these modifications is already underway, and Gerdau expects the modifications to be completed according to the schedule shown below. While evaluating the impact of the recommended damper control modification on system performance, Gerdau will also be exploring alternative options designed to improve capture.

Task	Estimated Completion Date
Initial Investigation	2/5/16
Implementation of Revised Logic	2/19/16
Retest to confirm new hood exhaust rates	March 2016
Reevaluate System Performance	March / April 2016

2. INTRODUCTION

Gerdau Specialty Steel N.A. (Gerdau) operates an SBQ meltshop in Jackson, Michigan. The meltshop is equipped with (2) 52 ton EAFs, a two-strand caster, and rolling mill. Each furnace is equipped with side draft fume collection hoods for local collection of emissions from the EAFs as well as canopy hoods located above each furnace for collection of secondary emissions generated during EAF operations. The combined gasses from the side draft hoods and secondary hoods tie into a common 828,000 ACFM baghouse system. Gerdau completed several modifications to the Meltshop Air Pollution Control (APC) system in 2010 (at the cost of approximately $4 million) in order to comply with a more stringent 6% opacity requirement from the meltshop.

Gerdau is currently experiencing some drift from the EAF aisle towards the caster aisle. Gerdau has therefore contracted Gas Cleaning Technologies (GCT) to perform a meltshop air pollution control system study to assess the current performance of the APC system and evaluate options to reduce emissions drift within the meltshop.

The focus of this study is as follows:

- Evaluate the current EAF side draft hood system and canopy hood performance
- Compare operating conditions and system performance against the previous evaluation conducted in 2010
- Evaluate options to optimize system performance and reduce fugitive emissions through:
    - Modifications to controls and damper control logic
    - Modification of operating practices
    - Other measures to prevent migration of emissions into the caster area and reduce meltshop fugitive emissions due to EAF operations and from other emission sources

As a part of the evaluation, GCT conducted a site visit from December 8 to 10, 2015 to collect updated measurements, data, and observations of the APC system to allow GCT to conduct the evaluation of the system performance. GCT also collected the measurements required to conduct Computational Fluid Dynamic (CFD) modeling during this site visit in the event a CFD modeling study is needed in the future.

This preliminary report provides a summary of the outcomes of the APC system evaluation and presents a set of operational improvements designed to improve the performance of the APC system.

Additional equipment options designed to further reduce drift in the meltshop are currently under development and will be presented in a separate report.

3. MELTSHOP AIR POLLUTION CONTROL SYSTEM EVALUATION

GCT personnel traveled to Jackson, Michigan on December 8 to December 10, 2015 to conduct measurements, collect operating data, specifications and drawings, and to observe the performance of the existing air pollution control system. This information was used to establish the EAF ventilation requirements and to evaluate the performance of the APC system to meet these ventilation requirements.

3.1 Summary of Field Measurements and Observations

Flow rate, temperature, and static pressure measurements were collected at the following locations:

- EAF #1 side draft hood duct
- Canopy #1 hood duct
- EAF #2 side draft hood duct
- Canopy #2 hood duct
- LMF and VAD duct

Tables 3.1 to 3.5 below summarize the off-gas measurements collected during the testing period.

Table 3.1
Side Draft Hood 1 Duct Measurement – December 8th, 2015

	Temp	Flow Rate		S.P.
	F	ACFM	SCFM	inH2O
EAF 1 Overall	347	65,000	40,700	-0.69
EAF 1 Melting	392	75,400	45,100	-0.83
EAF 1 Charging	310	0	0	-0.08
EAF 1 Tapping	243	25,200	18,300	-0.25
EAF 1 Power Off	273	56,500	39,300	-0.56

Table 3.2
Canopy Hood 1 Duct Measurement – December 8th, 2015

	Temp	Flow Rate		S.P.
	F	ACFM	SCFM	inH2O
EAF 1 Overall	92	246,400	227,600	-1.48
EAF 1 Melting	94	254,900	234,600	-1.49
EAF 1 Charging	97	333,100	306,000	-1.05
EAF 1 Tapping	83	300,900	282,200	-1.39
EAF 1 Power Off	89	206,300	191,400	-1.56

Table 3.3
Side Draft Hood 2 Duct Measurement – December 9th, 2015

	Temp	Flow Rate		S.P.
	F	ACFM	SCFM	inH2O
EAF 2 Overall	333	64,700	40,800	-0.60
EAF 2 Melting	385	74,700	44,600	-0.70
EAF 2 Charging	135	0	0	0.00
EAF 2 Tapping	240	38,200	27,200	-0.25
EAF 2 Power Off	288	57,900	38,900	-0.55

Table 3.4
Canopy Hood 2 Duct Measurement – December 9th, 2015

	Temp	Flow Rate		S.P.
	F	ACFM	SCFM	inH2O
EAF 2 Overall	94	274,100	252,600	-1.40
EAF 2 Melting	93	262,500	242,300	-1.48
EAF 2 Charging	102	331,700	301,400	-1.12
EAF 2 Tapping	90	353,200	327,800	-1.26
EAF 2 Power Off	94	275,900	254,100	-1.32

Table 3.5
LMF and VAD Duct Measurement – December 10th, 2015

	Temp	Flow Rate		S.P.
	F	ACFM	SCFM	inH2O
LMF Duct	145	41,000	34,500	-2.09

Figure 3.1 below shows a graph of the flow rate measured by GCT at the side draft 1 duct on December 8th, 2015.

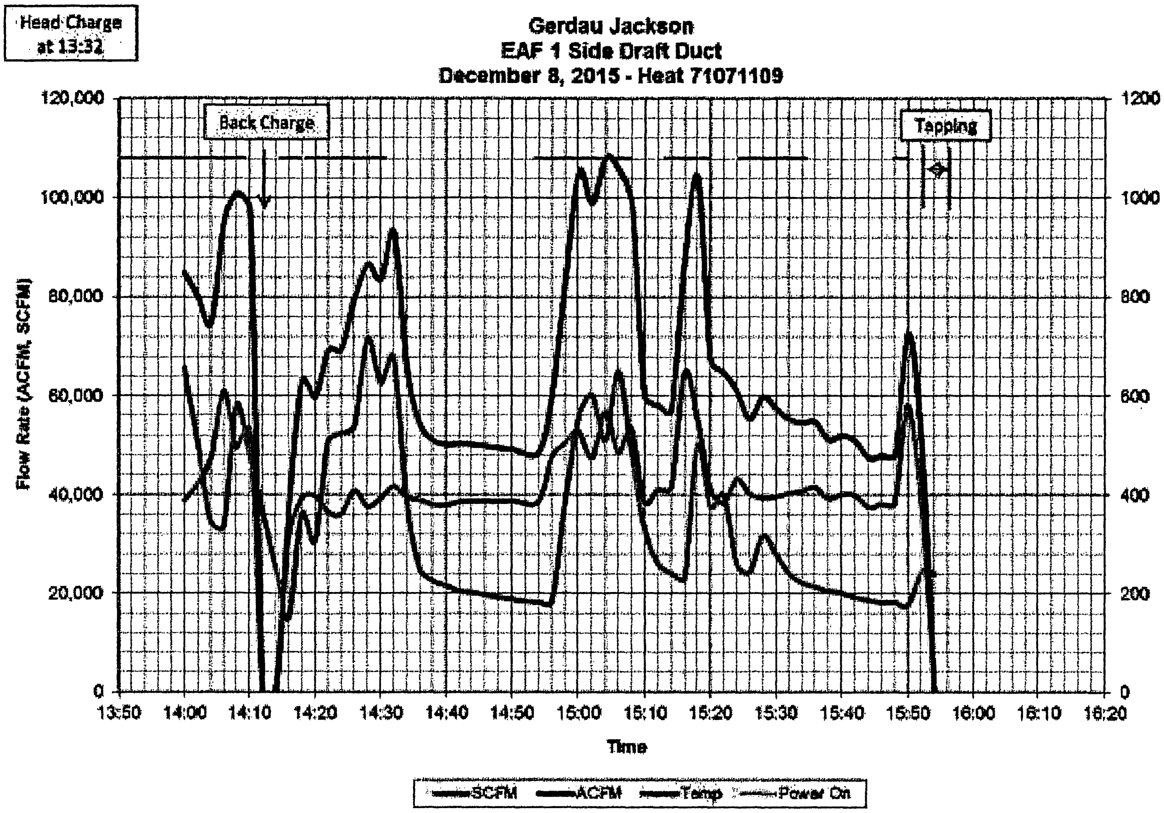


Figure 3.1
Side Draft 1 Flow Rate Measurements – December 8th, 2015
Heat 71071109

Figure 3.2 below shows a graph of the flow rate measured by GCT at the Canopy #1 duct in the elbow near the mixing box on December 8th, 2015.

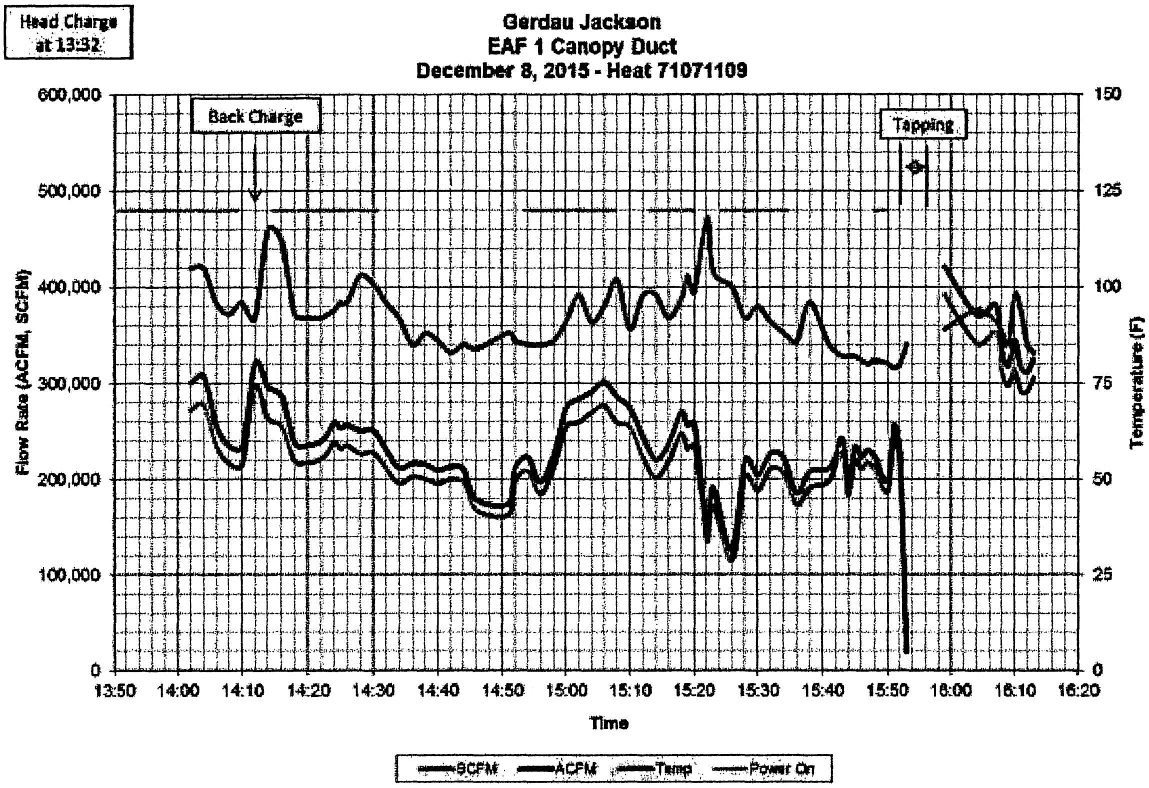


Figure 3.2
Canopy #1 Duct Flow Rate Measurements – December 8th, 2015
Heat 71071109

As the figure above shows, GCT measured for nearly a complete heat from shortly after the head charge to just after tapping. It is important to note that just before tapping occurred, the total flow rate in Canopy #1 duct dropped to near zero. GCT initially believed that the measurements were faulty at this moment and examined the equipment to verify the Pitot tube did not have blockages. GCT therefore did not measure during the remainder of tapping. Further evaluation subsequent to the site visit revealed that the drop in flow rate was a result of the current damper control logic, discussed in further detail in Section 3.7 below.

Figure 3.3 below shows a graph of the flow rate measured by GCT at the Side Draft 2 duct on December 9th, 2015.

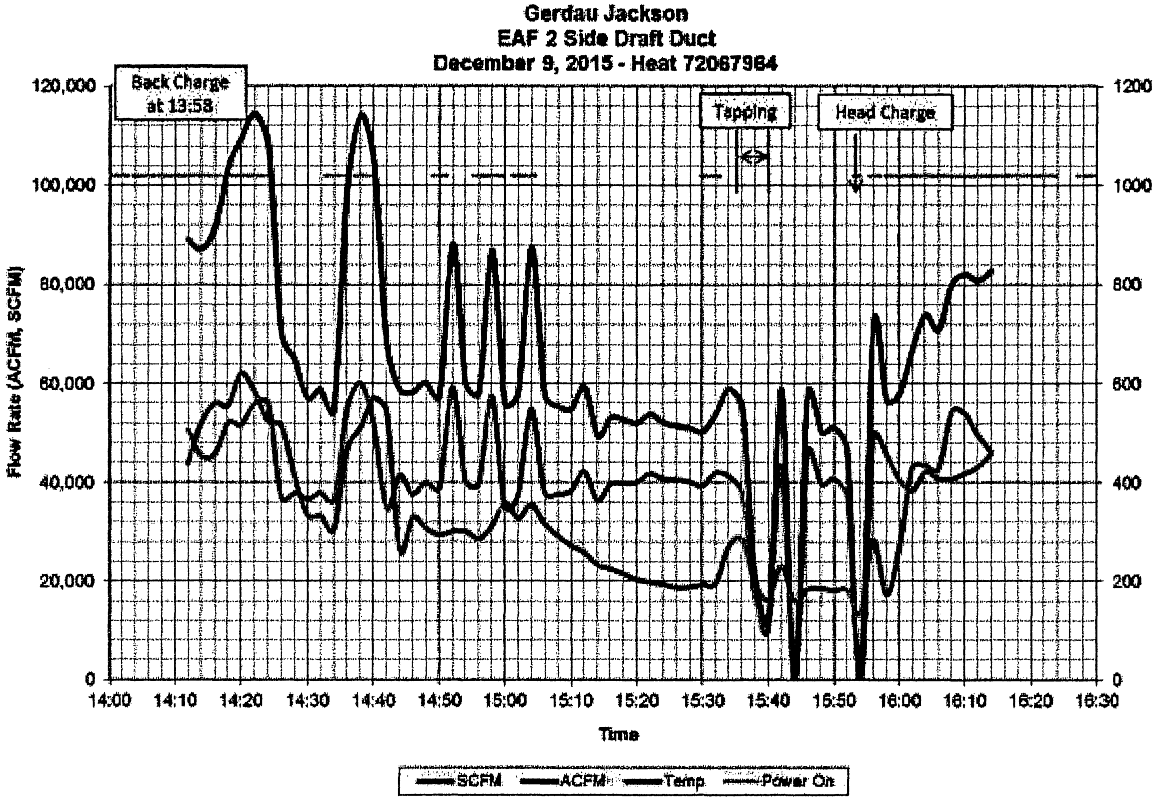


Figure 3.3
Side Draft 2 Flow Rate Measurements – December 9th, 2015
Heat 72067964 & 72067965

Figure 3.4 below shows a graph of the flow rate measured by GCT at the Canopy #2 duct in the elbow near the mixing box on December 9th, 2015.

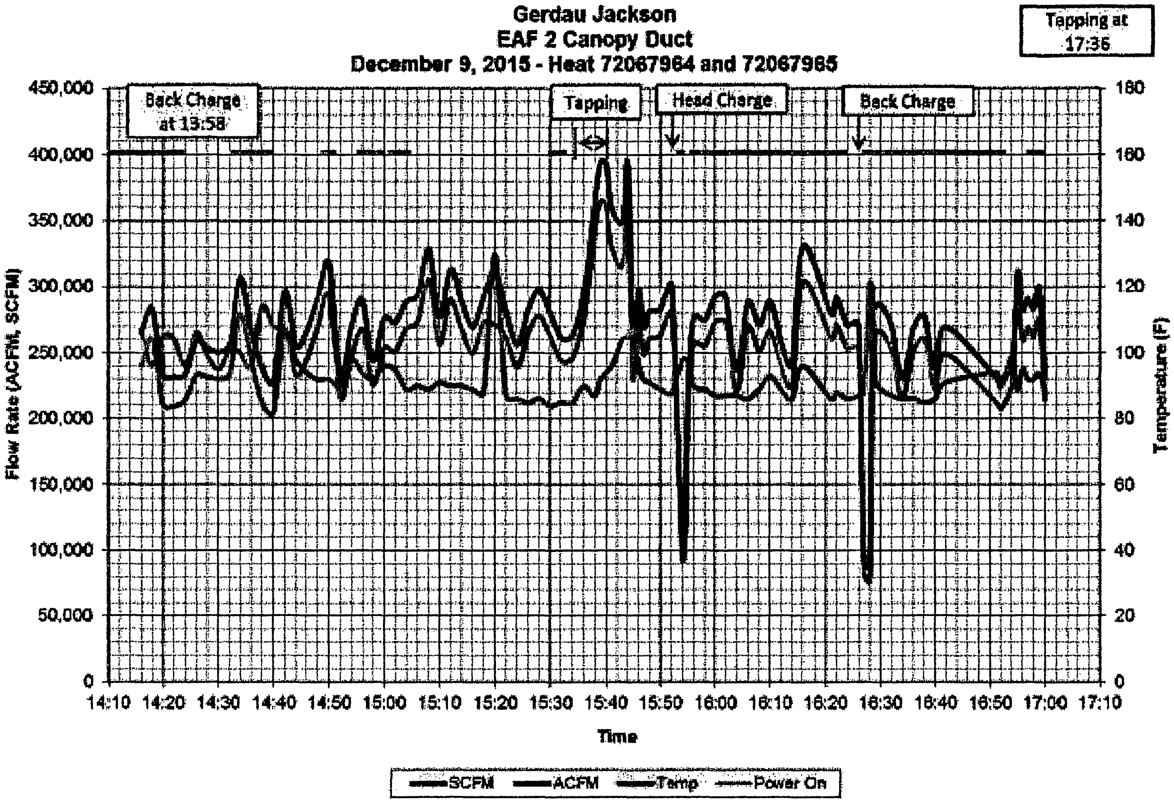


Figure 3.4
Canopy #2 Duct Flow Rate Measurements – December 9th, 2015
Heats 72067964 & 72067965

As the figure above shows, GCT started measuring just after the back charge from Heat 72067964 until 30 minutes after the back charge from Heat 72067965. The flow rate measurements at Canopy #2 experienced similar patterns as those experienced at the Canopy #1 duct on December 8th, 2015. During the head charge and back charge in Heat 72067965, the Canopy #2 flow rate dropped significantly to about 100,000 ACFM.

Figure 3.5 below shows a graph of the flow rate measured by GCT at the LMF and VAD duct on December 10th, 2015.

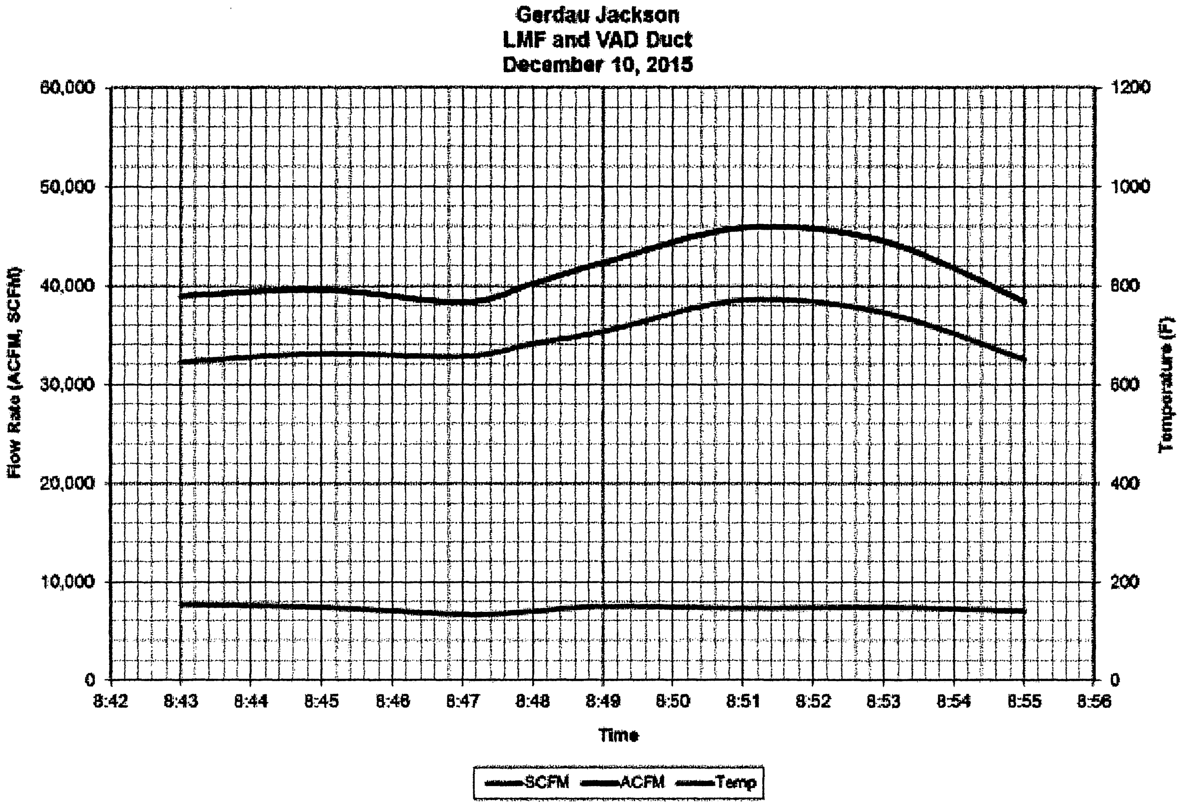


Figure 3.5
LMF and VAD Duct Flow Rate Measurements – December 10th, 2015

As the figure above shows, the flow rate through the LMF and VAD duct ranged from 38,300 ACFM to 45,900 ACFM and averaged 41,000 ACFM (34,500 SCFM) at 145°F.

3.2 2015 vs 2010 Measurement Comparison

GCT previously conducted ductwork measurements at Gerdau Jackson in 2010 as part of the T4023 APC System Improvements project. Table 3.6 below compares the measurements taken in 2010 versus the measurements taken as part of the 2015 measurements at the side draft ducts.

Table 3.6
Side Draft Flow Rate Measurement Comparison – July 2010 vs. December 2015

Location	Parameter	Unit	July 16, 2010	Dec. 2015	% Change
Side Draft #1	Melting	ACFM	80,400	75,400	-6%
		SCFM	44,100	45,100	2%
		°F	479	392	-
	Foamy Slag	ACFM	129,000	103,400	-20%
		SCFM	70,500	51,900	-26%
		°F	468	560	-
Side Draft #2	Melting	ACFM	87,500	74,700	-15%
		SCFM	60,500	44,600	-26%
		°F	278	385	-
	Foamy Slag	ACFM	155,800	100,600	-35%
		SCFM	88,900	51,100	-43%
		°F	430	544	-

As the table above shows, the side draft #1 exhaust rate is currently approximately 2% higher (based on the SCFM value) during melting and 26% lower during foamy slag than it was during the 2010 study while the side draft #2 exhaust rate is currently approximately 26% lower during melting and 43% lower during foamy slag. Gerdau personnel indicated that the side draft damper positions were adjusted to reduce EAF draft as the higher draft was leading to unacceptable furnace wear and energy use. The reduced draft at the side draft hoods has resulted in a significant reduction in the side draft hood exhaust rate.

Table 3.7 below compares the measurements taken in 2010 versus the measurements taken as part of the 2015 measurements at the canopy hood ducts.

Table 3.7
Canopy Flow Rate Measurement Comparison – July 2010 vs. December 2015

Location	Parameter	Unit	July 16, 2010	Dec. 2015	% Change
Canopy #1	Melting / Foamy Slag	ACFM	278,600	254,900	-9%
		SCFM	244,600	234,600	-4%
		°F	118	94	-
	Charging	ACFM	472,400	333,100	-29%
		SCFM	410,300	306,000	-25%
		°F	128	97	-
Canopy #2	Melting / Foamy Slag	ACFM	247,000	262,500	6%
		SCFM	219,100	242,300	11%
		°F	113	93	-
	Charging	ACFM	377,200	331,700	-12%
		SCFM	331,300	301,400	-9%
		°F	122	102	-

As the table above shows, the Canopy #1 exhaust rate is currently approximately 9% lower (based on the ACFM value) during melting/foamy slag and 29% lower during charging than it was during the 2010 study while the Canopy #2 exhaust rate is currently approximately 6% higher during melting/foamy slag and 12% lower during charging.

It should be noted that ambient temperatures during the December 2015 site visit were significantly lower than the July 2010 site visit due to a difference in seasonal temperatures. This resulted in lower temperatures in the meltshop and consequently lower measured temperatures in the canopy hood ductwork.

It should also be noted that during the 2010 measurement campaign, the ID fans were operating at a reduced amp set point, which results in lower total system flow rate than if the system was operating at full load amps.

3.3 Meltshop Ventilation Survey and Observations

GCT personnel conducted ventilation surveys by measuring ambient air temperature with a thermocouple and air velocity with a propeller anemometer at each major opening in the meltshop building to quantify the air flow rate into and out of the building and heat release rate in the meltshop. GCT also measured the flow rate and temperature of the gasses exiting the caster roof vent.

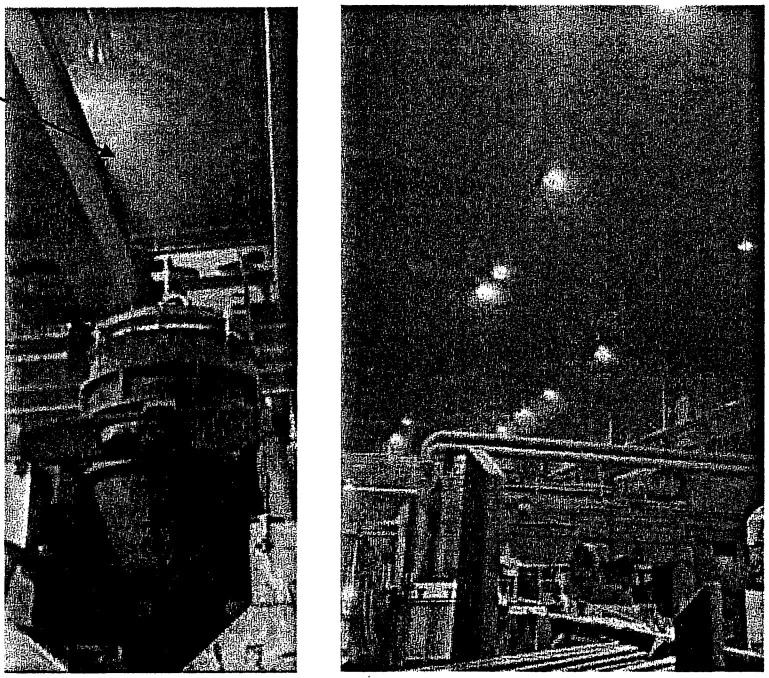
Figure T4027-SK001 in Appendix B shows the ventilation survey diagram that summarizes the measurements collected during the site visit. These measurements were collected primarily to serve as calibration data for a future CFD model (currently not in scope) and additional analysis has therefore not been conducted at this time.

In addition to the ventilation survey measurements collected, GCT also observed the overall meltshop ventilation patterns. These observations are summarized below:

- Meltshop Ventilation Patterns Observed
  - During melting the shop is generally clean
  - EAF emissions escaping the side draft hood generally report to canopy hood
  - Drift of melting emissions is not significant, due to higher origination elevation where shop cross drafts have less effect
  - Tapping emissions
    - Tend to drift towards the caster area when viewed from the operating floor
    - When observed from the caster area, tapping emissions appear to lose buoyancy as they drift towards the caster and generally report to the caster deck area rather than directly to the roof vent
- Shop Ventilation
  - Dust generated at the ladle clean out / slag clean up area and AOD also drift towards caster
  - Drift towards the caster is present even with majority of doors closed
  - Continuous emissions are generated from the ladles at the caster that report to the caster roof vent (Figure 3.6)

  - Emissions generated at caster mix with other emissions sources in the caster area are difficult to differentiate from EAF emissions (Figure 3.6)
- During GCT visit, winds were from the south. As expected, wind conditions can affect system performance.

As noted above, the general ventilation pattern of the building forces any dust generated to migrate towards the caster area. However this dust does not appear to report directly to the caster roof vent. Rather the dust comingles with other emission sources and appears to accumulate near the caster deck. It is therefore difficult to distinguish between emissions generated at the caster from other emission sources at the roof vent elevation, however the caster does appear to contribute significantly towards the white haze that accumulates in the caster roof trusses.



Emissions Generated at Caster Ladles

Figure 3.6
Emissions Generated at Caster (Left) / View from Caster Deck (Right)

3.4 EAF Operation

Gerdau Jackson currently utilizes two (2) electric arc furnace systems, each consisting of the following major components:

- (1) EAFs – 52 ton, 14ft ID, Spout Tapping
- (1) 27/34 MVA AC transformer
- (3) 18" diameter electrodes
- (1) 3 MW Sidewall Praxair Co-Jet burners per furnace

Figure 3.7 below shows the EAF operating diagram developed to represent an average operation based on the data provided by Gerdau Jackson and collected during the field visit.

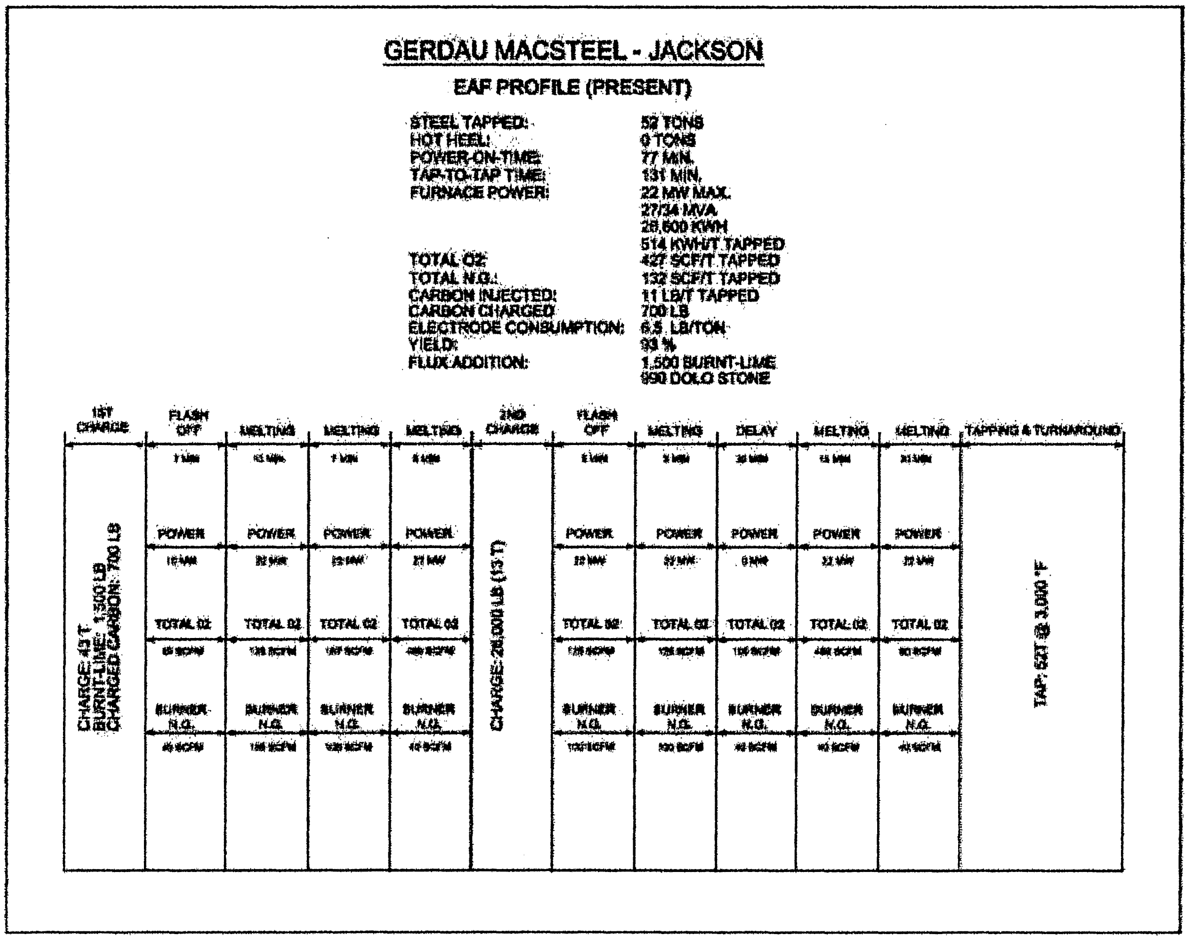


Figure 3.7
EAF Operating Diagram
Average Profile Based on Data Collected in December 2015

GCT used this profile to develop the furnace mass and energy balance used to predict off-gas conditions during each operating phase of a heat. The following assumptions were made in developing the model.

Inputs

- Furnace operations as shown in Figure 3.7
- Metal oxidation based on average scrap mix and slag composition

Outputs

- Off-gas energy loss based on volumetric flow and heat content diagram (Figure 3.8)
- Energy loss to water-cooled furnace side wall and roof based on cooling water flow rate and temperature differential.
- Energy in the steel is calculated based on a tap temperature of 3,000°F
- Energy lost to the slag is based on the reported slag tap weight and temperature.
- Electrical and miscellaneous losses are based on the difference between energy inputs and outputs calculated from furnace operating profile.

Figure 3.8 shows the predicted EAF energy balance. As shown, approximately 28% of the energy input to the EAF is lost in the off-gas, 17% to the cooling system and slag, while 42% goes to the steel.

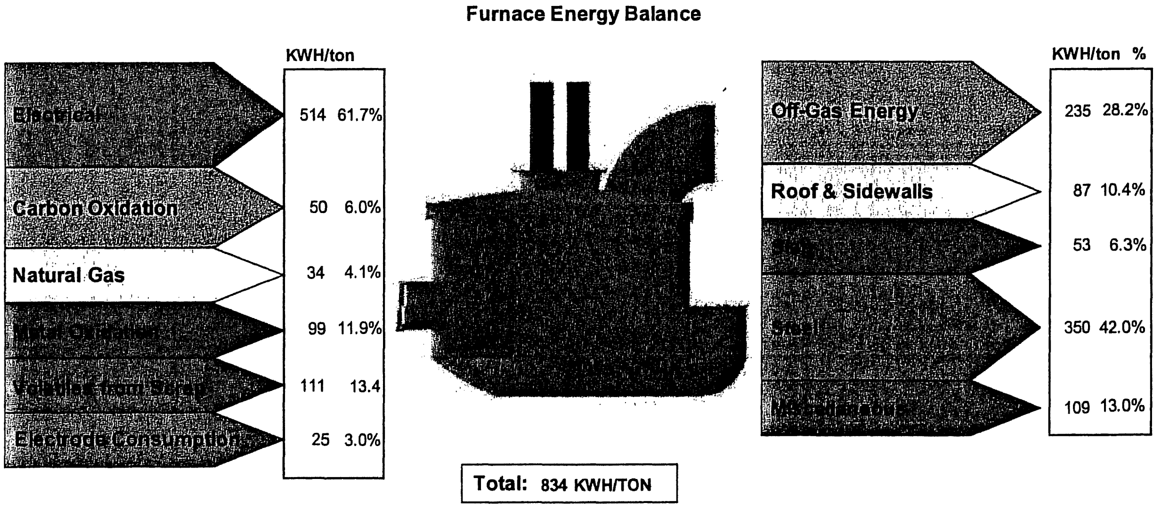


Figure 3.8
EAF Energy Balance

Figure 3.9 below presents the predicted EAF off-gas flow rate and heat content profile. The peak off-gas generation rate occurs during the 2-3 minute flash-off period after each charge. However, a large portion of this energy is released when the furnace roof is swung open following the charge.

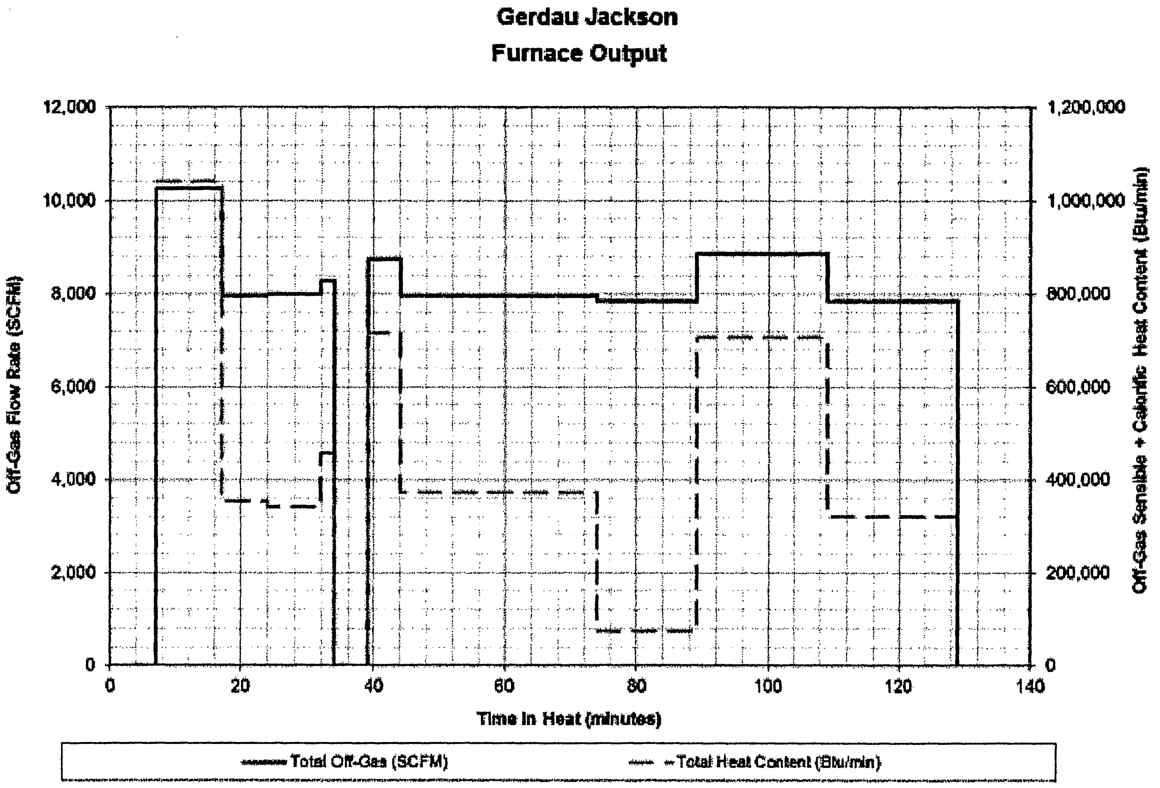


Figure 3.9
EAF Off-Gas Volumetric Flow Rate and Heat Content Diagram

Based on the measurements collected and the EAF off-gas conditions calculated by GCT, a mass and energy balance of the APC system was developed to predict the average gas conditions at each point in the APC system. The balance was utilized to validate the measurements collected at each location and to serve as the basis for the evaluation of the APC system summarized in the sections below.

Since the melting cycle varies from heat to heat, in order to evaluate the APC system performance GCT has used an off-gas generation rate based on a weighted average of the various melting cycles. The average weighted off-gas conditions during melting are calculated to be 7,980 SCFM with a total sensible and calorific heat content of 353,500 Btu/min. In addition, GCT evaluated the system performance during the peak "refining" period, when foamy slag is injected and the off-gas flow rate averages approximately 8,800 SCFM with a total sensible and calorific heat content of 710,500 Btu/min.

Drawing T4027-F-001 shown in Appendix A presents a process flow diagram summarizing the average December 2015 APC system conditions based on GCT's mass and energy balance.

3.5 Side Draft Hood System Performance

The fumes generated by each EAF when power is on are collected using a side draft hood located just above the electrode ports on the furnace roof. The side draft hood was the most common fume collection arrangement at the time these furnaces were built (1973).

Gerdau Jackson's side draft hood system includes a butterfly damper in the dry ductwork to control draft to the furnace. As part of the draft control system, the butterfly damper modulates to maintain a ductwork draft set-point according to the current phase of operation.

Based on the heat and mass balance around the EAF, the predicated off-gas generated by the furnace, and the measurements, GCT estimates the side draft hood systems capture approximately 80-90% of the process off-gas during melting and approximately 75-80% of the process off-gas during refining.

As previously noted, GCT observed that emissions not collected by the side draft hoods generally report to the canopy hood. The melting emissions not captured by the side draft hood are therefore not expected to be a major contributor to the emissions drifting towards the caster.

Increasing the side draft exhaust rate would likely negatively impact EAF operation without significantly impacting overall meltshop emission levels.

3.6 EAF Canopy Hood Performance

Canopy hoods #1 and #2 are deep storage canopy hoods centered over each EAF used to collect fugitive emissions from the side draft hoods during melting operations, and as the primary collection hoods during charging and tapping.

Exhaust Rate

The average exhaust rate of 333,100 ACFM at Canopy 1 and 331,700 ACFM at Canopy 2 during charging are each lower than the design exhaust rate of 481,000 ACFM during charging.

Using GCT's standard analytical methods for EAF canopy hood design, the required exhaust flow rates were calculated for charging operations based on the existing meltshop and canopy hood geometry. The calculated canopy hood exhaust under these conditions is 384,000 ACFM.

Table 3.8 below compares the measured canopy hood exhaust rates to required exhaust rate calculated by GCT and the 2010 design data. The canopy hood flow rate currently fluctuates significantly during each phase of operation due to an identified issue with the existing damper control logic (discussed further in Section 3.7). The measured exhaust rates have therefore been shown as a range to allow better comparison against the design data.

Table 3.8
Canopy Hood Flow Rates

EAF Operating Phase	Unit	Current Canopy 1	Current Canopy 2	Calculated Req.[1]	2010 Design[3]
Charging	ACFM	296,200 – 381,000	257,500 – 393,000	384,000	481,000
Melting	ACFM	197,400 – 344,600	224,200 – 330,900	175,500	226,000
Tapping	ACFM	225,000 – 421,100	297,200 – 394,800	233,900[2]	481,000

Note 1: Required represents GCT hood exhaust rate requirement based on 2015 operating data and observations
Note 2: Calculation does not account for impact of cross drafts. Tapping Plume heavily influenced by shop ventilation patterns
Note 3: Design refers to 2010 design basis (refer to PFD Drawing BH-M-3058)

As the table above shows, the exhaust rates during charging are well below the design value, but do achieve the calculated required exhaust rate for brief periods of time. It should be noted that the charging requirements will vary based on the current scrap mix in use. In developing the calculated exhaust rate requirement, a scrap oil content of 0.5% was used based on data provided by Gerdau. Higher scrap oil content can significantly increase the canopy hood exhaust rate requirements. Furthermore, it should be noted that this calculation does not account for the impact of meltshop cross drafts on canopy hood capture efficiency. The 2010 design value is based on results of CFD modeling which accounted for the impact of aisle cross drafts. The 2010 design value should therefore be considered a more robust design value than the currently calculated hood requirement and used as the basis for comparison for the current operation.

While on site, GCT observed some spillage from the hood which is likely a result of a reduced exhaust rate. However, the roof clears relatively quickly following a charge and meltshop cleanliness is generally good (the roof trusses are visible during the majority of the heat and the shop is not excessively dusty or hot). Increasing the canopy hood exhaust rate is expected to minimize the spillage from the canopy hood and improve overall shop cleanliness.

Evacuation Time

Evacuation time refers to the amount of time required to remove fumes from a full hood at a given exhaust rate. The evacuation time is calculated by dividing canopy volume by the exhaust rate. Evacuation times between 10 to 15 seconds maintain an appropriate balance between the hood exhaust rate and the storage volume. Evacuation times of less than 10 seconds are not disadvantageous, but times greater than 15 seconds can lead to settling and spillage of the fumes from the canopy hood even with adequate face velocities and storage volumes.

The canopy hoods each have a storage volume of approximately 52,600 ft^3. Currently, at a canopy hood 1 exhaust rate of 333,100 ACFM, the evacuation time is calculated to be approximately 9.5 seconds. Additionally, at a canopy hood 2 exhaust rate of 331,700 ACFM, the evacuation time is calculated to be approximately 9.5 seconds.

Face Area

The canopy hood face is the opening at the bottom of the canopy hood. This area must be large enough to physically collect the plume when it reaches the canopy hood. The minimum canopy hood face dimensions can be calculated by determining the anticipated extents of the plume at the elevation of the canopy hood face. This method is summarized in U.S. Environmental Protection Agency [EPA] Publication No. 600/7-86/016, 1986. The following assumptions were used in developing this calculation:

- Plume rises at an 18° entrainment angle from the virtual origin
- 14 ft furnace inner diameter
- 52 ft distance between the furnace and canopy hood face
- A resulting virtual plume origin distance of 72 ft. from the hood face
- Current canopy hood face of 67' x 52' (face area of 3,467 ft^2).

Based on this criteria, GCT calculates that the minimum canopy hood face requirement is approximately 24 ft (face area of 452 ft^2). The existing canopy hood therefore meets and exceeds this requirement, indicating that the hood face is sized appropriately to capture EAF emissions. It should be noted that this approach does not account for the impact of cross drafts in the meltshop that will affect the trajectory of the plume as it rises to the hood face.

Face Velocity

The canopy hood face velocity is the velocity through the open face of the canopy hood. Face velocity is calculated by dividing the exhaust rate by the face area of the canopy hood. GCT recommends a canopy hood face velocity of at least 120 FPM to prevent fume stored in the canopy hood from exiting the hood. Based on the current exhaust rate of 336,600 ACFM, the face velocity is 96 FPM, slightly below what GCT typically recommends. It should be noted that increasing the canopy hood exhaust rate will result in a higher face velocity.

3.7 Canopy Damper Control Logic

During the evaluation of the APC system, GCT observed that the canopy hood damper positions are currently not aligning with EAF 1 activities during charging and EAF 2 activities during tapping and charging. Dampers are either opening after the activity has started or close too early while emissions may still be in the canopy hood. In addition, the damper positions are not consistent, and appear to vary from heat to heat. This may be a result of incorrect EAF "modes" triggering inappropriate damper positions or incorrect settings within the system programming.

Figure 3.10 and Table 3.9 summarize an example of this issue observed at Canopy Hood 2 during GCT's measurements. As Figure 3.10 shows, the charge damper was fully open while the tap damper was fully closed before tapping from EAF 2 occurred. Tapping occurred at about 15:41 but the center damper was at about 40% open and the charge damper was fully open. The three canopy hood dampers were not fully open until 15:44, approximately 3 minutes after tapping started. Then during charging, the charge damper was fully open during the charge, however the center damper was only 40% open while the tap damper was closed. During charging, all (3) canopy hood dampers should be in the full open position.

Additional analysis of the damper control logic can be found in the memo attached in Appendix C.

Table 3.9
Canopy Hood 2 Damper Positions

			Damper Positions			Recommended Positions		
Time	**EAF Activity**	**EAF Step**	**Charge**	**Center**	**Tap**	**Charge**	**Center**	**Tap**
15:41:17	Tapping	EAF2 - Advance EAF Step	[illegible]	[illegible]	[illegible]	100%	100%	100%
15:44:48	Tapping	EAF2 - Automatic End Heat	100%	100%	100%	100%	100%	100%
15:47:48	Head Charge	EAF2 - Advance EAF Step	[illegible]	[illegible]	[illegible]	100%	100%	100%
15:49:00	Head Charge	EAF2 - Roof Swung IN	[illegible]	[illegible]	[illegible]	100%	100%	100%
15:53:48	Head Charge	EAF2 - Manual Start Delay	[illegible]	[illegible]	[illegible]	100%	100%	100%
15:57:16	Head Charge	EAF2 - Roof Swung OUT	[illegible]	[illegible]	[illegible]	100%	100%	100%
15:57:33	Head Charge	Scrap Charged	[illegible]	[illegible]	[illegible]	100%	100%	100%
15:58:34	Head Charge	EAF2 - Roof Swung IN	[illegible]	[illegible]	[illegible]	100%	100%	100%

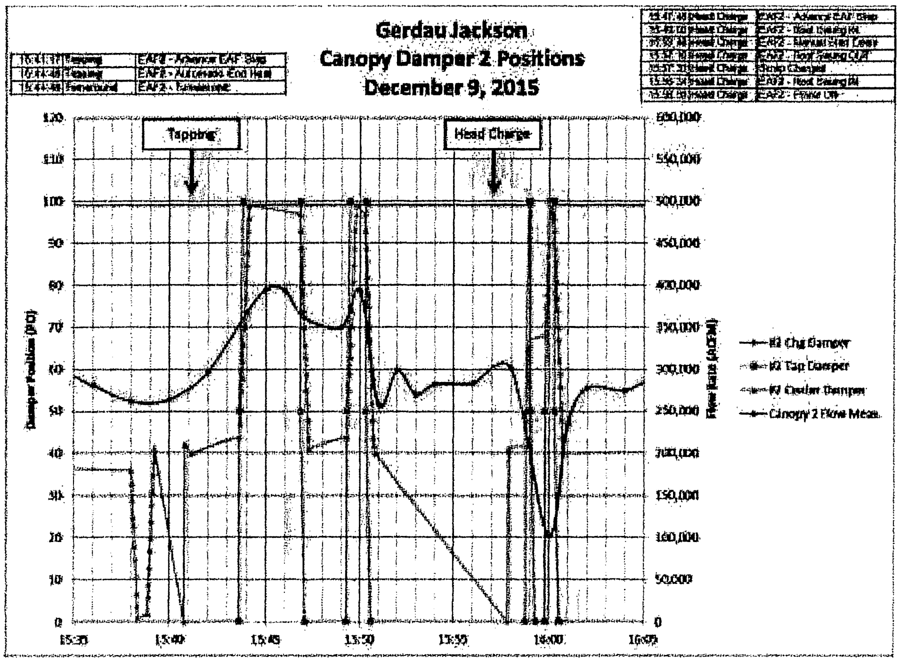


Figure 3.10
Canopy Hood 2 Damper Positions
December 9th, 2015

3.8 I.D. Fans and Baghouse System Performance

The combined off-gas from the side draft hoods and canopy hoods is exhausted by three I.D. fans to a reverse air baghouse system. The baghouse has a design capacity of 828,000 ACFM. Table 3.10 below shows a comparison between the design and the current operating parameters of the two baghouse systems.

As shown, based on the measurements collected during the site visit, the baghouse systems are operating at approximately 96% of its stated design capacity during melting (745,000 ACFM v. 772,000 ACFM design) and 85% of design charging (707,000 ACFM v. 828,000 ACFM design). GCT expects the difference in charging flow rate is attributable to current canopy hood damper control logic that causes the canopy dampers to close during charging operations.

Based on GCT's observations while on site, the I.D. fans are operating with the inlet louver dampers fully open indicating the system is operating at full capacity. However, modification of the canopy hood damper control logic should reduce system pressure loss during charging and tapping operations and allow the system to be operated near the design flow rate of 828,000 ACFM. At a flow rate of 828,000 ACFM, the baghouse is operating at the upper limits of the recommended air-to-cloth ratio for a reverse air baghouse on an EAF operation and a further increase in flow rate is therefore not recommended.

Table 3.10
Baghouse Operating Summary

		Design Melting	December 2015 Melting	Design Charging	December 2015 Charging
Baghouse Type	-	Reverse Air	Reverse Air	Reverse Air	Reverse Air
Operating Temp.	°F	177	140	185	119
BH Inlet Flow Rate	ACFM	772,000	745,000	828,000	707,200
Pressure Drop	in w.g.	10	-	10	-
Air-to-Cloth Ratio Net	ft/min	3.19	3.19	3.51	3.04
Air-to-Cloth Ratio Gross	ft/min	2.61	2.61	2.9	2.48
Filter Area per Compartment	ft^2	28,512	28,512	28,512	28,512
No. of Compartments	-	10	10	10	10
Total Filter Area	ft^2	285,120	285,120	285,120	285,120
Bags per Compartment	-	264	264	264	264
Bag Diameter	in	12	12	12	12
Bag Length	ft	35.5	35.5	35.5	35.5

4. DEVELOPMENT OF MODIFICATION OPTIONS

In general, based on GCT's evaluation the baghouse system is adequately sized for the current operation, however it may be possible to operate the existing system more effectively resulting in improved capture of emissions and improved shop cleanliness.

As previously discussed, the canopy hood dampers do not appear to be meeting the intended set-points during charging and tapping operations. In order to increase the canopy hood exhaust rate during secondary operations, GCT recommends investigating the cause of the inconsistent damper control and modifying the control logic and/or damper set-points.

Table 4.1 below presents the recommended canopy hood damper positions for each EAF activity logged in the heat sheet. As shown, all (3) canopy hood dampers for the charging or tapping furnace should be fully open for the duration of the charging or tapping process.

Table 4.1

Design Canopy Hood Damper Positions

EAF Activity		**Damper Positions**		
		Charge	**Center**	**Tap**
EAF CHARGE SEQUENCE	Electrodes Out	100%	100%	100%
	Furnace Swing Out	100%	100%	100%
	Bucket Over	100%	100%	100%
	Charge	100%	100%	100%
	Bucket Out	100%	100%	100%
	Roof Swing In	100%	100%	100%
	Electrodes In	100%	100%	100%
EAF TAP	Tapping Start	100%	100%	100%
	Tapping Stop	100%	100%	100%

By improving the damper position control logic, the average canopy exhaust rates are expected to increase for EAF charging and tapping back to design levels according to Table 4.2 below:

Table 4.2

Canopy Hood Exhaust Rates

	Unit	Current[1] Canopy 1	Current[1] Canopy 2	2010 Design[2]
Charging Exhaust Rate	ACFM	296,200 – 381,000	257,500 – 393,000	481,000
Tapping Exhaust Rate	ACFM	225,000 – 421,100	297,200 – 394,800	481,000

Note 1: Current flow rates measured based on average flow rate measured in December 2015 by GCT.
Note 2: Design refers to 2010 design basis (refer to PFD Drawing BH-M-3058)

GCT recommends that during the trials to attempt to resolve the damper control logic, Gerdau should place personnel to observe the actual damper positions during EAF charging/tapping activities while other personnel observe the actual furnace activity so that immediate changes in damper position can be verified. This method is more effective than simply comparing the heat sheets to the Plantnet data since the times recorded on the heat sheets may not be perfectly aligned.

Modification of the damper control logic can be implemented relatively quickly and is expected to result in improved shop cleanliness, reduced spillage from the canopy and reduced fugitive emissions from the EAF aisle to the caster area. Following modification of the damper control logic, the canopy hood exhaust rates should be retested to determine the resulting hood exhaust rates and to determine if further tuning is required. The system performance should then be reevaluated to determine the impact of the new canopy hood exhaust rates on system performance.

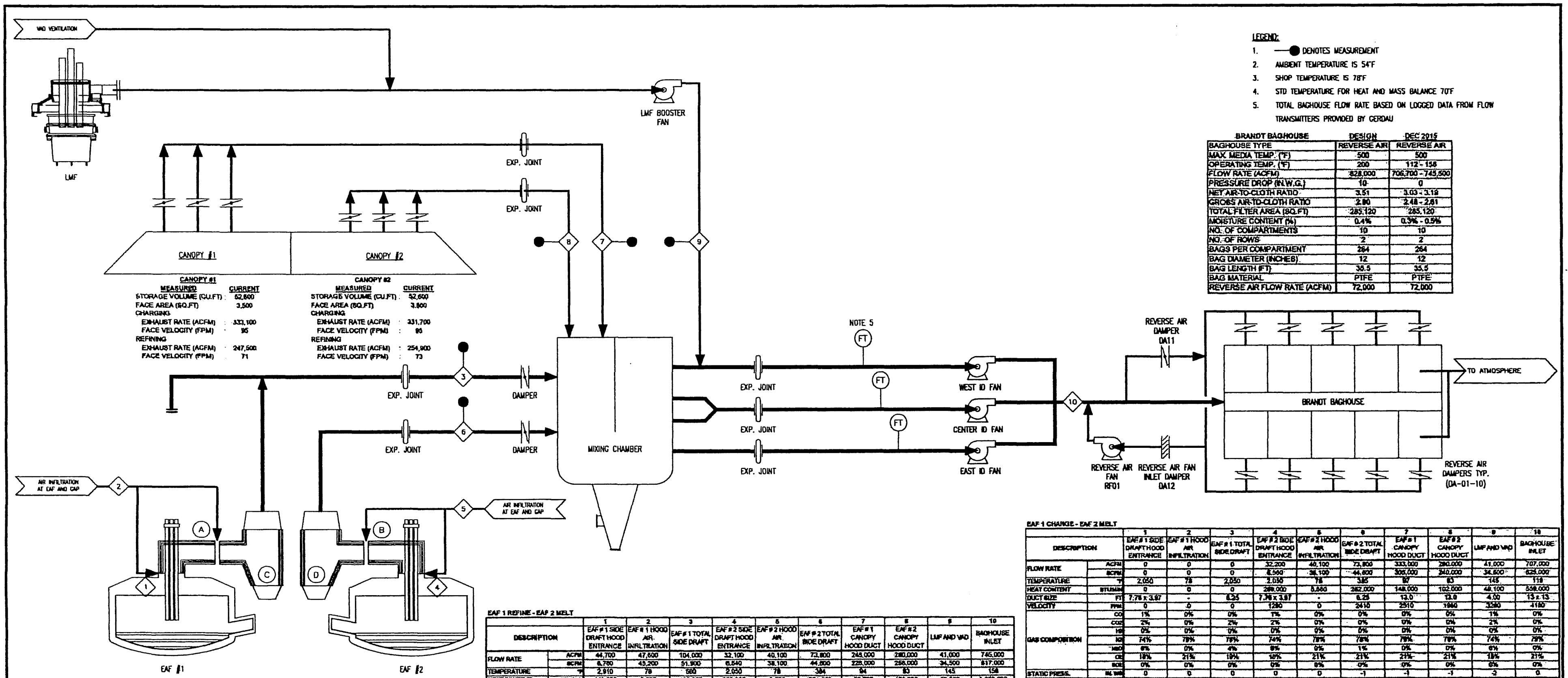
Long term, the building ventilation pattern makes high capture of tapping emissions difficult and promotes drift into caster aisle making it difficult to distinguish between various emissions sources. A higher canopy hood exhaust rate or even a larger baghouse would not eliminate drift in the meltshop. Additional modifications may therefore be required to demonstrate regulatory compliance.

Based on feedback from Gerdau, the investigation of these modifications is already underway, and Gerdau expects the modifications to be completed according to the schedule shown in Table 4.3. While evaluating the impact of the recommended damper control modification on system performance, Gerdau will also be exploring alternative options designed to improve capture.

Table 4.3
Estimated Schedule for Implementation of Damper Control Modifications

Task	Estimated Completion Date
Initial Investigation	2/5/16
Implementation of Revised Logic	2/19/16
Retest to confirm new hood exhaust rates	March 2016
Reevaluate System Performance	March / April 2016
Evaluate Alternative Options to Improve Capture	2/5/16

Appendix A – Process Flow Diagrams



LEGEND:
1. DENOTES MEASUREMENT
2. AMBIENT TEMPERATURE IS 54°F
3. SHOP TEMPERATURE IS 78°F
4. STD TEMPERATURE FOR HEAT AND MASS BALANCE 70°F
5. TOTAL BAGHOUSE FLOW RATE BASED ON LOGGED DATA FROM FLOW TRANSMITTERS PROVIDED BY GERDAU

BRANDT BAGHOUSE	DESIGN	DEC 2015
BAGHOUSE TYPE	REVERSE AIR	REVERSE AIR
MAX MEDIA TEMP. (°F)	500	500
OPERATING TEMP. (°F)	200	112 - 158
FLOW RATE (ACFM)	828,000	706,700 - 745,500
PRESSURE DROP (IN.W.G.)	10	0
NET AIR-TO-CLOTH RATIO	3.51	3.03 - 3.19
GROSS AIR-TO-CLOTH RATIO	2.90	2.48 - 2.61
TOTAL FILTER AREA (SQ.FT)	285,120	285,120
MOISTURE CONTENT (%)	0.4%	0.3% - 0.5%
NO. OF COMPARTMENTS	10	10
NO. OF ROWS	2	2
BAGS PER COMPARTMENT	264	264
BAG DIAMETER (INCHES)	12	12
BAG LENGTH (FT)	35.5	35.5
BAG MATERIAL	PTFE	PTFE
REVERSE AIR FLOW RATE (ACFM)	72,000	72,000

CANOPY #1

MEASURED		CURRENT
STORAGE VOLUME (CU.FT)	:	52,600
FACE AREA (SQ.FT)		3,500
CHARGING		
EXHAUST RATE (ACFM)	:	333,100
FACE VELOCITY (FPM)	-	95
REFINING		
EXHAUST RATE (ACFM)	-	247,500
FACE VELOCITY (FPM)		71

CANOPY #2

MEASURED		CURRENT
STORAGE VOLUME (CU.FT)	:	52,600
FACE AREA (SQ.FT)		3,500
CHARGING		
EXHAUST RATE (ACFM)	:	331,700
FACE VELOCITY (FPM)	:	95
REFINING		
EXHAUST RATE (ACFM)	:	254,900
FACE VELOCITY (FPM)	:	73

FURNACE OPENING AREAS

ROOF RING	:	3.67 SQ.FT
SLAG DOOR	:	2.00 SQ.FT
ELECTRODE PORTS	.	5.78 SQ.FT
OTHER		3.50 SQ.FT
TOTAL	:	14.9 SQ.FT

ELECTRIC FURNACE

	CURRENT
FURNACE DIAMETER :	14 FT
TONS TAPPED :	82 TONS
POWER :	27 MVA
P.O.T. :	77 MIN.
TAP-TO-TAP :	131 MIN.
% CAPTURE MELT :	85-90 %
% CAPTURE REFINE :	75-80 %
YIELD :	92.5 %

EAF 1 REFINE - EAF 2 MELT

DESCRIPTION		1 EAF # 1 SIDE DRAFT HOOD ENTRANCE	2 EAF # 1 HOOD AIR INFILTRATION	3 EAF # 1 TOTAL SIDE DRAFT	4 EAF # 2 SIDE DRAFT HOOD ENTRANCE	5 EAF # 2 HOOD AIR INFILTRATION	6 EAF # 2 TOTAL SIDE DRAFT	7 EAF # 1 CANOPY HOOD DUCT	8 EAF # 2 CANOPY HOOD DUCT	9 LMF AND VAD	10 BAGHOUSE INLET
FLOW RATE	ACFM	44,700	47,600	104,000	32,100	40,100	73,800	248,000	280,000	41,000	745,000
	SCFM	6,780	45,200	51,900	6,540	38,100	44,600	228,000	258,000	34,500	617,000
TEMPERATURE	°F	2,910	78	580	2,050	78	384	94	83	145	158
HEAT CONTENT	BTU/MIN	446,000	6,590	483,000	258,000	5,550	261,000	99,700	109,000	50,300	1,000,000
DUCT SIZE	FT	7.76 x 3.97	-	6.25	7.76 x 3.97	-	6.25	13.0	13.0	4.00	13 x 13
VELOCITY	FPM	1800	0	3390	1290	0	2400	1860	2110	3260	4410
GAS COMPOSITION	CO	4%	0%	0%	1%	0%	0%	0%	0%	4%	0%
	CO2	17%	0%	3%	2%	0%	0%	0%	0%	17%	1%
	H2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	N2	66%	79%	78%	74%	79%	78%	79%	79%	68%	78%
	H2O	4%	0%	4%	5%	0%	1%	0%	0%	4%	0%
	O2	9%	21%	19%	18%	21%	21%	21%	21%	9%	20%
	SO2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
STATIC PRESS.	IN. WG	0	0	-1	0	0	-1	-1	-1	-2	-

EAF 1 CHARGE - EAF 2 MELT

DESCRIPTION		1 EAF # 1 SIDE DRAFT HOOD ENTRANCE	2 EAF # 1 HOOD AIR INFILTRATION	3 EAF # 1 TOTAL SIDE DRAFT	4 EAF # 2 SIDE DRAFT HOOD ENTRANCE	5 EAF # 2 HOOD AIR INFILTRATION	6 EAF # 2 TOTAL SIDE DRAFT	7 EAF # 1 CANOPY HOOD DUCT	8 EAF # 2 CANOPY HOOD DUCT	9 LMF AND VAD	10 BAGHOUSE INLET
FLOW RATE	ACFM	0	0	0	32,200	40,100	73,800	333,000	280,000	41,000	707,000
	SCFM	0	0	0	6,560	38,100	44,600	305,000	240,000	34,600	625,000
TEMPERATURE	°F	2,050	78	2,050	2,050	78	385	97	83	145	118
HEAT CONTENT	BTU/MIN	0	0	0	269,000	5,550	262,000	148,000	102,000	48,100	558,000
DUCT SIZE	FT	7.76 x 3.97	-	6.25	7.76 x 3.97	-	6.25	13.0	13.0	4.00	13 x 13
VELOCITY	FPM	0	0	0	1290	0	2410	2510	1960	3260	4180
GAS COMPOSITION	CO	1%	0%	0%	1%	0%	0%	0%	0%	1%	0%
	CO2	2%	0%	2%	2%	0%	0%	0%	0%	2%	0%
	H2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	N2	74%	79%	78%	74%	79%	78%	79%	79%	74%	79%
	H2O	6%	0%	4%	6%	0%	1%	0%	0%	6%	0%
	O2	18%	21%	19%	18%	21%	21%	21%	21%	18%	21%
	SO2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
STATIC PRESS.	IN. WG	0	0	0	0	0	-1	-1	-1	-2	0

EAF 1 TAP - EAF 2 MELT

DESCRIPTION		1 EAF # 1 SIDE DRAFT HOOD ENTRANCE	2 EAF # 1 HOOD AIR INFILTRATION	3 EAF # 1 TOTAL SIDE DRAFT	4 EAF # 2 SIDE DRAFT HOOD ENTRANCE	5 EAF # 2 HOOD AIR INFILTRATION	6 EAF # 2 TOTAL SIDE DRAFT	7 EAF # 1 CANOPY HOOD DUCT	8 EAF # 2 CANOPY HOOD DUCT	9 LMF AND VAD	10 BAGHOUSE INLET
FLOW RATE	ACFM	0	0	0	32,200	40,100	73,800	300,000	325,000	41,000	736,000
	SCFM	0	0	0	6,540	38,100	44,600	282,000	300,000	34,500	661,000
TEMPERATURE	°F	2,050	78	2,050	2,050	78	385	83	93	145	112
HEAT CONTENT	BTU/MIN	0	0	0	269,000	5,550	262,000	65,100	127,000	48,100	502,000
DUCT SIZE	FT	7.76 x 3.97	-	6.25	7.76 x 3.97	-	6.25	13.0	13.0	4.00	13 x 13
VELOCITY	FPM	0	0	0	1290	0	2410	2260	2450	3260	4370
GAS COMPOSITION	CO	1%	0%	0%	1%	0%	0%	0%	0%	1%	0%
	CO2	2%	0%	2%	2%	0%	0%	0%	0%	2%	0%
	H2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	N2	74%	79%	78%	74%	79%	78%	79%	79%	74%	79%
	H2O	6%	0%	4%	6%	0%	1%	0%	0%	6%	0%
	O2	18%	21%	19%	18%	21%	21%	21%	21%	18%	21%
	SO2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
STATIC PRESS.	IN. WG	0	0	0	0	0	-1	-1	-1	-2	-

WATER-COOLED COMPONENTS - EAF 1 MELT / EAF 2 MELT

Ⓐ EAF # 1 INTERMEDIATE HOOD

SHAPE:	TAPERED RECT.
DIMENSIONS:	7.78 to 6.28 x 3.97 FT
LENGTH:	4.47 FT
ENTRANCE VEL.:	1,333 FPM
EXIT VEL.:	1,236 FPM
HEAT REMOVAL:	27,694 BTU/MIN
SQ.FT W/C AREA:	96 SQ.FT
GPM/SQ.FT:	2.3
GPM:	220

Ⓑ EAF # 2 INTERMEDIATE HOOD

SHAPE:	TAPERED RECT.
DIMENSIONS:	7.76 to 6.28 x 3.97 FT
LENGTH:	4.47 FT
ENTRANCE VEL.:	1,294 FPM
EXIT VEL.:	1,197 FPM
HEAT REMOVAL:	27,621 BTU/MIN
SQ.FT W/C AREA:	96 SQ.FT
GPM/SQ.FT:	2.3
GPM:	220

Ⓒ EAF # 1 DROPOUT BOX

SHAPE	RECTANGULAR
DIMENSIONS:	8.25 x 9.58 x 6.5
ENTRANCE VEL.:	2,465
EXIT VEL.:	2,451
HEAT REMOVAL	5,591
SQ.FT W/C AREA:	257.8
GPM/SQ.FT:	0.97
GPM	250

Ⓓ EAF # 2 DROPOUT BOX

SHAPE	RECTANGULAR
DIMENSIONS:	8.25 x 9.58 x 6.5 FT
ENTRANCE VEL.:	2,421 FPM
EXIT VEL.:	2,407 FPM
HEAT REMOVAL	5,374 BTU/MIN
SQ.FT W/C AREA:	258 SQ.FT
GPM/SQ.FT:	0.97
GPM	250

TOTAL WATER-COOLED COMPONENT HEAT REMOVAL SUMMARY FOR FURNACE

HEAT REMOVAL:	66,000 BTU/MIN
SQ.FT W/C AREA:	700 SQ.FT
GPM/SQ.FT:	1.3
GPM:	900

NOTE: HEAT REMOVAL RATES ESTIMATED

ISSUED FOR:
PRELIMINARY REPORT
BY: CG DATE: 1/29/2016

REV.	ISSUE FOR	DATE	DRAWN BY	CHECKED BY	APPROVED BY
A	PRELIMINARY REPORT	1/29/2016	FC	CG	CG

DWG. No. | REFERENCE DRAWINGS | ISSUE AUTHORIZATION

GCT
4853 N. O'CONNOR BLVD.
IRVING, TEXAS 75062 USA
PH: (214) 613-1785
FAX: (214) 613-1786

DESIGNED BY: CG DATE: 12/21/2015	DRAWN BY: F.C. DATE: 12/21/2015
CHECKED BY: CG DATE: 12/21/2015	PROJECT ENGR: CG DATE: 12/21/2015
PROJECT MGR: CG DATE: 12/21/2015	PROJECT NUMBER: T4027

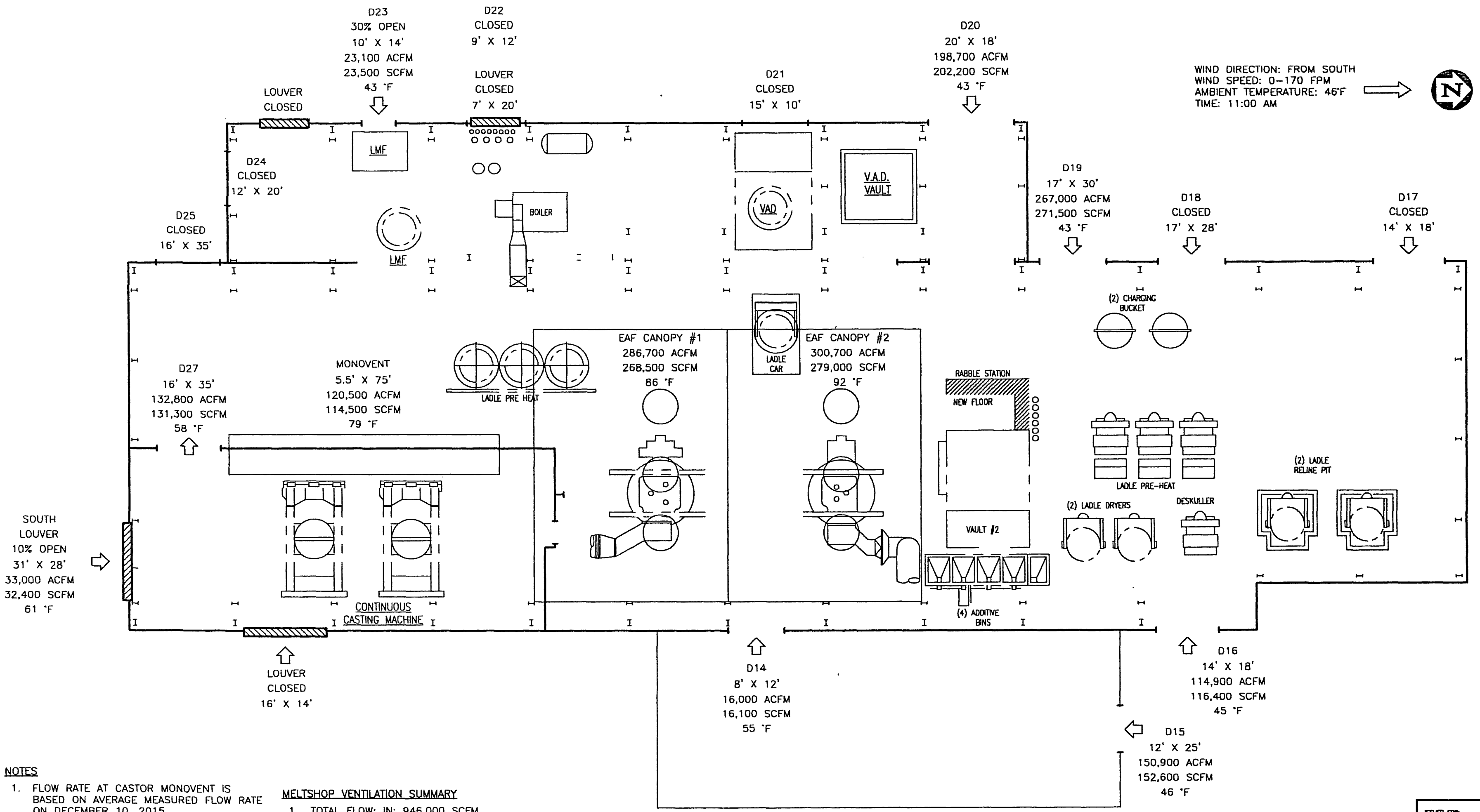
GERDAU

GERDAU JACKSON
AIR POLLUTION CONTROL EVALUATION SYSTEM
SUMMARY OF FIELD MEASUREMENTS
DECEMBER 2015 OPERATION

SCALE: N.T.S. DWG NO: T4027-F-001 REV. A

DO NOT SCALE THIS DRAWING

Appendix B – Ventilation Surveys



NOTES

1. FLOW RATE AT CASTOR MONOVENT IS BASED ON AVERAGE MEASURED FLOW RATE ON DECEMBER 10, 2015
2. CANOPY EXHAUST RATES ARE BASED ON AVERAGE MEASURED EXHAUST RATES DURING THE MEASUREMENT CAMPAIGN ON DECEMBER 8TH AND 9TH, 2015

MELTSHOP VENTILATION SUMMARY

1. TOTAL FLOW: IN: 946,000 SCFM
   OUT: 699,100 SCFM
2. NET HEAT RELEASE RATE: 612,600 BTU/MIN
3. BUILDING CROSS-SECTIONAL AREA: 39,000 FT2

ISSUED FOR:
PRELIMINARY REPORT
BY: CG DATE: 1/29/2016

REV.	ISSUE FOR	DATE	DRAWN BY	CHECKED BY	APPROVED BY
A	PRELIMINARY REPORT	1/29/2016	FC	CG	CG

ISSUE AUTHORIZATION

DWG. No.	REFERENCE DRAWINGS

GCT
4953 N. O'CONNOR BLVD.
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FAX: (214) 613-1786

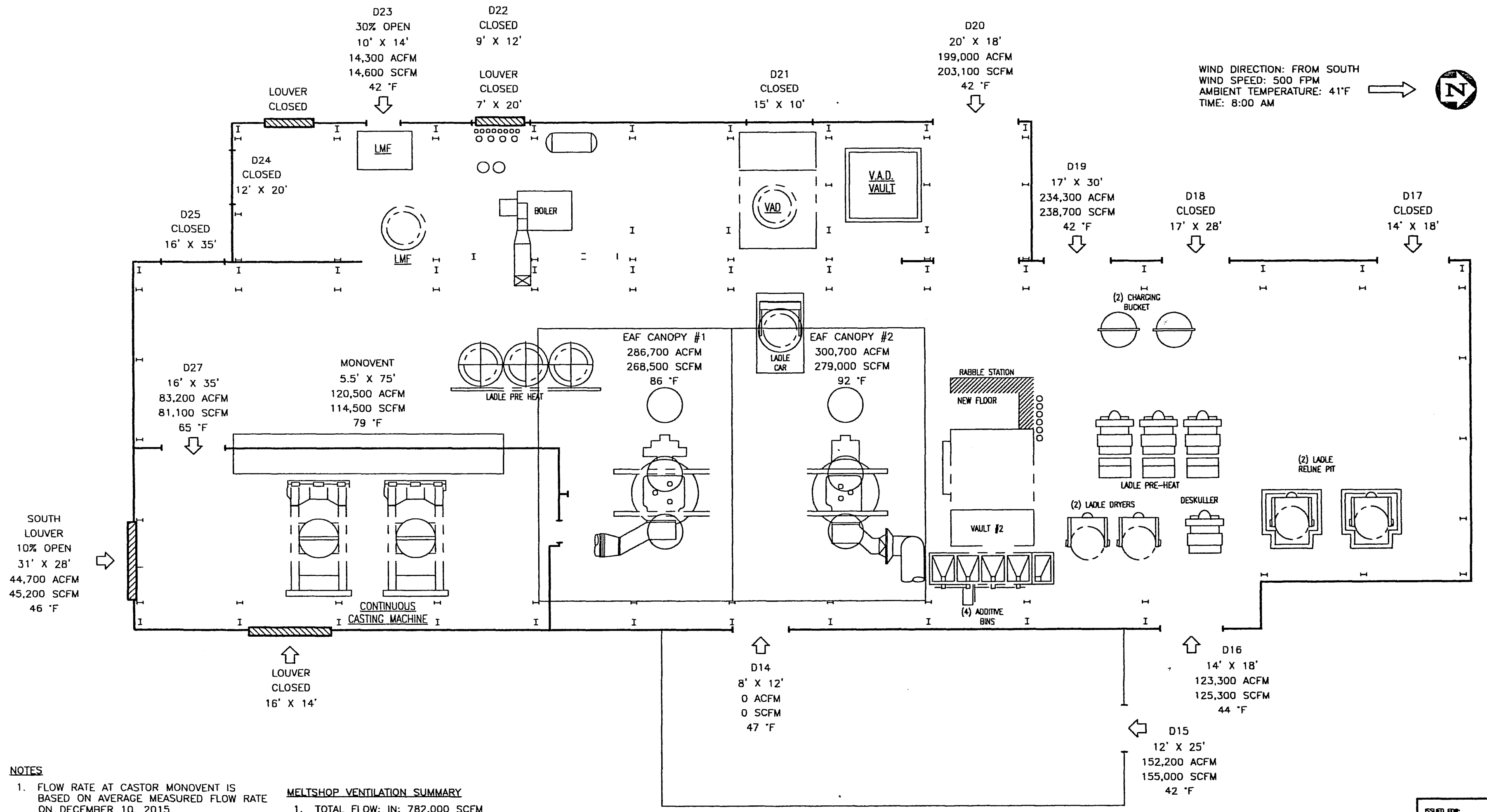
DESIGNED BY: FC DATE: 12/21/2015	DRAWN BY: F.C. DATE: 12/21/2015
CHECKED BY: CG DATE: 12/21/2015	PROJECT ENGR: CG DATE: 12/21/2015
PROJECT MGR: CG DATE: 12/21/2015	PROJECT NUMBER: T4027

GERDAU

GERDAU JACKSON
VENTILATION SURVEY DIAGRAM
SUMMARY OF FIELD MEASUREMENTS
DECEMBER 8, 2015 MORNING

SCALE: N.T.S. DWG NO: T4027-SK001 REV. A

DO NOT SCALE THIS DRAWING



NOTES

1. FLOW RATE AT CASTOR MONOVENT IS BASED ON AVERAGE MEASURED FLOW RATE ON DECEMBER 10, 2015
2. CANOPY EXHAUST RATES ARE BASED ON AVERAGE MEASURED EXHAUST RATES DURING THE MEASUREMENT CAMPAIGN ON DECEMBER 8TH AND 9TH, 2015

MELTSHOP VENTILATION SUMMARY

1. TOTAL FLOW: IN: 782,000 SCFM
   OUT: 777,500 SCFM
2. NET HEAT RELEASE RATE: 621,200 BTU/MIN
3. BUILDING CROSS-SECTIONAL AREA: 39,000 FT2

ISSUED FOR:
PRELIMINARY REPORT
BY: CG DATE: 1/29/2016

DWG. No.	REFERENCE DRAWINGS	REV.	ISSUE FOR	DATE	DRAWN BY	CHECKED BY	APPROVED BY
		A	PRELIMINARY REPORT	1/29/2016	FC	CG	CG

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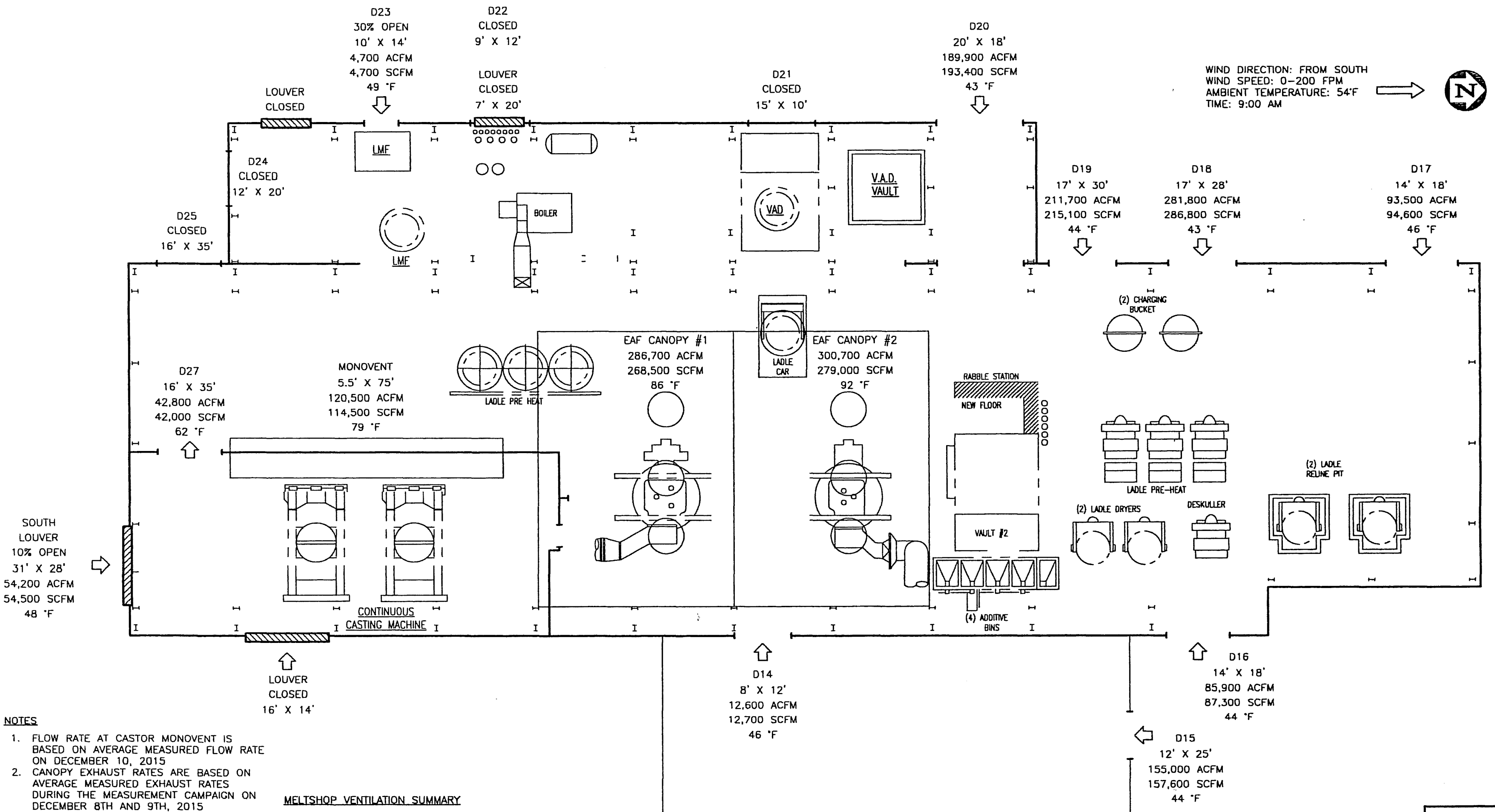
DESIGNED BY: FC DATE: 12/21/2015	DRAWN BY: F.C. DATE: 12/21/2015
CHECKED BY: CG DATE: 12/21/2015	PROJECT ENGR: CG DATE: 12/21/2015
PROJECT MGR: CG DATE: 12/21/2015	PROJECT NUMBER: T4027

GERDAU

GERDAU JACKSON
VENTILATION SURVEY DIAGRAM
SUMMARY OF FIELD MEASUREMENTS
DECEMBER 9, 2015 MORNING

SCALE: N.T.S. DWG NO: T4027-SK002 REV. A

DO NOT SCALE THIS DRAWING



NOTES

1. FLOW RATE AT CASTOR MONOVENT IS BASED ON AVERAGE MEASURED FLOW RATE ON DECEMBER 10, 2015
2. CANOPY EXHAUST RATES ARE BASED ON AVERAGE MEASURED EXHAUST RATES DURING THE MEASUREMENT CAMPAIGN ON DECEMBER 8TH AND 9TH, 2015
3. DOORS 17 18 ARE PERIODICALLY OPENED AS NEEDED FOR SCRAP. IT IS LIKELY THESE DOORS WERE CLOSED FOR THE MAJORITY OF THE MAJORITY OF THE MEASUREMENT CAMPAIGN.

MELTSHOP VENTILATION SUMMARY

1. TOTAL FLOW: IN: 1,148,600 SCFM
   OUT: 699,100 SCFM
2. NET HEAT RELEASE RATE: 746,500 BTU/MIN
3. BUILDING CROSS-SECTIONAL AREA: 39,000 FT2

ISSUED FOR:
PRELIMINARY REPORT
BY: CG DATE: 1/29/2016

DWG. No.	REFERENCE DRAWINGS

REV.	ISSUE FOR	DATE	DRAWN BY	CHECKED BY	APPROVED BY
A	PRELIMINARY REPORT	1/29/2016	FC	CG	CG

ISSUE AUTHORIZATION

GCT
4953 N. O'CONNOR BLVD.
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DESIGNED BY: FC DATE: 12/21/2015	DRAWN BY: F.C. DATE: 12/21/2015
CHECKED BY: CG DATE: 12/21/2015	PROJECT ENGR: CG DATE: 12/21/2015
PROJECT MGR: CG DATE: 12/21/2015	PROJECT NUMBER: T4027

GERDAU

GERDAU JACKSON
VENTILATION SURVEY DIAGRAM
SUMMARY OF FIELD MEASUREMENTS
DECEMBER 10, 2015 MORNING

SCALE: N.T.S. DWG NO: T4027-SK003 REV. A

DO NOT SCALE THIS DRAWING

Appendix C – Damper Control Logic Improvements Memo

GCT
Metallurgical Process Specialists

Gas Cleaning Technologies, LLC
4953 N. O Connor Blvd.
Irving, TX 75062 USA
Telephone +1 214 613 1785
Facsimile +1 214 613 1786

January 21, 2016

Ross Bradley
Environmental Manager
Gerdau Jackson
Jackson, MI

Re: T4027 APC System Evaluation - Canopy Hood Damper Control Logic Improvements (Revised)

Dear Ross,

During the evaluation of the APC system, GCT observed that the canopy hood damper positions are currently not aligning with EAF 1 activities during charging and EAF 2 activities during tapping and charging. Dampers are either opening after the activity has started or close too early while emissions may still be in the canopy hood. In addition, the damper positions are not consistent, and appear to vary from heat to heat. This may be a result of incorrect EAF “modes” triggering inappropriate damper positions or incorrect settings within the system programming.

Figure 1 below presents the canopy hood 1 damper positions on December 8th, 2015 during a backcharge. As shown in Figure 1, the back charge to EAF 1 occurred at about 14:18 when all three dampers were fully open. However, the charge damper and tap damper fully closed shortly after the back charge occurred and then reopened briefly. It is important for all three canopy hood dampers to be fully open before the charge occurs and remain fully open during the duration of the charge until the electrodes are back in the furnace.

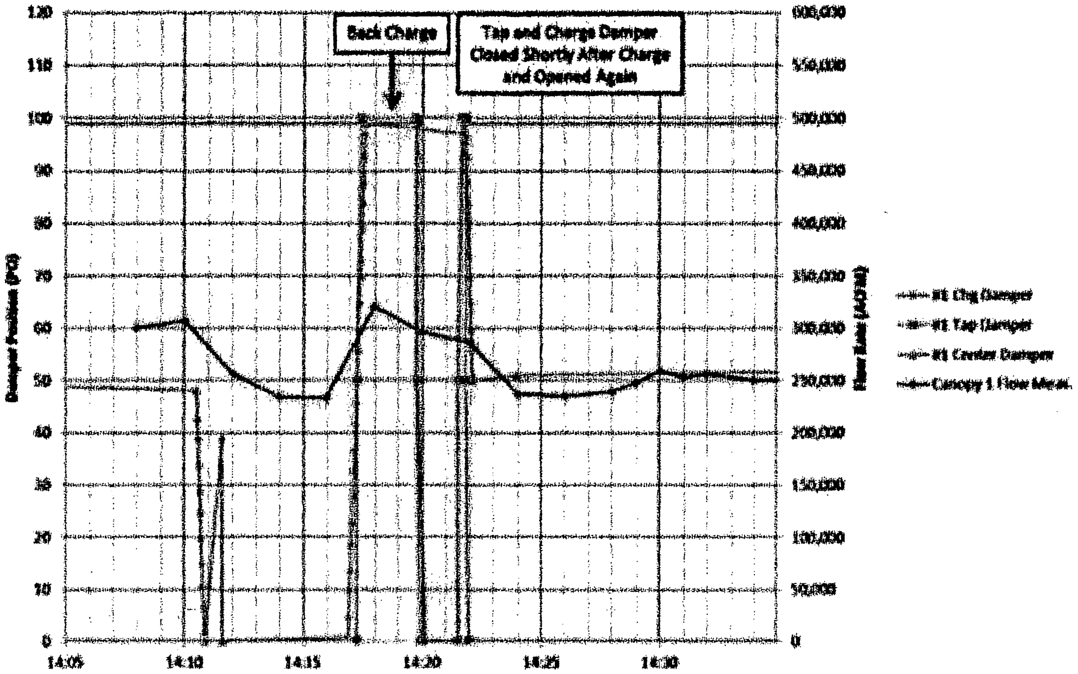

Figure 1

Canopy Hood 1 Damper Positions
December 8th, 2015

Table 1 presents the EAF 1 furnace activities and the actual canopy damper positions during each noted activity on the heat sheet. Damper positions that were in the correct position are shaded green, while those in an incorrect position are shaded red. Note that the times shown align with the time stamps provided in the Plantnet data provided. It should be noted that this time is approximately 4 mins ahead of the times noted on the heat sheet.

Table 1

Canopy Hood 1 Damper Positions

			Damper Positions			Recommended Positions		
Time (Plantnet)	**EAF Activity per Heat Sheet**	**EAF Step Per Heat Sheet**	**Charge**	**Center**	**Tap**	**Charge**	**Center**	**Tap**
14:18:23	Melt 1	EAF1 - Roof Swung OUT	100%	100%	100%	100%	100%	100%
14:18:23	Back Charge	Advance EAF Step	100%	100%	100%	100%	100%	100%
14:18:37	Back Charge	Scrap Charged	100%	100%	100%	100%	100%	100%
14:20:26	Back Charge	EAF1 - Roof Swung IN	[illegible]	[illegible]	[illegible]	100%	100%	100%

Figure 2 below presents the canopy hood 1 damper positions on December 9th, 2015. Note that during this heat, the dampers were fully open during tap, however this does not appear to be the case during every tap. At 14:44, following the tap, the tap and charge damper fully closed leaving only the center damper fully open. With the charge occurring at 14:43, all three dampers were fully open for under a minute during a charge. It is important for all three dampers to be fully open after a charge until the electrodes are back in the furnace so that the canopy hood's capture efficiency can be maximized during charging.

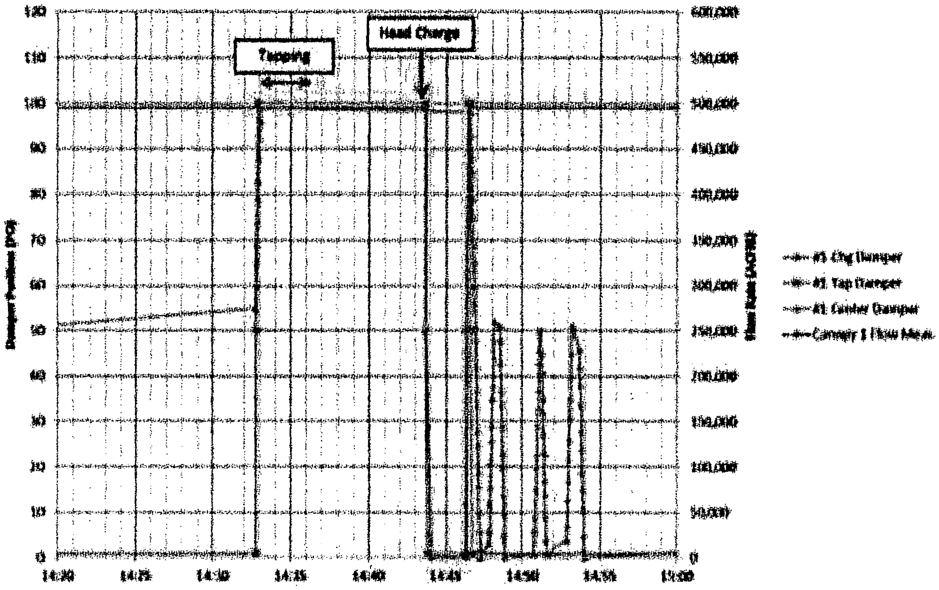

Figure 2
Canopy Hood 1 Damper Positions
December 9th, 2015

Table 2 presents the EAF 1 furnace activities and the actual canopy damper positions during that activity. Again, damper positions that were in the correct position are shaded green, while those in an incorrect position are shaded red.

Table 2
Canopy Hood 1 Damper Positions

			Damper Positions			**Recommended Positions**		
Time (Plantnet)	**EAF Activity Per Heat Sheet**	**EAF Step Per Heat Sheet**	**Charge**	**Center**	**Tap**	**Charge**	**Center**	**Tap**
14:33:06	Melt 2	EAF1 - Tapping	100%	100%	100%	100%	100%	100%
14:33:06	Tapping	Advance EAF Step	100%	100%	100%	100%	100%	100%
14:36:18	Tapping	EAF1 - Automatic End Heat	100%	100%	100%	100%	100%	100%
14:38:29	Turnaround	EAF1 - Roof Swung OUT	100%	100%	100%	100%	100%	100%
14:38:29	Head Charge	Advance EAF Step	100%	100%	100%	100%	100%	100%
14:43:11	Head Charge	Scrap Charged	100%	100%	100%	100%	100%	100%
14:44:29	Head Charge	EAF1 - Manual Start Delay	[illegible]	[illegible]	[illegible]	100%	100%	100%
14:45:03	Head Charge	EAF1 - Roof Swung IN	[illegible]	[illegible]	[illegible]	100%	100%	100%

Figure 3 below presents additional canopy hood 1 damper positions on December 9th, 2015 during a back charge. As shown, the charge and tap damper were nearly fully closed as EAF 1 was about to charge at 15:16. The three canopy dampers did not fully open until about 15:17, about a minute after the charge. Approximately 30 seconds after the dampers fully opened, the charge and tap damper fully closed only to open again at 15:18.

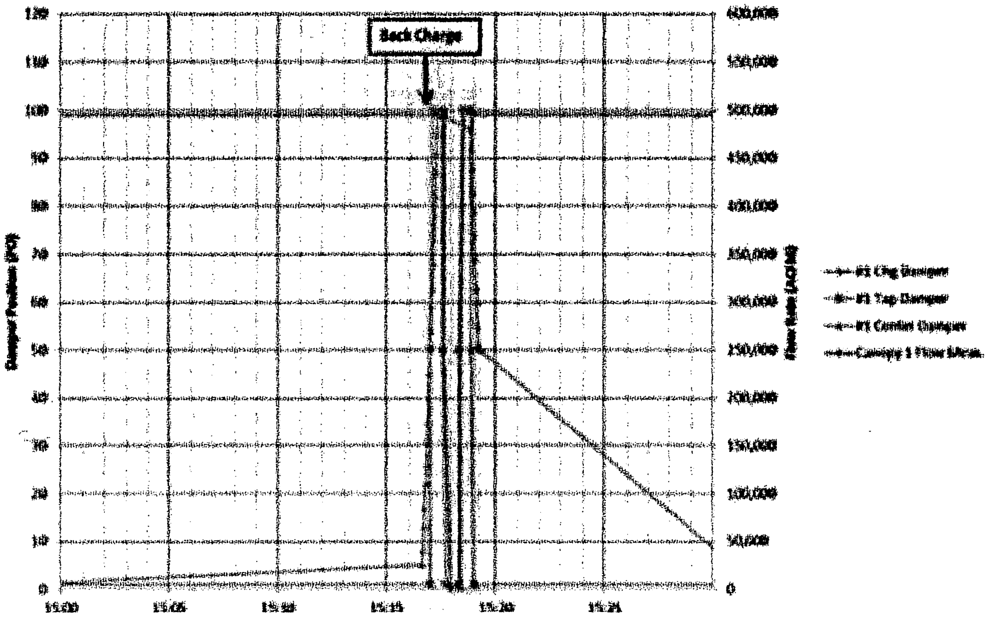

Figure 3
Canopy Hood 1 Damper Positions
December 9th, 2015

Table 3 presents the EAF 1 furnace activities and the actual canopy damper positions during that activity.

Table 3
Canopy Hood 1 Damper Positions

			Damper Positions			Recommended Positions		
Time	**EAF Activity**	**EAF Step**	**Charge**	**Center**	**Tap**	**Charge**	**Center**	**Tap**
15:16:00	Melt 1	EAF1 - Roof Swung OUT	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:16:00	Back Charge	Advance EAF Step	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:16:42	Back Charge	Scrap Charged	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:17:02	Back Charge	EAF1 - Roof Swung IN	100%	100%	100%	100%	100%	100%

Figure 4 below presents the canopy hood 2 damper positions on December 9th, 2015 while Table 4 presents the EAF 2 furnace activities and the actual canopy damper positions during that activity.

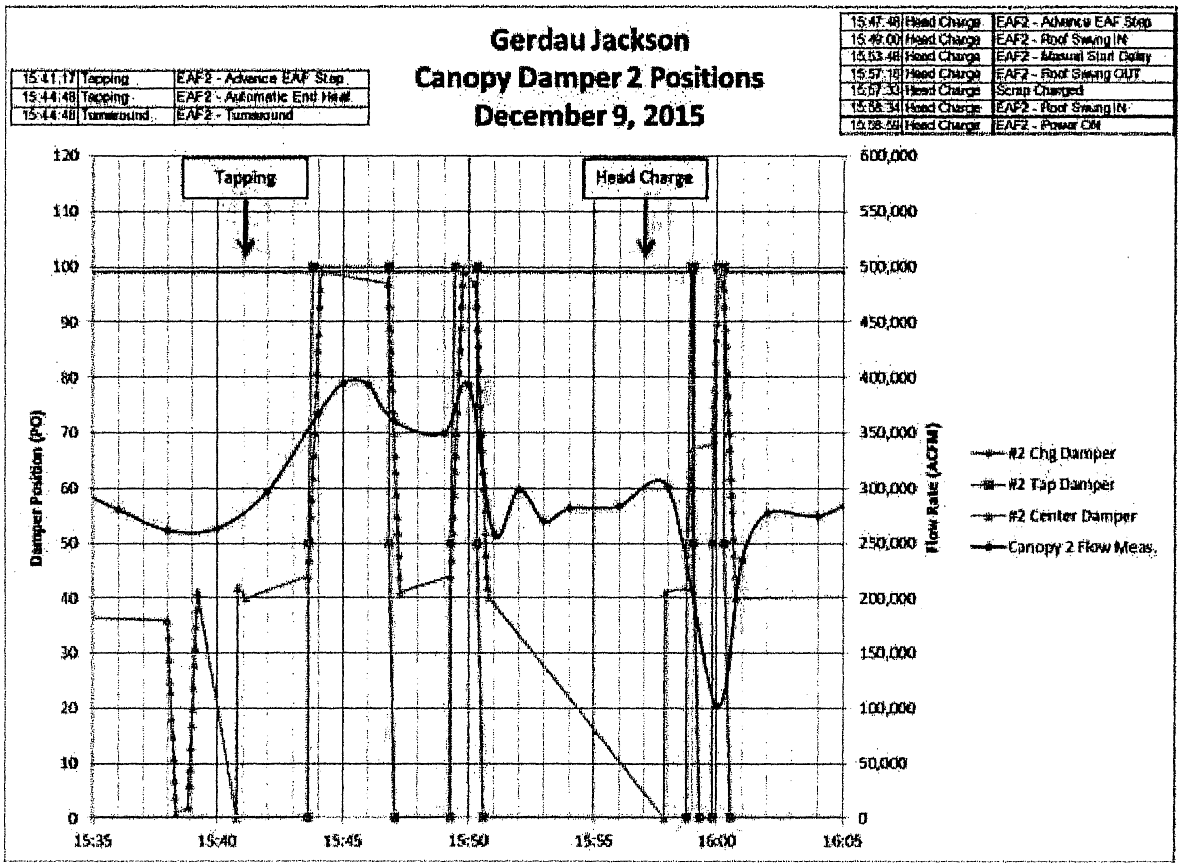

Figure 4
Canopy Hood 2 Damper Positions
December 9th, 2015

Table 4
Canopy Hood 2 Damper Positions

			Damper Positions			Recommended Positions		
Time	**EAF Activity**	**EAF Step**	**Charge**	**Center**	**Tap**	**Charge**	**Center**	**Tap**
15:41:17	Tapping	EAF2 - Advance EAF Step	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:44:48	Tapping	EAF2 - Automatic End Heat	100%	100%	100%	100%	100%	100%
15:47:48	Head Charge	EAF2 - Advance EAF Step	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:49:00	Head Charge	EAF2 - Roof Swung IN	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:53:48	Head Charge	EAF2 - Manual Start Delay	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:57:16	Head Charge	EAF2 - Roof Swung OUT	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:57:33	Head Charge	Scrap Charged	[redacted]	[redacted]	[redacted]	100%	100%	100%
15:58:34	Head Charge	EAF2 - Roof Swung IN	[redacted]	[redacted]	[redacted]	100%	100%	100%

As Figure 4 above shows, the charge damper was fully open while the tap damper was fully closed before tapping from EAF 2 occurred. Tapping occurred at about 15:41 but the center damper was at about 40% open and the charge damper was fully open. The three canopy hood dampers were not fully open until 15:44, approximately 3 minutes after tapping started. It is important to have all three canopy hood dampers open before tapping starts instead of after so that the canopy hood's capture efficiency can be maximized.

Figure 4 also shows that the charge damper was fully open and the center damper was 50% open during the head charge at 15:57. Since the tap damper did not open until 15:59, it would not have provided additional exhaust to maximize the total canopy hood exhaust rate. As stated earlier, it is important for all three canopy hood dampers to be fully open before the charge occurs and remain fully open during the duration of the charge until the electrodes are back in the furnace.

Figure 5 below presents the canopy hood 2 damper positions on December 9th, 2015 while Table 5 presents the EAF 2 furnace activities and the actual canopy damper positions during that activity. As shown, the charge and tap damper closed fully as EAF 2 was about charge at 16:32. The three canopy dampers did not fully open until about 16:33, over a full minute after the back charge.

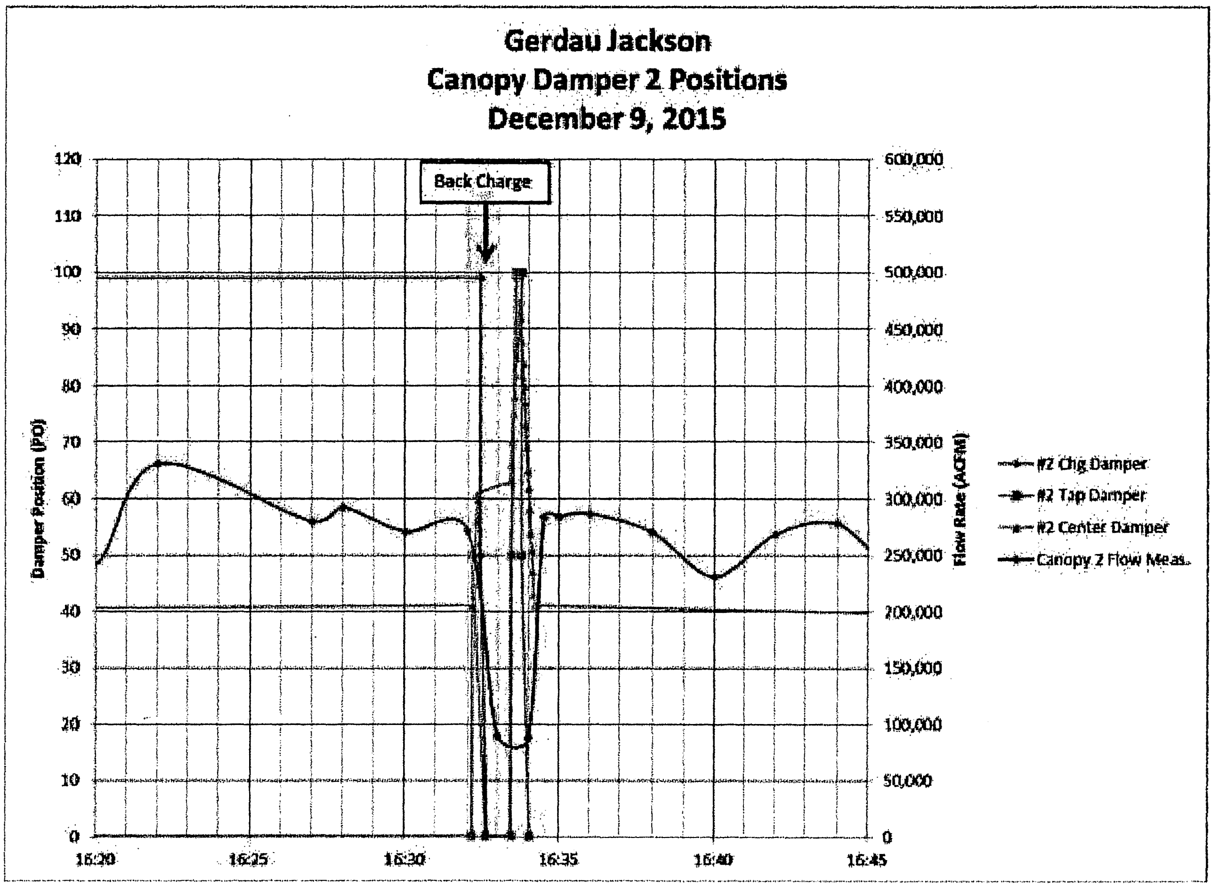

Figure 5
Canopy Hood 2 Damper Positions
December 9th, 2015

Table 5
Canopy Hood 2 Damper Positions

			Damper Positions			Recommended Positions		
Time	**EAF Activity**	**EAF Step**	**Charge**	**Center**	**Tap**	**Charge**	**Center**	**Tap**
16:30:53	Melt 1	EAF2 - Roof Swung OUT	[redacted]	[redacted]	[redacted]	100%	100%	100%
16:30:53	Back Charge	EAF2 - Advance EAF Step	[redacted]	[redacted]	[redacted]	100%	100%	100%
16:32:04	Back Charge	Scrap Charged	[redacted]	[redacted]	[redacted]	100%	100%	100%
16:32:09	Back Charge	EAF2 - Roof Swung IN	[redacted]	[redacted]	[redacted]	100%	100%	100%

Table 6 below presents the recommended canopy hood damper positions for each EAF activity logged in the heat sheet. As shown, all (3) canopy hood dampers for the charging or tapping furnace should be fully open for the duration of the charging or tapping process.

Table 6
Design Canopy Hood Damper Positions

EAF Activity		**Damper Positions**		
		Charge	**Center**	**Tap**
EAF CHARGE SEQUENCE	Electrodes Out	100%	100%	100%
	Furnace Swing Out	100%	100%	100%
	Bucket Over	100%	100%	100%
	Charge	100%	100%	100%
	Bucket Out	100%	100%	100%
	Roof Swing In	100%	100%	100%
	Electrodes In	100%	100%	100%
EAF TAP	Tapping Start	100%	100%	100%
	Tapping Stop	100%	100%	100%

By improving the damper position control logic, the average canopy exhaust rates are expected to increase for EAF charging and tapping back to design levels according to Table 7 below:

Table 7
Canopy Hood Exhaust Rates

	Unit	Current[1] Canopy 1	Current[1] Canopy 2	2010 Design[2]
Charging Exhaust Rate	ACFM	296,200 – 381,000	257,500 – 393,000	481,000
Tapping Exhaust Rate	ACFM	225,000 – 421,100	297,200 – 394,800	481,000
Note 1: Current flow rates based on flow rate measured in December 2015 by GCT. Note 2: Design refers to 2010 design basis (refer to PFD Drawing BH-M-3058)				

GCT recommends that during the trials to attempt to resolve the damper control logic, Gerdau should place personnel to observe the actual damper positions during EAF charging/tapping activities while other personnel observe the actual furnace activity so that immediate changes in damper position can be verified. This method is more effective than simply comparing the heat sheets to the Plantnet data since the times recorded on the heat sheets may not be perfectly aligned.

Appendix D – Raw Ductwork Measurements

T4027 Gerdau Jackson
Meltshop Air Pollution Control
System Evaluation

EAF 1 Side Draft Ductwork Ventilation Survey

T amb. 51 F Tstd 70 F
Patm. 28.89 in. Hg. Pstd 29.92 in. Hg.

	Time	Density	Static Pressure	Duct Diameter	Area	Avg Velocity	Avg Temperature	Flow Rate		Heat Content
			in.w.g.	(ft)	(ft^2)	(ft/min)	(deg F)	(ACFM)	(SCFM)	Btu/min
EAF 1 Side Draft Duct										
8-Dec-15										
	2:00 PM	0.034	-0.65	6.50	33.18	2,559	656	84,922	38,881	420,709
	2:02 PM	0.040	-0.75	6.50	33.18	2,412	505	80,030	42,364	337,629
	2:04 PM	0.048	-0.75	6.50	33.18	2,255	345	74,824	47,481	237,832
	2:06 PM	0.048	-1.24	6.50	33.18	2,874	337	95,380	61,055	296,869
	2:08 PM	0.037	-1.30	6.50	33.18	3,045	580	101,041	49,559	464,764
	2:10 PM	0.041	-1.20	6.50	33.18	2,944	476	97,684	53,250	395,592
	2:12 PM	0.046	-0.14	6.50	33.18	0	366	0	0	0
	2:14 PM	0.054	-0.01	6.50	33.18	0	254	0	0	0
	2:16 PM	0.063	-1.36	6.50	33.18	1,115	151	37,014	30,897	45,472
	2:18 PM	0.047	-0.65	6.50	33.18	1,902	360	63,104	39,320	207,788
	2:20 PM	0.050	-0.65	6.50	33.18	1,800	307	59,744	39,799	171,651
	2:22 PM	0.040	-0.54	6.50	33.18	2,087	507	69,242	36,597	293,034
	2:24 PM	0.039	-0.46	6.50	33.18	2,095	524	69,502	36,107	300,596
	2:26 PM	0.038	-0.65	6.50	33.18	2,408	540	79,894	40,822	352,093
	2:28 PM	0.033	-0.78	6.50	33.18	2,610	715	86,618	37,654	450,033
	2:30 PM	0.035	-0.89	6.50	33.18	2,522	626	83,674	39,344	403,238
	2:32 PM	0.034	-0.83	6.50	33.18	2,802	677	92,995	41,772	468,762
	2:34 PM	0.045	-0.65	6.50	33.18	1,976	386	65,567	39,600	228,206
	2:36 PM	0.054	-0.48	6.50	33.18	1,631	250	54,118	38,963	127,498
	2:38 PM	0.056	-0.40	6.50	33.18	1,538	226	51,051	38,048	107,875
	2:40 PM	0.057	-0.45	6.50	33.18	1,512	216	50,178	37,946	100,680
	2:42 PM	0.058	-0.54	6.50	33.18	1,515	205	50,277	38,641	94,792
	2:44 PM	0.058	-0.58	6.50	33.18	1,513	202	50,194	38,748	92,940
	2:50 PM	0.059	-0.53	6.50	33.18	1,481	188	49,137	38,757	83,095
	2:54 PM	0.060	-0.56	6.50	33.18	1,466	182	48,635	38,717	78,787
	2:56 PM	0.060	-0.80	6.50	33.18	1,813	184	60,155	47,709	98,820
	2:58 PM	0.046	-1.00	6.50	33.18	2,508	382	83,226	50,459	287,069
	3:00 PM	0.038	-1.30	6.50	33.18	3,174	555	105,318	52,929	471,439
	3:02 PM	0.036	-1.24	6.50	33.18	2,984	602	99,006	47,562	465,818
	3:04 PM	0.040	-1.25	6.50	33.18	3,260	510	108,169	56,891	458,725
	3:06 PM	0.035	-1.23	6.50	33.18	3,187	650	105,755	48,609	520,408
	3:08 PM	0.041	-1.30	6.50	33.18	2,972	482	98,605	53,396	402,641
	3:10 PM	0.048	-0.62	6.50	33.18	1,806	332	59,923	38,662	184,442
	3:12 PM	0.053	-0.51	6.50	33.18	1,752	262	58,126	41,150	143,657
	3:14 PM	0.055	-0.55	6.50	33.18	1,720	241	57,089	41,622	129,376
	3:16 PM	0.055	-0.40	6.50	33.18	2,643	232	87,705	64,800	190,799
	3:18 PM	0.040	-1.10	6.50	33.18	3,137	500	104,079	55,331	435,811
	3:20 PM	0.046	-0.55	6.50	33.18	2,036	377	67,549	41,246	230,860
	3:22 PM	0.045	-0.62	6.50	33.18	1,948	400	64,646	38,411	231,270
	3:24 PM	0.053	-0.60	6.50	33.18	1,839	261	61,040	43,263	150,245
	3:26 PM	0.055	-0.49	6.50	33.18	1,669	243	55,367	40,258	126,603
	3:28 PM	0.049	-0.60	6.50	33.18	1,803	317	59,841	39,356	176,940
	3:30 PM	0.052	-0.45	6.50	33.18	1,731	280	57,425	39,671	151,522
	3:32 PM	0.055	-0.61	6.50	33.18	1,667	241	55,313	40,321	125,333
	3:34 PM	0.056	-0.58	6.50	33.18	1,644	222	54,547	40,874	112,909
	3:36 PM	0.057	-0.61	6.50	33.18	1,650	213	54,736	41,560	108,000
	3:38 PM	0.058	-0.54	6.50	33.18	1,540	205	51,091	39,267	96,326
	3:40 PM	0.058	-0.53	6.50	33.18	1,566	201	51,966	40,182	95,648
	3:42 PM	0.059	-0.42	6.50	33.18	1,535	192	50,938	39,942	88,541
	3:44 PM	0.059	-0.52	6.50	33.18	1,429	186	47,402	37,505	79,048
	3:46 PM	0.060	-0.62	6.50	33.18	1,448	182	48,038	38,236	77,808
	3:48 PM	0.060	-0.62	6.50	33.18	1,453	182	48,205	38,368	78,079
	3:50 PM	0.060	-1.00	6.50	33.18	2,189	177	72,649	58,221	113,188
	3:52 PM	0.054	-0.50	6.50	33.18	1,521	245	50,471	36,593	116,409
	3:54 PM	0.055	0.00	6.50	33.18	0	240	0	0	0

T4027 Gerdau Jackson
Meltshop Air Pollution Control
System Evaluation

EAF 1 Canopy Hood Ductwork Ventilation Survey

T amb. 51 F   Tstd 70 F
Patm. 28.89 in. Hg.   Pstd 29.92 in. Hg.

	Time	Density	Static Pressure	Duct Diameter	Area	Avg Velocity	Avg Temperature	Flow Rate		Heat Content
			in.w.g.	(ft)	(ft^2)	(ft/min)	(deg F)	(ACFM)	(SCFM)	Btu/min
EAF1 Canopy Hood Duct										
8-Dec-15	2:02 PM	0.068	-0.73	13.00	132.73	2,265	105	300,573	271,764	172,876
	2:04 PM	0.068	-0.68	13.00	132.73	2,313	105	306,975	277,588	176,581
	2:06 PM	0.069	-1.00	13.00	132.73	1,930	96	256,113	235,152	111,132
	2:08 PM	0.069	-1.03	13.00	132.73	1,766	93	234,372	216,341	90,449
	2:10 PM	0.069	-1.15	13.00	132.73	1,760	96	233,561	214,363	101,308
	2:12 PM	0.070	-0.92	13.00	132.73	2,419	92	321,014	296,937	118,749
	2:14 PM	0.067	-0.38	13.00	132.73	2,232	115	296,198	263,386	215,395
	2:16 PM	0.067	-2.14	13.00	132.73	2,157	112	286,249	254,727	194,432
	2:18 PM	0.069	-1.58	13.00	132.73	1,791	93	237,676	219,083	91,595
	2:20 PM	0.070	-1.60	13.00	132.73	1,772	92	235,206	217,187	86,856
	2:22 PM	0.070	-1.42	13.00	132.73	1,807	92	239,907	221,630	88,633
	2:23 PM	0.069	-1.64	13.00	132.73	1,870	93	248,146	228,699	95,615
	2:24 PM	0.069	-1.50	13.00	132.73	1,954	94	259,402	238,726	104,146
	2:25 PM	0.069	-1.45	13.00	132.73	1,906	96	253,031	232,055	109,669
	2:26 PM	0.069	-1.49	13.00	132.73	1,929	96	256,036	234,787	110,960
	2:28 PM	0.068	-1.45	13.00	132.73	1,885	103	250,265	226,665	135,951
	2:30 PM	0.068	-1.37	13.00	132.73	1,888	101	250,623	227,845	128,379
	2:32 PM	0.069	-1.44	13.00	132.73	1,740	96	231,015	211,870	100,130
	2:34 PM	0.070	-1.44	13.00	132.73	1,595	92	211,703	195,565	78,209
	2:36 PM	0.070	-1.48	13.00	132.73	1,630	85	216,403	202,454	55,208
	2:38 PM	0.070	-1.71	13.00	132.73	1,623	88	215,361	200,258	65,528
	2:40 PM	0.070	-1.65	13.00	132.73	1,577	86	209,375	195,435	56,846
	2:42 PM	0.071	-1.44	13.00	132.73	1,604	83	212,859	199,892	47,243
	2:44 PM	0.070	-1.49	13.00	132.73	1,583	85	210,052	196,507	53,586
	2:46 PM	0.071	-1.47	13.00	132.73	1,346	84	178,615	167,413	42,610
	2:51 PM	0.070	-1.24	13.00	132.73	1,315	88	174,523	162,479	53,166
	2:52 PM	0.070	-1.55	13.00	132.73	1,589	86	210,923	196,930	57,281
	2:54 PM	0.070	-1.54	13.00	132.73	1,679	85	222,894	208,494	56,855
	2:56 PM	0.070	-1.52	13.00	132.73	1,487	85	197,400	184,657	50,355
	2:58 PM	0.070	-1.50	13.00	132.73	1,703	86	225,994	211,029	61,382
	3:00 PM	0.070	-1.79	13.00	132.73	2,067	91	274,367	253,685	96,842
	3:02 PM	0.069	-1.91	13.00	132.73	2,138	98	283,765	259,004	131,818
	3:04 PM	0.070	-1.72	13.00	132.73	2,194	91	291,272	269,364	102,827
	3:06 PM	0.069	-1.78	13.00	132.73	2,267	95	300,914	276,233	125,528
	3:08 PM	0.068	-1.83	13.00	132.73	2,151	102	285,477	258,765	150,502
	3:10 PM	0.070	-1.80	13.00	132.73	2,062	89	273,661	253,948	87,712
	3:12 PM	0.069	-1.53	13.00	132.73	1,837	98	243,841	222,780	113,382
	3:14 PM	0.069	-1.46	13.00	132.73	1,661	98	220,402	201,402	102,502
	3:16 PM	0.070	-1.55	13.00	132.73	1,784	92	236,760	218,651	87,441
	3:18 PM	0.069	-1.24	13.00	132.73	2,030	97	269,442	246,795	121,120
	3:19 PM	0.068	-1.86	13.00	132.73	1,923	103	255,294	230,977	138,537
	3:20 PM	0.069	-1.51	13.00	132.73	1,942	99	257,756	235,084	123,915
	3:22 PM	0.066	-1.85	13.00	132.73	1,166	118	154,803	136,427	119,004
	3:23 PM	0.068	-1.79	13.00	132.73	1,437	104	190,693	172,255	106,446
	3:26 PM	0.069	-1.89	13.00	132.73	954	100	126,596	115,142	62,785
	3:28 PM	0.070	-1.50	13.00	132.73	1,655	92	219,710	202,931	81,154
	3:30 PM	0.069	-1.46	13.00	132.73	1,541	95	204,587	187,961	85,415
	3:32 PM	0.070	-1.44	13.00	132.73	1,712	91	227,301	210,356	80,301
	3:34 PM	0.070	-1.49	13.00	132.73	1,675	88	222,273	206,802	67,669
	3:36 PM	0.070	-1.66	13.00	132.73	1,398	86	185,516	173,160	50,367
	3:38 PM	0.069	-1.59	13.00	132.73	1,570	96	208,433	191,086	90,307
	3:41 PM	0.070	-1.46	13.00	132.73	1,594	85	211,550	197,924	53,973
	3:43 PM	0.071	-1.71	13.00	132.73	1,824	82	242,090	227,605	49,655
	3:44 PM	0.071	-1.61	13.00	132.73	1,468	82	194,903	183,288	39,987
	3:45 PM	0.071	-1.62	13.00	132.73	1,757	82	233,225	219,321	47,848
	3:46 PM	0.071	-1.41	13.00	132.73	1,685	81	223,640	210,809	42,159
	3:47 PM	0.071	-1.70	13.00	132.73	1,735	80	230,290	217,318	39,511
	3:48 PM	0.071	-1.66	13.00	132.73	1,680	81	223,028	210,097	42,017
	3:50 PM	0.071	-1.68	13.00	132.73	1,489	80	197,585	186,465	33,901
	3:51 PM	0.071	-1.85	13.00	132.73	1,931	79	256,349	242,265	39,642
	3:52 PM	0.071	-1.70	13.00	132.73	1,696	80	225,108	212,428	38,622
	3:53 PM	0.070	-0.97	13.00	132.73	153	85	20,308	19,023	5,188
	3:59 PM	0.070	-0.61	13.00	132.73	3,173	89	421,095	391,951	135,377
	4:04 PM	0.069	-1.30	13.00	132.73	2,797	94	371,315	341,894	149,154
	4:07 PM	0.070	-1.45	13.00	132.73	2,871	91	381,049	352,632	134,614
	4:08 PM	0.070	-1.45	13.00	132.73	2,518	88	334,277	311,041	101,779
	4:09 PM	0.070	-1.45	13.00	132.73	2,393	85	317,694	297,238	81,055
	4:10 PM	0.069	-1.51	13.00	132.73	2,596	98	344,600	314,852	160,241
	4:11 PM	0.069	-1.47	13.00	132.73	2,388	94	316,977	291,735	127,271
	4:12 PM	0.070	-1.40	13.00	132.73	2,349	85	311,778	291,741	79,556
	4:13 PM	0.071	-1.56	13.00	132.73	2,449	83	325,095	305,197	72,131

T4027 Gerdau Jackson
Meltshop Air Pollution Control
System Evaluation

EAF 1 Canopy Hood Ductwork Ventilation Survey

T amb. 51 F
Patm. 28.89 in. Hg.

Tstd 70 F
Pstd 29.92 in. Hg.

	Time	Density	Static Pressure	Duct Diameter	Area	Avg Velocity	Avg Temperature	Flow Rate		Heat Content
			in.w.g.	(ft)	(ft^2)	(ft/min)	(deg F)	(ACFM)	(SCFM)	Btu/min
EAF1 Canopy										
9-Dec-15	4:20 PM	0.072	-1.60	13.00	132.73	2,473	76	328,222	312,125	34,051
	4:22 PM	0.070	-1.60	13.00	132.73	2,141	89	284,215	263,877	91,141
	4:24 PM	0.070	-1.74	13.00	132.73	2,269	88	301,203	280,059	91,641
	4:28 PM	0.070	-1.30	13.00	132.73	2,867	90	380,537	352,934	128,315
	4:29 PM	0.070	-1.35	13.00	132.73	2,343	91	310,978	287,860	109,888
	4:30 PM	0.070	-1.37	13.00	132.73	2,312	87	306,938	286,184	88,443
	4:32 PM	0.070	-1.32	13.00	132.73	2,414	87	320,405	298,778	92,336
	4:34 PM	0.071	-0.92	13.00	132.73	2,850	84	378,227	355,005	90,355
	4:36 PM	0.070	-0.66	13.00	132.73	2,940	90	390,182	362,471	131,782
	4:38 PM	0.070	-1.00	13.00	132.73	2,940	91	390,262	361,573	138,027
	4:40 PM	0.069	-1.20	13.00	132.73	2,962	93	393,141	362,738	151,655
	4:41 PM	0.069	-1.02	13.00	132.73	2,935	98	389,631	356,442	181,408
	4:42 PM	0.069	-1.12	13.00	132.73	2,975	95	394,928	363,147	165,024
	4:44 PM	0.069	-2.28	13.00	132.73	2,395	96	317,929	290,955	137,505
	4:45 PM	0.069	-1.98	13.00	132.73	2,241	100	297,513	270,534	147,517
	4:46 PM	0.069	-1.72	13.00	132.73	2,298	96	305,073	279,590	132,134
	4:50 PM	0.070	-1.20	13.00	132.73	2,147	91	284,946	263,865	100,728
	4:52 PM	0.070	-1.25	13.00	132.73	2,345	86	311,232	290,808	84,587
	4:54 PM	0.070	-1.38	13.00	132.73	2,366	88	314,054	292,277	95,639
	4:56 PM	0.070	-1.20	13.00	132.73	2,632	87	349,391	325,908	100,720
	4:58 PM	0.071	-1.56	13.00	132.73	2,322	84	308,210	288,814	73,508
	5:00 PM	0.070	-1.37	13.00	132.73	2,346	91	311,400	288,236	110,031

T4027 Gerdau Jackson
Meltshop Air Pollution Control
System Evaluation

EAF 2 Side Draft Ductwork Ventilation Survey

T amb. 51 F
Patm. 28.89 in. Hg.

Tstd 70 F
Pstd 29.92 in. Hg.

	Time	Density	Static Pressure	Duct Diameter	Area	Avg Velocity	Avg Temperature	Flow Rate		Heat Content
			in.w.g.	(ft)	(ft^2)	(ft/min)	(deg F)	(ACFM)	(SCFM)	Btu/min
EAF 2 Side Draft Duct										
9-Dec-15										
	2:12 PM	0.043	-0.90	6.50	33.18	2,684	439	89,080	50,597	341,119
	2:14 PM	0.039	-0.81	6.50	33.18	2,626	520	87,154	45,422	374,741
	2:16 PM	0.038	-0.91	6.50	33.18	2,760	560	91,582	45,846	412,660
	2:18 PM	0.038	-1.01	6.50	33.18	3,127	556	103,763	52,135	465,344
	2:20 PM	0.036	-1.20	6.50	33.18	3,301	621	109,544	51,705	525,020
	2:22 PM	0.037	-1.10	6.50	33.18	3,452	585	114,556	55,948	529,959
	2:24 PM	0.039	-1.10	6.50	33.18	3,261	524	108,205	56,122	467,223
	2:26 PM	0.039	-0.48	6.50	33.18	2,114	514	70,160	36,821	299,651
	2:28 PM	0.044	-0.43	6.50	33.18	1,955	414	64,866	37,943	238,255
	2:30 PM	0.048	-0.50	6.50	33.18	1,722	335	57,130	36,732	177,253
	2:32 PM	0.048	-0.52	6.50	33.18	1,772	332	58,799	37,946	181,028
	2:34 PM	0.050	-0.47	6.50	33.18	1,642	305	54,489	36,410	155,701
	2:36 PM	0.041	-1.04	6.50	33.18	3,031	469	100,575	55,261	403,340
	2:38 PM	0.040	-0.65	6.50	33.18	3,443	511	114,242	60,115	485,845
	2:40 PM	0.037	-1.06	6.50	33.18	3,174	571	105,336	52,149	480,194
	2:42 PM	0.038	-0.98	6.50	33.18	2,061	544	68,388	34,774	302,544
	2:44 PM	0.053	-0.53	6.50	33.18	1,773	265	58,834	41,476	147,067
	2:46 PM	0.049	-0.46	6.50	33.18	1,756	330	58,278	37,711	178,521
	2:48 PM	0.050	-0.56	6.50	33.18	1,816	307	60,270	40,159	173,201
	2:50 PM	0.051	-0.50	6.50	33.18	1,729	294	57,363	38,887	158,473
	2:52 PM	0.050	-1.13	6.50	33.18	2,658	301	88,208	59,152	248,625
	2:54 PM	0.050	-0.45	6.50	33.18	1,808	301	60,002	40,307	169,419
	2:56 PM	0.051	-0.44	6.50	33.18	1,750	286	58,079	39,801	156,379
	2:58 PM	0.050	-1.01	6.50	33.18	2,622	313	87,008	57,459	254,123
	3:00 PM	0.047	-0.45	6.50	33.18	1,689	358	56,036	35,020	183,774
	3:02 PM	0.049	-0.42	6.50	33.18	1,750	328	58,081	37,683	177,009
	3:04 PM	0.047	-1.14	6.50	33.18	2,640	355	87,611	54,858	284,855
	3:06 PM	0.049	-0.40	6.50	33.18	1,733	316	57,518	37,896	169,683
	3:08 PM	0.051	-0.50	6.50	33.18	1,669	291	55,389	37,699	151,564
	3:10 PM	0.052	-0.43	6.50	33.18	1,656	272	54,942	38,372	140,960
	3:12 PM	0.053	-0.40	6.50	33.18	1,787	258	59,314	42,237	144,370
	3:14 PM	0.055	-0.48	6.50	33.18	1,488	233	49,391	36,432	107,935
	3:16 PM	0.056	-0.56	6.50	33.18	1,602	225	53,149	39,654	111,705
	3:18 PM	0.057	-0.52	6.50	33.18	1,588	215	52,685	39,894	105,122
	3:20 PM	0.058	-0.53	6.50	33.18	1,569	203	52,057	40,131	96,987
	3:22 PM	0.058	-0.53	6.50	33.18	1,624	198	53,879	41,851	97,338
	3:24 PM	0.059	-0.46	6.50	33.18	1,571	193	52,115	40,798	91,181
	3:26 PM	0.059	-0.48	6.50	33.18	1,549	187	51,414	40,620	86,353
	3:28 PM	0.059	-0.47	6.50	33.18	1,535	188	50,942	40,186	86,160
	3:30 PM	0.059	-0.55	6.50	33.18	1,517	193	50,342	39,401	88,059
	3:32 PM	0.059	-0.55	6.50	33.18	1,626	196	53,965	42,043	96,257
	3:34 PM	0.053	-0.54	6.50	33.18	1,779	270	59,030	41,329	150,313
	3:36 PM	0.052	-0.44	6.50	33.18	1,671	285	55,462	38,058	148,838
	3:38 PM	0.059	-0.06	6.50	33.18	632	194	20,967	16,406	36,964
	3:40 PM	0.062	-0.03	6.50	33.18	371	163	12,310	10,112	17,086
	3:42 PM	0.056	-0.58	6.50	33.18	1,772	231	58,794	43,483	127,240
	3:44 PM	0.062	0.00	6.50	33.18	0	160	0	0	0
	3:46 PM	0.060	-0.76	6.50	33.18	1,752	184	58,140	46,116	95,520
	3:48 PM	0.060	-0.56	6.50	33.18	1,516	185	50,303	39,858	83,282
	3:50 PM	0.060	-0.42	6.50	33.18	1,539	181	51,077	40,738	82,161
	3:52 PM	0.060	-0.48	6.50	33.18	1,400	182	46,441	36,978	75,249
	3:54 PM	0.065	0.00	6.50	33.18	0	135	0	0	0
	3:56 PM	0.052	-0.80	6.50	33.18	2,173	283	72,106	49,567	192,037
	3:58 PM	0.061	-0.68	6.50	33.18	1,711	173	56,776	45,826	85,759
	4:00 PM	0.053	-0.53	6.50	33.18	1,743	266	57,826	40,709	145,090
	4:02 PM	0.043	-0.57	6.50	33.18	2,014	430	66,829	38,374	252,321
	4:04 PM	0.043	-0.60	6.50	33.18	2,228	435	73,948	42,222	281,530
	4:06 PM	0.043	-0.60	6.50	33.18	2,136	428	70,887	40,793	266,715
	4:08 PM	0.038	-0.50	6.50	33.18	2,417	544	80,216	40,839	355,305
	4:10 PM	0.038	-0.69	6.50	33.18	2,475	540	82,119	41,954	361,861
	4:12 PM	0.040	-0.78	6.50	33.18	2,436	496	80,847	43,196	337,002
	4:14 PM	0.042	-0.75	6.50	33.18	2,497	462	82,852	45,903	329,064

T4027 Gerdau Jackson
Meltshop Air Pollution Control
System Evaluation

EAF 2 Canopy Hood Ductwork Ventilation Survey

T amb. 51 F
Patm. 28.89 in. Hg.

Tstd 70 F
Pstd 29.92 in. Hg.

	Time	Density	Static Pressure	Duct Diameter	Area	Avg Velocity	Avg Temperature	Flow Rate		Heat Content
			in.w.g.	(ft)	(ft^2)	(ft/min)	(deg F)	(ACFM)	(SCFM)	Btu/min
EAF 2 Canopy Hood Duct										
8-Dec-15	3:58 PM	0.071	-1.40	13.00	132.73	2,251	82	298,792	281,137	61,334
	4:00 PM	0.071	-1.40	13.00	132.73	2,401	83	318,738	299,352	70,749
	4:02 PM	0.070	-1.48	13.00	132.73	2,122	85	281,630	263,477	71,849
	4:04 PM	0.071	-1.55	13.00	132.73	2,296	82	304,807	286,687	62,545
	4:06 PM	0.071	-1.77	13.00	132.73	2,104	80	279,312	263,531	47,913
	4:08 PM	0.071	-1.70	13.00	132.73	2,329	80	309,193	291,777	53,048
	4:10 PM	0.071	-1.67	13.00	132.73	2,402	80	318,809	300,874	54,702

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EAF 2 Canopy Hood Ductwork Ventilation Survey

T amb. 51 F
Patm. 28.89 in. Hg.

Tstd 70 F
Pstd 29.92 in. Hg.

	Time	Density	Static Pressure	Duct Diameter	Area	Avg Velocity	Avg Temperature	Flow Rate		Heat Content
			in.w.g.	(ft)	(ft^2)	(ft/min)	(deg F)	(ACFM)	(SCFM)	Btu/min
EAF 2 Canopy Hood Duct										
9-Dec-15	2:16 PM	0.068	-0.87	13.00	132.73	2,009	106	266,672	240,601	157,423
	2:18 PM	0.069	-0.95	13.00	132.73	2,136	96	283,495	260,326	123,030
	2:20 PM	0.068	-1.45	13.00	132.73	1,759	105	233,425	210,665	134,009
	2:22 PM	0.068	-1.38	13.00	132.73	1,747	104	231,856	209,657	129,559
	2:24 PM	0.069	-1.20	13.00	132.73	1,761	96	233,711	214,474	101,360
	2:26 PM	0.068	-1.25	13.00	132.73	1,946	106	258,264	232,788	152,312
	2:28 PM	0.069	-1.17	13.00	132.73	1,911	99	253,588	231,483	122,017
	2:30 PM	0.069	-1.14	13.00	132.73	1,888	95	250,661	230,478	104,736
	2:32 PM	0.068	-1.36	13.00	132.73	1,939	101	257,356	233,972	131,832
	2:34 PM	0.069	-1.29	13.00	132.73	2,311	100	306,785	279,457	152,383
	2:36 PM	0.069	-1.32	13.00	132.73	2,015	96	267,513	245,418	115,984
	2:38 PM	0.067	-1.22	13.00	132.73	1,795	114	238,194	211,722	169,299
	2:40 PM	0.068	-1.32	13.00	132.73	1,718	108	227,981	204,732	141,394
	2:42 PM	0.068	-1.32	13.00	132.73	2,231	107	296,154	266,423	179,159
	2:44 PM	0.069	-1.50	13.00	132.73	1,925	98	255,544	233,490	118,832
	2:46 PM	0.069	-1.34	13.00	132.73	2,012	94	267,080	245,893	107,272
	2:48 PM	0.070	-1.33	13.00	132.73	2,202	92	292,304	270,098	108,016
	2:50 PM	0.070	-1.41	13.00	132.73	2,396	92	317,967	293,751	117,475
	2:52 PM	0.070	-1.39	13.00	132.73	1,758	90	233,322	216,347	78,657
	2:54 PM	0.069	-1.43	13.00	132.73	2,033	98	269,827	246,584	125,497
	2:56 PM	0.069	-1.33	13.00	132.73	2,189	94	290,551	267,509	116,703
	2:58 PM	0.070	-1.38	13.00	132.73	1,841	92	244,398	225,802	90,301
	3:00 PM	0.069	-1.27	13.00	132.73	2,085	96	276,739	253,915	120,000
	3:02 PM	0.069	-1.27	13.00	132.73	2,060	95	273,383	251,287	114,192
	3:04 PM	0.070	-1.42	13.00	132.73	2,181	89	289,482	268,890	92,873
	3:06 PM	0.070	-1.26	13.00	132.73	2,220	90	294,614	273,271	99,352
	3:08 PM	0.070	-1.25	13.00	132.73	2,476	89	328,662	305,416	105,489
	3:10 PM	0.070	-1.21	13.00	132.73	2,088	91	277,192	256,677	97,984
	3:12 PM	0.070	-1.35	13.00	132.73	2,360	90	313,266	290,505	105,618
	3:14 PM	0.070	-1.78	13.00	132.73	2,184	90	289,827	268,474	97,608
	3:16 PM	0.070	-1.50	13.00	132.73	2,030	89	269,439	250,222	86,425
	3:18 PM	0.070	-1.55	13.00	132.73	2,211	88	293,533	273,060	89,350
	3:20 PM	0.065	-0.63	13.00	132.73	2,362	130	313,479	271,493	296,000
	3:22 PM	0.070	-1.24	13.00	132.73	2,118	87	281,184	262,258	81,049
	3:24 PM	0.070	-1.42	13.00	132.73	1,931	86	256,306	239,383	69,629
	3:26 PM	0.070	-1.55	13.00	132.73	2,136	85	283,547	265,222	72,325
	3:28 PM	0.070	-1.50	13.00	132.73	2,245	86	298,007	278,273	80,941
	3:30 PM	0.071	-1.48	13.00	132.73	2,111	84	280,198	262,619	66,841
	3:32 PM	0.070	-1.61	13.00	132.73	1,969	85	261,306	244,381	66,641
	3:34 PM	0.070	-1.30	13.00	132.73	1,987	85	263,678	246,795	67,299
	3:36 PM	0.070	-1.36	13.00	132.73	2,239	90	297,214	275,612	100,203
	3:38 PM	0.070	-1.42	13.00	132.73	2,769	87	367,491	342,599	105,878
	3:39 PM	0.070	-1.00	13.00	132.73	2,975	92	394,847	365,158	146,031
	3:40 PM	0.069	-0.91	13.00	132.73	2,963	94	393,270	362,470	158,130
	3:41 PM	0.069	-0.96	13.00	132.73	2,717	96	360,615	331,135	156,494
	3:43 PM	0.068	-1.57	13.00	132.73	2,632	104	349,407	315,800	195,151
	3:44 PM	0.068	-0.99	13.00	132.73	2,961	105	392,993	355,091	225,882
	3:45 PM	0.068	-0.87	13.00	132.73	1,940	107	257,521	231,935	155,967
	3:46 PM	0.069	-1.23	13.00	132.73	2,246	97	298,154	273,100	134,030
	3:47 PM	0.070	-1.33	13.00	132.73	2,032	92	269,670	249,184	99,652
	3:48 PM	0.070	-1.50	13.00	132.73	2,123	91	281,735	260,691	99,516
	3:50 PM	0.070	-1.47	13.00	132.73	2,135	89	283,339	263,151	90,890
	3:52 PM	0.070	-1.48	13.00	132.73	2,264	88	300,477	279,569	91,480
	3:54 PM	0.069	-4.22	13.00	132.73	772	98	102,533	93,033	47,348
	3:55 PM	0.069	-1.00	13.00	132.73	1,769	97	234,837	215,230	105,629
	3:56 PM	0.070	-1.36	13.00	132.73	2,089	90	277,219	257,070	93,462
	3:58 PM	0.070	-1.39	13.00	132.73	2,070	89	274,738	255,215	88,149
	4:00 PM	0.070	-1.33	13.00	132.73	2,211	87	293,442	273,628	84,563
	4:02 PM	0.070	-1.33	13.00	132.73	2,205	87	292,633	272,874	84,330
	4:04 PM	0.070	-1.23	13.00	132.73	1,786	87	237,054	221,104	68,331
	4:06 PM	0.070	-1.33	13.00	132.73	2,174	86	288,579	269,587	78,415
	4:08 PM	0.070	-1.50	13.00	132.73	2,045	89	271,480	252,117	87,079
	4:10 PM	0.069	-1.67	13.00	132.73	2,180	93	289,414	266,712	111,508
	4:12 PM	0.070	-1.44	13.00	132.73	1,947	89	258,379	239,987	82,890
	4:14 PM	0.070	-1.07	13.00	132.73	1,819	86	241,468	225,726	65,657
	4:16 PM	0.069	-0.87	13.00	132.73	2,493	96	330,904	303,922	143,634
	4:21 PM	0.070	-1.40	13.00	132.73	2,109	86	279,957	261,485	76,058
	4:22 PM	0.070	-1.50	13.00	132.73	2,201	88	292,145	271,804	88,939
	4:24 PM	0.070	-1.37	13.00	132.73	2,040	86	270,753	252,908	73,563
	4:26 PM	0.070	-1.41	13.00	132.73	2,047	87	271,721	253,322	78,288
	4:27 PM	0.070	-4.20	13.00	132.73	676	88	89,739	82,915	27,131
	4:28 PM	0.066	-4.23	13.00	132.73	665	121	88,214	76,870	71,242
	4:28 PM	0.066	-1.31	13.00	132.73	2,138	119	283,754	249,984	222,599
	4:29 PM	0.070	-1.21	13.00	132.73	2,143	92	284,458	262,929	105,148
	4:30 PM	0.070	-1.34	13.00	132.73	2,160	89	286,745	266,402	92,013
	4:32 PM	0.070	-1.38	13.00	132.73	2,034	87	270,031	251,766	77,807
	4:34 PM	0.070	-1.04	13.00	132.73	1,736	86	230,477	215,468	62,673
	4:36 PM	0.070	-1.08	13.00	132.73	2,023	86	268,478	250,968	72,999
	4:38 PM	0.070	-1.13	13.00	132.73	2,093	85	277,816	260,141	70,939
	4:40 PM	0.070	-1.20	13.00	132.73	1,795	86	238,237	222,632	64,757
	4:42 PM	0.070	-1.23	13.00	132.73	2,030	91	269,443	249,489	95,240
	4:51 PM	0.069	-1.21	13.00	132.73	1,744	94	231,427	213,139	92,983
	4:52 PM	0.070	-1.42	13.00	132.73	1,689	90	224,230	207,901	75,586
	4:54 PM	0.069	-1.16	13.00	132.73	1,870	99	248,184	226,557	119,421
	4:55 PM	0.070	-1.53	13.00	132.73	2,345	89	311,229	289,009	99,822
	4:56 PM	0.069	-1.50	13.00	132.73	2,132	95	282,951	259,929	118,119
	4:57 PM	0.070	-1.27	13.00	132.73	2,197	92	291,663	269,547	107,795
	4:58 PM	0.070	-1.39	13.00	132.73	2,136	92	283,473	261,898	104,736
	4:59 PM	0.069	-1.46	13.00	132.73	2,250	94	298,702	274,922	119,937
	5:00 PM	0.070	-1.38	13.00	132.73	1,742	89	231,187	214,764	74,178

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LMF and VAD Ductwork Ventilation Survey

T amb.	51 F	Tstd	70 F
Patm.	28.89 in. Hg.	Pstd	29.92 in. Hg.

	Time	Density	Static Pressure	Duct Diameter	Area	Avg Velocity	Avg Temperature	Flow Rate		Heat Content
			in.w.g.	(ft)	(ft^2)	(ft/min)	(deg F)	(ACFM)	(SCFM)	Btu/min
LMF VAD Duct										
10-Dec-15										
	8:43 AM	0.063	-2.17	4.00	12.57	3,103	154	38,995	32,324	49,334
	8:45 AM	0.063	-2.20	4.00	12.57	3,151	148	39,603	33,150	46,981
	8:47 AM	0.065	-2.08	4.00	12.57	3,050	134	38,333	32,853	38,206
	8:48 AM	0.064	-1.97	4.00	12.57	3,203	140	40,249	34,160	43,449
	8:49 AM	0.063	-1.97	4.00	12.57	3,372	150	42,378	35,377	51,423
	8:51 AM	0.063	-1.80	4.00	12.57	3,650	146	45,862	38,555	53,241
	8:53 AM	0.063	-2.10	4.00	12.57	3,541	148	44,498	37,257	52,802
	8:55 AM	0.064	-2.40	4.00	12.57	3,054	140	38,375	32,534	41,380

Exhibit B

Subject: Method 9 Guidance
Date: 9/15/2015 8:05 AM
From: "Ross Bradley" <ross.bradley@gerdau.com>
To: "Letuchy, Alexandra" <letuchy.alexandra@epa.gov>
Cc: "Anna M. Maiuri" <AMaiuri@dickinson-wright.com>, "DeLeon, Jose" <deleon.jose@epa.gov>, "Andre Wollmann" <andre.wollmann1@gerdau.com>

Sasha,

As discussed during our call last week, please see the attached documents published on EPA's website concerning Method 9 Readings. I've highlighted the sections which pertain to reading rectangular vents, which indicate readers should position themselves perpendicular to the longest axis. While there is some guidance regarding compensation for readings taken at slant angles exceeding 18%, I've been unable to locate any guidance regarding readings taken on a rectangular vent parallel with the longest axis other than the attachments included.

Are you aware of any formulas/factors that could be applied? Thank you.

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While we have taken steps to ensure the accuracy of this Internet version of the document, it is not the official version. Please refer to the official version in the FR publication, which appears on the Government Printing Office's eCFR website:
(http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr60_main_02.tpl).

Method 9 - Visual Determination of the Opacity of Emissions From Stationary Sources

Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume. This method involves the determination of plume opacity by qualified observers. The method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of plume opacity. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: Angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer, and can affect the ability of the observer to accurately assign opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. It follows from this, and is confirmed by field trials, that the opacity of a plume, viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100 percent of the sets were read with a positive error[1] of less than 7.5 percent opacity; 99 percent were read with a positive error of less than 5 percent opacity.

(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99 percent of the sets were read with a positive error of less than 7.5 percent opacity; 95 percent were read with a positive error of less than 5 percent opacity. The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

1. Principle and Applicability

---

[1] For a set, positive error-average opacity determined by observer' s 25 observations-average opacity determined from transmissometer's 25 recordings.

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to §60.11(b) and for qualifying observers for visually determining opacity of emissions.

2. Procedures

The observer qualified in accordance with section 3 of this method shall use the following procedures for visually determining the opacity of emissions:

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his line of vision is approximately perpendicular to the plume direction, and when observing opacity of emissions from rectangular outlets (e.g., roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g., stub stacks on baghouses).

2.2 Field Records. The observer shall record the name of the plant, emission location, type facility, observer's name and affiliation, a sketch of the observer's position relative to the source, and the date on a field data sheet (Figure 9–1). The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded on a field data sheet at the time opacity readings are initiated and completed.

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume, but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached Steam Plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached Steam Plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording Observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9–2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9–1 for an example.)

3. *Qualifications and Testing*

3.1 Certification Requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and an average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in section 3.2. Smoke generators used pursuant to section 3.2 shall be equipped with a smoke meter which meets the requirements of section 3.3.

The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any observer in order to retain certification.

3.2 Certification Procedure. The certification test consists of showing the candidate a complete run of 50 plumes—25 black plumes and 25 white plumes—generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program, and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke Generator Specifications. Any smoke generator used for the purposes of section 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display instack opacity based upon a pathlength equal to the stack exit diameter, on a full 0 to 100 percent chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 9–1.
The smoke meter shall be calibrated as prescribed in section 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 9–1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

Table 9–1—Smoke Meter Design and Performance Specifications

Parameter	Specification
a. Light source	Incandescent lamp operated at nominal rated voltage.
b. Spectral response of photocell	Photopic (daylight spectral response of the human eye—Citation 3).
c. Angle of view	15° maximum total angle.
d. Angle of projection	15° maximum total angle.
e. Calibration error	±3% opacity, maximum.

f. Zero and span drift	±1% opacity, 30 minutes.
g. Response time	5 seconds.

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warmup by alternately producing simulated opacity of 0 percent and 100 percent. When stable response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent readings are produced without adjustment. Simulated 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

3.3.2 Smoke Meter Evaluation. The smoke meter design and performance are to be evaluated as follows:

3.3.2.1 Light Source. Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within ±5 percent of the nominal rated voltage.

3.3.2.2 Spectral Response of Photocell. Verify from manufacturer's data that the photocell has a photopic response; i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity curve for photopic vision which is referenced in (b) of Table 9–1.

FIGURE 9-1
RECORD OF VISUAL DETERMINATION OF OPACITY

PAGE___of___

COMPANY____________________
LOCATION____________________
TEST NUMBER____________________
DATE____________________
TYPE FACILITY____________________
CONTROL DEVICE____________________

HOURS OF OBSERVATION____________________
OBSERVER____________________
OBSERVER CERTIFICATION DATE____________________
OBSERVER AFFILIATION____________________
POINT OF EMISSIONS____________________
HEIGHT OF DISCHARGE POINT____________________

	Initial			Final
CLOCK TIME				
OBSERVER LOCATION Distance to Discharge				
Direction from Discharge				
Height of Observation Point				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, % clouds, etc.)				
PLUME DESCRIPTION Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY

Set Number	Time	Opacity	
	Start--End	Sum	Average

Readings ranged from ____ to ____ % opacity

The source was/was not in compliance with ____ at the time evaluation was made.

Figure 9–2—Observation Record

Company	Observer	
Location	Type facility	
Test Number	Point of emissions	
Date		

		Seconds				Steam plume (check if applicable)		
Hr.	**Min.**	**0**	**15**	**30**	**45**	**Attached**	**Detached**	**Comments**
	0							
	1							
	2							
	3							
	4							
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	29							

Company	Observer	
Location	Type facility	
Test Number	Point of emissions	
Date		

		Seconds				Steam plume (check if applicable)		
Hr.	**Min.**	**0**	**15**	**30**	**45**	**Attached**	**Detached**	**Comments**
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							
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	59							

3.3.2.3 Angle of View. Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15°. The total angle of view may be calculated from: $\Theta = 2 \tan^{-1} d/2L$, where Θ = total angle of view; d = the sum of the photocell diameter+ the diameter of the limiting aperture; and L = the distance from the photocell to the limiting aperture. The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters this is normally an orifice plate.

3.3.2.4 Angle of Projection. Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15°. The total angle of projection may be calculated from: $\Theta = 2 \tan^{-1} d/2L$, where Θ = total angle of projection; d=the sum of the length of the lamp filament + the diameter of the limiting aperture; and L = the distance from the lamp to the limiting aperture.

3.3.2.5 Calibration Error. Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter according to 3.3.1 and then inserting a series of three neutral-density filters of nominal opacity of 20, 50, and 75 percent in the smoke meter pathlength. Filters calibrated within ±2 percent shall be used. Care should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum error on any one reading shall be 3 percent opacity.

3.3.2.6 Zero and Span Drift. Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

3.3.2.7 Response Time. Determine the response time by producing the series of five simulated 0 percent and 100 percent opacity values and observing the time required to reach stable response. Opacity values of 0 percent and 100 percent may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

4. Bibliography

1. Air Pollution Control District Rules and Regulations, Los Angeles County Air Pollution Control District, Regulation IV, Prohibitions, Rule 50.

2. Weisburd, Melvin I., Field Operations and Enforcement Manual for Air, U.S. Environmental Protection Agency, Research Triangle Park, NC. APTD–1100, August 1972, pp. 4.1–4.36.

3. Condon, E.U., and Odishaw, H., Handbook of Physics, McGraw-Hill Co., New York, NY, 1958, Table 3.1, p. 6–52.

Exhibit C

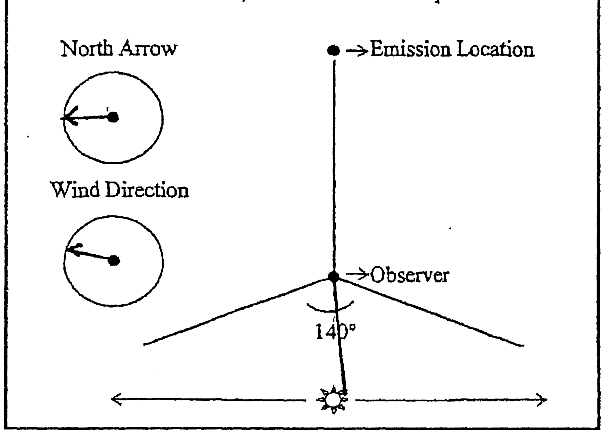
METHOD 9 VISIBLE EMISSION OBSERVATION FORM

Date: 9/17/15
Observer: Kushal Som
Affiliation: U.S. EPA

Source name: Gerdau
Source address: 3100 Brooklyn Road
Jackson, MI

Facility type: Electric Arc Furnace

Show north arrow, wind direction and sun position:



Emission location (stack, roof, etc.): Roof Monitor - South	Estimated emission location height: 350 feet
Direction from emission location: West	Estimated distance to emission location: 350 feet

Plume color: White
Background: Sky
Background color: Blue

Sky color: Blue
Cloud color: No visible clouds

Estimated wind speed: 4 mph
Approximate wind direction: SSW to NNE

Temperature: 80 °F

Additional Comments (photos/video taken, etc.):

40 C.F.R. Part 60, Appendix A, Reference Method 9
2.3 Observations. "Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present."
2.3.1 Attached Steam Plumes. "When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made."
2.3.2 Detached Steam Plume. "When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume."
"On an overcast day when no shadows are observed and the lighting is diffuse or flat, this rule might not be as important from a scientific standpoint as on a bright, sunny day. Observers might have trouble defending their positions in court if they disregard the rule. The best practice for an observer is to always have the sun at his or her back, even if it is not visible and no shadows are cast." http://www.epa.gov/ttn/emc/methods/VECourse.pdf

		Seconds				Steam Plume?		
Time	Minute	0	15	30	45	Attached	Detached	Comments
5:20	1	15	25	30	45	✓		
	2	30	20	10	25	✓		
	3	20	15	5	10	✓		
	4	10	10	5	0	✓		
	5	0	0	0	0	✓		
	6	0	0	0	0	✓		
	7	0	0	10	5	✓		
	8	5	10	10	10	✓		
	9	5	10	15	20	✓		
	10	10	15	10	10	✓		
	11	10	10	15	5	✓		
	12	5	10	20	15	✓		
	13	10	20	20	20	✓		
	14	25	20	20	15	✓		
	15	15	20	15	10	✓		
	16	10	10	15	15	✓		
	17	20	10	5	0	✓		
	18	10	10	10	5	✓		
	19	10	10	10	5	✓		
	20	0	10	15	15	✓		
	21	20	15	20	15	✓		
	22	5	5	5	10	✓		
	23	10	0	5	0	✓		
	24	0	0	0	0	✓		
	25	5	10	10	5	✓		
	26	5	5	10	0	✓		
	27	15	10	5	0	✓		
	28	0	5	5	0	✓		
	29	0	0	10	10	✓		
	30	5	5	0	0	✓		

(Continued on other side→)

Signature:
Date last certified: April 22, 2015

Exhibit D

GCT

Gerdau Jackson

Meltshop Air Pollution Control System Re-Evaluation

Project Report

GCT Project: T4027

April 19, 2016

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Disclaimer

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PROJECT T4027 - MELTSHOP AIR POLLUTION CONTROL SYSTEM RE-EVALUATION

REV	DESCRIPTION	ORIG	REVIEW	GCT APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Project Report	F. Concha	C. Grass	N/A	4/19/2016	N/A	

CONTENTS

1. EXECUTIVE SUMMARY

Gerdau Specialty Steel N.A. (Gerdau) operates a special bar quality (SBQ) meltshop in Jackson, Michigan equipped with (2) 52-ton Electric Arc Furnaces (EAFs). Each furnace is equipped with side draft fume collection hoods for local collection of emissions from the EAFs as well as canopy hoods located above each furnace for collection of secondary emissions generated during EAF operations. The combined gasses from the side draft hoods and secondary hoods tie into a common 828,000 ACFM baghouse system.

Gerdau is currently experiencing some drift from the EAF aisle towards the caster aisle and therefore contracted Gas Cleaning Technologies (GCT) in December 2015 to perform a meltshop Air Pollution Control (APC) system study to assess the current performance of the APC system and evaluate options to improve capture efficiency within the meltshop. Based on the results of the evaluation, it was determined that the baghouse system is adequately sized for the current operation, however GCT identified that the canopy hood dampers were operating in incorrect positions during charging and tapping which was reducing the exhaust rate available to the canopy hoods. Gerdau subsequently modified the damper control logic to rectify this issue and indicated that there has been, visually, a considerable improvement in the capture efficiency of the canopy hood during tapping and charging since the modifications were implemented. Gerdau have now requested GCT verify this improvement, re-evaluate the APC system following the change, and make recommendations for further improvements as necessary.

Observations

GCT personnel traveled to Jackson, Michigan on March 15 to March 17, 2016 to conduct updated measurements and to observe the performance of the existing air pollution control system in order to allow an updated evaluation of the system to be conducted. The observations collected during the site visit are summarized as follows:

- The wind direction was similar to December (with winds primarily from the south and southwest), however wind speeds were higher at 20 to 30 mph, compared to 5 to 10 mph in December. Additionally, the caster louvers (closed during the December 2015 site visit) were open during the March site visit due to warmer weather resulting in increased shop cross drafts.
- EAF emissions escaping the side draft hood generally report to the canopy hood, however, significant drift towards the caster aisle was observed that was not present in December 2015. Since the wind direction was similar during both site visits, GCT attributes the change in shop ventilation pattern to the opening of the caster area louvers.
- As observed in December, continuous emissions were generated from the ladles at the caster that report to the caster roof vent during the March site visit. When operating, emissions generated at caster mix with other emissions sources in the caster area and are not distinguishable from EAF emissions.

- No opacity readings of over 6% on a 6-minute average were collected at the caster roof vent during charging or tapping operations for the (3) periods Method 9 readings were collected by Gerdau.
- Elevated opacity was observed at the caster roof vent on (2) periods. During both of these periods, the furnaces were operating in "Hold Fire" mode.

System Re-Evaluation

Based on GCT's re-evaluation of the APC system performance, the revised damper control logic has rectified the previously identified control issue and has resulted in a significant increase in canopy hood exhaust rate during charging and tapping operations. This appears to have improved capture of charging and tapping emissions and, based on the (3) periods of Method 9 readings collected, reduced opacity at the caster roof vent below the 6% limit during these periods.

However, due to the change in meltshop ventilation pattern with the caster louvers open, fugitive EAF emissions from the side draft hood during "hold fire" mode were now observed to travel towards the caster aisle. Since emissions were also observed to be generated at the caster, the root cause of the elevated opacity during the (3) periods Method 9 readings were collected could not be determined. However, based on GCT's analysis, EAF emissions during this furnace mode could have significantly contributed to the observed periods above 6% opacity on a 6-minute average at the caster roof vent.

GCT therefore evaluated several options on a conceptual level to further improve capture and reduce drift in the meltshop.

Option Evaluation

The options evaluated were as follows:

- Further Optimize Damper Control Logic
- Equipment Modification Options
    - Option 1 – Larger baghouse
    - Option 2 – Enlarged Canopy Hood
    - Option 3 – Aisle Air Curtain
    - Option 4 – Segregate EAF Aisle from Caster Aisle
    - Option 5 – Meltshop Wall Fans
    - Option 6 – Enclose Caster Roof Vent and Ventilate with Baghouse

As previously noted, it appears that emissions from the side draft hood are now contributing to the incidence of observable opacity at the caster roof vent. GCT developed preliminary side draft damper set-points and modified canopy damper logic that could be trialed to improve shop cleanliness, reduce spillage from the canopy, and reduce fugitive emissions from the EAF aisle to the caster area.

GCT also evaluated six different equipment modification options designed to improve capture of fugitive emissions and/or reduce aisle drift. A summary of the equipment option evaluation is as follows:

- Equipment modification Options 1 through 4 are either not feasible or would not be effective in reducing fugitive emissions reporting to the caster aisle roof vent. GCT therefore dismissed these options from further consideration.
- Equipment Modification Option 5 is feasible and should further reduce aisle cross drafts, minimizing drift of EAF emissions to the caster aisle. At a conceptual level, this option would involve removing the louvers, installing new sheeting, and installing new wall fans.
- Equipment Modification Option 6 is feasible and highly effective. At a conceptual level, this option would involve enclosing the existing roof vent and ventilating it with modular filter units.

Recommendations

To further improve capture of EAF emissions and reduce drift to the caster aisle, GCT recommends Gerdau first pursue the additional damper control logic tuning recommendations outlined in this report. Tuning of the dampers is relatively easy to implement and should result in a significant reduction of fugitive emissions. GCT has provided preliminary damper set-points in this report, however further evaluation should be conducted to finalize the damper set-points to ensure the modifications result in an improvement in emissions capture, while minimizing the impact on CO emissions and equipment life and reliability.

If, after further tuning of the dampers, drift to the caster aisle is still a concern, GCT recommends Gerdau further evaluate the option of closing the caster area louvers and installing wall ventilation fans (Equipment Modification Option 5 in this report). This option could significantly reduce cross drafts in the EAF aisle and minimize drift to the caster aisle while improving working conditions at the caster. If this option is pursued, GCT would recommend the next step is to conduct CFD modeling to optimize the location of the fans and more definitively quantify the effects of the modifications on aisle cross drafts.

If closing the louvers and installing the fans does not definitively eliminate the possibility of elevated opacity at the caster roof vent, GCT recommends enclosing the caster roof vent and ventilating the caster aisle with modular filter units. This option requires a major investment in new equipment (estimated at $2.4M) as well as new ongoing operating and maintenance commitments.

GCT recommends fully exploring the damper control logic optimization and building louver modifications prior to proceeding with Option 6 as significant reductions in fugitive emissions can likely be achieved that may make closure of the roof vent unnecessary.

2. INTRODUCTION

Gerdau Specialty Steel N.A. (Gerdau) operates a special bar quality (SBQ) meltshop in Jackson, Michigan. The meltshop is equipped with (2) 52 ton EAFs, a two-strand caster, and rolling mill. Each furnace is equipped with side draft fume collection hoods for local collection of emissions from the EAFs as well as canopy hoods located above each furnace for collection of secondary emissions generated during EAF operations. The combined gasses from the side draft hoods and secondary hoods tie into a common 828,000 ACFM baghouse system. Gerdau completed several modifications to the Meltshop Air Pollution Control (APC) system in 2010 (at the cost of approximately $4 million) to comply with a more stringent 6% opacity requirement from the meltshop.

In December 2015, Gas Cleaning Technologies (GCT) performed a meltshop air pollution control system study to assess the current performance of the APC system and evaluate options to reduce emissions drift within the meltshop. Based on the results of the evaluation, it was determined that the baghouse system is adequately sized for the current operation, however it may be possible to operate the existing system more effectively. To this end, GCT identified that the canopy hood dampers were operating in incorrect positions during charging and tapping.

Gerdau subsequently modified the damper control logic to rectify this issue and indicated that there has been, visually, a considerable improvement in the capture efficiency of the canopy hood since the modifications were implemented. Gerdau has now requested GCT re-evaluate the APC system and make recommendations for further improvements as necessary.

The focus of this study is to:

- Re-evaluate the current EAF side draft hood system and canopy hood performance
- Compare operating conditions and system performance against the December 2015 and 2010 measurements
- Evaluate modifications to existing controls and operating practices to further optimize existing system performance and reduce fugitive emissions, as required

This report provides a summary of the outcomes of the APC system re-evaluation and presents and evaluates various possible options designed to further improve the performance of the APC system.

3. MELTSHOP AIR POLLUTION CONTROL SYSTEM EVALUATION

GCT personnel traveled to Jackson, Michigan from March 15 to March 17, 2016 to conduct updated measurements and to observe the performance of the existing air pollution control system. The updated information was then utilized to evaluate the performance of the APC system to meet the established ventilation requirements.

3.1 Summary of Field Measurements and Observations

Flow rate, temperature, and static pressure measurements were collected at the following locations:

- EAF #1 side draft hood duct
- Canopy #1 hood duct
- EAF #2 side draft hood duct
- Canopy #2 hood duct

Measurements were collected at each location for (2) heats per furnace, measuring the side draft and canopy hood of each furnace simultaneously. A total of (4) heats of data were therefore measured. Tables 3.1 to 3.4 below summarize the average off-gas measurements collected during the testing period of March 16 to 17, 2016. Measurements were not collected on the 15th as the furnaces were down for refractory maintenance for the majority of the day.

Table 3.1
Side Draft Hood 1 Duct Measurement – March 16 - 17, 2016

	Heat 71071796 (3/16)				Heat 71071805 (3/17)			
	Temp	Flow Rate		S.P.	Temp	Flow Rate		S.P.
EAF Mode	°F	ACFM	SCFM	in.H_2O	°F	ACFM	SCFM	in.H_2O
EAF 1 Melting	512	80,200	42,700	-0.86	446	74,800	43,400	-0.88
EAF 1 Refining	640	97,900	45,600	-1.1	705	107,900	47,300	-1.26
EAF 1 Charging	247	13,100	9,500	0	231	13.000	9,600	0
EAF 1 Tapping	221	12,100	9,200	0	250	13,100	9,500	0

Table 3.2
Canopy Hood 1 Duct Measurement – March 16-17, 2016

	Heat 71071796 (3/16)				Heat 71071805 (3/17)			
	Temp	Flow Rate		S.P.	Temp	Flow Rate		S.P.
EAF Mode	°F	ACFM	SCFM	in.H_2O	°F	ACFM	SCFM	in.H_2O
EAF 1 Melting	90	316,200	293,000	-1.3	90	316,200	293,800	-1.3
EAF 1 Refining	88	297,300	276,400	-1.5	93	263,400	242,900	-1.4
EAF 1 Charging	96	393,300	360,900	-1.2	99	417,800	381,900	-1.0
EAF 1 Tapping	92	397,600	367,800	-1.1	89	411,700	382,600	-1.1

Table 3.3
Side Draft Hood 2 Duct Measurement – March 16, 2016

	Heat 72068612				Heat 72068613			
	Temp	Flow Rate		S.P.	Temp	Flow Rate		S.P.
EAF Mode	°F	ACFM	SCFM	in.H_2O	°F	ACFM	SCFM	in.H_2O
EAF 2 Melting	311	73,500	48,500	-0.74	388	76,200	46,100	-0.7
EAF 2 Refining	584	105,300	51,500	-1.1	584	102,400	50,100	-1.1
EAF 2 Charging	110	12,500	11,200	0	127	7,600	6,600	0
EAF 2 Tapping	166	5,600	4,500	0	170	8,700	7,100	0

Table 3.4
Canopy Hood 2 Duct Measurement – March 16, 2016

	Heat 72068612				Heat 72068613			
	Temp	Flow Rate		S.P.	Temp	Flow Rate		S.P.
EAF Mode	°F	ACFM	SCFM	in.H_2O	°F	ACFM	SCFM	in.H_2O
EAF 2 Melting	82	280,900	264,300	-1.4	87	288,300	268,600	-1.3
EAF 2 Refining	89	244,600	227,500	-1.3	90	245,900	228,000	-1.4
EAF 2 Charging	87	397,900	371,000	-1.2	87	389,400	363,200	-1.3
EAF 2 Tapping	82	387,000	364,300	-1.0	85	387,500	362,800	-1.0

Figures 3.1 through Figures 3.6 below show graphs of the flow rate and temperature measurements collected by GCT during the site visit period, annotated with the major EAF operating phases.

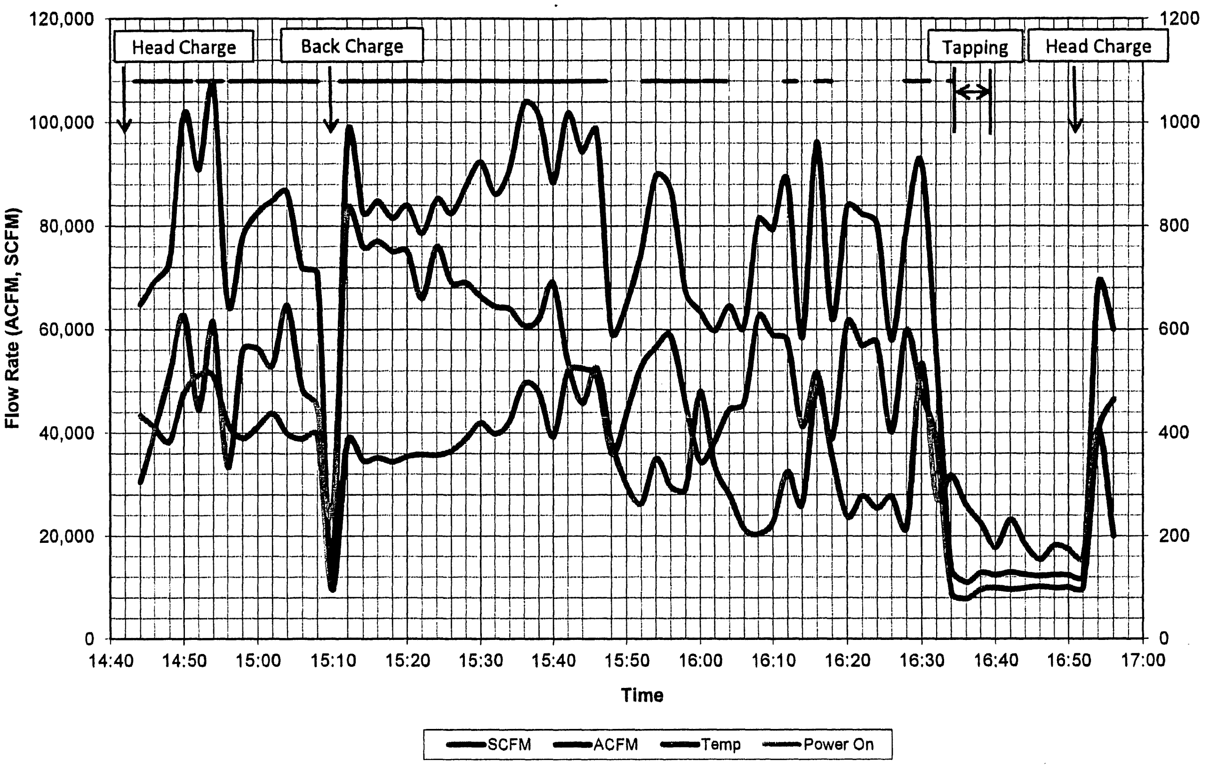

Figure 3.1
Side Draft 1 Flow Rate Measurements – March 16th, 2016
Heat 71071796

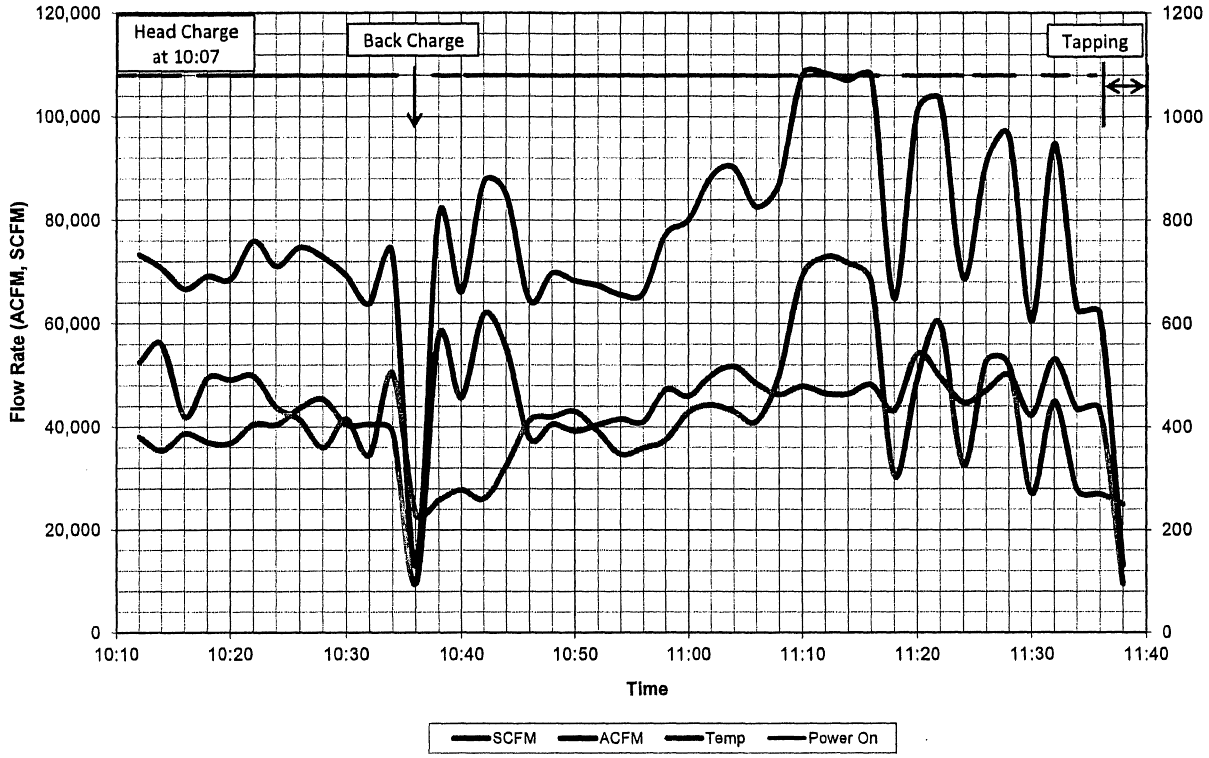

Figure 3.2
Side Draft 1 Flow Rate Measurements – March 17th, 2016
Heat 71071805

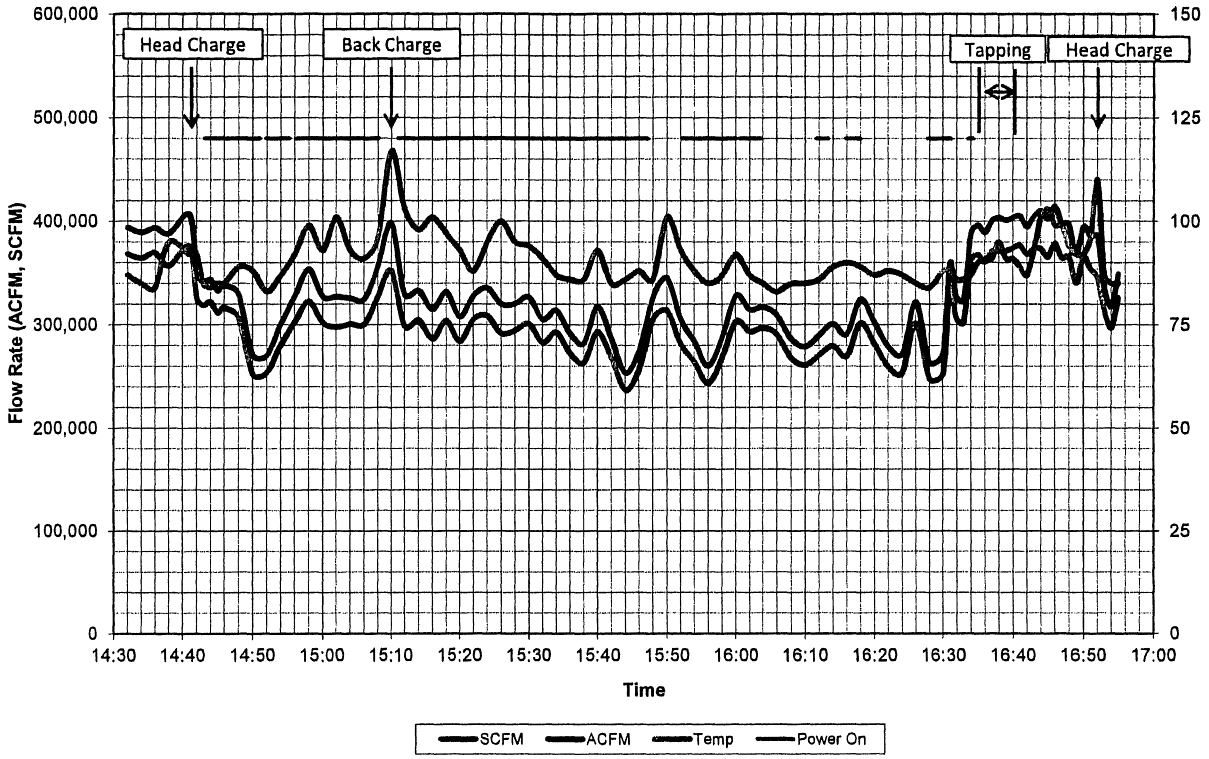

Figure 3.3
Canopy 1 Flow Rate Measurements – March 16th, 2016
Heat 71071796

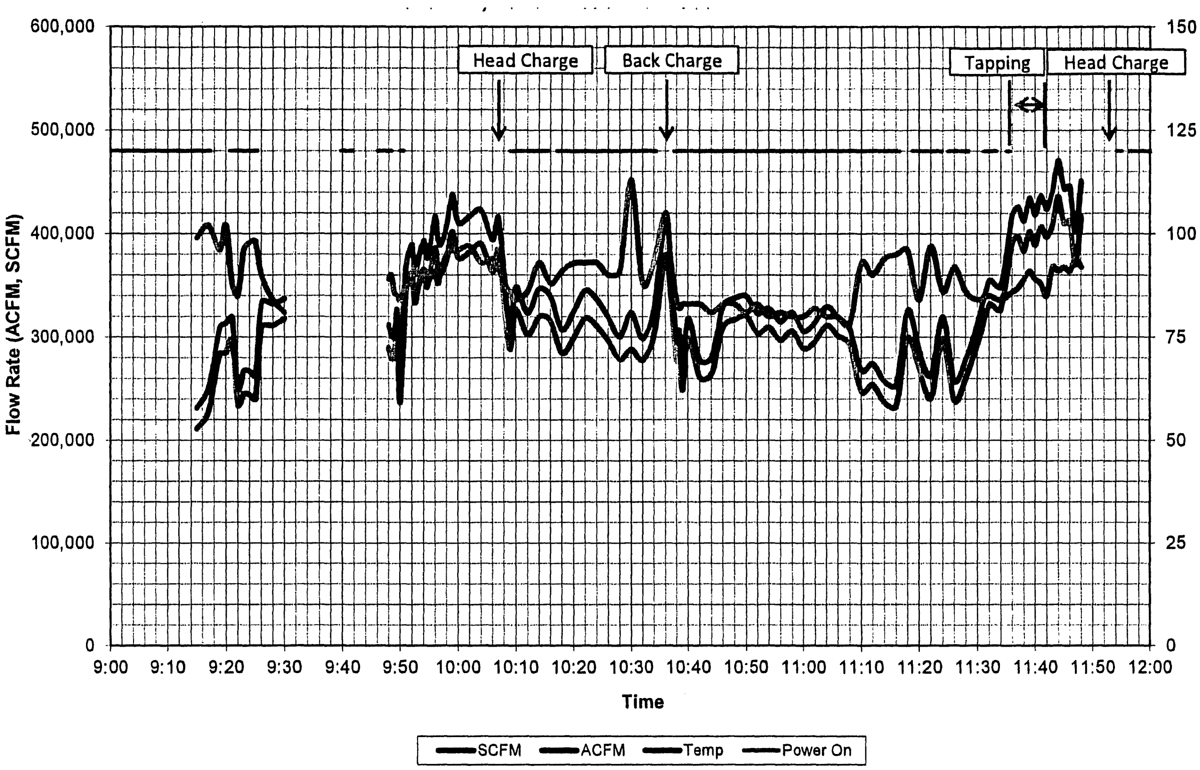

Figure 3.4
Canopy 1 Flow Rate Measurements – March 17th, 2016
Heat 71071805

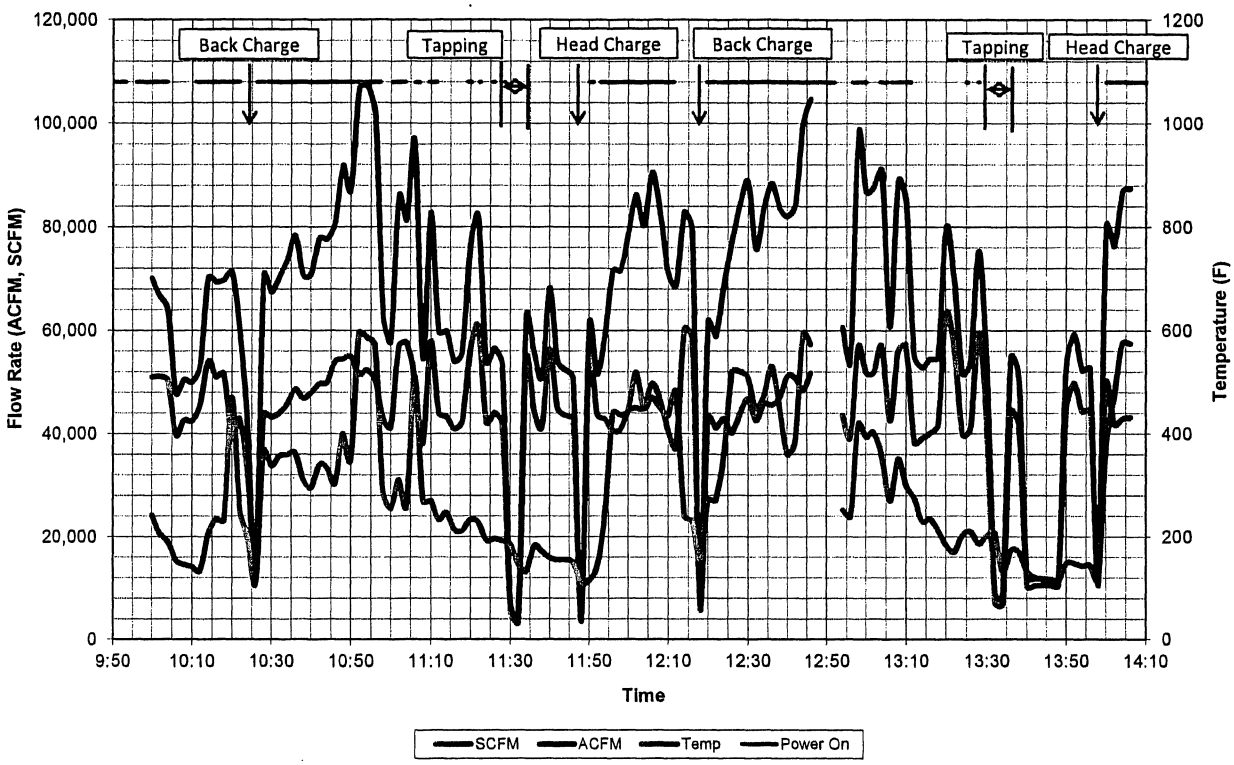

Figure 3.5
Side Draft 2 Flow Rate Measurements – March 16th, 2016
Heat 72068612 and 72068613

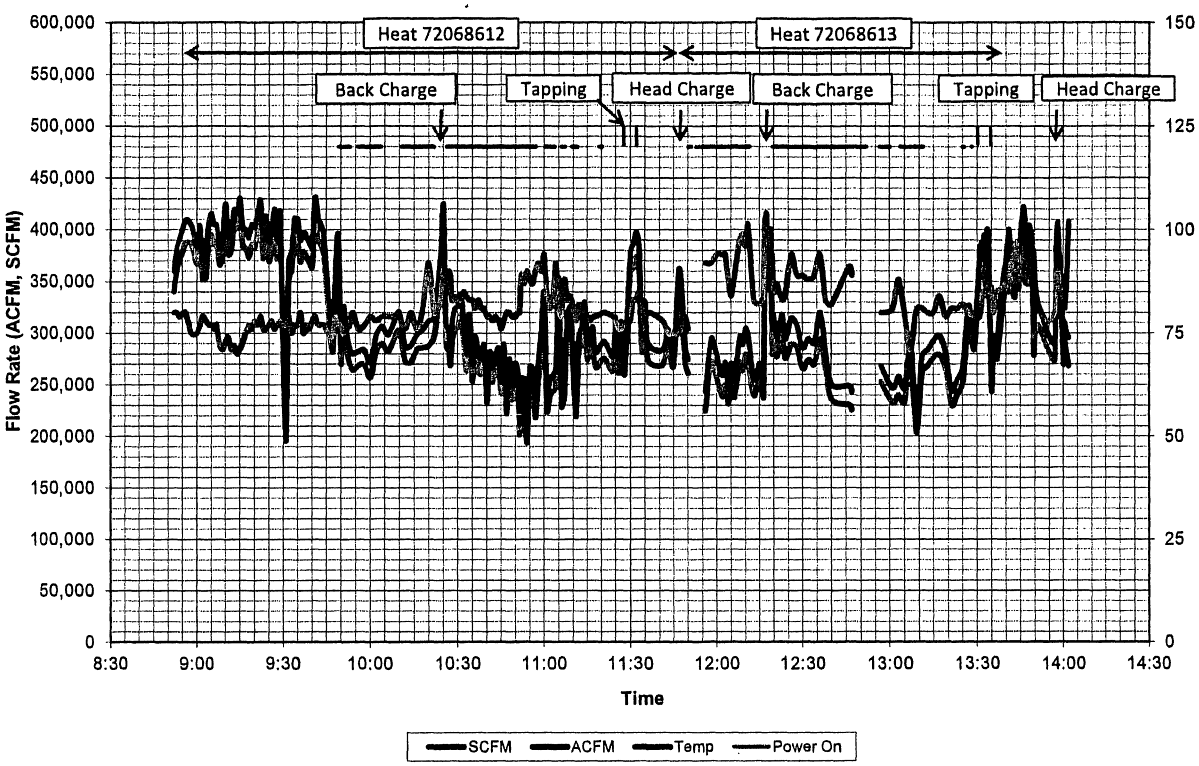

Figure 3.6
Canopy 2 Flow Rate Measurements – March 16th, 2016
Heat 72068612 and 72068613

3.2 Measurement Comparison

Table 3.5 below compares the measurements taken in 2010 versus the December 2015 and March 2016 measurements at the side draft ducts. As shown, the side draft measurements are largely unchanged from the December measurements. Since the side draft set-point was not changed following the December site visit, this outcome is to be expected.

Table 3.5
Side Draft Flow Rate Measurement Comparison – July 2010 vs. December 2015 & March 2016

Location	Mode	Unit	July 16, 2010	Dec. 2015	Change from 2010	March 2016	Change from 2010	Change from 2015
Side Draft #1	Melting	ACFM	80,400	75,400	-6%	77,500	-4%	3%
		SCFM	44,100	45,100	2%	43,100	-2%	-4%
		°F	479	392	-	480	-	-
	Foamy Slag	ACFM	129,000	103,400	-20%	102,900	-21%	-1%
		SCFM	70,500	51,900	-26%	46,500	-34%	-10%
		°F	468	560	-	673	-	-
Side Draft #2	Melting	ACFM	87,500	74,700	-15%	74,900	-14%	<1%
		SCFM	60,500	44,600	-26%	47,300	-22%	6%
		°F	278	385	-	350	-	-
	Foamy Slag	ACFM	155,800	100,600	-35%	103,900	-33%	3%
		SCFM	88,900	51,100	-43%	50,800	-42%	-1%
		°F	430	544	-	584	-	-

Gerdau personnel indicated that the side draft damper positions were adjusted over time after the system was commissioned in 2010 to reduce EAF draft as the higher draft was leading to elevated CO levels, increased furnace and ductwork wear, and increased EAF electrode consumption.

Table 3.6 compares the March 2016 canopy hood measurements against the previous measurements. Note that tapping measurements from 2010 were not available. As shown, the canopy hood exhaust rate during charging and tapping has increased significantly since December 2015. Based on GCT's evaluation, the previously identified damper control issues have been rectified and the canopy hood dampers are now in the correct positions during the full charging and tapping cycle. Although, the canopy hood exhaust rates are still below the original design value of 481,000 ACFM, additional tuning of the damper control logic is expected to allow the canopy hoods to achieve the design exhaust rate during charging and tapping operations.

Table 3.6
Canopy Flow Rate Measurement Comparison – July 2010 vs. December 2015 and March 2016

Location	EAF Mode	Unit	July 16, 2010	Dec. 2015	Change from 2010	Mar. 2016	Change from 2010	Change from 2015
Canopy #1	Melting / Foamy Slag	ACFM	278,600	254,900	-9%	298,300	7%	15%
		SCFM	244,600	234,600	-4%	276,500	13%	15%
		°F	118	94	-	90	-	-
	Charging	ACFM	472,400	333,100	-29%	405,600	-14%	22%
		SCFM	410,300	306,000	-25%	371,400	-9%	21%
		°F	128	97	-	98	-	-
	Tapping	ACFM	-	300,900	-	404,700	-	34%
		SCFM	-	282,200	-	375,200	-	33%
		°F	-	83	-	91	-	-
Canopy #2	Melting / Foamy Slag	ACFM	247,000	262,500	6%	264,900	8%	1%
		SCFM	219,100	242,300	11%	247,100	13%	2%
		°F	113	93	-	87	-	-
	Charging	ACFM	377,200	331,700	-12%	393,700	4%	19%
		SCFM	331,300	301,400	-9%	367,100	10%	22%
		°F	122	102	-	87	-	-
	Tapping	ACFM	-	353,200	-	387,300	-	10%
		SCFM	-	327,800	-	363,600	-	11%
		°F	-	90	-	84	-	-

3.3 Meltshop Ventilation Observations

3.3.1 GCT Observations

Observations collected by GCT during the March 2016 site visit are summarized below:

- The wind direction was similar to December (with winds primarily from the south and southwest). However, wind speeds were higher at 20 to 30 mph, compared to 5 to 10 mph in December.
- Meltshop Ventilation Patterns Observed
    - The caster louvers (closed during the December 2015 site visit) were open during the March site visit due to warmer weather.
    - EAF emissions escaping the side draft hood generally report to the canopy hood, however significant drift towards the caster aisle was observed during refining periods that was not present in December 2015 (Figure 3.7).
    - Since the wind direction was similar during both site visits, GCT attributes the change in shop ventilation pattern to the opening of the caster area louvers.
    - During refining operations, both the tap damper and the center damper are closed in order to increase draft to the side draft hood. This leads to a circulation pattern in the hood (shown in

    Figure 3.8) where emissions reporting to the center of the hood (the highest elevation point of the roof) are not evacuated and settle on the tapping side of the aisle. Opening the center hood damper rather than the charge damper during this period may improve emissions capture by the canopy hood.

  - Tapping emission patterns were similar to those in December
    - Emissions tend to drift towards the caster area when viewed from the operating floor.
    - When observed from the caster area, tapping emissions appear to lose buoyancy as they drift towards the caster and generally report to the caster deck area rather than directly to the roof vent.
- Caster Area Shop Ventilation
  - In March, Melting / Refining emissions appeared to contribute to the haze over the caster during operation. This was a significant change from December when melting emissions reported to the canopy and minimal drift was observed.
  - As observed in December, continuous emissions were generated from the ladles at the caster that report to the caster roof vent during the March site visit. As shown in Figure 3.9, a haze over the caster was present on March 15th, following shutdown of the EAFs for maintenance, indicating emissions from the caster contribute significantly to the haze in the aisle.
  - When operating, emissions generated at caster mix with other emissions sources in the caster area and are not distinguishable from EAF emissions.

As noted in the December report, the general ventilation pattern of the building forces any dust generated to migrate towards the caster area. However, this dust does not appear to report directly to the caster roof vent. Rather the dust comingles with other emission sources and appears to accumulate near the caster deck. GCT could not distinguish between emissions generated at the caster from other emission sources at the roof vent elevation, however the caster does appear to contribute significantly towards the white haze that accumulates in the caster roof trusses.

Figure 3.7
Emissions Drift from EAF Aisle
3/17/2016 9:09 AM (EAF#1 Refining / EAF#2 Melting Head Charge)

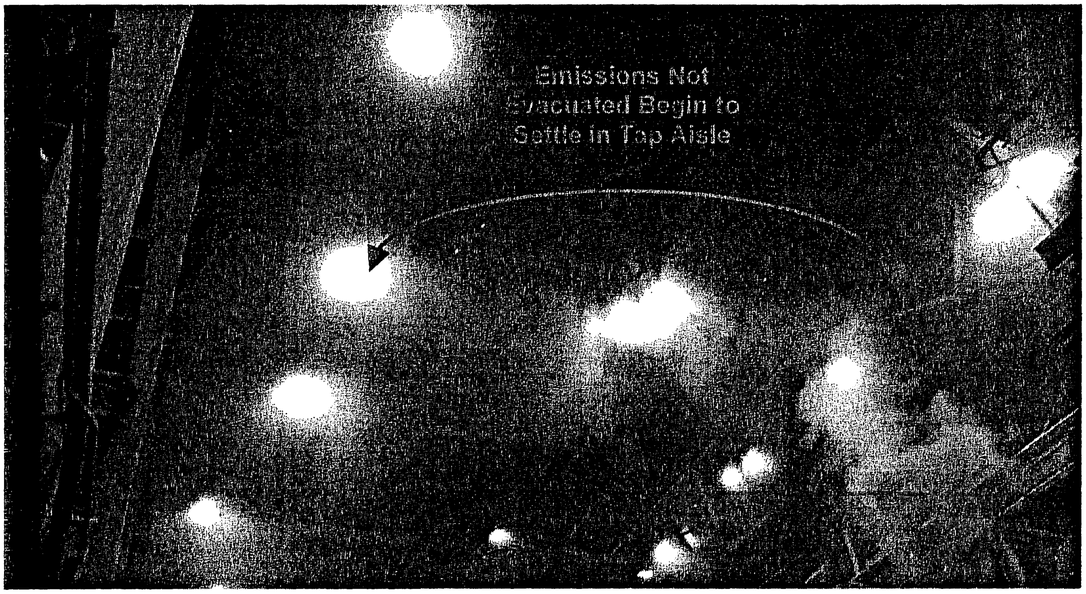

Figure 3.8
Canopy 1 Emission Pattern – Tap and Center Damper Closed
3/17/2016 9:39 AM (EAF#1 End of Melt / EAF#2 Melting Back Charge)

Emissions Generated at Caster

Figure 3.9
Emissions Generated at Caster (Above) / View of Inactive EAFs
3/15/2016 11:06 AM

3.3.2 Evaluation of Method 9 Periods

Gerdau collected Method 9 readings for (3) – 1-hour periods during GCT's site visit. During the period the readings were collected, there were two instances in which the caster roof monitor exceeded 6% opacity on a

6-minute average. GCT analyzed the collected video from these periods along with the logged operating data to determine the operating conditions that occurred during these two periods.

The first high reading occurred on March 16 from approximately 11:14 to 11:18. During this period, EAF# 1 was melting the head charge, while EAF #2 was near the end of melting the back charge (in "hold fire" mode).

Figure 3.10 shows a capture from the video taken of the area above the transformer vault. As shown, emission drift from the EAF aisle to the caster aisle was occurring during this period. Analysis of the EAF video shows generally poor capture by the side draft hoods during this period, with high emissions to the canopy hood. Due to the ventilation patterns in the shop, some emissions that escape the side draft hoods drift to the caster aisle.

The video also shows significant emissions being generated at the caster during this period from what appears to be the tundish area. A ladle change at the caster was also completed just prior to this period. GCT could not determine whether the high opacity at the roof vent is attributable to the EAF emissions or the caster emissions during this period, however it is likely a combination of the two factors occurring simultaneously.

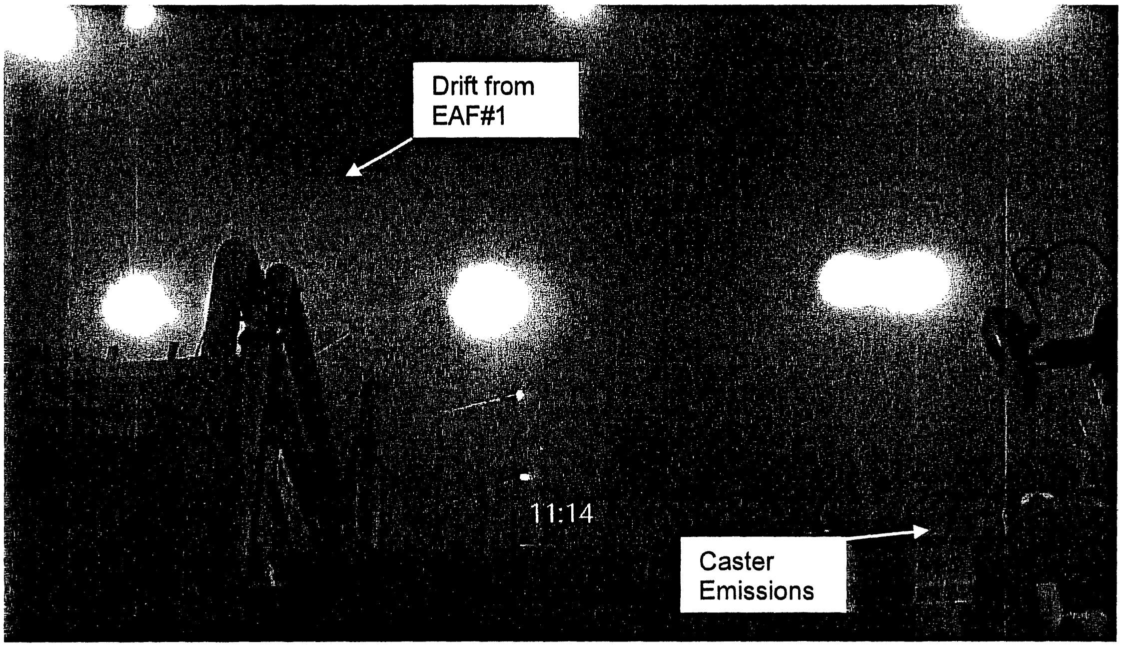

Figure 3.10
Video Still from March 16, 2016 11:14AM
EAF#1 melting head charge, EAF#2 end of melting back charge

Figure 3.11 shows a capture from the video taken of the area above the transformer vault for the second period of elevated opacity observed. During this period, EAF# 1 was melting the back charge (in "hold fire" mode, while EAF #2 was melting the head charge (a reverse of the previous period). Similar to the previous period, emissions drift from the EAF aisle to the caster aisle was occurring during this period and analysis of the EAF video shows generally poor capture by the side draft hoods during this period. During this period, significant emissions from the caster were not visible from the video. Therefore, EAF emissions could have significantly contributed to the observed periods above 6% opacity.

It should be noted that both furnaces were identified as being in "hold fire" mode during these periods. As the side draft damper positions are different in this period than the rest of the melting period, there may be an opportunity to improve capture of fugitive emissions during "hold fire" mode through further damper control modifications.

It should also be noted that other observable opacity readings that were still well below 6% opacity on a 6-minute average occurred during similar operating conditions on March 17th, and on both days during tapping.

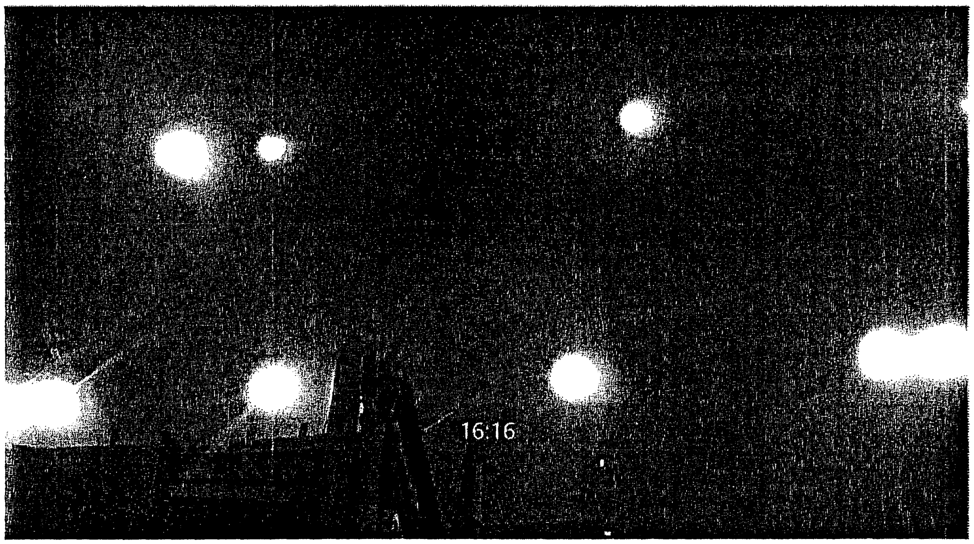

Figure 3.11
Video Still from March 16, 2016 16:16 (4:16 PM)
EAF#1 end of melting back charge / EAF#2 melting head charge

3.4 EAF Operation

GCT previously calculated the EAF off-gas conditions during each phase of operation in report T4027 dated January 29, 2016. The March operating conditions were compared to the December conditions and it was found that the peak off-gas generation rates established in December were still valid for the March operating period.

Table 3.7 summarizes the off-gas generation rates for all periods of operation.

Ck. that conc'n was w/in range

Table 3.7
Average EAF Off-Gas Generation Rates during Operating Modes

EAF Operating Mode	Flow Rate (SCFM)	Temperature (°F)	Total Heat Content (Btu/min)
Charging (at hood face)	290,000	130	322,300
Melting	8,000	2,010	350,000
Refining	9,000	3,000	733,000
Tapping (at hood face)	190,000	92	61,300

3.5 Side Draft Hood System Performance

Based on a heat and mass balance of the EAF off-gas system and the measurements collected by GCT in March 2016, GCT estimates the side draft hood systems capture approximately 80-90% of the process off-gas during melting and approximately 75-80% of the process off-gas during refining. This is consistent with the side draft performance measured in December 2015. However, as previously noted, the ventilation patterns during the March site visit led to drift of EAF emissions to the caster aisle that was not observed in December.

Increasing the side draft hood exhaust rate could improve capture of emissions at the side draft hood and reduce drift to the caster. In the previous report this was not recommended by GCT as the side draft emissions generally were collected by the canopy hood and did not appear to drift to the caster aisle. However, with the caster louvers open, additional draft to the side draft hoods may be necessary to reduce emissions drift to the caster aisle. As previously identified, opacity events were observed during operation of the furnaces in "hold fire" mode. Investigation of further damper tuning should therefore focus initially on this period in order to maximize the reduction in fugitive emissions. While optimizing the damper control logic, it will be important to ensure that the new damper set points do not increase CO emissions or reduce equipment life/reliability.

3.6 EAF Canopy Hood Performance

GCT updated the previous canopy hood analysis conducted based on the December 2015 data. An evaluation of the key canopy hood design parameters based on the updated March data and observations is summarized below.

Exhaust Rate

Table 3.9 below compares the measured canopy hood exhaust rates to the required exhaust rate calculated by GCT and the 2010 design data. Using GCT's standard analytical methods for EAF canopy hood design, GCT calculated the required exhaust flow rates for all operations based on the existing meltshop and canopy hood geometry.

As shown, the average exhaust rates measured during tapping and charging do not meet the original design exhaust rates, but do generally meet GCT's calculated requirements for the 2016 operation. As noted in the previous report, GCT's canopy hood calculation does not account for the impact of meltshop cross drafts on canopy hood capture efficiency, while the 2010 design value is based on results of CFD modeling which accounted for the impact of aisle cross drafts. The 2010 design value should therefore be considered a more robust design value than the currently calculated hood requirement and used as the basis for comparison for the current operation.

As a result of the recent damper control logic modification, exhaust rates to the canopy hood during charging and tapping have been increased significantly since December. It should be noted that peaks of up to 420,000 ACFM were measured at both Canopy 1 and Canopy 2 during charging, however this was not regularly achieved due to variations in the operations of the other furnace operation and off-gas system during charging. Additional damper logic tuning should allow the canopy hoods to achieve the design exhaust rates during all phases of operation.

Table 3.8
Canopy Hood Flow Rates

EAF Operating Phase	Unit	Current Canopy 1	Current Canopy 2	Calculated Req.[1]	2010 Design[3]
Charging	ACFM	405,600	393,700	384,000	481,000
Melting	ACFM	298,300	264,900	175,500	230,000
Tapping	ACFM	404,700	387,300	233,900[2]	481,000

Note 1: Required represents GCT hood exhaust rate requirement based on 2016 operating data and observations
Note 2: Calculation does not account for impact of cross drafts. Tapping Plume heavily influenced by shop ventilation patterns
Note 3: Design refers to 2010 design basis (refer to PFD Drawing BH-M-3058)

Evacuation Time

Evacuation time refers to the amount of time required to remove fumes from a full hood at a given exhaust rate. The evacuation time is calculated by dividing canopy volume by the exhaust rate. Evacuation times between 10 to 15 seconds maintain an appropriate balance between the hood exhaust rate and the storage volume. Evacuation times of less than 10 seconds are not disadvantageous, but times greater than 15 seconds can lead to settling and spillage of the fumes from the canopy hood even with adequate face velocities and storage volumes.

The canopy hoods each have a storage volume of approximately 52,600 ft^3. Currently, at a Canopy 1 exhaust rate of 405,600 ACFM, the evacuation time is calculated to be approximately 7.8 seconds. Additionally, at a Canopy 2 exhaust rate of 393,700 ACFM, the evacuation time is calculated to be approximately 8.0 seconds.

Face Area

The canopy hood face is the opening at the bottom of the canopy hood. This area must be large enough to physically collect the plume when it reaches the canopy hood. The minimum canopy hood face dimensions can be calculated by determining the anticipated extents of the plume at the elevation of the canopy hood face. This method is summarized in U.S. Environmental Protection Agency [EPA] Publication No. 600/7-86/016, 1986. The following assumptions were used in developing this calculation:

- Plume rises at an 18° entrainment angle from the virtual origin
- 14 ft furnace inner diameter
- 52 ft distance between the furnace and canopy hood face
- A resulting virtual plume origin distance of 72 ft. from the hood face
- Current canopy hood face of 67' x 52' (face area of 3,467 ft^2).

Based on this criteria, GCT calculates that the minimum canopy hood face requirement is approximately 24 ft. The existing canopy hood therefore meets and exceeds this requirement, indicating that the hood face is sized appropriately to capture EAF emissions. It should be noted that this approach does not account for the impact of cross drafts in the meltshop that will affect the trajectory of the plume as it rises to the hood face.

Face Velocity

The canopy hood face velocity is the velocity through the open face of the canopy hood. Face velocity is calculated by dividing the exhaust rate by the face area of the canopy hood. GCT recommends a canopy hood face velocity of at least 120 FPM to prevent fume stored in the canopy hood from exiting the hood. Based on the current exhaust rate of 405,600 ACFM (Canopy 1) and 393,700 ACFM (Canopy 2) the face velocity is 117 FPM (Canopy 1) and 113 FPM, slightly below what GCT typically recommends.

4. DEVELOPMENT OF MODIFICATION OPTIONS

4.1 Damper Control Modifications

Following the change to the damper control logic, the exhaust rate to the canopy hoods during charging and tapping operations has increased significantly, resulting in improved capture of EAF emissions. As previously noted, during tapping and charging operations the caster roof vent was observed to remain under 6% opacity on a 6-minute average during all (3) of the observation periods. However, based on GCT's analysis, the damper controls could be further optimized to improve capture of melting/refining emissions to reduce fugitives that report to the canopy, and to further increase the canopy hood exhaust rate during charging and tapping operations.

In order to demonstrate the approach that could be taken to optimizing the damper control logic, GCT updated the existing pressure loss model of the off-gas system to determine a preliminary side draft pressure set point that could serve as a starting point towards improving side draft capture. The pressure loss model is used to evaluate possible modifications to the damper control logic designed to improve capture of fugitive emissions. It is important to note there are multiple furnace operating modes with different pressure set points, each of which should be evaluated in more detail before selecting a final draft set-point.

The pressure loss model was developed using Applied Flow Technology's (AFT) Fathom software. Fathom uses the Newton-Raphson method to solve the fundamental equations of pipe flow that govern mass and momentum balance.

AFT Fathom assumes the fluid is incompressible, but does consider the effects of temperature on the fluid density. This means that gas handling processes in which the pressure is fairly low can be simulated quite accurately regardless of gas temperatures. Fathom is able to model the entire fume collection system, including performance of the flow control dampers and I.D. fans, and pressure loss across the baghouse, mixing box, and other equipment.

The following assumptions and considerations were made in developing the AFT Fathom model:

- Steady-state flow
- Incompressible fluid
- Constant gas composition throughout the entire model
- Fan performance predicted using the manufacturer's fan performance curves
- 10% Infiltration air introduced into the system at the I.D. fans based on GCT experience
- Gas temperature in ducts calculated based on heat balance, including dry duct heat losses to ambient air
- Model utilizes pressure loss coefficients for ductwork, dampers and other equipment based on the values published by Crane, Idelchick, and Miller
- Pressure loss coefficients for the baghouse were adjusted to allow for approximately 8 in.w.g. loss across the baghouse system during melting.
- The damper set-points were specified for the canopy hoods based on the logged data provided by Gerdau

- EAF#1 operation was modeled, as this represents the worst case for potential drift to the caster aisle due to the proximity to the caster

The model has been calibrated using the flow rate, static pressure, and temperature data collected during the March site visit. The validation modeling results are presented in Appendix C.

Table 4.1 compares the measured values at the side draft and canopy hoods against the results from the Fathom model. The model was calibrated against the EAF refining and EAF tapping measurements collected. A summary of the off-gas system conditions for each case can also be found in the Process Flow Diagrams (PFDs) shown in Appendix A.

As shown, the model results are within the ranges measured by GCT in March and the model was therefore considered to provide a good estimation of the system performance under various operating conditions.

Table 4.1

System Pressure Loss Model Calibration Results

EAF 1 Tapping - EAF 2 Melting		**Unit**	**March Measurements**	**Model Calibration**
Side Draft 1	Flow Rate	ACFM	11,028 to 12,908	7,654
	Static Pressure	inH2O	0.00 to 0.00	-0.01
Side Draft 2	Flow Rate	ACFM	53,987 to 104,731	78,840
	Static Pressure	inH2O	-1.20 to -0.43	-0.98
Canopy 1	Flow Rate	ACFM	389,365 to 403,750	422,443
	Static Pressure	inH2O	-1.15 to -0.97	-1.38
Canopy 2	Flow Rate	ACFM	216,235 to 320,171	258,215
	Static Pressure	inH2O	-1.55 to -1.05	-1.38
EAF 1 Refining - EAF 2 Charging		**Unit**	**March Measurements**	**Model Calibration**
Side Draft 1	Flow Rate	ACFM	107,137 to 108,406	100,457
	Static Pressure	inH2O	-1.30 to -1.15	-1.17
Side Draft 2	Flow Rate	ACFM	3,925 to 12,525	8,800
	Static Pressure	inH2O	0.00 to 0.00	-0.02
Canopy 1	Flow Rate	ACFM	253,831 to 274,255	237,342
	Static Pressure	inH2O	-1.46 to -1.33	-1.38
Canopy 2	Flow Rate	ACFM	362,749 to 423,162	422,468
	Static Pressure	inH2O	-1.64 to -0.99	-1.37

The validated model was then used to predict the damper set-points required to achieve the target hood exhaust rates during the "hold fire mode" and during charging and tapping operations to further increase the canopy hood exhaust rate. It should be noted that various operations occur when the Cojets are in "hold fire" mode, while the current damper control logic uses a single draft set-point for this mode. As an example, GCT has used the model to predict an estimated set point for the period in hold fire mode when the furnace is melting and when carbon is being injected into the EAF. A similar evaluation could be conducted for the other hold fire operating scenarios in order to develop suitable set points prior to implementing the damper control changes.

Table 4.2 below summarizes the results of the model and compares the predicted hood exhaust rates with the target values. It should be noted that the side draft hood exhaust rate was chosen to achieve an approximate capture of 90%. While higher capture by the side draft hoods is possible, GCT recommends Gerdau use this as a starting point. Following the modification, furnace electrode consumption, energy use, CO emissions, and equipment integrity should be monitored and compared against historical data to determine if higher draft to the EAF can be tolerated.

Table 4.2

System Pressure Loss Model – Optimization Results

Hold Fire Mode Optimization Example				
EAF 1 Hold Fire (Carbon Injection) EAF 2 Hold Fire (Melting)		**Unit**	**Model Result**	**Target Value**
Side Draft 1	Flow Rate	ACFM	130,300	130,000
	Static Pressure	inH2O	-2.0	-
Side Draft 2	Flow Rate	ACFM	80,300	80,000
	Static Pressure	inH2O	-1.00	-
Canopy 1	Flow Rate	ACFM	248,100	-
	Static Pressure	inH2O	-4.1	-
Canopy 2	Flow Rate	ACFM	247,500	-
	Static Pressure	inH2O	-4.1	-
Charging and Tapping Optimization				
EAF 1 Charging - EAF 2 Melting		**Unit**	**Model Result**	**Target Value**
Side Draft 1	Flow Rate	ACFM	13,000	-
	Static Pressure	inH2O	-0.03	-
Side Draft 2	Flow Rate	ACFM	80,300	80,000
	Static Pressure	inH2O	-1.02	-
Canopy 1	Flow Rate	ACFM	484,800	481,000
	Static Pressure	inH2O	-1.80	-
Canopy 2	Flow Rate	ACFM	156,400	-
	Static Pressure	inH2O	-1.81	-
EAF 1 Tapping - EAF 2 Melting		**Unit**	**Model Result**	**Target Value**
Side Draft 1	Flow Rate	ACFM	8,800	-
	Static Pressure	inH2O	-0.02	-
Side Draft 2	Flow Rate	ACFM	80,300	80,000
	Static Pressure	inH2O	-1.00	-
Canopy 1	Flow Rate	ACFM	485,200	481,000
	Static Pressure	inH2O	-1.80	-
Canopy 2	Flow Rate	ACFM	180,700	-
	Static Pressure	inH2O	-1.80	-

Table 4.3 presents the example damper logic changes developed to achieve the above hood exhaust rates shown above. Values shown in red have been modified from the current operating modes. A key change to note in the damper control logic is that the Charge Damper was closed during melting/refining instead of the center damper. GCT anticipates that this will improve capture of emissions that report to the canopy hood, and reduce the tendency of the emissions to settle on the tap side of the hood. In addition, this allows the center damper to be partially closed in order to increase draft to the side draft hoods when required. Based on the modeling results and GCT's observations, without implementing this modification, draft to the side draft hood is limited as the side draft hood damper is already nearly fully open during the refining period. These set points serve as a starting point from which further optimization of the side draft capture efficiency can be conducted.

Table 4.3
Preliminary Recommended Canopy Hood Damper Positions

#1 FURNACE							
MODE No.	Furnace Cojet Mode	Baghouse Mode	Side Draft Damper	Side Draft DP Setting	Charge Damper (east)	Tap Damper (west)	Center Damper
1	HOLD FIRE	HEATING	D.P. Controlled	**1.0 - 2.0**	**Varied**	**Varied**	**Varied**
2	CHARGE FIRE	CHARGE	15%	None	OPEN	OPEN	100%
3	HOT FIRE 1	HEATING	D.P. Controlled	0.80	**CLOSED**	CLOSED	**75%**
4	HOT FIRE 2	HEATING	D.P. Controlled	0.80	**CLOSED**	CLOSED	**75%**
5	HOT FIRE 3	HEATING	D.P. Controlled	0.90	**CLOSED**	CLOSED	**75%**
6	LANCE 1	HEATING	D.P. Controlled	0.90	**CLOSED**	CLOSED	**75%**
7	LANCE 2	HEATING	D.P. Controlled	1.00	**CLOSED**	CLOSED	**75%**
8	LANCE 3	SLAGGING	D.P. Controlled	3.0	**CLOSED**	CLOSED	**75%**
9	IDLE	IDLE	50%	None	OPEN	CLOSED	100%
10	TAPPING	TAPPING	15%	None	OPEN	OPEN	100%

Modification of the damper control logic can be implemented relatively quickly and is expected to result in improved shop cleanliness, reduced spillage from the canopy, and reduced fugitive emissions from the EAF aisle to the caster area. However, the building ventilation pattern promotes drift into the caster aisle and the various emissions sources are then indistinguishable. Additional modifications may therefore be required.

4.2 Equipment Modifications

GCT evaluated several options on a conceptual level to further improve capture and reduce drift in the meltshop following implementation of the revised damper control logic. The options evaluated were as follows:

- Option 1 – Larger baghouse
- Option 2 – Enlarged Canopy Hood
- Option 3 – Aisle Air Curtain

- Option 4 – Segregate EAF Aisle from Caster Aisle
- Option 5 – Meltshop Wall Fans
- Option 6 – Enclose Caster Roof Vent and Ventilate with Baghouse

4.2.1 Equipment Modification Option 1 – Larger Baghouse

For this option, the size of the baghouse would be increased in order to increase the canopy hood exhaust rate and improve collection of fugitive emissions. Since the existing baghouse system is limited in fan capacity and the baghouse is currently operating at the maximum recommended air-cloth ratio, a new baghouse or additional baghouse compartments would be required. New I.D. fans would also be required to provide additional draft to the system and new ductwork would be required to maintain acceptable gas velocities in the off-gas system at the new higher flow rate.

While this option would result in improved shop cleanliness and reduced meltshop temperatures, this option would not reduce cross drafts in the shop and therefore is not expected to address the current performance issue, i.e. reduction in drift to the caster aisle. Since this option would not achieve the objectives of this study, GCT dismissed this option.

4.2.2 Equipment Modification Option 2 – Enlarged Canopy Hood

For this option, the canopy hood would be modified to better collect fugitive emissions and reduce the chance of drift to the caster aisle.

Three modifications to the canopy hood were explored:

1. Lowering the canopy hood face
2. Enlarging the canopy hood face
3. Installing a doghouse on the roof to increase the storage volume of the hood

Based on GCT's evaluation, the bottom of roof truss (current hood face) is approximately 3" above the top of crane. Therefore, the face of the hood is already at the lowest practical elevation and lowering the hood face further was not a feasible option.

The second modification of enlarging the canopy hood face would effectively increase the storage volume of hood. This would improve capture if the hood was currently overwhelmed with emissions, however this was not the case based on GCT observations. A larger hood face would also reduce the canopy hood face velocity below recommended levels, increasing the potential for spillage from hood and drift into the caster aisle. In addition, emissions that drift due to the shop ventilation patterns would still miss the face of an enlarged canopy hood. Therefore, GCT deemed this option infeasible as it would not address the objectives of this study and may actually increase the chance of spillage from the hood due to reduced hood face velocity.

Similar to the option of enlarging the canopy hood face, a doghouse would improve capture if the hood was currently overwhelmed with emissions, but would not improve capture of emissions that miss the canopy hood due to shop cross drafts.

Since none of the three possible canopy hood configuration modifications would achieve the project objectives, GCT dismissed the option of modifying the canopy hood as ineffective.

4.2.3 Equipment Modification Option 3 – Aisle Air Curtain

In a previous study, GCT recommended the option of an air curtain located over the EAF#1 transformer vault. The air curtain concept was recommended to reduce the drift of emissions to the operations area of the caster and improve the visibility on the caster deck.

Air curtains are normally used to locally influence air flow patterns, rather than to influence the air flow pattern over a large area like the boundary between the EAF and caster aisle. Applications are typically limited to an opening height of less than 20' to maintain practical air velocities at the air curtain blower slot.

To effectively form a barrier between the EAF aisle and the caster aisle, the aisle width of 90' would need to be covered, at a throw distance of approximately 80' from the roof truss to meltshop floor.

This would require a large air flow rate that would likely negatively impact air flow patterns in the area. In addition, the high air velocity near the roof truss could have negative impacts on equipment and ladles as they pass under the air curtain.

Due to the large area that would need to be covered, the high air flow rate, and uncertain effectiveness of this option, GCT deemed this option as infeasible.

4.2.4 Equipment Modification Option 4 – Segregate EAF Aisle from Caster Aisle

In this option, the meltshop configuration would be modified to isolate the EAF aisle from the Caster. In order to implement this option, the following modifications, at a minimum, would be required:

1. Install new aisle sheeting to isolate EAF aisle from Caster aisle
2. Install a roll up door to allow crane and equipment to pass when required
3. Relocate the ladle preheaters (future location unclear, may not be feasible)
4. Install ladle car to transfer ladle to LMF and caster
5. Install a new aisle crane to maintain current operational flexibility and a backup crane

Figure 4.1 shows a conceptual location of the proposed meltshop partition, while Figure 4.2 shows a concept of the roll up door configuration.

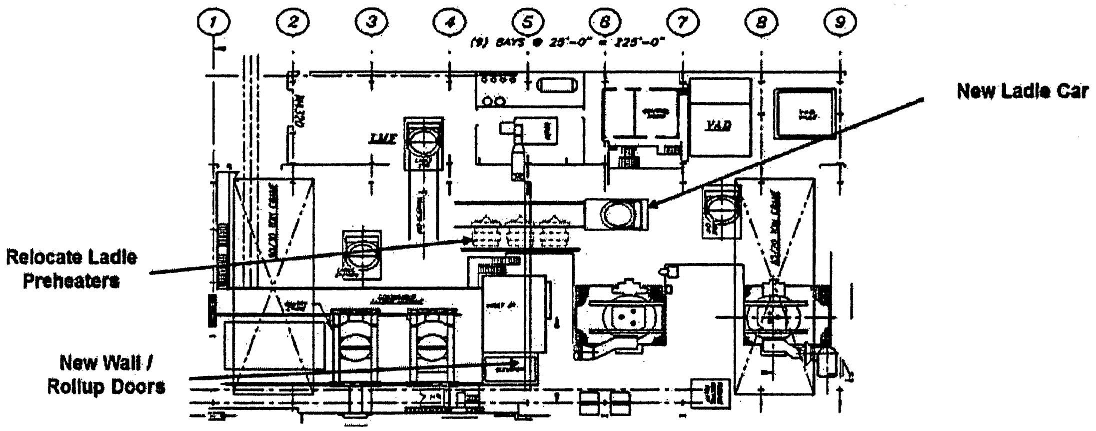

Figure 4.1
Meltshop Partition Concept

Figure 4.2
Meltshop Roll Up Door Concept

While this arrangement has been successfully used in other meltshops, these shops generally have a larger / more optimized overall footprint than the Gerdau meltshop. In Gerdau's case, on the conceptual level, this configuration is not feasible. Separating the aisle would also lead to several configuration and operational issues. A more detailed operability study would be required to fully define these, however at the conceptual level, the following issues are anticipated:

- Due to the close proximity of the EAF transformer vault to the caster, there is limited space to locate the partition while still maintaining crane access to the EAF and caster. It is unclear if there is sufficient clearance to allow a ladle to be picked from the new ladle car, without affecting the existing LMF ladle car.
- In order to install the ladle car, the ladle preheaters would need to be relocated. There is no clear location where these could be moved that would not significantly impact operations.

- The new configuration would severely limit storage area and temporary set down area for equipment in the meltshop. Limited storage on the meltshop floor may lead to staging issues during normal operations and maintenance periods.
- Staging of ladles and the efficient transfer of ladles to the caster would be impacted and may lead to increased meltshop delays and potential quality concerns.
- Operation and maintenance of the cranes would become much more complex. Due to the spout arrangement on the EAFs, the crane is required to hold the ladle during tap. Transfer of ladles and other crane activities would therefore not be possible in the EAF aisle during tapping unless a third crane was installed. Even with a third crane, due to clearance issues with the new partition, ladles would not be able to be transferred to or from the ladle car during tapping.
- Reducing the EAF aisle footprint may lead to an increase in noise levels in the shop.

Based on the above evaluation, GCT deemed this option infeasible at the current level of study.

4.2.5 Equipment Modification Option 5 – Meltshop Wall Fans

In this option, the existing louvers on the south, southeast, and southwest sides of the caster aisle would be removed and sheeting installed to permanently close the current openings. New wall fans would be installed on the south and southeast sides of the building to provide cool air to the caster operators. By eliminating the louvers, and sizing the wall fans to provide the 120,000 ACFM of makeup air that was measured exiting the caster roof vent, the shop ventilation pattern should be altered to reduce drift towards the caster. This option has the added advantage of potentially reducing caster area temperatures in the summer, however this may mean temperatures at the caster are reduced in the winter as well. Figure 4.3 shows the location of the louvers on the caster aisle.

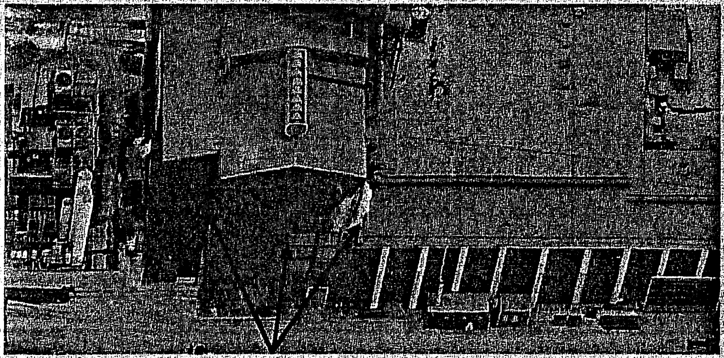

Figure 4.3
Location of Caster Aisle Louvers

Based on observations collected by GCT in December and March and Gerdau's observations in February, cross drafts are significantly reduced when the caster louvers are closed. This modification should further reduce aisle cross drafts by providing additional makeup air to reduce the draw of the caster roof vent from the EAF aisle and minimize drift of EAF emissions to the caster aisle. However, without modeling or testing, the impact of this modification is difficult to quantify. GCT would recommend that the location of the fans be optimized using CFD modeling to maximize cooling to the caster deck while also minimizing shop cross drafts.

At a conceptual level, this option would involve removing the louvers, installing new sheeting, and installing new wall fans.

4.2.6 Equipment Modification Option 6 – Enclose Caster Roof Vent and Ventilate with Baghouse

For this option, the caster roof vent would be enclosed and ventilated to a baghouse. This option eliminates the possibility of high opacity at the roof vent, as the entire building would be enclosed and ventilated to a pollution control system.

When enclosing the roof vent, GCT would recommend that the existing roof ventilation rate of 120,000 ACFM be maintained to avoid an increase in the ambient temperatures within the shop or a reduction in meltshop hygiene.

GCT evaluated several options to ventilate the caster roof vent, including:

- Ventilating with the existing baghouse
- Ventilating with any expanded baghouse
- Ventilating with a new baghouse
- Ventilating with modular filter units

Based on GCT's analysis, the existing baghouse is at capacity and tying in the caster roof vent to the existing baghouse would significantly reduce the EAF canopy hood exhaust rate and therefore would not be recommended.

Expanding the existing baghouse is a feasible option, however since the existing off-gas system is at capacity, installation of new I.D. fans and ductwork would also be required. Based on GCT's estimate, the modifications required to implement this option could quickly exceed the cost of installing a new baghouse. Therefore, this option is also not recommended.

Ventilating the caster roof vent with a new baghouse or modular filter unit is therefore the preferred method for enclosing the caster roof vent. Based on GCT's further analysis, utilization of modular filter units can provide the same performance as a traditional baghouse, however at a lower cost and, due to the modular nature of the units, offers a potentially simpler design and installation.

Figure 4.4 shows an example of a modular filter unit. Modular filter units are a proven solution for controlling fugitive emissions from metallurgical facilities to control roofline emissions from the teeming aisle. At Gerdau Jackson, (3) units sized at 50,000 ACFM each would meet requirement to ventilate the caster roof vent. The units are equipped with integral fans and stacks to simplify installation. New ductwork would be required to connect the units to the roof, and a new dust handling system would be required to handle the particulate collected by the filters.

At the conceptual level, GCT estimates the project CAPEX for this option to be approximately $2,400,000.

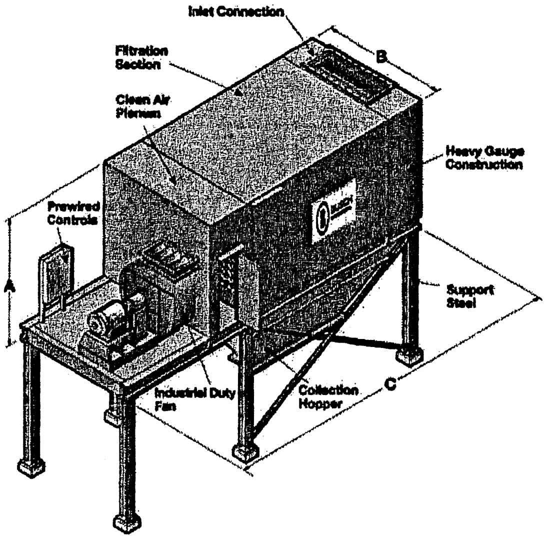

Figure 4.4
Example of Modular Filter Unit (Busch FEF Series)

4.3 Option Comparison and Path Forward

Table 4.4 compares the various options presented to improve capture of EAF emissions and reduce drift to the caster aisle.

As shown, the easiest option to implement is to further refine the damper control logic to improve capture of melting and refining emissions by the side draft hood, and tapping emissions at the canopy hood. Since this option will not lead to reduced cross drafts in the meltshop, there may still be conditions in which unacceptable drift to the caster aisle occurs. However, since this option is relatively easy to implement, GCT recommends Gerdau pursue this option prior to proceeding with further evaluation of the equipment modification options.

If, after further tuning of the dampers, drift to the caster aisle is still a concern, GCT recommends Gerdau further evaluate the option of closing the caster area louvers and installing wall ventilation fans (Option 5). This option could significantly reduce cross drafts in the EAF aisle and minimize drift to the caster aisle while improving working conditions at the caster. If this option is pursued, GCT would recommend the next step is to conduct CFD modeling to optimize the location of the fans and more definitively quantify the effects of the modifications on aisle cross drafts.

While Option 6 would definitively eliminate the possibility of elevated opacity at the caster roof vent, this option requires a major investment in new equipment as well as new ongoing operating and maintenance commitments. GCT therefore recommends the previous options be evaluated fully prior to proceeding to Option 6. Since modification of the damper control logic and the closure of the louver dampers would be recommended even if enclosure of the roof vent is completed, these are the logical next steps and, following implementation, it may be concluded that no further modifications are required to comply with current building opacity regulations.

Table 4.4
Option Comparison Summary

Option	Damper Control Improvements	Equipment Modification Options					
		1 - Larger Baghouse	2 - Enlarge Canopy Hood	3 - Aisle Air Curtain	4 - Aisle Segregation	5 - Meltshop Wall Fans	6 - Caster Roof Vent Enclosure
Feasible & Effective	Feasible, Effective under some conditions	Not Effective	Not Effective	Not Feasible	Not Feasible	Feasible, effectiveness to be verified by modeling	Yes
Advantages	- Can be immediately implemented	N/A	N/A	N/A	- Highly effective - Improved conditions at caster deck	- Possible improvement in summer caster area temps.	- Highly effective - No interference w/ operations - Maintain existing ventilation rate
Disadvantages	- May not be effective for all wind conditions - Still cannot distinguish caster from EAF emissions	N/A	N/A	N/A	- Does not appear design could be integrated into existing shop - Major interference w/ operations	- May not be effective for all wind conditions - Still cannot distinguish caster from EAF emissions - May result in cold conditions at caster in winter	- - No improvement in conditions at caster deck - Additional equipment maintenance