Ontario

[DRAFT] Rationale Document for a Proposed Mini Mills Industry Standard under Ontario's Local Air Quality Regulation

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EXECUTIVE SUMMARY

In 2011, the Ministry of the Environment (now the Ministry of Environment and Climate Change or the ministry) introduced new/updated standards for eight contaminants which will take effect on July 1, 2016 [see EBR 010-7190] including chromium and chromium compounds (hexavalent), chromium and chromium compounds (metallic, divalent and trivalent), dioxins, furans and dioxin-like PCBs, manganese and manganese compounds, and nickel and nickel compounds.

On July 18, 2013, representatives of some integrated and non-integrated iron and steel mills in Ontario requested to work collaboratively with the ministry to develop a technical standard under Ontario's Local Air Quality Regulation (O. Reg. 419/05) for iron and steel mills and ferro-alloy manufacturing sector (NAICS code 331110) including integrated and non-integrated steel mills[i].

A response letter[ii] for this request was sent on September 12, 2013. This letter clarified that the ministry has already been working with the integrated steel mills to develop a proposed technical standard to address benzene and benzo[a]pyrene air standards. These standards came into effect on July 1, 2016. Therefore, the focus of this document is on developing a proposed technical standard for non-integrated iron and steel mills (Mini Mills).

As set out in the Regulation[iii], the Minister has the authority to establish two types of technical standards: an Industry Standard (based on one industry sector) and an Equipment Standard (for sources or emissions from multiple sectors).

A technical standard is a technology-based solution designed for two or more facilities in a sector that may not be able to meet an air standard due to technical or economic limitations. This approach can include technology, operation, monitoring and reporting requirements. Once established, any facility in the sector (that may or may not meet the air standard), may request to be registered under the technical standard. Technical standards can be used to manage air emissions for multiple facilities within one or more sectors and can include a wide range of contaminants.

1.0 INTRODUCTION

Ontario protects air quality through a comprehensive air management framework that includes regulations, targeted programs and partnerships with other jurisdictions to address sources of air pollution. Ontario's local air quality regulation (O. Reg. 419/05: Air Pollution – Local Air Quality herein "Regulation") works within the province's air management framework by regulating air contaminants released into communities by various sources, including local industrial and commercial facilities. The regulation aims to limit exposure to substances released into air that can affect human health and the environment, while allowing industry to operate responsibly under a set of rules that are publicly transparent.

1.1 Background

Under the regulation, industry can implement one of three compliance approaches, each designed to manage the risks associated with a facility's air emissions:

- Meet the provincial air standard;
- Request and meet a site-specific standard; or
- Register and meet the requirements under a technical standard (if available).

All three approaches are allowable under the regulation.

All industrial and commercial facilities must comply with the local air quality regulation. Air standards are a key part of the regulation. They are used to evaluate the contribution of a contaminant to air from a regulated facility. New or updated air standards are phased in to give industry reasonable time to plan to meet them or to request another compliance approach (i.e. through a site-specific standard or sector-based technical standard).

Since the provincial air standards are set based on science, they may not be achievable by a facility or a sector due to unique technical or economic limitations. Rather than making the air standard less stringent, the regulation allows facilities or sectors to exceed the air standard as long as they are working to reduce their air emissions as much as possible with technology-based solutions and best practices. The ministry closely oversees their progress using a framework for managing risk that was developed in cooperation with public health units in Ontario and other stakeholders. Some facilities may never meet the air standard and instead will be regulated under one of the other compliance approaches.

1.2 The Technical Standard Compliance Approach

A technical standard is a technology-based solution designed for two or more facilities in a sector that are not able to meet an air standard due to technical or economic limitations. This approach can include technology, operation, monitoring and reporting requirements that are relevant to day-to-day activities at a facility. Once the technical standard is published, any facility in the sector (that may or may not meet the air standard) may apply to be registered under this compliance approach. Such registration would involve a posting on the Environmental Registry and may involve a public meeting. The goal is to have a more efficient tool to better manage air emissions in the sector and reduce overall exposure from various industrial and commercial facilities.

The technical standards are published under the authority of section 38 of the Regulation. The technical standards publication specifies the classes of facilities and the contaminants the technical standard applies to and the steps and time periods for compliance. A facility may be registered for an industry standard, an equipment standard or a combination of industry standards and equipment standards.

There are two types of technical standards under the Regulation: industry standards that regulate all sources of specified contaminants within an industry sector and equipment standards that address a specific type of equipment or source of contaminant, but may apply to one or multiple industry sectors.

If the technical standards published address all sources of a contaminant from a facility, then, the registered facility is exempt from the relevant air standard and instead must abide by the requirements of the technical standard. If the published technical standards do not address all sources of a contaminant from a facility, then only certain sources of the contaminant may be excluded from the Emission Summary and Dispersion Modelling (ESDM) report. A facility can also choose the contaminants for which it would like to register. A facility must comply with the relevant air standards for the contaminants emitted by the facility excluded from the technical standard, as well as with the relevant air standards for the contaminants within a technical standard that were not registered for by the facility.

In the development of a technical standard, the ministry assesses all sources of a contaminant related to a North American Industry Classification System (NAICS) code and makes a decision as to whether or not that source needs to be better controlled, monitored or managed. Development of a technical standard includes a better understanding of sources of the contaminant for that sector, benchmarking technology to address the sources of a contaminant and consideration of economic issues. Specific requirements are included in the technical standard for those major sources that are determined to need better management or control. Timeframes are also specified for implementation of the requirements.

In 2011, the ministry introduced new or updated air standards for nine contaminants. The nine new or updated air standards outlined in Table 1 took effect on July 1, 2016. All pathways are equally valid compliance approaches and can lead to better management and control of air emissions from facilities.

Table 1: New or Updated Air Standards in 2016

Contaminant Name	Air Standard (1)
Benzene	0.45 μg/m^3, annual average
Benzo-a-pyrene (as a surrogate of total PAHs)	0.00001 μg/m^3, annual average
1,3-Butadiene	2 μg/m^3, annual average
Chromium and Chromium Compounds (Metallic, Divalent & Trivalent)	0.5 μg/m^3, 24-hour average
Chromium Compounds (Hexavalent)	0.00014 μg/m^3, annual average
Dioxins, Furans and Dioxin-like PCBs	0.0000001 μg/m^3, 24-hour average
Manganese and Manganese Compounds	0.4 μg/m^3, 24-hour average
Nickel and Nickel Compounds	0.04 μg/m^3, annual average
Uranium and Uranium Compound (in the PM_{10} fraction)	0.03 μg/m^3, annual average

(1) For those facilities that are not yet using new air dispersion models, the MOECC has also expressed the new standards as half hour average.

Members of Ontario's iron and steel mini mills sector have identified challenges for their facilities in meeting the new nickel and nickel compounds, manganese and manganese compounds, chromium compounds (hexavalent form), chromium compounds (metallic, divalent & trivalent forms), dioxins, furans and dioxin-like PCBs that phase-in on July 1, 2016 and the suspended particulate matter (SPM) air standards and foresee that an optional registration to a technical standard would be beneficial to the sector.

1.3 Purpose and Scope

The scope of this document was established in a Terms of Reference (ToR) for the process to develop a proposed Mini Mills technical standard. It involves the creation of a technical committee, which entails:

- Determination of dominant sources;
- Consideration of appropriate Canadian and other jurisdictional requirements such as methods and technologies to assess, reduce and control emissions from dominant sources at mini mill operations;
- Consultation and consideration of input from the sector including the Canadian Steel Producers Association (CSPA) member companies as well as interested non-member companies regarding the technical aspects and potential impacts of the proposed Mini Mills TS;
- Consultation and consideration of input from the public and other interested parties located in the communities surrounding Ontario's mini mill facilities including Indigenous communities, if applicable; and

- Development of a proposed technical standard that fosters continuous improvement, where possible and focuses on better management of emissions from Ontario's mini mill facilities and encourages new investments in mini mills infrastructure.

Table 2 sets out the scope work for this technical committee for the proposed Mini Mills TS. The scope and mandate of this proposed technical standard may be expanded based on mutual agreement between the ministry and the sector companies.

Table 2: Scope of Technical Standards for Mini Mills Sector

"IN" Scope	"OUT" of Scope
▪ Determine/confirm the NAICS code(s) that apply to the Mini Mills TS. ▪ Consideration of all air emission sources of manganese and manganese compounds as well as suspended particulate matter (SPM) from mini mills operations. Proposal will focus on emissions of SPM, manganese and manganese compounds from mini mills and has included other contaminants, i.e. chromium, dioxins, furans and dioxin-like PCBs during the course of discussions with the technical committee. ▪ Harmonization with requirements (as appropriate) for mini mills under the *Canadian Environmental Protection Act*. ▪ Assessment of applicable air pollution control and process technology options that can better manage air emissions from mini mills operations. ▪ Assessment and identification of the best available operating practices and control technologies to better manage air emissions from mini mills operations. ▪ Cost effectiveness and economic achievability, as appropriate and as identified by the sector. ▪ Engagement with local community groups and the public as appropriate.	▪ Waste and wastewater management and noise. ▪ Scope of work of the proposed technical standard for integrated iron and steel mills.

1.4 Organization of the Report

Chapter 1.0 provides background to Ontario's local air quality regulation including the three compliance pathways available to facilities along with the underpinning authority through which the ministry administers technical standards. It also outlines the purpose and scope as well as the overall organization of the report.

Chapter 2.0 provides an overview of the mini mills sector in Ontario including a general description of the mini mills processes and a summary of sources of emissions for identified contaminants in the scope of the proposed technical standard.

Chapter 3.0 summarizes includes the methodologies used to determine dominant sources for various contaminants at the mini mills facilities as well as a generic overview of the outcomes of the dominant source analysis in Ontario mini mills.

Chapter 4.0 contains the results of the jurisdictional review that has been conducted to identify the best practices and systems for the capture and control of emissions of identified contaminants in the technical standard for Ontario mini mills sector. This chapter further defines the types of technically feasible methods available to address air emissions from mini mills operations and concludes by providing a summary table of the recommended air pollution control strategy taking into consideration cost effectiveness.

Chapter 5.0 discusses the public consultation efforts which were carried out in support of a technical standard for the mini mills sector and the planned path forward taking into account stakeholder comments.

Chapter 6.0 takes into consideration the first four chapters of this report and presents the proposed structure for a technical standard for the mini mills sector. The rationale for the proposed requirements and the means of assessing continuous improvement are explored. It provides an overview on performance measures that are recommended for use by Ontario mini mills sector within the context of the proposed technical standard.

1.5 Authority

The Regulation provides authority to the Minister of the Environment and Climate Change (under the authority of section 38) to publish and amend the Technical Standards Publication entitled: “Technical Standards to Manage Air Pollution”. See sections 38 through 44 of the Regulation.

The technical standards publication specifies the classes of facilities, the contaminants the technical standard applies to and the steps and time periods for compliance. Industry standards and equipment standards are published in the document “Technical Standards to Manage Air Pollution”. This technical standards publication may be updated from time to time, based upon public consultation consistent with the Ontario Environmental Bill of Rights legislation.

Although industries participating in the technical standards may not meet certain air standards in the Regulation, they are still expected to make continual improvements to reduce air emissions to the extent that the technology and methods make this possible.

In the development of a technical standard, the ministry assesses all sources of a contaminant related to a North American Industry Classification System (NAICS) code and makes a decision as to whether or not that source needs to be better controlled, monitored or managed. Development of a technical standard includes a better understanding of sources of the contaminant for that sector, benchmarking technology to address the sources of a contaminant and consideration of economic issues. Specific requirements are included in the technical standard for those major sources that are determined to need better management or control. Timeframes are specified for implementation of the requirements.

2.0 THE IRON AND STEEL INDUSTRY IN CANADA

The Canadian steel sector comprises of 17 facilities as listed in Figure 1: Canadian steel plants by type (1996). The sector consists of five integrated mills, including QIT-Fer et Titane Inc., and 12 non-integrated mills (10 mini-mills and two specialty steel mills). Nine of these facilities, including four mini mills and four integrated mills, are located in Ontario. One mini mill in Hamilton has closed after this list was published by Environment Canada and Climate Change. There are four mills in Quebec and one each in Alberta, Saskatchewan, Manitoba, and Nova Scotia.

Plant No.	Plant Company/Name	Location	Manufacturing Process	Steel Shipments[1] (tonnes)
1	AltaSteel Ltd.	Edmonton, AB	MM	225,000[2]
2	IPSCO Inc.	Regina, SK	MM	800,000 e
3	Gerdau MRM Steel Inc.	Selkirk, MB	MM	254,000
4	Algoma Steel Inc.	Sault Ste. Marie, ON	IM	1,907,000
5	Dofasco Inc.	Hamilton, ON	IEM	3,400,000[3]
6	Stelco Inc., Hilton Works	Hamilton, ON	IM	2,672,000[4]
7	Lake Erie Steel Co. (Stelco)	Nanticoke, ON	IM	1,485,000[5]
8	Slater Steels, Specialty Bar Division	Hamilton, ON	MM	306,000
9	Gerdau Courtice Steel Inc.	Cambridge, ON	MM	250,000
10	Atlas Specialty Steels	Welland, ON	SS	200,000 e
11	Co-Steel Lasco	Whitby, ON	MM	672,000
12	Ivaco Inc.	L'Orignal, ON	MM	525,000 e
13	Ispat Sidbec Inc.	Contrecoeur, QC	DRM	1,367,000
14	Stelco-McMaster Ltée	Contrecoeur, QC	MM	417,000[6]
15	Atlas Stainless Steels	Tracy, QC	SS	73,000
16	QIT-Fer et Titane Inc.	Sorel, QC	IM	350,000 e
17	Sydney Steel Corporation	Sydney, NS	MM	137,000

Legend:
e estimated
IM Integrated Mill
IEM Integrated and Electric Arc Furnace Mill
MM Mini-Mill
DRM Direct Reduction Mini-Mill
SS Specialty Steel Mill

Figure 1: Canadian steel plants by type (1996)[iv]

Canada plays a major role in the international steel trade, exporting 5.2 million tonnes and importing 7.4 million tonnes in 1998. The United States, Canada's traditional major trade partner in steel, accounted for 88% of Canada's exports and 42% of imports in 1998. International competitiveness is a significant issue for the industry[1]. Ontario accounts for about 70% of Canadian steel capacity. In 1998, the 17 plants shipped 15.5 million tonnes of steel with a sales value of $11.2 billion and employed approximately 34,500 people.

Steelmaking is a very complex, capital and energy intensive operation involving a progression of manufacturing processes that transform raw materials into iron and steel products.

Steel is produced in Canada by two main steelmaking processes:

- BOF, Basic Oxygen Furnaces (58.5% in 1998); and
- EAF, Electric Arc Furnaces (41.5% in 1998).

The basic oxygen furnace is used in integrated mills in conjunction with coke making, sintering and blast furnace iron making operations. The integrated mills, which smelt iron ore and melt scrap, produce the greatest diversity of products including bars, rods, structural shapes, plates, sheets, pipes and tubes and wire rod. The integrated mills are gradually changing their product mix towards a greater concentration in flat-rolled products.

While electric arc furnace technology is gaining importance, it is usually used in non-integrated mills (mini-mills or specialty steel mills) fed by scrap or direct reduced iron (DRI) to produce a wide product range of carbon and alloy steels. Dofasco Inc. operates the only integrated steel plant in Canada that produces part of its steel by the electric arc furnace process. Ispat Sidbec Inc. operates the only Canadian steel mill that produces and uses DRI as part of its raw material feed[1].

Ancillary or secondary steelmaking processes that are common to both integrated and non-integrated steel making include ladle metallurgy, continuous casting, hot forming, cold forming and finishing. Three of the integrated mills have finishing operations, which may include acid pickling, pickle acid regeneration, annealing and coating. Lake Erie Steel Co. Ltd. produces hot-rolled flat product only. Two non-integrated mills (Ispat Sidbec Inc. and Atlas Stainless Steels) have some finishing operations (acid pickling, cold rolling, and annealing).

QIT-Fer et Titane Inc. was grouped with the integrated mills because it operates a basic oxygen furnace, a ladle metallurgy station and a continuous casting machine for secondary steel making. QIT-Fer et Titane Inc. also produces titanium (TiO_2) slag and high-quality pig iron from smelting calcined ilmenite ore and coal in rectangular electric arc furnaces. The iron oxide slag from the electric arc furnaces is fed to a basic oxygen furnace to produce high-quality steel billets.

The non-integrated mills or mini mills segment of the steel sector includes all facilities that use scrap steel and direct reduced iron (DRI) as raw materials to produce primary steel products. Primary steel production processes include direct iron reduction, steelmaking, hot and cold forming, coating operations and associated production and ancillary processes and facilities. It does not include pipe or tube making or steel fabricating facilities.

Ontario is a more represented province in terms of the mini mill industry. Other provinces that are home to mini mill facilities are Alberta, Saskatchewan, Manitoba, Quebec and Nova Scotia. Table 5 shows the breakdown of Canadian steel plants by different types in 1996. In 1998, the 17 plants shipped 15.5 million tonnes of steel with a sales value of $11.2 billion and employed approximately 34,500 people[v].

The North American Industry Classification System Canada 2017 (NAICS) includes mini mills under the NAICS code 331110, Iron and steel mills and ferro-alloy manufacturing[vi]. The description under NAICS is as follows "This industry comprises establishments primarily engaged in smelting iron ore and steel scrap to produce pig iron in molten or solid form; converting pig iron into steel by the removal, through combustion in furnaces, of the carbon in the iron. These establishments may cast ingots only, or also produce iron and steel basic shapes, such as plates, sheets, strips, rods and bars, and other fabricated products. Electric arc furnace mini-mills are included. Establishments primarily engaged in producing ferro-alloys are also included.".

Table 3: Canadian steel plants by type (1996)

Province	Specialty Mills	Integrated Mills	Integrated & EAF Mills	Mini Mills	Direct Reduction Mini Mills	Total
Alberta	-	-	-	1	-	1
Manitoba	-	-	-	1	-	1
Nova Scotia	-	-	-	1	-	1
Ontario	**1**	**3**	**1**	**4**	**-**	**9**
Quebec	1	1	-	1	1	4
Saskatchewan	-	-	-	1	-	1
Total	2	4	1	9	1	17

2.1 Industry Overview

Mini mills produce a variety of steel products that vary in their carbon content and in the amount and composition of alloying elements[vii]. Most of the steel produced in mini mills is carbon steel used in the manufacture of construction materials, automobiles, appliances and other applications. Approximately 4 percent (about 2 million tons) is specialty and stainless steel. Stainless and alloy steels contain less carbon and zinc and more chromium, manganese and nickel than carbon steels. Typical stainless steel grades contain 12 to 28 percent chromium and 4 to 25 percent nickel.

Sixteen substances that are released, produced or used by Canadian steel manufacturing sector were assessed as toxic under Section 11 of CEPA (1988). Those substances are: benzene, polycyclic aromatic hydrocarbons (PAHs), inorganic arsenic compounds, inorganic cadmium compounds, hexavalent chromium compounds, lead, mercury, oxidic, sulphidic and soluble, inorganic nickel compounds, inorganic fluorides, dichloromethane, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, polychlorinated biphenyls, polychlorinated dibenzodioxins (dioxins), and polychlorinated dibenzofurans (furans). Dioxins and furans have been identified as substances targeted for virtual elimination[viii].

Operational activities for mini mills are generally similar. Emissions are usually from the same sources, regardless of facility differences. There is, however, variability between some types of emissions depending on the scrap feed and emission rates which are affected by facility capacity.

To demonstrate the increase in dependence on mini mill facilities, one can observe the increase in contribution to the national steel production in the United States (US). Over the past 30 years, the production of steel from mini mills has increased dramatically. In 1970, the production was 10% of the national steel production followed by 30-40% in the 1980s, 40-50% in the 1990s to 57% in 2006. This growth can be attributed to the expansion of the types of steel produced including heavy structural shapes, rail, plate, specialty bar, hot rolled, cold rolled, galvanized and stainless flat rolled products.

In addition to the range of products that mini mills contribute to society, they are also the largest recyclers in the US. The range of scrap varies from home scrap which is from operations in the plant, prompt scrap which is from plants manufacturing steel products and post-consumer scrap which includes automobile scrap.

2.1.1 General Mini Mill Process and Components

The flow sheet provided in Figure 2 shows the emissions and their origin in mini mill facilities. In April 1995, a multi-stakeholder Strategic Options Process (SOP) was started to address these emissions and develop the recommended ways to manage them. The development of the Strategic Options Report (SOR) was released December 1997. This led to the development of an Environmental Code of Practice (CoP) which will be discussed further in this chapter.

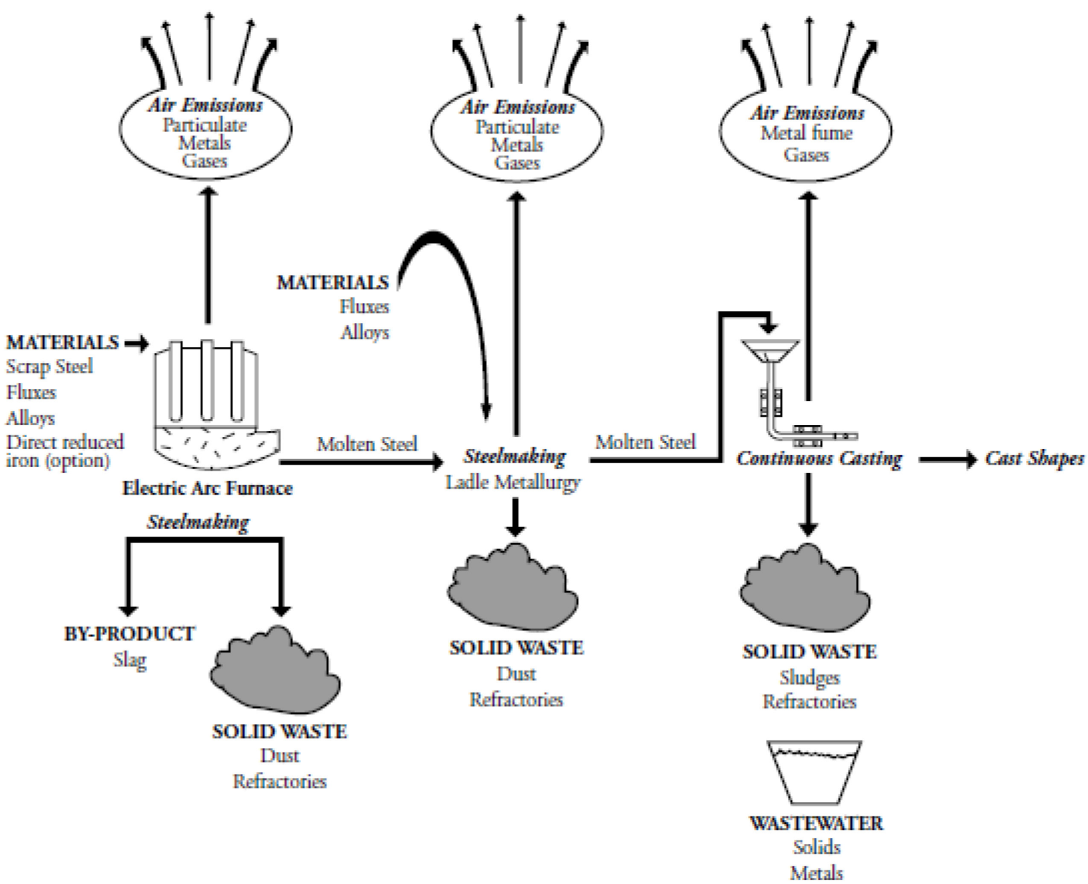

Figure 2: Simplified Non-Integrated Steel Manufacturing Flow Sheet and Emissions

Steel is produced in Canada by two main primary steel making processes. As of 1998, this included 58.5% using basic oxygen furnaces and 41.5% using electric arc furnaces. Electric arc furnaces are mainly used on mini mill facilities that are fed by scrap or direct reduced iron (DRI) to produce a wide range of carbon and alloy steel products. Ispat Sidbec Inc. was the only Canadian plant that produces DRI as part of its raw material feed.

Primary steel production processes in a mini mill include:

- Melt Shop: Electric Arc Furnace (EAF) and Ladle Refining/Metallurgy Furnace (LRF/LMF);
- Continuous Casting;
- Reheat Furnaces;
- Hot Rolling, Cold Rolling and Finishing.

Figure 3 shows a simplified process for steel manufacturing that is usually a very complex, capital and energy intensive operation. Figure 4 shows more details on the raw materials that are used, as well as the process equipment. It involves the progression of manufacturing processes that transform raw materials into iron and steel products.

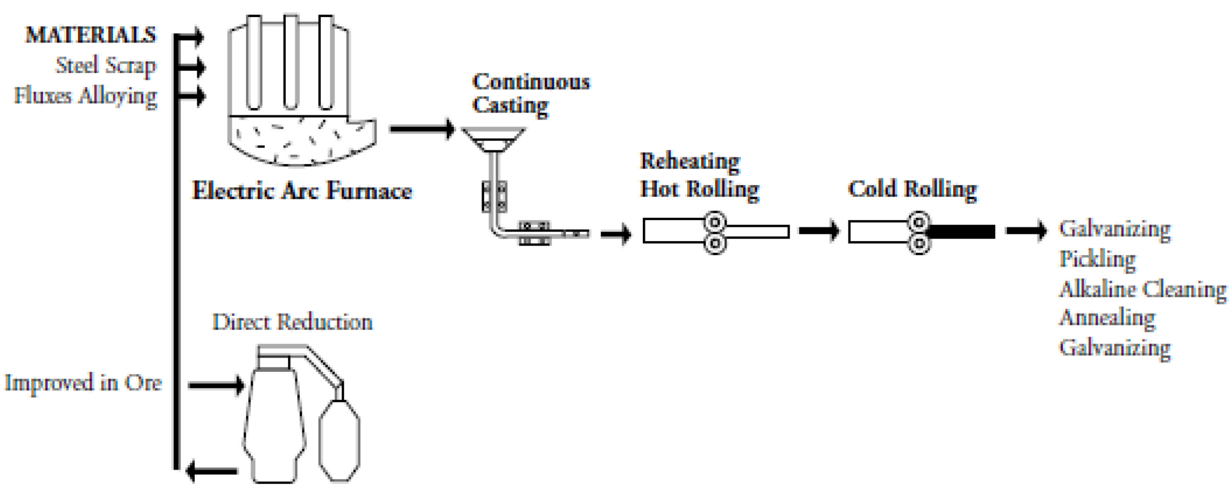

Figure 3: Simplified steel manufacturing process flow sheet

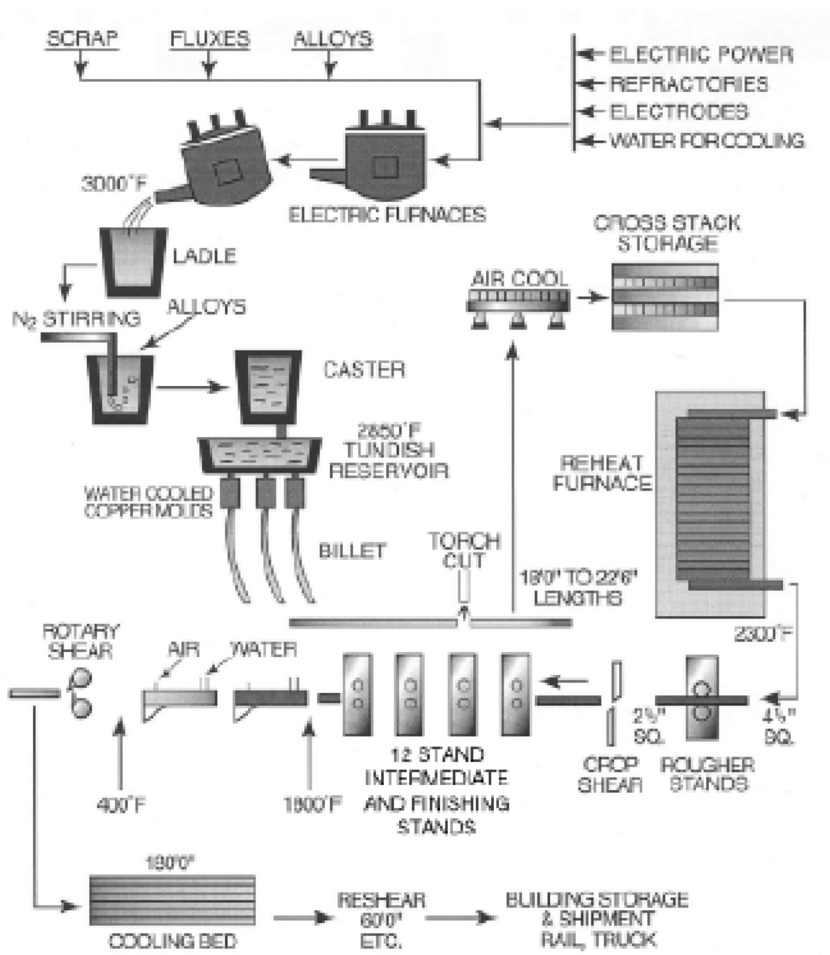

Figure 4: Detailed flow diagram for mini mills with general process equipment

In a non-integrated steel mill (mini mill), scrap steel is brought on site by truck and rail to the scrap receiving, storage and handling area[ix]. During each batch of steel (also called a "heat"), scrap steel is loaded into a charge bucket via overhead crane, lime and/or carbon in the form of chopped tires or petroleum coke is added to remove impurities from the heat. The loaded charge bucket is then positioned above the open Electric Arc Furnace (EAF) located in the melt shop (with the exception of Consteel EAFs).

For a mini mill specifically, scrap metal is melted and refined in an EAF to make steel products. Molten steel is produced in the EAF which is then tapped from the EAF to a ladle. There, the molten steel is usually refined further with the addition of alloys. The molten metal then moves through a continuous casting or ingot casting and put through finishing processes. Each part of the process has its own necessary function, and associated emissions to the environment.

Upon obtaining accurate positioning, the charge bucket loads the scrap steel into the EAF. An electric arc furnace consists of a refractory-lined vessel, covered with a retractable roof, through which one or more carbon or graphite electrodes enter the furnace.

The EAF furnace is primarily split into three sections:

- **Shell:** consists of the sidewalls and lower steel 'bowl';
- **Hearth:** consists of the refractory that lines the lower bowl; and
- **Roof:** may be refractory-lined or water-cooled. The roof also supports the refractory delta in its center, through which one or more electrodes enter.

Melting of the scrap steel is achieved through a combination of both electric and chemical energy. The chemical energy is supplied through oxy-fuel burners that provide a mix of natural gas and oxygen, as well as through oxygen lances and carbon injection into the slag. After the scrap is dropped, the charging bucket is raised, the top of the EAF is closed, and carbon/graphite electrodes are lowered into the furnace, which provide the electrical energy.

The electrical current that passes between the electrodes is in the form of an arc which melts the scrap steel. After the charge is partially melted, the slag production process begins where oxygen and carbon are injected into the liquid steel to agitate the slag into a consistent layer. Petroleum coke or crushed coal may also be injected into the slag to foam it as well. The lime and additives form the slag layer, which serves to remove impurities from the steel. Once the temperature and chemistry are correct, the steel is tapped out into a preheated ladle through tilting the furnace.

2.1.1.1 Electric Arc Furnace (EAF)

An EAF is a cylindrical, refractory lined container with openings in the furnace roof through which carbon electrodes can be raised and lowered. When the electrodes are retracted, the rotating furnace roof allows for the scrap metal to be placed or charged into the EAF by an overhead crane. Some furnaces are charged through a shaft or continuously charged from a conveyor. This eliminates the need to remove the furnace roof. This process is also called Consteel.

The input material for an EAF is almost 100% ferrous scrap. This scrap is melted by the electric current generating heat between the electrodes. Steel production in the EAF is a batch process with stages that include charging, melting, refining, slagging and tapping. After the charging stage, electrical energy is supplied to the furnace interior during the melting stage. Oxy-fuel burners and oxygen lances that burn natural gas and oxygen can be used to supply chemical energy. Heat is transferred by convection and flame radiation to the scrap metal. During the oxygen lancing, oxygen is injected directly into the molten steel and additional energy for melting is provided from the exothermic reactions with iron and other components. This also helps in the removal of excess carbon. During this time, additional alloying elements can be added for the desired composition. Typically, the alloying materials that are not easily oxidized are charged before the scrap metal charge. In order to reduce the sulphur and phosphorus content in the molten steel, lime is used as a fluxing agent as well. Depending on the carbon content of the steel, iron ore and coke may be charged before melting as well.

While melting in the EAF where oxygen is introduced throughout the batch, molten steel refining can occur simultaneously with melting. During the refining stage, a layer of slag is formed that contains oxides of calcium, iron, silicon, phosphorus, sulphur, aluminum, magnesium and manganese in complexes of calcium silicates, aluminosilicates and aluminoferrite. A slag door is used for slag removal as the furnace is tipped backwards[x]. The slag is then processed further into a different product, often used to pave roads.

At the end of the batch, the tap hole is opened and the steel is poured from the EAF to a ladle to continue to the next step in the process. An example of a typical EAF can be found in Figure 5.

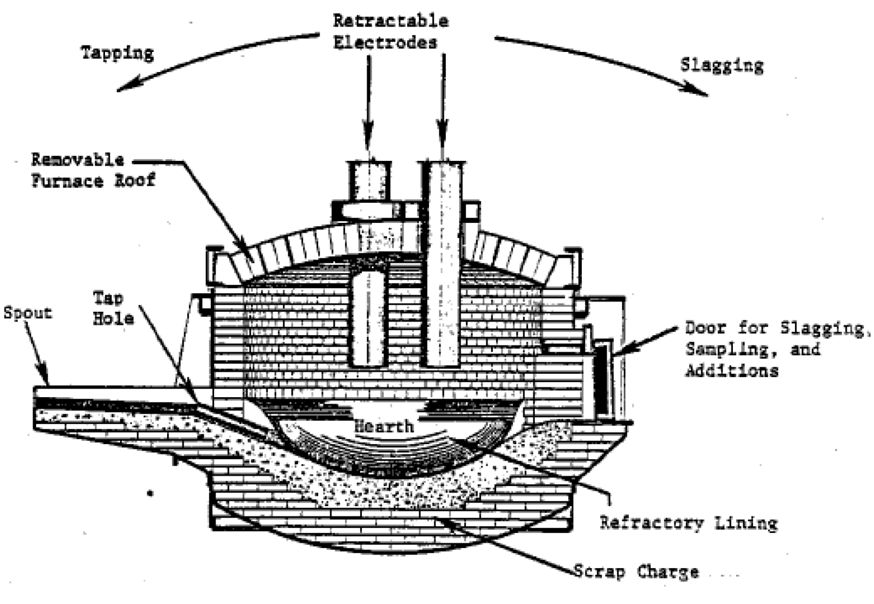

Figure 5: Typical cross section of an electric arc steel furnace

2.1.1.2 EAF Injection Jets

The equipment on board of the EAF shell can be made-up of four different fixed shell injector systems[xi]. Each injector is developed to satisfy a very specific requirement of the melting and refining processes:

- Deep fines injection: This equipment injects the fines shrouded by an annular supersonic stream of oxygen. As a result, the highly coherent, high speed injected fines penetrate deeply into the steel bath.
- Supersonic Oxygen injection. This injector delivers a highly coherent supersonic stream of oxygen that penetrates into the steel bath for carbon oxidation and other oxidizing reactions in the steel/slag interface.
- Soft Carbon injection. The carbon injection into the slag promotes FeO and MnO reduction with consequent early slag foaming metallic yield better control.

- Flux injection into the slag. Typical injected solids are lime and/or dololime used to control slag chemistry and its foaming.

The furnace is built on a tilting platform so that the liquid steel can be poured into another vessel for transport. The operation of tilting the furnace to pour molten steel is called "tapping". Modern EAFs have an eccentric bottom tap-hole (EBT) to reduce inclusion of nitrogen and slag in the liquid steel.

For plain-carbon steel furnaces, as soon as the slag is detected during tapping, the furnace is rapidly tilted back towards the de-slagging side, minimizing slag carryover into the ladle. For some special steel grades, including stainless steel, the slag is poured into the ladle as well to be treated at the ladle furnace to recover valuable alloying elements. During tapping, some alloys are introduced into the metal stream and some more lime is added on top of the ladle to begin building a new slag layer.

Often, a few tons of liquid steel and slag is left in the furnace in order to form a 'hot heel' which helps preheat the next charge of scrap and accelerate its meltdown. During and after tapping, the furnace is 'turned around', i.e. the slag door is cleaned of solidified slag, repairs may take place, and electrodes are inspected for damage or lengthened through the addition of new segments; the tap hole is filled with sand at the completion of tapping.

Additional oxygen is then injected to cause the steel to boil from the formation of CO and CO_2, which facilitates the removal of the slag and impurities from the steel. The Direct Exhaust Control (DEC) system evacuates fumes from the EAF and ladle metallurgical station (LMS) by maintaining a negative pressure inside the furnaces, directly from the "fourth hole" exhaust duct located on the top (or roof) of the EAF (so named the fourth hole because the EAF includes three holes for the arc electrodes that extend into the EAF) and the ladle furnace. The fourth hole exhaust has an air gap in the duct to allow for furnace tilting during tapping of the EAF as well as EAF roof movement to allow for the opening and charging of the EAF. Air is drawn into this gap by the induced draft (ID) fan during system operation to provide sufficient oxygen within the EAF evacuation duct for burning of combustible gases (CO and hydrogen) exiting the EAF. The gases collected by the DEC are water cooled, then mixed with the high volume of cooler gases from the building canopy prior to entering the baghouse.

The majority of the gases from the EAF are collected directly through the fourth hole during the melting process, however, during periods of charging when the roof is off, the EAF gases will exhaust into the building that houses the EAF (referred to as the melt shop) and are usually captured and collected by means of canopy hoods and roof monitors that are located above the EAFs and LMFs and are routed to the same air pollution control ducting system (usually a high temperature baghouse) as is the DEC system for the control of particulate matter emissions. US EPA NESHAP for EAFs recognizes that fugitive emissions as a key source and sets limits to control them (see jurisdictional review in Chapter 4).

Several factors impact the heat cycle of an electric arc furnace, however, the whole process will usually take anywhere from less than 60 minutes to approximately 90 minutes from the tapping of one heat to the tapping of the next (the tap-to-tap time). There could be multiple charges per heat cycle as well.

2.1.1.3 Bucket Charging

Scrap selection plays an important role in any EAF operations. The characteristics of scrap as density, metallic Fe content, gangue content, oil, grease and non-metallic content, have important impacts on the process.

- **Scrap density** in a bucket-charged EAF, not only affects the number of charges required to produce a heat, but also impacts the electrical and chemical energy profiles. Dense scrap can be slower to melt and if aggressive burner and oxygen lancing profiles are employed, dense scrap may deflect the jet back onto the furnace walls resulting in damage. If large quantities of dense scrap are charged, it may be necessary to operate at lower arc voltage and higher current during refining in order to ensure that the dense material is fully melted prior to tapping.
- **Non-metallic content** in scrap leads to dust generation in the furnace and increased slag volume.
- **Gangue** also leads to increased slag volume and increases the requirement for calcic and dolomitic lime additions. In addition, since fluxes are typically added in the buckets, the slag chemistry will vary throughout the melting of the charge.
- **Oil, grease and combustible content** in the scrap results in higher energy content in the off-gas stream and, in some cases, will result in higher VOC content in the off-gas if they are not fully combusted.
- **Metallic yield** has an important effect on specific energy and raw material consumption. Thus, it is important to ensure that chemical energy inputs along with carbon inputs are balanced to reduce losses of iron units to the slag.
- **Layering scrap** in the bucket has been demonstrated to have significant effects on melting dynamics, thus affecting energy consumption. The scrap profile determines electrical and chemical energy efficiency. An optimal scrap profile in the bucket affects energy consumption by as much as 20kWh/t. In addition, every time the furnace roof is opened to charge scrap, about 10kWh/t of energy is lost due to radiating heat.

2.1.1.4 Consteel EAF

Consteel charged EAF[xii] is a very flexible process that can adopt a wide range of scrap mixes in the metallic charge. More than 40 plants are currently operating Consteel technology, producing any kind of steel grades, from rebar to stainless steel. They are using different types of scrap mixes for their purposes.

Consteel combines preheating the scrap charge with continuous charging by directing the off-gas from the EAF into a tunnel through which the scrap is slowly conveyed and charged continuously to the furnace via a side wall port.

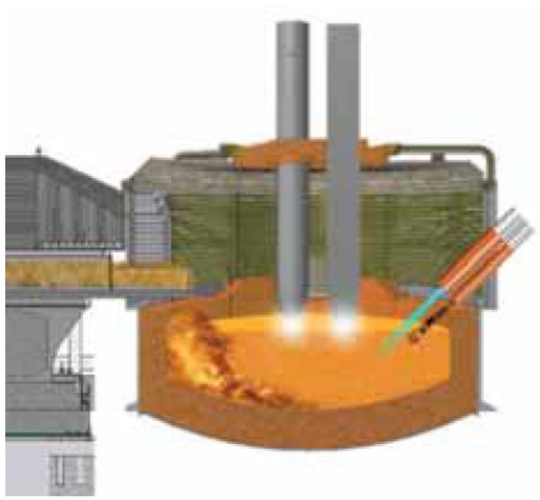

Figure 6: Consteel EAF

2.1.1.5 Consteel Charging

The Consteel furnace is by its nature both different and similar to a conventional EAF.

- The Consteel process is continuous, so scrap density does not affect the number of charges as the scrap is continuously fed into the EAF through the side of the furnace. A good Consteel operation is achieved matching energy input to scrap feed-rate. In the early days, that was achieved by manual control of the scrap feed rate into the furnace. Nowadays this operation is fully automated, thanks to the weighing systems on the EAF shell, which provides real time liquid steel weight in the furnace.
- The key to maximum throughput in the Consteel is to contain the arc in the slag, leading to maximum arc stability and maximum and stable active power.
- Being a continuous process, the best practice for scrap charge is always to keep as near constant as possible the layer of scrap, in size (height) and grade (mix), in order to have a smooth flow of scrap into the EAF.
- Non-metallic components in the scrap will report to the dust in the off-gas. The Consteel process typically generates about a third less dust than a conventional bucket charged EAF. The heavier dust is captured in the incoming scrap and is recycled to the furnace.
- The high yield in the Consteel process benefits from its design. Fluxes, chemical energy inputs and carbon inputs – whether in the metallic charge, through injection into the EAF or other – must be properly balanced to maximize yield.
- Consteel operates without any highly oxidizing burner flame and the constant flat bath in the EAF helps keep the FeO oxidizing/reducing reactions within the slag itself, so that the proper carbon balancing in the slag can lead to iron recovery and maximize metallic yield.

2.1.1.6 Slag Formation and Removal

Slag formed during this process is poured into a concrete containment area under the EAF. Water is applied to the slag for cooling which will allow for the handling of the slag. The slag is then removed from the containment area with a front-end loader and transported to an outdoor processing area for reclamation.

After being transported to the outdoor processing area, the slag will be quenched with water and large metallic pieces will be removed from the slag stockpile by magnet and returned to the scrap yard for reuse in the EAF. The final aggregate is sized into three fractions with a set of screens, then sold as a by-product, or used on-site for fill or road building.

Any fugitive air emissions generated from handling and processing of the slag are controlled through the use of water sprays. No stacks are associated with this process.

It should be noted that one facility in Ontario has a dedicated enclosed building complete with control equipment used for slag cooling.

After melting of the scrap is completed and slag is removed, samples of the melt are collected and analyzed for chemical composition, the EAF is tapped and the molten metal flows into a ladle, which has been preheated with natural gas for transfer to the next process.

2.1.1.7 Argon Oxygen Decarburization, AOD

During the production of certain stainless and specialty steels, argon oxygen decarburization (AOD) is used to further refine steel which takes place outside of the EAF. Gaseous mixtures of argon and oxygen or nitrogen are blown into a vessel with the steel to assist with carbon removal. This is due to the argon increasing the affinity of carbon for oxygen[xiii]. The process is started when molten steel from the EAF is transferred to the AOD vessel. The vessel rotates forward to accept the molten charge and within 1-8 minutes, it is rotated back to an upright position for refining. At this point, lime or alloys are added to the molten steel with a charge pan or through a charge chute.

It is important to avoid oxidizing alloys that are necessary for specialty steel production by controlling the gas mixture and flow. Certain amounts of steel scrap may be added periodically to the vessel in order to reach the desired chemical composition of the final product.

2.1.1.8 Ladle Metallurgy Furnace, LMF

After the steel has been melted and refined, it is transferred to the ladle metallurgy process. Within this step, there are multiple processes that occur, e.g. ladle temperature control, compositional control, de-oxidation, degassing, cleanliness control, and others. Alloys may be added in this process as well, and electric arc heating is generally used in the final refining process.

Ferro alloys are added to the ladle during the tapping process. The ladle is moved by transfer car to the ladle metallurgy furnace (also referred to as the ladle metallurgical furnace, LMF or ladle metallurgical station, LMS) where final chemistry and temperature adjustments to the heat are made. The ladle furnace also has 3 electrodes and a separate power supply from the EAF, which similarly heats up the steel in the ladle. A second Direct Exhaust Control (DEC) fume collection system will collect gases from the ladle furnace, which is usually routed to the melt shop baghouse.

The lime and carbon used in the process are stored in silos, which generally have filters for the collection of any dust generated during storage and transfer of material to the silos. A third silo will store the dust collected in the baghouse, prior to being shipped off site by rail. This silo along with the conveyor feeding the silo is vented back into the main EAF baghouse and will not therefore vent to the atmosphere.

2.1.1.9 Continuous Caster

There are two major routes involved with final processing which are continuous casting and ingot casting. The most common process is continuous casting where a ladle with molten steel is lifted to the top of a continuous caster where molten steel is poured into a reservoir called a Tundish. When the steel is at the proper temperature and composition at the LMF, the ladle containing the steel is moved to the continuous caster via an overhead crane. The molten steel is poured from the ladle into the Tundish reservoir. The Tundish is a vessel that acts as a reservoir of molten metal to feed the casting machine while ladles are switched, thus acting as a buffer of hot metal, regulating metal feed to the molds. In the caster, two streams of liquid steel flow from the Tundish into water-cooled molds to form the solid steel outer shell of the steel billets. The outer shell of the caster is continuously cooled with water sprays.

The molten metal then flows through a continuous casting machine and as the steel passes through the molds, the steel is cooled and a thin skin forms on the outside of the steel. Various casters can shape the steel as it flows continuously. The steel can be shaped into semi-finished products such as blooms, billets or slabs.

The billets will be cut to specified lengths when solidification is complete using oxy-natural gas torches. The fumes from the torches are open vented into the melt shop building. The billets are then conveyed to a transfer table and allowed to cool further to approximately 1100 °F. Some mini mills employ a hot charging system which is designed to load the hot billets directly into the reheat furnace, unlike the conventional practice of storing the billets in a billet yard where they are further cooled and reloaded back into the reheat furnace at a later time. The continuous caster will have a separate vent for the release of steam formed from the use of the direct-sprayed cooling water.

Ingot casting is not a continuous process; the molten metal is poured into an ingot mold where it cools and begins to solidify. The molds are then stripped away and the ingots are placed in soaking pits or reheat furnaces where they are heated to a uniform temperature. The ingots are shaped by rolling into semi-finished products.

The semi-finished products may be further processed through annealing, hot forming, cold rolling, pickling, galvanizing, coating, or painting. Additional heating or reheating may be done in furnaces fired with natural gas. These furnaces are custom designed for the type of steel, dimensions of the semi-finished steel pieces and desired temperature.

2.1.1.10 Reheat Furnace, RHF

The steel then enters the natural gas-fired reheat furnace, where it is heated to approximately 2,000 °F and then conveyed to the rolling mill. The rolling mill consists of a series of rollers that forms the steel to the appropriate thickness and shape. Scale is recovered from the water used in the continuous caster and the rolling mill and is sold as a by-product.

2.1.2 Emissions[xiv]

The processes mentioned above that generate emissions are charging scrap, melting, refining, removing slag and tapping steel. The main emissions of interest are gaseous products and metal dusts. The metal dusts include ferrous and non-ferrous oxide particulates. The amount and composition of the suspended particulate matter (SPM) that is emitted will vary from process to process, as well as between different batches. The different composition of scrap and types of additives used greatly affect the composition of the SPM. The primary component of SPM is iron or iron oxides, however zinc, chromium, nickel, lead, cadmium, and other metals (and the oxides of the metals) may also be present. Gaseous pollutants include NO_x and CO and these depend on the equipment or operating practices. Using chlorinated compounds in steel processes and contaminated recycle scrap metal with oils and plastics all aid in the formation of chlorinated aromatic compounds, namely chlorinated dibenzo dioxins/furans (CDD/CDF). This section will focus on the contaminants included in this technical standard.

2.1.2.1 Electric Arc Furnace (EAF)

Ideally, emissions from the EAF including process emissions and fugitive emissions are mostly captured using the direct shell evacuation (e.g. 4th hole Direct Evacuation Control (DEC)) supplemented with secondary ventilation, a canopy hood located above the EAF where they are then directed to a baghouse. Mini mills direct all emissions from the EAF, LMF and continuous casters (melt shop) to a common baghouse, or baghouses. Controls built directly into the EAF are the water-cooled glands that are present at the holes. These are used to cool the electrodes and minimize the gap between the electrodes and roof openings. This reduces the fugitive emissions, noise levels, electrode oxidation and heat loss. Furnace emissions are the highest during melting and refining operations, but charging and tapping may also be significant. Other causes of emission increases during melting and refining include increases in electrical power and using oxygen lancing.

Mercury (Hg) is a contaminant that can be emitted from EAF operations if the scrap being charged has elements with mercury in it. The concentration of mercury emissions is projected to decrease as programs to improve scrap management increase over time. On August 11, 2006, the US EPA announced a national program targeted at the main source of mercury emissions from steel mills.

The National Vehicle Mercury Switch Recovery Program (NVMSRP) was created to support the removal of mercury-containing light switches from scrap vehicles before they are flattened, shredded and used as scrap steel in the EAF. This program, combined with the existing mercury reduction efforts, is expected to reduce mercury emissions to 50% less over the next 15 years in the US.

Stainless steels contain 12-25% chromium; thus, facilities that produce stainless steel have potentially higher chromium and hexavalent chromium emissions than those that produce carbon steel. When facilities produce carbon steel, the EAF is used for melting scrap as well as a refining unit where oxygen blowing takes place. This eliminates the need for the AOD vessel and amount of transfers thereby reducing emissions.

A problem that sometimes occurs upon charging the EAF is that scrap can remain above the furnace ring. In order to avoid damage to the refractory, these pieces of scrap must be repositioned so that the roof can swing back into place. Repositioning can be done manually, using the charge bucket or any other large mass of metal. An oxygen lance can also be used to cut pieces blocking the roof. This problem allows more emissions to escape from the EAF to either be collected by the baghouse or released as fugitive emissions.

As a result, the melting operation particulate emissions consist of metallic and mineral oxide particulates, carbon monoxide, hydrocarbons, and trace constituents like hexavalent chromium.

2.1.2.2 Argon Oxygen Decarburization (AOD)

The AOD vessel is one of the sources that emit particulate and gaseous pollutants such as CO and NO_X. SPM and metal compounds are emitted from the AOD, where the emissions are usually directed to a baghouse for pollution control. Other than argon, oxygen and nitrogen gases, alloys are added in this process as well. The fluxing agents are lime and fluorspar and the alloys that can contribute to SPM emission are aluminum, chrome, nickel, manganese, boron, silicon, vanadium and titanium.

There exists a carbon-chromium equilibrium relationship which can help determine the amount of chromium within the final product. As the carbon level decreases with oxygen blowing, excess chromium will be oxidized, therefore becoming chromium oxides which are not beneficial to the final product.

The AOD vessel is typically used when facilities are producing specialty steels. Here, the AOD vessel is used as the secondary refining vessel where oxygen blowing takes place to oxidize impurities. Phosphorus, silicon, manganese and carbon are examples of elements in the scrap metal that are oxidized. This is also the point where slag forms and is carefully monitored during meltdown stages to control the chemical concentration and product quality. Other additions depending on if the facility uses single or double slagging processes include fluorspar, silica, ferrosilicon, sand, powdered coke and burnt lime.

2.1.2.3 Ladle Metallurgy

Ladle metallurgy includes the ladle furnace and the ladle heater. A roof canopy hood or side draft hood can be used to capture the emissions. These emissions are then vented to either a common baghouse shared with the EAF emissions, or to its individual baghouse.

Ideally the process should limit the contact that the molten metal has with the oxygen in the air to prevent excessive oxidation. Sometimes it is necessary to add ferromanganese, ferrosilicon, aluminum and other alloying agents to adjust the oxygen content of the steel. Chrome can also be added just before the tap to avoid oxidation of the chromium.

2.1.2.4 Casting and Finishing

Casting and finishing can generate fugitive emissions of SPM at the caster and emitted through a roof monitor. It is not common that control devices are employed for these processes which can be problematic depending on the layout and ventilation in the facility.

The reheat furnace, annealing furnaces and other furnaces used in the finishing process are sources of NO_x and CO emissions. In order to control the NOx in these processes, different processes or control devices can be used. For example, process modifications are low NOx burners, ultra-low NO_x burners and flue gas recirculation. Selective catalytic reduction (SCR) is an example of a control device for NO_x.

2.1.3 Variability

Although the general emissions present can be predicted[xv] and emission factors can be used to a given degree of accuracy, there is significant variability present at mini mills. The processes present are similar, however, the variability means that different plants will have varying magnitudes of emissions. Variability exists in the scrap material, facility configuration and rate of emissions. The European Union lists the following as the primary variables in mini mills which apply to mini mills in other jurisdictions as well.

- <u>Product Type</u>
  Different types of products produced have an effect on the levels of the contaminants present. For example, manufacturing high carbon steel, low carbon steel, stainless steel, specialty alloy steel or leaded steel will change the concentrations of different metals in the SPM. The wide range of products also requires different feedstock, steel melting and refining equipment, and melting/refining practices.

- Furnace Type, Size and Power
  EAFs vary in terms of their type, size and power. Direct current (DC) electricity or alternating current (AC) electricity may be used. There is also a wide variability in terms of the amount of steel that is produced per heat. This can range from 10-15 tons of steel per heat, to over 100 tons. The rate of energy consumption also impacts the chemical energy required and therefore, can vary the gaseous pollutants produced.
- Furnace Design
  SPM emissions are greatly impacted by the furnace design due to the evacuation systems. For example, furnaces with the fourth-hole duct work that comes directly off the side of the furnace with no bends will direct significantly more dust to the baghouse. A 'gooseneck' design does not direct as much due to the bends.
- Type of Scrap and Raw Material Inputs
  Grade of scrap metal used, type and amount of other raw materials used will produce different types of emissions at different levels. These raw materials depend not only on the product to be produced, but the availability of scrap in the vicinity of the facility as well. This means that even if facilities in different areas are producing the same material, their raw material inputs can vary depending on availability and cost of material.
- Scrap Feed Practices
  Scrap feed practices capture the differences in how the EAF is charged. With a traditional batch process where the furnace has a roof that swings open to allow for scrap feed, fugitive emissions are released every time the roof is opened. Some EAFs are equipped with continuous scrap feed where scrap can be preheated as well (i.e. Consteel) which decreases overall emissions. The shaft fed furnaces do not require a swing roof and therefore, result in a greater capture of the fugitive emissions. This will also amount to a higher level of emissions from the baghouse due to the increase in captured emissions, but this increase is not significant compared to if the emissions were to be emitted as fugitives.
- Slag Practices
  Slag production is vital in the steelmaking process. With a greater amount of carbon used during the steel and slag making process, more emissions will result. The type of carbon used can also make a difference, for example using petroleum coke, anthracite coal or metallurgical coke will change the emissions.

2.1.4 Common Emission Control Devices

2.1.4.1 Fabric Filters or Baghouses

Fabric filters are the most commonly used control device on EAFs, LMF, AOD vessels and other parts of the melt shop. They are also the most effective control devices for the removal of small particles. They are as effective at removing chromium as they are at removing total particulates. Pressure and suction type fabric filters exist and are used in facilities. Dust collected can sometimes be recycled for the recovery of chromium, nickel, iron, and zinc. Wet scrubbers and electrostatic precipitators are not common in mini mill facilities because they are generally less efficient at particulate removal.

2.1.4.2 Ventilation Hoods and Evacuation

It is very important to capture the emissions and route them to control devices, otherwise they will escape as fugitive emissions. There are various methods of capturing these emissions including:

- Direct- Evacuation Control systems (DEC)
- Side craft hoods
- Canopy hoods
- Tapping hoods
- Scavenger duct systems
- Dog house that encloses the electric arc furnace
- Total building evacuation

Each system has its own advantages and disadvantages. The DEC draws 90-100% of the process emissions before they escape. A disadvantage to the DEC is that it is not effective when the furnace is tilted or the roof is rotated aside for charging. Figure 7 shows a side view of the DEC.

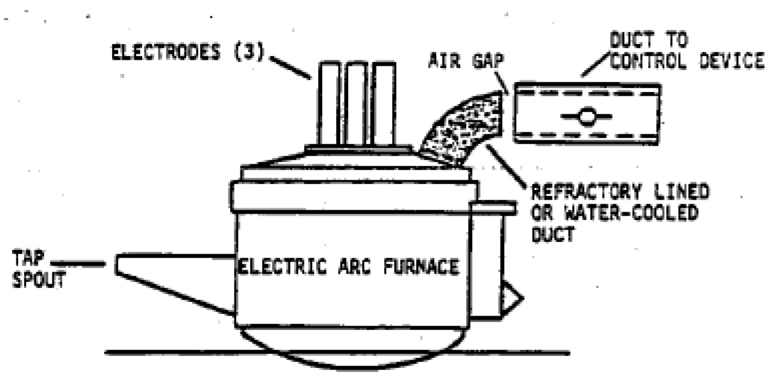

Figure 7: Side view of DEC with the EAF

Similar to the DEC, the side draft hood also only captures emissions during melting and refining. It is mounted to the EAF roof with one side open to account for electrode movement. The particulate capture is 90-100% as well but it is not as widely used as the DEC because it has a high operating costs. Figure 8shows the side view of a side draft hood.

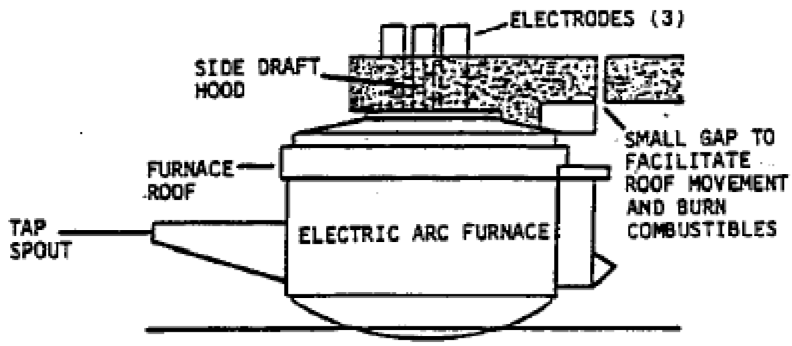

Figure 8: Side view of side hood draft with the EAF

A **scavenger duct system** can have multiple small auxiliary ducts that are located above a main canopy hood. A relatively low flow rate is required to capture what is not captured by the canopy hood but the use of this type of system is not well known.

Building evacuation systems use ductwork at closed roof shops to collect all emissions. This method requires a 25% increase in air flow as compared to canopy hoods. This type of emission collection is commonly used as well.

A doghouse that encloses the electric arc furnace is an enclosure that can moved or closed to fully surround and capture emissions from the electric arc furnace and is very effective at capturing emissions, in the range of 90% to 95% capture efficiency.

2.1.4.3 Collection of Primary Air Emissions

Figure 9 provides an overview for the input and output of electric arc furnaces. This overview may be used for the collection of data from an electric arc furnace[xvi]. The electric arc furnace steelmaking process is a source of primarily dust and solid wastes/byproducts. Energy consumption also plays an important role for EAF steelmaking. When abatement techniques are applied to reduce emissions, cross-media effects occur.

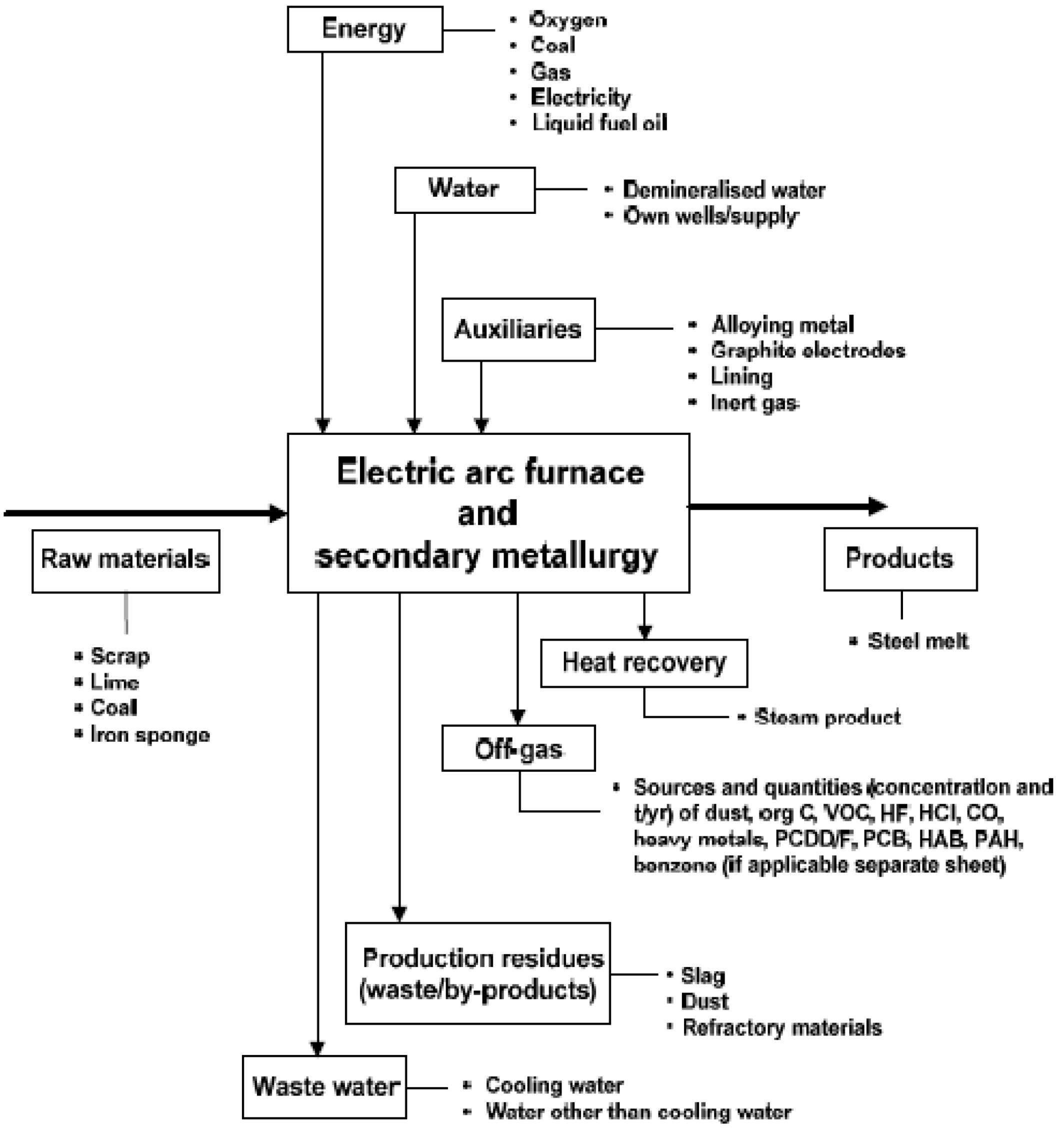

Figure 9: Mass stream overview of an electric arc furnace[xv]

Primary off-gases represent approximately 95 % of total emissions from an EAF. Most of the existing plants extract the primary emissions by the 4th hole (in the case of three electrodes – AC furnaces (see Figure 10) or by the 2nd hole (in the case of one electrode – DC furnaces). Thus 85 – 90 % of the total emissions during a complete cycle tap-to-tap can be collected[xv].

There are still few plants which do not have a 4th hole but a doghouse; a complete enclosure of the furnace with adequate gas extraction that can collect more emissions when in use but may not capture as much emissions during charging, when it is moved out of the way.

Another approach is to capture emissions from the entire building providing total building evacuation, which can be very effective and potentially collect the most emissions.

2.1.4.4 Collection of Primary Air Emissions

Off-gases are generated during scrap handling, charging and tapping as well as those escaping from the furnace openings like fumes (i.e. electrode openings and doors) are captured by a canopy hood generally located above the furnace[xv]. They may contain all of the pollutants described under primary emissions. The most recent furnaces are often installed inside buildings with closed upper parts and a powerful extraction at the roof top. Depending on the dimensions of the building and the capacity of the furnace, the flow rate of the extraction system can exceed 1 million m^3/h.

The following collection configurations are applied:

- EAF with extraction of primary off-gas at the furnace (2^{nd} and 4^{th} hole) and a canopy hood for the collection of the secondary off-gas flow, installed in a building with an open roof section.
- EAF with extraction of primary off-gas at the furnace (2^{nd} and 4^{th} hole) and with a doghouse collecting all the fumes from the furnace to one exhaust system, installed in a building with open roof sections.
- EAF with extraction of primary off-gas at the furnace (2^{nd} and 4^{th} hole) installed in a building with a totally enclosed roof that collects the secondary off-gas flow.
- In some installations, a 2^{nd} or 4^{th} hole extraction only.

Figure 10 shows the main three types of off-gas collection systems for AC furnaces with 4^{th} hole extraction.

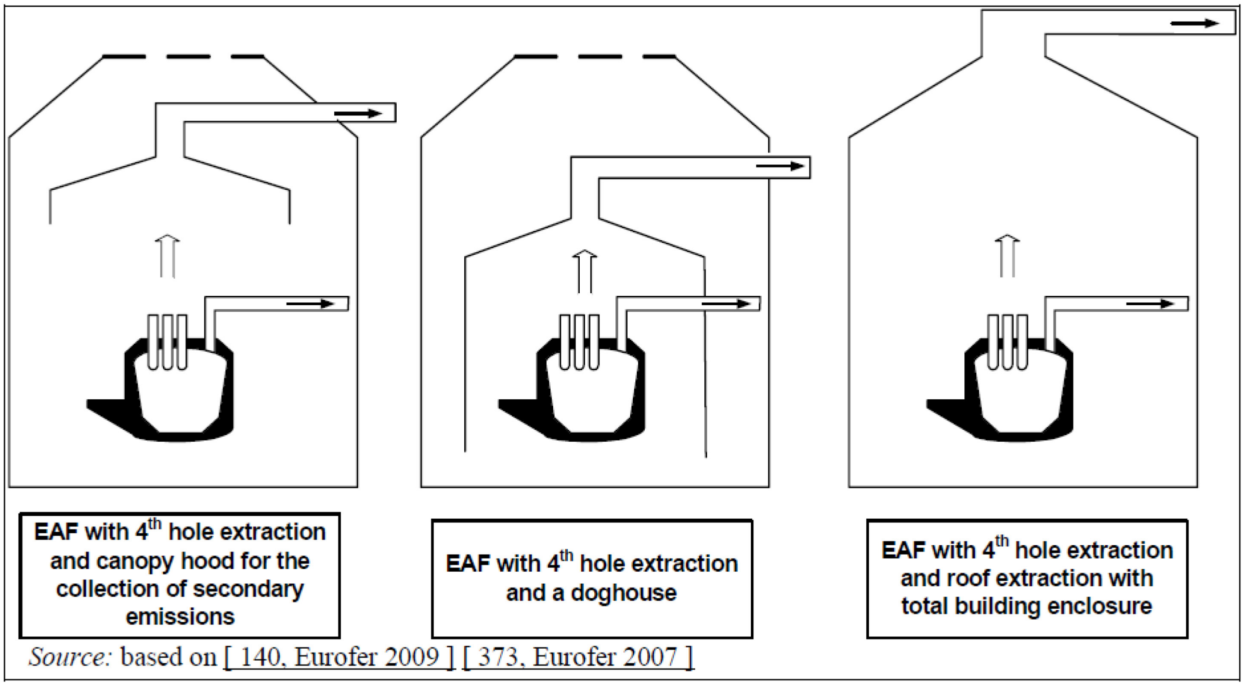

Figure 10: Collection systems at EAF[xv]

A doghouse can be built in different designs[xv]. There are large doghouses, where the charging crane is going into (or nearly into) the upper part of the doghouse, which is kept closed during charging and works as a hood. The other type of doghouse is small and totally open during charging. In this case an additional hood is necessary to capture the charging plumes.

If secondary metallurgy is carried out in the same building as the EAF, these emissions can also be collected by canopy hoods and roof extractions.

The canopy hood system must be high enough to allow for crane and electrode movement. This system collects process and fugitive emissions. The thermal currents help the particulates to rise to the hood, however, drafts or crane passages may disrupt the path of the emissions and affect total capture. The capture efficiency is typically 75-85%.

Partial furnace enclosures direct the fugitive emissions from charging and tapping to a canopy hood using a chimney-like structure. They are less expensive than total enclosures and are easier to install. Crane passages still disrupt the emission plume.

Total furnace enclosures completely surround the furnace and the required air flow is only 30-40% of that required for a canopy hood system. Tapping emissions are collected from a duct that is adjacent to the ladle and capture efficiency is 90-100%.

Tapping hoods are movable or stationary which are located directly above the tapping ladle when tapping takes place. This makes it more efficient than a canopy hood on its own.

Table 4 summarises the qualitative efficiencies to collect emissions from the main operations of electric arc furnace steelmaking.

Table 4: Sytems for the collection of emissions from EAF plants

Sources of emissions	Charging	Melting (in EAF)	Tapping	Secondary metallurgy (1)	Continuous casting (1)
4th hole	No	Yes	No	Yes, if also Equipped	NA
Canopy hood	Yes, partly	Yes	Yes, partly	Yes, if also Equipped	Yes, if also equipped
Doghouse	Only if closed (2)	Yes	Yes	Yes, if also Equipped	NA
Total building evacuation	Yes	Yes	Yes	Yes	Yes

(1) If located in the same building.
(2) Usually the doghouses are not closed during charging as they obstruct the access to the EAF.
NA = Data not available.

Figure 11 shows the percentages of the off-gas collection systems used in a sample of 51 EAFs in the EU. 4th hole collection of the primary emissions at the furnace roof is almost generalized. A vast majority of plants have either canopy hoods or total building enclosure. Some plants still operate with only a 4th hole extraction.

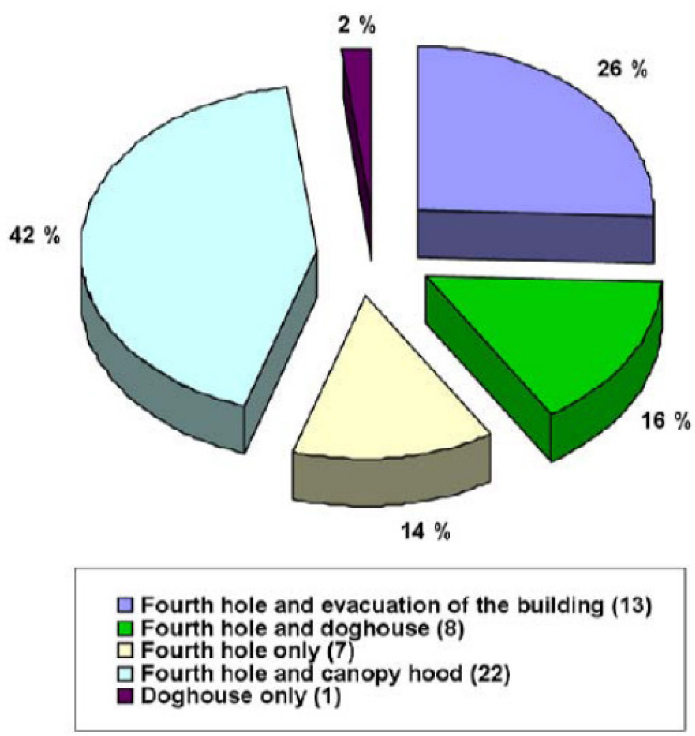

Figure 11: Percentage of existing dust collection systems in 51 EAFs in EU[xv]

With respect to micro pollutants like organochlorine compounds, especially PCDD/F, the contamination of secondary off-gases (mainly the leakages from the EAF) contribute to overall emissions. In order to minimise total PCDD/F emissions, secondary emissions should also be taken into account, thus strengthening the need for total building evacuation.

2.1.4.5 Primary and Secondary Emissions and Treatment

Off-gases from primary and secondary collection in EAF contains dust, metals, nitrogen and sulphur oxides and organic matter (e.g. VOC, chlorobenzenes, PCB, PAH and PCDD/F)[12]. Organic matter emissions mainly depend on the scrap quality. Some scraps contain paints, oils and other organic substances.

Information about secondary emissions is limited.

- From charging the EAF, usually 0.3 – 1 kg dust/t LS and from tapping usually 0.2 – 0.3 kg dust/t LS are emitted (emissions before abatement).
- For fume leakages during EAF operations, dust emission factors between 0.5 and 2 kg dust/t LS are reported.
- Emission factors as a sum of the aforementioned three sources (charging, tapping, fume leakages) are between 1.4 and 3 kg dust/t LS before abatement. This can be considered a confirmation that primary emissions are about ten times higher than secondary emissions.
- A part of the chromium can occur as hexavalent chromium. It is of paramount importance because it is highly carcinogenic by inhalation.
- In three EU EAF plants, emissions factors for arsenic between 0.025 and 14 g/t have been measured.
- Mercury emissions can strongly vary from charge to charge depending on scrap composition and quality. Mercury emissions in the sector are expected to decline due to the progressive phasing out of mercury following the full implementation of several directives already in place, such as the 'End-of-life Vehicles' Directive, the 'Waste from Electrical and Electronic Equipment' Directive and the Directive on the Restriction of Hazardous Substances in the Electrical and Electronic Equipment as well as the battery Directive. Nevertheless, relevant exceeding of mercury ELVs have been observed, indicating that mercury-bearing components still occur in the scrap sources, and apparently they are not always removed from the shredder input. Emissions factors for mercury of 170 mg/t LS, despite efforts to reduce mercury in purchased scrap, have been observed on an annual basis and seem to be fairly similar for steel, based on domestic and imported scrap.
- Sulphur and nitrogen oxides: SO_2 emissions mainly depend on the quantity of coal and oil input but is not generally of high relevance.
- NO_X emissions also do not need special consideration.

- Other inorganic pollutants: Fluorides and chlorides are other relevant inorganic pollutants but no further information was provided.
- VOC emissions may result from organic substances adhering to the raw materials (e.g. solvents, paints) charged to the furnace. In the case of the use of natural coal (anthracite), compounds such as benzene may degas before being burnt off.
- Polycyclic aromatic hydrocarbons (PAH): The emission factors for PAH are also relatively high (9 – 970 mg/t LS), but there are not many reported measurements. PAH are also already present in the scrap input, but may also be formed during EAF operation. The expectation that PAH adsorb to the filter dust to a high extent (also depending on the off-gas temperature) could not be confirmed by investigations in Luxembourg, where PAH emissions remained unchanged before and after abatement in a bag filter which achieved low residual dust contents (<5 mg/Nm^3) as a daily mean value. The PAH profile is dominated by the more volatile two or three ring PAH such as naphthalene, acenaphthene, anthracene and phenanthrene.
- Persistent organic pollutants (POPs): Since the nineties increasing note has been taken of POPs. Analytical results are only available for a limited number of compounds. Organochlorine compounds, such as chlorobenzenes, PCB and PCDD/F have been measured.
- There is a strong correlation between the concentrations of PCDD/F and WHO-12 PCB, with the I-TEQ of PCDD/F being approximately 16.5 times higher than that of WHO-12 PCB. This suggests that the formation mechanisms of PCB and PCDD/F are linked.
- Chlorobenzenes have been determined at several EAF operations (0.2 – 12 mg/t LS). From measurements at one EAF plant, it is known that hexachlorobenzene is present in the emitted off-gas.
- Polychlorinated biphenyls (PCB): Polychlorinated biphenyls (PCB) are a class of chlorinated semi-volatile organic compounds composed of 209 congeners. A group of 12 PCB, which exhibit 'dioxin-like' behaviour, has been identified by the World Health Organisation (WHO). The main contributor to the WHO-12 I-TEQ was PCB 126.
- Other PCB congeners found are PCB 28, 52, 101, 138, 153 and 180 which are known as the six Ballschmiter congeners [388, Fisher et al. 2005]. The toxicological purpose for the determination of the two sets of PCB is not the same. A common approach for an adequate estimate of the 'total PCB' (209) is to multiply the sum of the 6 Ballschmiter/DIN PCB by five.
- PCB emissions have been detected and measured at some EAFs. These measurements showed that different congeners have been determined. Values as low as 0.01 mg/t LS and as high as 5 mg/t LS have been reported. In addition, it is not known yet whether PCB can be formed by de novo synthesis during the process and/or within the off-gas devices. These uncertainties show that it is difficult if not impossible to draw general conclusions on the formation and decomposition processes of PCB in EAF off-gases.

- PCB may be present in the scrap input which could be the dominant source for the measured emissions. Regulations, for example as end-of-life electric equipment management, have greatly helped to prevent the introduction of items which contains PCB (for instance small capacitors in several technical devices like washing machines, dryers, cooker hoods, oil burners, fluorescent lamps, etc.). One investigation has shown that PCBs are practically not abated in bag filters. A recent study performed in Sweden has shown a correlation between dioxin-like PCB and PCDD/F but has also shown that the emission of PCB in terms of WHO-TEQ is far less important than the emission of PCDD/F.
- In general, it has been concluded that typical off-gas cleaning systems (e.g. filters, ESP, scrubbers) are more efficient at removing PCDD/F emissions than PCB. The compound-specific differences can be explained by differences in volatility between the congeners of the three compound groups. The variability in efficiency may be also due to the differences in the dust separation efficiency, gas temperature and adsorption properties of the dust.
- Polychlorinated dibenzo-p-dioxins and furans (PCDD/F) During the thermal treatment of scrap which contains paints, oils (e.g. cutting oils), PVC (polyvinyl chloride) or other organic substances, PCDD/F are released or produced during waste gas treatment and emitted into the atmosphere along with the furnace fumes. These emissions are especially important during the beginning of the scrap melting phase at the EAF, when the temperatures are still low. Even if downstream process temperatures are sufficiently high to destroy the PCDD/F, the PCDD/F generated during that initial phase will have an influence on its downstream generation.
- PCDD/F are generated as well by the combustion at low temperatures (250 – 500°C) of organochlorinated compounds that may be present in the charge as well as by de novo synthesis, catalyzed by metals (e.g. Cu and to a lesser extent Fe). Findings indicate that the temperature profile is more important than the mean temperature in determining the PCDD/F concentration in the waste gas. Regarding PCDD/F, there are many measurements available showing emission factors between 0.04 – 6 µg I-TEQ/t LS.
- Concentrations between 0.02 and 9.2 ng I-TEQ/Nm3 have been measured.

Figure 12 presents an example of the distribution of PCDD/F homologues in the off-gas of a twin shell EAF with scrap preheating before and after abatement. The PCDD/F homologues with four and five chlorine atoms dominate. With respect to the absolute PCDD/F emissions, there is a correlation between off-gas temperature and dust content.

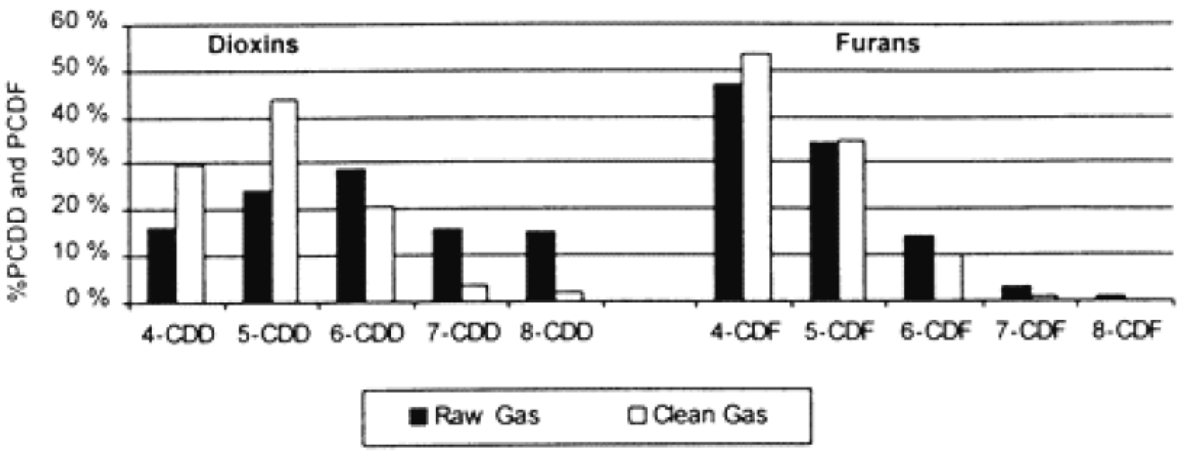

Figure 12: Distribution of PCDD/F homologues in the off-gas of a twin shell EAF with scrap preheating before and after abatement

Figure 13 indicates that as long as the clean gas temperature is below 75 °C, PCDD/F emissions will stay below 1 ng I-TEQ/Nm^3. The physical explanation of this pertains to the decrease of volatility of PCDD/F with decreasing temperature[xv]. At low temperatures, PCDD/F increasingly tends to adsorb to the filter dust.

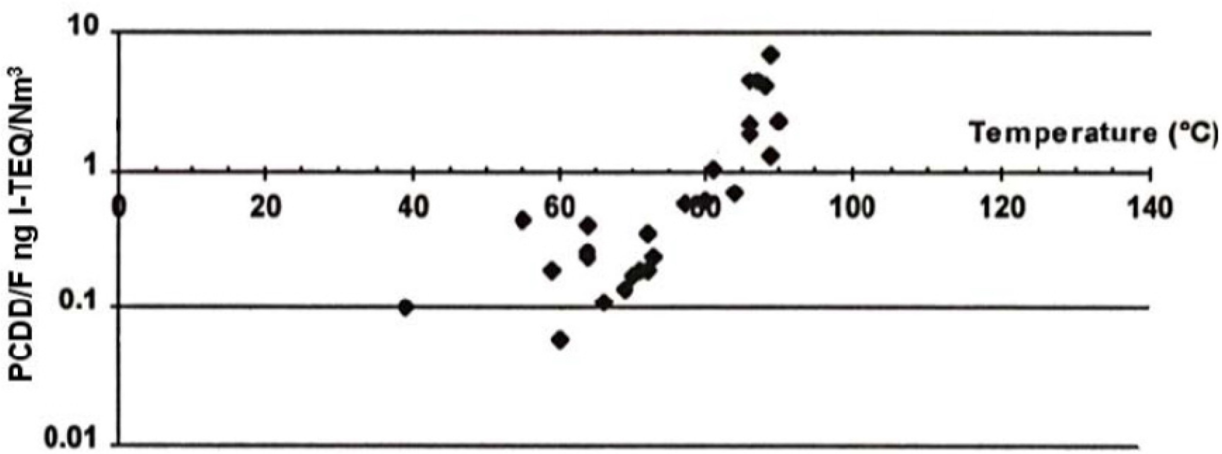

Figure 13: Correlation of PCDD/F emissions and temperature of the off-gas

Table 5 shows specific and annual emissions of PCDD/F and PCB to air from Swedish EAFs steel plants estimated from production in 2005[xv]. The reported values are according to the TEQ, using the latest weighting scheme by the WHO including both PCDD/PCDF and dioxin-like PCB. The contribution from dioxin-like PCB is mostly in the range of 10 – 20%. The TEQ is reported as an interval when some toxic congeners are below the limit of detection.

Table 5: Specific and annual emissions of PCDD/F and PCBs to air from Swedish EAF steel plants

Plant	PCDD/F (µg TEQ/t LS)	PCDD/F (g TEQ/yr)	PCB (µg TEQ/t LS)	PCB (g TEQ/yr)
A	0.67	0.29	0.22	0.096
B	0.41	0.025	0.04	0.002
C	0.091	0.008	0.015	0.0013
D	0.080	0.015	0.02	0.0034
E	3.7	1.8	0.42	0.21
F	0.056	0.015	0.012	0.0032
G	2.4	1.0	0.28	0.12
H	0.17	0.003	0.56	0.01
LS: Liquid Steel				

2.1.4.6 Emissions from Secondary Metallurgy Processes and Continuous Casting

Information about emissions from secondary metallurgy (mainly dust emissions) and from continuous casting is very limited. Dust emission factors reported before abatement from seven AOD/VOD refining installations between 6 and 15 kg dust/t LS and a single low figure of 1.35 kg dust/t LS. These seven installations have a de-dusting device independent from the de-dusting of EAFs.

The treatment of the collected off-gas flows from secondary metallurgy is performed in the same type of device, mostly in bag filters as primary and secondary emissions. Table 6shows some emissions concentration values for different parts of the secondary metallurgy after abatement.

Table 6: Emissions from different parts of the secondary metallurgy after abatement

Parameter	Primary de-dusting of ladle metallurgy units	Ingot casting and continuous casting (1)	Vacuum treatment and oxygen blow unit
SPM	0.6 – 1	0.5	4.1 – 13.2
Pb, Co, Ni, Se, Te	0.006		
Sb, Cr, CN, F, Cu, Mn, V, Sn	0.01	0.01 – 0.03	
(1) For stainless steel production only. Values are annual averages and in mg/Nm^3.			

2.1.4.7 Emissions from Scrap Preheating

The scrap preheating may lead to an important generation of organic pollutants due to the possible presence of organic substances on the scrap which are combusted during preheating under very unfavourable conditions[xv]. This can result in increased emissions of VOC and PCDD/F emissions. In this case, the off-gases need further after treatment, i.e. post-combustion.

2.1.4.8 Emissions from Slag Processing

If the slag is collected in a slag pot at the EAF, it needs to be poured into outside slag basins for solidification. The cooling of the slag may be enhanced by water sprays resulting in fumes. These fumes can be highly alkaline if the slag contains free CaO (see Table 7). This is very often the case. Alkaline depositions from the fumes may cause problems in the neighbourhood.

If the slag is poured on the floor, it is pre-crushed after solidification using excavators or shovel loaders and subsequently brought to an outside storage area[xv]. After a certain period of time, the slag is processed in crushing and screening devices in order to give it the desired consistency for separating metals from the slag and for its further use in construction.

Slag breaking and metal recovery can create dust emissions. The emission from crushing and screening should be extracted and subsequently cleaned. Water spraying can be applied at the conveyor belts transfer points. If the processed slag is stored, heaps can be wetted. During loading of broken slag, water fogs can be used to minimize dust emissions.

2.1.4.9 Slags from production of carbon steel/low alloyed steel/high alloyed steel

First a slag is produced during a process of melting steel scrap in an EAF by the addition of slag formers. During one or several ensuing processes, the raw steel produced in the EAF will pass subsequent treatments in converters and/or ladles. In this (these) process(es), ferroalloys are added to the liquid metal, and together with some additives (e.g. lime) basic slags are formed.

In contrast to EAF slag from carbon steel production, EAF slags from stainless steel production can have higher contents of heavy metals, which are, e.g. used as an alloying addition. The chemical composition of EAF slag from the production of carbon/low alloyed steel and stainless/high alloyed steel can be seen in Table 7.

Table 7: Chemical Composition of EAF slag from the production of carbon/low alloy steel and stainless /high alloy steel[xv]

Component (wt-%)	Carbon/low alloyed steel (1)			Stainless/high alloyed Steel (2)		
	Typical concentration	Lower Limit	Upper limit	Typical concentration	Lower limit	Upper limit
CaO	28	15	64	50	17	68
SiO_2	19	4	26	23	2	42
MgO	7	0.5	15.5	6	1.5	25
Al_2O_3	7	1	16.5	2.5	< 0.1	30
FeO	32	10	63	2	< 0.1	39
Cr_2O_3	1.8	< 0.1	11	2	< 0.1	22
F				2	< 0.1	9
MnO	5	0.5	19.5	1	< 0.1	21
TiO_2				0.8	< 0.1	3.5
Zn				< 0.1	< 0.1	2
P_2O_5	0.4	< 0.01	2			
Na_2O	0.2	< 0.01	2			
K_2O	0.14	< 0.01	2.5			

(1) Carbon/low alloyed steel: EAF C EINECS No: 294-410-9 CAS No: 91722-10-0.
(2) Stainless/high alloyed steel: EAF S EINECS No: 294-410-9 CAS No: 91722-10-0.

- The analytical information on ferrous slags is usually given in the form of oxides although components may occur in different mineral phases and different oxidation states.
- Components which usually have maximum concentrations <1 wt-% are not specified.
- The analysis relates not to aqua regia dissolution but to total digestion (see e.g. EPA 3052 or EN 13211:2001).
- In traces, other elements such as Pb, As, Sb, Hg, Cl, F and hexavalent chromium may also be present.

The rate of landfilling or recycling varies in the different Member States depending on legal requirements, availability of landfills, taxes, market situation, costs and possibilities to reuse processed slags. In the EU, a growing amount of slags from carbon and low alloyed steelmaking are used as secondary raw materials, mainly for road construction and for infrastructural measures in several applications. Slags from stainless steel production are generally less suitable for such uses and need to be landfilled. The percentage of the on-site recycling of slags from the production of high alloyed steels is significantly higher than for slags from carbon and low alloyed steelmaking. But still one third is landfilled and stored (see Table 8).

Table 8: Fate of EAF slags in EU

Kind of steel	Total slag quantity (kt/yr)	On-site recycling		External use		Sold		Landfilled and stored	
		(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)	(kt/yr)	(%)
Carbon steels (1)	958	-	-	164	17.1	362	37.8	432	45.1
Carbon steels (2)	1796	45.1	2.5	494.8	27.6	13.7	0.8	1242	69.2
Low alloyed steels (2)	444	-	-	61.6	13.9	108.0	24.4	261	58.9
High alloyed steels (2)	461	81.4	17.7	68.0	14.8	160.0	34.7	156	33.9
Total EAF slags (2)	2701	126.5	4.7	624.4	23.1	281.7	10.4	1659	61.4
Total EAF slags (3)	4408								

(1) Data from 11 plants producing 958 kt/yr of slags (131.7 kg/t LS) in 2008.
(2) Data from 57 plants producing 2.7 million t/yr of slags (133 kg/t LS) in 1996.
(3) Data from 2004 and related to the following EU countries: AT, BE, DE, DK, ES, FR, FI, LU, NL, UK, SE, SK.

2.1.4.10 Roof Monitors

Roof monitors are raised structures running along a ridge of a double pinched roof complete with manual or automated louvers to ventilate the area under the roof, and can occur in three different configurations; open, open except over the furnace and closed over the entire melt shop are possible. A variation includes a louvered roof monitor that can be controlled to lower and allow for closing during periods of fugitive emissions. Advantages include natural ventilation of the shop, however closed roof systems offer a more effective capture of emissions.

2.2 Ontario Industry Overview

As of 1999, there were 12 non-integrated steel mills in Canada, 4 of which were in Ontario:

- Hamilton Specialty Bar (2007) Inc., 319 Sherman Ave. N., Hamilton, ON, L8N 3R5
- Gerdau Ameristeel Corp., Cambridge Mill, 160 Orion Place, Cambridge, ON, N1T 1R9
- Gerdau Ameristeel Corp., Whitby Mill, 1801 Hopkins St. S., Whitby, ON, L1N 5T1

- Ivaco Rolling Mills 2004 Limited Partnership, 1040 Country Road 17, Box 322, L'Orignal, ON, K0B 1K0

In April 1995, a multi-stakeholder Strategic Options Process (SOP) was started to address emissions from mini mills and develop the recommended ways to manage them. The development of the Strategic Options Report (SOR) was released December 1997.

3.0 Summary of Dominant Source Analysis Methodology and Results

The purpose of this analysis is to identify the sources of emission that are the dominant contributors to point of impingement concentrations of a contaminant. The results of the analysis can be a key factor in the prioritization of air pollution control efforts; be used to eliminate lower priority sources from further review; and, correspondingly, prioritize capital and operating costs.

The dominant source analysis approach used to assist in the development of a technical standard for Mini-Mills involved the following basic approach that was applied to three operating Mini Mills in Ontario. The fourth mini mill was not operating it's melt shop at the time of the analysis.

- The use of the latest emission summary and dispersion modelling reports for each facility at the time.
- Emissions of all contaminants in question were estimated using the following methods:
  - Source testing
  - Melt shop Fugitive Dust Sampling Programs.
  - Slag Analysis and US EPA AP42 Ch. 12.5.
  - USEPA AP-42 Emission Factors and Facility Traffic Records for roads emissions.
- Point of impingement calculations modelled using AERMOD v. 12345 and regional meteorological data sets, all in accordance with the MOECC's modelling guidance document.
- The results from the above-noted modelling components of the all source analysis were used to identify the most dominant sources for further analysis within the development of a proposed technical standard for the Mini Mills.

The Dominant Sources that contribute to emissions of the various contaminants are outlined in the following table:

Dominant Source	Contaminants						Number of Facilities
	TSP	Mn	Ni	D&F	Cr	Cr6	
Roads (paved and unpaved)	X	X					3
Slag Processing, Screening/conveying, slag drop, slag transfer, storage piles.	X	X					2
All Melt Shop Fugitive Emissions (Doors and Vents)	X	X	X		X	X	3
Electric Arc Furnace	X	X	X	X	X	X	3
Alloy Processing	X		X		X		1

4.0 JURISDICTIONAL REVIEW

Ontario uses science and technology to generate limits and recommendations for environmental protection in the Local Air Quality Regulation (O. Reg 419/05). This approach allows for an analysis of facility specific areas of improvement, rather than prescribing specific technologies to all facilities. Different approaches are taken by other jurisdictions, therefore it is important to understand various other regulations, best available techniques (BATs), and control technologies available.

The contaminants of interest as indicated by the industry were studied in this jurisdictional review. The contaminants include manganese and manganese compounds (Mn), chromium and chromium compounds (hexavalent), chromium and chromium compounds (metallic, divalent and trivalent), dioxins, furans, dioxin-like PCBs and suspended particulate matter (SPM).

The jurisdictional review will also investigate best practices and controls that are used for the sources that emit the abovementioned contaminants. The regulatory review covers federal and provincial requirements in Canada, as well as the United States (US) and several of its states, the European Union (EU), and Australia. This includes the Canadian Council of Ministers of the Environment's (CCME) Canada Wide Standard (CWS) and Environment Canada's Codes of Practice. As discussed in section 2.0, Ontario is home to majority of the mini-mills in Canada. In the past, as outlined by Environment Canada's Code of Practice, Alberta, Quebec, Saskatchewan, Manitoba and Nova Scotia had at least one mini-mill in operation. For the US, New Source Performance Standards (NSPS) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) were addressed. Details are also given for the EU from their Best Available Techniques (BATs) and BAT Reference documents (BREFs).

4.1 Canada – Federal

4.1.1 Environment Canada Code of Practice (CoP)

Environment Canada's Codes of Practice[xvii] aim to outline environmental concerns as well as make recommendations that preserve and enhance the quality of the environment. A Code of Practice exists for Non-Integrated Steel Mills or Mini Mills, which outlines sources of interest in terms of emissions, recommended controls and best environmental management practices.

4.1.1.1 Emissions Management

Efforts to manage the emissions released from Mini Mill facilities should reduce the environmental impact caused by releases of emissions. The CoP suggests using emission control devices like fabric filters that are generally technically and economically feasible. The recommended emission limit after emission control devices for particulate matter (PM) is 20 mg/Nm^3 or <150 g/tonne raw steel product and is used as a performance measure. One method to confirm pollution control equipment meets an emission limit can be to use regular testing that follows Method 5D in the Ontario Source Testing Code (OSTC)[xviii]. The recommended sources to control include primary steelmaking, secondary steelmaking, scrap operations, tapping and slagging operations, slag transfer and processing, hot metal transfer, furnace operations and continuous casting operations.

It is also suggested that an ambient air quality monitoring program be developed and implemented with the regulating authority. This plan should be amended from time to time in order to capture potential changes in processes, meteorological conditions or facility layout. Specific mention is made for monitoring particulate matter.

Controlling fugitive emissions is also a recommended practice which is suggested to include enclosures or hooding with emission controls, developing operating practices for operations that are unable to be enclosed, and develop criteria for building, working and maintaining bulk-material and slag storage piles.

4.1.1.2 Fugitive Air Emissions Best Practices

Environment Canada has completed a CoP for the Reduction of Fugitive Emissions of Particulate Matter and Volatile Organic Compounds (VOCs) from the Iron, Steel and Ilmenite Sector. This CoP focuses on fugitive emissions and best practices that include good housekeeping and other documented procedures for all processes in mini mills. Collection and control of process air emissions are recommended to have emission control technology that are designed, operated and maintained on the basis of sound engineering. This includes minimizing releases to ambient air in the event of operational upsets. The emission control equipment should also be monitored and inspected regularly. The inspection procedure as well as the results should be documented and maintained. Specifically, the collection efficiency of the control equipment should be documented to ensure emission control and equipment performance. Material handling and storage including slag can also be a large source of fugitive emissions. Some aspects to consider monitoring include:

Handling:

- Height of loading, unloading and stockpiling equipment to minimize drop height
- Moisture content of materials – a best practice is to spray water on materials/equipment Limit material handling based on wind conditions
- Pave yards and roads, or limit vehicle speed on unpaved roads
- Spray water or dust suppressant on road surfaces
- Grow vegetation on open areas
- Install wind barriers noting wind direction
- Keep doors and openings closed to prevent dust from escaping Storage:
- Use large piles to minimize total surface area
- Store finer particles in the base and coarser materials on the top
- Set the orientation in the direction of prevailing winds
- Minimize pile ridges
- Install wind barriers
- Spray water
- Cover or seal stockpiles

4.1.1.3 Electric Arc Furnace (EAF)

Environment Canada recommends having a complete enclosure, or hooding equipped with emission controls over the charging and tapping operations in a controlled area with maximum efficiency. It is also important to cover the ladles that contain molten metal and enclosing the filter dust collection/discharge. Continual improvement of the baghouse should be explored, and a scrap management program should be put in place to minimize contaminants in feed material. This program should include removing non-ferrous contaminants and scrap with excessive dirt, oil and grease.

4.1.1.4 Continuous Casting

The area where the tundish is filled should be enclosed or have hooding with emission controls, and capture efficiencies should be maximized. Ladles containing molten metal should be covered.

4.1.1.5 Hot Rolling and Cold Forming

Oil spills and leakages should be collected and intercepted for disposal in an environmentally responsible system. Minimizing oil inputs is ideal.

For cold forming only, the entire process should be enclosed or hooded with emission controls. There should also be an oil mist emission collection system in place to collect and capture rolling oil mists.

4.1.1.6 Best Management Practices

The Best Management Practices suggested by Environment Canada's CoP are defined as activities, actions, processes and procedures that extend beyond legal requirements to ensure a minimal impact on the environment by facilities. An integral aspect of best management practice plans is the idea of continuous improvement. These recommendations are in accordance with the policies and principles of Environment Canada, Canadian Council of Ministers of the Environment (CCME), the provinces, the International Iron and Steel Institute (IISI) and the Canadian Steel Producers Association (CSPA).

Similar to the requirements of ISO 14001, facilities are encouraged to implement an Environmental Management System (EMS). It is also recommended to develop and implement an environmental policy statement. Facilities may also undertake an environmental assessment that is a self-assessment process that should be done during the early stages of new development, project planning and decommissioning. It is an iterative process that occurs through the lifetime of the project and special consideration should be given to valued ecosystem components (VECs) like air quality. Pollution prevention planning is also a recommendation given by this CoP in order to minimize or avoid environmental releases.

4.1.1.7 Performance Measures, Reporting and Record Keeping

Environment Canada suggests that performance measures as well as procedures for monitoring and reporting should be documented to include the following:

- Identification of parameters to be monitored, and sampling frequency
- Definition of procedures and protocols to be followed

- Actions to be undertaken when limits have been exceeded
- Quality assurance/quality control of monitoring data

Additionally, under the authority of the Canadian Environmental Protection Act (CEPA) owners or operators of facilities that meet published reporting requirements are required to report to the National Pollutant Release Inventory Program (NPRI).

Environmental auditing is also a check that can be done to ensure conformance with regulations, and identify areas of improvement.

No specific performance measures were given for mini mills, but the life cycle management should include a record of the types of materials used, sources of supply materials and energy, packaging and waste. An environmental performance data sheet can be used as provided by this CoP to keep track of potential performance measures of interest. It is also recommended that a community advisory panel be established to address facility operations, environmental concerns and community involvement.

4.1.2 Canadian Council of Ministers of the Environment (CCME)

The CCME is an intergovernmental forum that is minister-led and works collaboratively to tackle national and international environmental concerns. The CCME develops Canada Wide Standards (CWSs) with the intention of avoiding or minimizing the creation of pollution. In the CWS for dioxins and furans[xix,xx], research was conducted on pollution prevention options for steel manufacturing electric arc furnaces.

4.1.2.1 Emissions Management

Best available control technology was identified in the CWS for dioxins/furans by the CCME. These include high efficiency fabric filter baghouses that are connected to capture systems, therefore reducing the PM emissions along with the dioxins/furans emissions. The emission tests of Canadian EAFs reported total SPM emissions as low as 2 mg/Nm^3. The set out a tolerable limit of 400 µg/m^3 for a 24-hour averaging period and a desirable limit of 60 µg/m^3 for an annual averaging period.

Research done on European EAFs has shown that injecting activated carbon or other adsorptive material into the off-gas stream of baghouses reduced the emissions to less than 100 pg I-TEQ/Nm^3.

Lastly, selective catalytic reduction (SCR) technology, usually used for NOx removal, has been shown to reduce dioxin/furan emissions to less than 100 pg I-TEQ/Nm^3.[xxi] SCR dioxin reduction is considered an emerging technology and has not yet been proven for use with the electric arc furnace.

Mercury found in automotive control switches was also identified as a potential area of emissions reduction.

The current CWS dioxin/furan emissions limit is 100 pg ITEQ/Rm^3 for all EAF steelmaking facilities (both existing and new or expanding).

4.1.2.2 Best Management Practices

Pollution prevention techniques were identified specifically for the reduction of dioxin/furans, however these practices would reduce other contaminants of interest as well, including PM.

Raw material quality is an aspect of the steelmaking process that can reduce the production of dioxins/furans. It is best practice to remove contaminants from steel scrap including oil, plastics, other hydrocarbons, and mercury contained in automotive switches. Scrap quality control programs and scrap regulation should be used as a pollution prevention technique.

The EAF operation also has potential to create significant emissions of contaminants, and thus would benefit from pollution prevention techniques. These practices would be best associated for when the EAF roof is open for charging, and during operational delays. Also, since some dioxins/furans adsorb onto particulate matter or are in the form of fine particulate matter, fabric filter baghouses require bag leak detectors, off-gas entry temperature monitoring, preventive maintenance and continual improvements on design and operation.

Inadvertent releases of collected dust can also be minimized by keeping transfer in enclosed containers, enclosing the area in which collection and discharge of baghouse dust occurs, and disposing the dust in an environmentally responsible way.

4.1.2.3 Summary of Performance Measures, Reporting and Record Keeping

In accordance with the Canada Wide Standard (CWS) for dioxins and furans, operating practices and conditions should be recorded and included in emission testing programs and reports. This is used to assess the effectiveness of certain pollution prevention techniques and potentially identify new ones.

4.1.2.4 Dioxins and Furans Formation

Research and findings from the CWS show that increased formation in dioxins/furans occurs unless the entry temperature to the gas conditioning system is above 800°C, the exit temperature is below 225°C and the gas temperature transit time is short. This can be a performance measure that is monitored continuously, in order to give an estimate of dioxin/furan emissions.

4.2 Canada – Provincial

Thanks to the CCME, most of the provinces in Canada that have mini mill facilities follow the CWS for dioxins/furans and electric arc furnaces. This is the case for Saskatchewan, Manitoba and Nova Scotia. Under the CWS for dioxins/furans, source testing is performed annual but allows for a reduction in testing frequency to every other year if the concentration of dioxins/furans remained consistently below 32 pg/Rm3 as I-TEQ for 5 consecutive years and continues to remain below that threshold.

Additional requirements were found for existing facilities. For examples, source testing for dioxins/furans have been included in Environmental Compliance Approvals in Ontario, Memorandum of Understanding in Manitoba and voluntary agreement in Alberta with varying frequency of source testing appearing to range from annual to every 5 years.

4.2.1 Alberta

Alberta's Environmental Protection and Enhancement Act[xxii] endorses the CWS for fine particulate matter for 30 µg/m^3 and for total suspended PM, the standard is 100 µg /m^3 for a 24 hour average and 60 µg/m^3 annually.

Key principles were developed for management of industrial emissions to the atmosphere which can be managed through environmental assessment, approvals and enforcement. These best practices include designing and operating a facility for pollution prevention, sources of emissions must be controlled by high level technology considering economic factors, emissions must be dispersed through a stack and all emitting sources should strive to improve their performance with upgrades. Another key note is that cumulative impacts must be monitored and must not exceed the assimilative capacity of the airshed.

4.2.2 Saskatchewan

Saskatchewan's C-12.1 Reg. 1[xxiii] created in 1989 and the review conducted in 2003 endorse the CCME CWS for dioxins/furans. The annual suspended PM limits are 120 μg/m^3 (24 hour) and 70 μg/m^3 (annual). Specific opacity limits exist in Saskatchewan where industrial sources shall not release an air contaminant that exceeds 40% opacity averaged over 6 minutes continuously. It is also indicated as important to document a description of raw materials and efficiency for burning equipment.

4.2.3 Manitoba

Manitoba's Ambient Air Quality Criteria[xxiv] created in July 2005 endorses the CCME CWS for dioxins/furans. The suspended PM limit for a 24 hour average is 120 µg/m^3 and for an annual average is 70 µg/m^3.

4.2.4 Quebec

In Quebec's Clean Air Regulation, chapter Q-2, r.4.1 Schedule K[xxv], air quality standards show the value for total particulates as 120 µg/m^3 over 24 hours. In Division IV, opacity standards state that contaminants discharged from stationary sources to the atmosphere must not exceed 20% opacity. For steel mills in general, the particle emission standards are that with a feed rate equal to or less than 5 tonnes/hour, the plant must not emit more than 5.9 kg of particles/hour.

There is also a note for the presence of local ventilation systems for activities such as casting. The standard is to have a concentration of less than 30 mg/Rm^3 of particles for each emission point.

Suggested monitoring practices include having continuous leak and malfunction detection devices. As well, it is required that once a year, samples of the stack gases are taken and every 3 years, samples of the gases in the building with furnaces be taken as well to analyze their concentration.

4.2.5 Nova Scotia

Nova Scotia's Air Quality Regulations under section 112 of the Environment Act[xxvi] endorses the CCME CWS for dioxins/furans. The mini mill facility was located in Sydney which has an Air Quality Health Index accessible online:

http://weather.gc.ca/airquality/pages/nsaq-003_e.html. The suspended PM limit is also 120 µg/m^3 for 24 hours and 70 µg/m^3 annually.

4.3 United States Environmental Protection Agency (US EPA)

The United States Environmental Protection Agency (US EPA) regulates various industries including steel manufacturing. National Emission Standards of Hazardous Air Pollutants[xxvii] (NESHAP) and New Source Performance Standards (NSPS) are used for rulemaking in the US. For mini mills, the most applicable sources of emissions that relate to Iron and Steel production are the EAF, fugitive emissions from the entire process and any monitoring/reporting that is required.

4.3.1 National Emissions Standards of Hazardous Air Pollutants (NESHAP)

Facilities that operate an EAF steelmaking facility are subject to subpart YYYYY – National Emission Standards for Hazardous Air Pollutants for Area Sources: Electric Arc Furnace Steelmaking Facilities. This subpart applies to new and existing sources. This subpart tackles many of the common processes found in mini mill facilities for example scrap management, melt shop including the EAF, and monitoring environmental performance measures.

4.3.1.1 Scrap Management

A pollution prevention plan is for raw material storage and handling in order to control the contaminants found in steel scrap. It is important to control chlorinated plastics, lead and free organic liquids, as well as automotive scrap with oily parts or mercury switches. In order to enforce this, a plan for metallic scrap selection and inspection shall be submitted for approval. This plan shall include inspecting for the abovementioned contaminants, as well as metallic scrap that is restricted: motor vehicle bodies, engine blocks, oil filters, oily turnings, machine shop borings, transformers and capacitors containing polychlorinated biphenyls (PCBs). Specifically to avoid mercury emissions, a site-specific plan should be submitted for approval with vendor collaboration. Facilities can also choose to participate in an approved mercury program where companies specifically remove mercury switches, choose only specialty metal scrap, or choose scrap that does not contain motor vehicle scrap. Another common requirement could be to test for radiation in the scrap, or at least some form of visual inspection.

4.3.1.2 Process Emissions

Most emissions identified in the NESHAP are from the EAF. After controls are placed on the EAF, the gas cannot contain more than 0.0052 gr/dscf of PM. Facilities may choose to comply with this standard or if it has a production capacity of <150 000 tons/year, then the discharge must be less than 0.8 lbs/ton. In addition, the facility must not exceed 6% opacity.

As such, there are also various requirements placed on EAFs with details on the controls to be placed, as well as the compliance performance tests. Facilities must install, operate and maintain a capture and control system that collects any emissions from EAFs. This includes charging, melting and tapping. In order to demonstrate compliance with the applicable emission limits, facilities must conduct compliance performance tests.

Standards were also proposed based on generally available control technology (GACT) for the control of hazardous air pollutants such as chromium, manganese and nickel from area source electric arc furnace steelmaking facilities. The maximum achievable control technology (MACT) based regulation outlined in NESHAP can be based on emission reduction through reducing the production, substituting materials, enclosing systems, collecting and treating pollutants, or a combination of the aforementioned.

Some of the most common types of such capture systems for ladle metallurgy are canopy hoods, side draft hoods, and close fitting hoods. EAF emission collection involves direct-shell evacuation control (DEC) systems, canopy hoods, side draft hoods and tapping hoods. Most plans direct the captured emissions to a baghouse which are highly efficient for PM control. The US EPA correlates the capture of PM to metals emission reduction since hazardous air pollutant metals can be found in particulate form.

4.3.1.3 Monitoring and Reporting

As mentioned for scrap management, it is a good practice to document procedures with vendors that show inspections and agreements related to unsuitable scrap. These procedures are also important for inspections and audits of a facility's emissions management system.

Another important document that could lead to future inspection is the site-specific plan. Other items that should be documented through the process include:

- Communications with scrap providers/purchasers requesting mercury free scrap
- Confirmation from providers that scrap meets the specifications
- Periodic inspections to check the plan implementation
- Corrective actions that took place
- Estimates of the number of mercury switches removed from scrap (with a goal of 80% removal)

4.3.2 New Source Performance Standards (NSPS)

As part of the US Code of Federal Regulations (CFR), title 40, volume 7, part 60 subpart AA and AAa, standards were first promulgated in 1975 and most recently amended in 2005. They specify the performance of electric arc furnaces in steel plants for facilities constructed on or before August 17, 1983 or after August 17, 1983 respectively. Subpart AAa contains more relevant information for the best practices in NSPS. The rules are similar to those of the NESHAP however, has more focus on operation and maintenance of the systems in place, as well as the monitoring of performance measures.

4.3.2.1 Process Emissions

For the EAF itself, the gas exiting from the control device must not exceed 0.0052 gr/dscf. The opacity limits are outlined as three different values depending on the exit location of the gas. Table 9 shows the process exit point and the related opacity limit.

Table 9: Opacity limits for various process exit points

Process exit point	Opacity Limit
Control Device	3%
Shop (EAF Operations)	6%
Dust Handling Equipment	10%

These limits now include charging and tapping time, whereas in subpart AA, the opacity limit during charging was 20% and the opacity limit during tapping was 40%.

A bag leak detection system is also to be installed and continuously operated if opacity is not continuously monitored. This is for operation on single-stack fabric filters and must be capable of detecting 1mg/m^3. This should continuously record the output of PM, and for negative pressure, induced air and positive pressure baghouses, the sensor should be installed downstream of the baghouse itself and upstream of wet scrubbers if applicable.

4.3.2.2 Performance Measures

Several performance measures should be noted and records should be kept as well. These can help demonstrate if a process is operating out of specifications or within a range that would contribute to emissions.

Some options of operating parameters to measure and record are as follows:

- If a DEC system is being used, the facility should check the furnace static pressure once per shift.
- System fan motor amperes and damper positions, as well as a continuous record of volumetric flow rate through each separately ducted hood
- Install, calibrate and maintain a monitoring device to record volumetric flow rate at the control device inlet, and damper positions once per shift

These measurements would be submitted to the regulating authority for approval and can be found within a site-specific monitoring plan.

If emissions are controlled using a DEC system, the facility should use a monitoring device that records pressure data for 15 minute integrated averages. The accuracy must be within +/- 5mm of water (gauge pressure). The device should be placed in the EAF or DEC system before ambient air is introduced.

4.3.2.3 Monitoring and Reporting

Opacity is an aspect of operation that can be monitored, and is also indicative of emission control performance that is not directly related to the EAF. It is recommended by the NSPS that visible emission observations be conducted at least once a day for three 6 minute periods. The ideal time to monitor this would be during the melting and refining period where the furnace is running, using method 9.

Alarms should be employed to alert the facility of equipment malfunction or required replacements. If any percentage of opacity other than zero is observed over four consecutive 15 second intervals the alarm should sound, otherwise this would be a sign to adjust the sensitivity (should be once per quarter). The sounding of this alarm indicates that there is an increase in relative particulate loading and action is required. The potential action steps include inspecting baghouses for air leaks, seal off defective bags, or to clean the bag leak detection system probe.

If these opacity monitoring requirements are fulfilled, furnace static pressure monitoring devices are not required on any EAF that are equipped with DEC systems. Shop opacity data should be determined as the arithmetic average of 24 consecutive 15-second observations as per method 9. Facilities should record any points where visible emissions occurred. If multiple emission occurred at once, the highest opacity that directly relates to the cause or location should be documented.

This continuous monitoring system for opacity is not required for:

- Control devices that are for dust handling systems
- Modular, multi-stack, negative pressure or positive-pressure fabric filters if the opacity is measured through visual checks
- Any single-stack fabric filter as long as visual checks are done and a bag leak detection system is in place

In Summary, there are 3 different parameters to measure: emissions with bag leak detection systems, pressure or opacity.

4.4 United States Regions

4.4.1 Michigan Department of Environmental Quality (DEQ)

As part of the Federal Hazardous Air Pollutant Standard[xxviii], there were certain rules developed again for EAF steelmaking area sources. If it is a new piece of equipment, facilities must conduct initial performance testing to show that the EAF does not exceed the PM emission limit. This standard also follows the CFR Part 64 for Compliance Assurance Monitoring (CAM). Facilities are also required to conduct opacity testing, and the records for the CAM requirements should be kept in a facility's Title V permit for 5 years. Control equipment shall also be monitored as outlined in CAM.

Monitoring design criteria as per CAM includes:

- Designing the monitor to obtain data for one or more indicators of emission control performance; this includes visual indicators such as opacity, or process parameters
- Establishing appropriate ranges that reflect proper operation and maintenance of the control device and capture system
- Verification procedures to confirm operational status of the monitor prior to collecting data
- Specifying an appropriate period of time for data to be collected/measured
- If continuous emission monitoring systems (CEMS) or continuous opacity monitoring systems (COMS) are used, an indicator range must be decided on that is appropriate to the process and the contaminants being emitted

All indicator ranges shall be submitted along with testing plans and any other related components to the regulating authority.

4.5 European Union

The European Union (EU) is a partnership between 28 European countries that fosters economic cooperation and helps to raise living standards[xxix]. Best available techniques (BATs) were developed as part of the BAT Reference Document (BREF)[xxx] for Iron and Steel Production. A technical working group (TWG) was used and supported by the European Integrated Pollution Prevention Control (IPPC) Directive in order to decide on these BATs. Criteria for selecting these BATs include:

- Identification of best environmental performance levels on the basis of available data in the EU and worldwide
- Examination of the conditions under which these environmental performance levels were achieved
- Selection of appropriate emission levels and the associated monitoring for this sector according to Article 3(10) of and Annex III to the Directive

Note that developing BATs is a dynamic concept and therefore the review of BREFs is continually changing. Currently the BREF includes information on controlling process emissions, material management, and monitoring practices.

4.5.1.1 Process Emissions

The BAT is outlined for the EAF including scrap preheating, charging, melting, tapping, ladle furnace and secondary metallurgy such that all emission sources should be extracted efficiently, as well as controlled by a bag filter. The emissions must follow one of the following means of extraction from the processes and directed to a bag filter:

- Direct off-gas extraction (4th or 2nd hole) in combination with hood systems
- Direct gas extraction and doghouse systems (enclosed space with air extraction system)
- Direct gas extraction and total building evacuation

The overall collection efficiency shall be greater than 98% with less than 5 mg/Nm^3 emitted as a daily average of dust. The mercury limits are less than 0.05 mg/Nm^3. For the same processes, other BATs were developed for reducing the amount of polychlorinated dibenzodioxins/furans (PCDD/F) and polychlorinated biphenyls (PCB). These include:

- Post-combustion
- Rapid quenching
- Injection of adsorption agents into the duct before dedusting

The limit is 0.1 ng I-TEQ/Nm^3.

Even before any EAF steelmaking is operating, there is potential for PM emissions through material handling, slag processing and material transportation. The BATs identified can be used in combination to reduce dust emissions before they reach the abovementioned processes.

- Transport untreated slag by shovel loaders
- Wetting the conveyor transfer points or extracting broken material
- Wetting slag storage heaps

The associated BAT emission level for PM is 10-20 mg/Nm^3.

4.5.1.2 Material Management

There is a strong focus on material management within the BREF, as storage piles can be significant source of emissions and material management can reduce the propagation of emissions in later processes. Hence, it is important to optimize the management and control of internal material flows wherever possible. Storage, handling, and transportation or materials are key aspects where emissions can be reduced.

Scrap inspection can reduce undesired metals from emission later in the process, for example, mercury, which has been mentioned by other jurisdictions. The BATs recommended are:

- List acceptance criteria specific to the production profile in purchase orders for scrap
- Have a good knowledge of scrap composition, or perform a melt test to characterize the scrap composition
- Check deliveries for undesired scrap
- Store scrap according to different criteria and with minimized chance of release to the atmosphere for example using a roof, or ensuring surfaces are impermeable Note that scrap sorting can benefit the process, as unwanted scrap can be identified and removed then as well (like mercury switches in automobiles)
- Have an operation and management plan detailing the abovementioned

Scrap specifications are classified into 6 categories: old scrap, new uncoated scrap with low residuals, shredded scrap, steel turnings, high residual scrap and fragmentized scrap from incineration. Scrap separation not only has environmental benefits, but health and safety benefits as well. Flammable, radioactive or explosive material may also be sorted out in this process.

Handling and transporting bulk raw materials has specific techniques as well for the prevention of PM releases.

- Long stockpiles should be oriented in the direction of prevailing winds
- Wind barriers or natural terrain like trees could be used to provide shelter
- The moisture content of material delivered should be controlled
- Long unclosed drops should be avoided
- Containment should be provided on conveyors and in hoppers

- Dust suppressing sprays or water can be used Equipment should be well maintained and up to standard
- Cleaning and damping of roads should be at high standard in terms of housekeeping
- Dust extraction coupled with bag filters should be used where applicable

Delivery, storage and reclamation control techniques include:

- Total enclosures
- Limiting drop heights to 0.5 m
- Using water sprays
- Storage bins with filter units
- Using just in time delivery
- Height and shape restrictions of stockpiles
- Use windbreaks or natural terrain to capture and absorb dust without suffering long term harm
- Cover stockpiles with tarpaulins or coating

The processes within a mini mill facility also include transporting lime, carbon and other raw materials. Another BAT is to transport these materials in sealed bags or transporting them pneumatically. There are also many suggestions for minimizing the dust emissions from travel on roads. Roads should be paved where applicable or a water/dust suppressant spray should be used periodically. Transport vehicles should also be covered when transporting materials. Transfers should be minimized and using tubular conveyors is a good practice.

4.5.1.3 Monitoring and Reporting

A general technique for pollution prevention is to develop an environmental management system (EMS). Specifically, this system should include a dust action plan that details the methods used to reduce PM emissions from all processes in the facility.

A consideration for temporary cessation of operations during high PM_{10} emissions should be made. This decision can be achieved by having sufficient PM monitors that also monitor wind direction and strength. This allows facilities to locate the source of emissions and find a solution when necessary.

A BAT is to measure all relevant parameters that are necessary for efficient plant operation and minimal emissions. This information should be collected on computer based systems in order to optimize processes online and identify issues quickly. Continuous measurements should be made for:

- Primary emissions of dust, NOx, and SO_2
- Dust emissions from large electric arc furnaces

A facility may also consider monitoring parameters that affect mass flow and emission characteristics. Stack emissions can be measured by regular, discontinuous measurements to obtain representative emissions values. The polychlorinated dibenzodioxins/furans (PCDD/F) should be sampled during steady state conditions using a random sample that lasts 6-8 hours.

4.6 Australia

In Australia, State and Territory Governments agreed to the National Environment and Protection Measure for Ambient Air Quality through the National Environment Protection Council[xxxi, xxxii, xxxiii]. This measure sets legally binding air quality standards for each level of the government. Thus the jurisdictions within Australia put strategies in place in order to achieve the emission limits set in the standard. These standards relate to 6 criteria air pollutants: carbon monoxide, nitrogen dioxide, photochemical oxidants, sulphur dioxide, lead and particles. The relevant PM emissions and emission reduction measures were explored further within the Australian jurisdictions.

As part of the Air Environment Protection Policy, there are various methods of environmental management. Several environmental management instruments are:

- Environmental improvement plan: improve the environmental performance of an activity to achieve a best environmental practice
- Environmental Audit: similar to an environmental assessment on activities that cause harmful impacts to the environment
- Environment Protection Order: issued if a person or facility has breached the Environmental Management Authority (EMA)
- Emergency plan: deals with foreseeable but unplanned emissions to the environment
- Financial Assurance: provided to EMA to remedy environmental harm caused by authorised activity

4.6.1 South Australia

As part of the Environment Protection (Air Quality) Policy 1994[xxxiv], mini mills are addressed by stack emissions limits in Schedule 1 applying to any process using a plant to heat metals or metal ores (other than cold blast cupolas). The maximum particulate matter concentration taken before mixture with air is a total of 100 mg/m^3, including smoke or other gases.

Foundries include similar processes to mini mills, and foundries are subjected to specific maintenance, recording and opacity rules. The facility must carry out tests for emissions and keep records dependent on the specific notice from the Authority. Facilities must maintain and operate fuel burning equipment efficiently. The opacity from the chimney (or stack) where emissions are exiting should not be darker than Shade 1 on the Ringelmann Chart or the Miniature Smoke Chart (specific charts used for measuring opacity).

Temporary exemptions are granted for facilities that are implementing environmental improvement programs in order to bring the facility into compliance.

4.6.2 New South Wales

New South Wales uses the Protection of the Environment Operations (Clean Air) Regulation[xxxv] to regulate the air impurities emitted from activities and plants. Part 5 of the regulation includes dioxins and furans, hexavalent chromium compounds, and other metals.

4.6.2.1 Process Emissions

Certain exemptions exist for start-up and shutdown periods; however the facility is still responsible for preventing and minimizing air pollution. Facilities are also responsible for any mixing stream of pollutants, as well as all points of emission whether controlled by pollution control technology or not.

Destruction efficiency of an air pollution control device must be determined for any type of treatment with the exception of flares. If the air impurity contains any principal toxic air pollutant as listed by the regulation such as dioxins or furans, the destruction efficiency of the control technology must be greater than 99.9999%, otherwise, greater than 99.99%.

4.6.2.2 Performance Measures

Specific performance measures are given for afterburners and combustion applications. If an afterburner is used, the residence time should be more than 2 seconds if the material entering was from a toxic air pollutant. Otherwise, it should be more than 0.3 seconds. This procedure will also use a 1 hour rolling averaging period.

Combustion temperature in an afterburner must be more than 980 °C if the impurity originates from a toxic air pollutant or 760 °C for any other case.

4.6.3 Jurisdictional Review Summary

A review of the jurisdictional review process can be found in the following three tables. Table 10 outlines the jurisdiction, related regulation and the associated limits. Table 11 summarizes the best practices for process emissions and Table 12 summarizes the requirements and suggestions for monitoring and reporting for mini mill facilities.

Table 10: Summary of regulations and related emission limits for relevant jurisdictions

Jurisdiction	Guideline	Year	PM	Dioxins/Furans
Environment and Climate Change Canada	Environmental Code of Practice for Non-Integrated Steel Mills	EPS 1/MM/8 2001	20 mg/Nm³ or <150 g/tonne raw steel	
Environment and Climate Change Canada	Code of Practice to Reduce Fugitive Emissions of Total Particulate Matter and Volatile Organic Compounds from the Iron, Steel and Ilmenite Sector	April 2016	Best practices	
CCME	Canada Wide Standard (CWS)	2003		100 pg I-TEQ/Nm³
Alberta	Ambient Air Quality Objectives and Guidelines	2013	PM 2.5, 24hr - 30 µg/m³ 24hr - 100 µg/m³ Annual – 60 µg/m³	Endorses CWS
Quebec	Clean Air Regulation (Chapter Q-2, r.4.1) Division IV and Schedule K	2015	24hr - 120 µg/m³ Or <1.18 kg /tonne steel (<5 tonnes/hour facility)	
Saskatchewan	C-12.1 Reg .1	1989	24hr - 120 µg/m³ Annual - 70 µg/m³	Endorses CWS
Manitoba	Ambient Air Quality Criteria	2005	24hr - 120 µg/m³ Annual - 70 µg/m³	Endorses CWS
Nova Scotia	Air Quality Regulation section 112 of Environment Act	2010	24hr - 120 µg/m³ Annual - 70 µg/m³	Endorses CWS
NESHAP	Subpart YYYYY	2012	0.0052 gr/dscf or if the facility has a production capacity of <150 000 tons/year then <0.8 lbs/ton	
NSPS	US CFR, title 40, volume 7, part 60, subpart AA and AAa	2012	0.0052 gr/dscf	
Michigan DEQ	Federal Hazardous Air Pollutant Standard	2008		
European Union	Best Available Techniques (BAT) Reference Document for Iron and Steel Production	2012	24hr - 5 mg/Nm³	0.1 ng I-TEQ/Nm³
South Australia	Environment Protection (Air Quality) Policy	1994	100 mg/m³	
New South Wales	Protection of the Environment Operations (Clean Air)	2021		

Table 11: Summary of best practices for process emissions in relevant jurisdictions

Jurisdiction	Fugitive Emissions	Emissions from Raw Material and By-Products	Control Equipment	Management
Environment and Climate Change Canada	-Complete hooding, enclosures, linked to control devices -Operating practices for operations that are unable to be enclosed -Good housekeeping	-Develop criteria for building, working and maintaining bulk-material storage piles -Minimize drop height, moisture content, wind consideration, covers -Scrap management program	-Complete hooding, enclosures -Dust collection, Baghouse	-Develop Best Management Practices (BMPs) -Develop an Environmental Management System (EMS) -Optional voluntary Environmental Assessment
CCME		-Mercury switch removal as part of scrap quality control programs	-High efficiency fabric filter baghouses, connection to capture systems -Activated carbon injection -Selective catalytic reduction (SCR)	
Alberta			-High level technology considering economic factors -Emissions dispersed through a stack	-Environmental Assessment, approvals and other types of enforcement
Quebec	-With local ventilation systems the concentration at each emission point should be < $30mg/Rm^3$			
NESHAP	-Canopy hoods, side draft hoods, close fitting hoods, DEC, tapping hoods	-Develop a pollution prevention plan for raw material storage and handling (include inspection and scrap selection) -Mercury removal program	-Capture and control system (baghouse) that collects emissions from melt shop processes -Substitute materials, enclose systems, collect and treat pollutants (combination)	-Emissions management system
NSPS	(Complimented by NESHAP)	(Complimented by NESHAP)	(Complimented by NESHAP)	(Complimented by NESHAP)

European Union		-For slag processing (by-product), the following is recommended: transport untreated slag by shovel loaders, wetting conveyor or transfer points or extracting broken material, wetting slag storage heaps -Strong focus on material management; consider: wind direction, moisture, enclosures, covers, dust suppressing sprays, just in time delivery, limiting drop height to 0.5 m	-Emissions from the processes should be extracted efficiently and controlled by a bag filter -For PCDD/F the following can be used individually or in combination: post-combustion, rapid quenching, and injection of adsorption agents into the duct before de-dusting -Emissions from the processes should be extracted efficiently and controlled by a bag filter: Direct off-gas extraction with a hood system, doghouse system, or total building evacuation	-Develop an operation and management plan -General technique for pollution prevention is to develop an environmental management system
South Australia				-Exemptions are granted to facilities with Environmental Improvement programs in place
New South Wales			-for new and altered sources destruction efficiency of control technology must be greater than 99.9999% or 99.99% if a principal toxic air pollutant is present, as listed in the Protection of the Environment Operations (Clean Air) Regulation	

Table 12: Summary of recommended monitoring and reporting practices for relevant jurisdictions

Jurisdiction	Monitoring Programs	Performance Measures	Reporting and Documentation	External Involvement
Environment and Climate Change Canada	-Method 5D in the Ontario Source Testing Code (OSTC) -Ambient Air Quality Monitoring Program -Audits are also recommended -LDAR programs	-Particulate matter from control devices -Collection efficiency of control equipment	-Document procedure and results for inspection of control equipment -Reporting to NPRI -Document performance measures, QA/QC, procedures and protocols -Keep a record of the types of materials used	-Recommends a community advisory panel
CCME	-Baghouses equipped with bag leak detectors and preventative maintenance	-Off-gas entry temperature for fabric filters -Entry temperature to gas conditioning system should be >800°C, exit temperature < 225°C and short transit time	-Operating practices and conditions should be recorded for emission testing	-Endorsed by provinces
Alberta	-Cumulative effects must be monitored and must not exceed assimilative capacity of the airshed			Endorses CCME CWSs
Quebec	-Opacity should be monitored to be <20% -Continuous leak and malfunction detection devices should be used -Stack testing is required annually -Gas in buildings with furnaces is sampled every 3 years			
Saskatchewan	-Opacity should be monitored to be <40% averaged over 6 min continuously		-Document description of raw materials and efficiency of burning equipment	Endorses CCME CWSs

NESHAP	-Opacity must not exceed 6% opacity -Facility must conduct compliance performance tests		-Document procedures with vendors showing inspections and agreements related to scrap -Site specific plans for scrap management including periodic inspections for plan implementation, corrective actions, and number of mercury switches removed	-Site specific plan includes communication with scrap providers/purchasers, and confirmation from providers that scrap meets specifications
NSPS	-Opacity limits from control device, melt shop and dust handling are 3%, 6%, and 10% respectively (limits include charging and tapping time) -Bag leak detection system should be continuously monitored if opacity is not (must detect 1mg/m^3) -This must be installed downstream of the baghouse and upstream of any wet scrubbers	-Furnace static pressure -System fan motor amperes and damper positions -Volumetric flow rate through each separately ducted hood -Volumetric flow rate at control device inlet and damper positions	-Continuously record the output of PM in the bag leak detection system -Keep a record of all measured performance measures -When using a DEC system, record pressure data for 15 minute integrated averages	-An alarm system should be utilized to notify the facility of equipment malfunction or required replacements for example when opacity limits are exceeded
Michigan DEQ	-Follow CFR Part 64 for Compliance Assurance Monitoring an should be kept in a facility's Title V permit for 5 years -Control equipment should also be monitored as outlined in CAM	-Visual indicators such as opacity and process parameters	-Establish appropriate ranges that reflect proper operation and maintenance of the capture and control system (especially for CEMS and COMS) -Document verification procedures to confirm operational status of monitors -Report testing plans	

European Union	-Understand scrap composition and perform a melt test to characterize the scrap -If PM emissions are high during monitoring (including impact of wind direction and strength), facilities should consider temporary cessation of operations	-Parameters for plant operation to be monitored include parameters that affect mass flow and emission characteristics -Stack emissions can be measured by regular discontinuous measurements, and PCDD/F should be sampled during steady state conditions	-Document acceptance criteria for scrap that is specific to the production profile	-Radioactivity in scrap is identified by an expert group from the UNECE -Check deliveries for undesired scrap like mercury switches
South Australia	-Opacity from the chimney or stack should not be darker than Shade 1 on the Ringelmann Chart or the Miniature Smoke Chart -Emission tests should be conducted		-Keep records depending on specific notice from the Authority	
New South Wales		-Performance measures for afterburners and combustion applications: Residence time should be more than 2 seconds if a toxic air pollutant is involved, otherwise >0.3 seconds Combustion temperature must be more than 980°C for toxic air pollutants, otherwise 760°C	-Destruction efficiencies for control equipment should be documented other than for flares	

4.7 A Review of Available Measures and Methods for Determining Fugitive Emissions from Mini Mill Melt Shops

4.7.1 Process Overview

4.7.1.1 Electric Arc Furnace Steelmaking

Molten metal is produced in the electric arc furnace (EAF) by generating an electrical arc between graphite cathodes and the charge in the furnace which is the anode[xxxvi]. In direct current EAFs, there is one anode and one cathode, whereas there are three anodes in an alternating current EAF[xxxvi]. Both the cathode and electrode are made of carbon (graphite), and are consumed during the melting process[xxxvi]. A schematic diagram of a basic EAF is shown in Figure 14.

A typical EAF is composed of a refractory vessel (also called the pot) with a removable lid[xxxvii]. The lid has holes where the electrodes are fed into the vessel for the melting process[xxxvii]. Fume extraction from the primary exhaust system is typically located on the roof. This may be in the form of a duct, a “goose neck”, or may directly come off the side with no bends[xxxviii xxxix]. These are often referred to as the 2^{nd} or 4^{th} hole depending on where the electrical melting mode is employed[xl]. There are also openings in the vessel for the removal of the molten steel, called the spout or the taphole[xxxvii]. The key EAF operations that generate emissions include charging scrap, melting, refining, slag removal and tapping[xxxviii]. Generally, scrap metal is used as the charge for EAFs but other sources of ferrous materials such as direct reduced iron, pig iron or iron carbide may be used as well[xxxvi]. Metal fume and particulates are released as a result of the furnace being charged[xxxvi].

Many EAFs operate on a batch basis and thus will be “charged” when materials are periodically loaded into the furnace when the roof is open[xxxvii]. During the opening of the roof, fugitive emissions are released[xxxviii]. Some EAFs are fed continuously using a continuous feed process to preheat the scrap to near-bath temperatures, and the electrodes within the vessel are used to maintain the melt temperature[xli]. Some continuous feed processes use a shaft into the EAF, reducing the need to open the roof thereby reducing fugitive emissions during this activity[xxxviii]. Additives such as lime and coal are added to the furnace during charging to produce the desired chemistry[xl]. After charging the furnace, the scrap mixture is melted through the formation of an electric arc between the carbon electrodes, also forming a layer of slag on top of the molten metal[xl]. The slag layer is important as it allows some of the volatile solute species, such as zinc, to be removed[xl]. During melting, particulate and metal fumes, CO and volatiles such as dioxins and furans are released due to bubble bursting in the foamy slag layer[xl]. After melting, refining of the molten steel will take place at the interface of the metal and slag, where phosphorus and other impurities are removed[xl]. Oxygen is injected into the EAF at this stage to promote decarburization such that dissolved carbon and CO bubbles form to remove any other dissolved gases[xl]. Slag foaming occurs when the dissolved CO bubbles leave the molten steel layer and cross the slag interface[xl]. The addition of coal dusts can expedite this process with further bubble bursting that result in the release of more particulates, metals, CO and dioxins and furans[xl]. Even the type of carbon such as petroleum coke, anthracite coal or metallurgical coke can make a difference in the emissions. The molten steel can be then refined further in a ladle refining furnace or with an Argon Oxygen Decarburizer (AOD), typically used for stainless steel production, or it can be cast once the temperature has been controlled[xl]. Tapping operations also generate particulate which include metal emissions[xl].

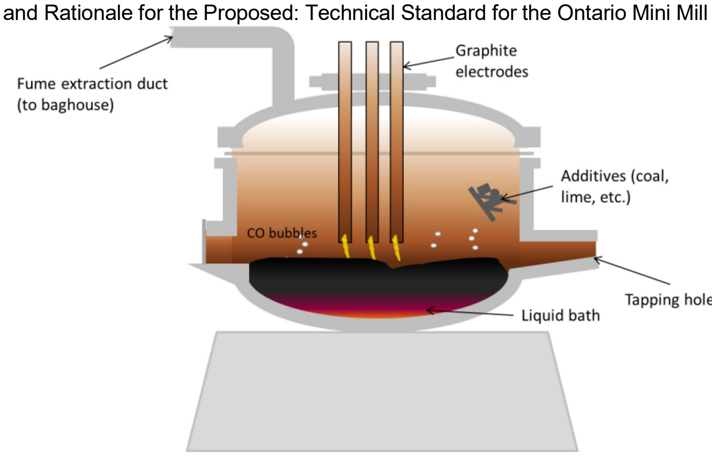

Figure 14: Schematic diagram of an electric arc furnace

This process can generate between 15 to 25 kg of dust per ton of steel produced[xl]. Hence, emissions from the EAF are captured and conveyed to air pollution control devices[xl]. This is most commonly achieved using both a direct evacuation control system (DEC) and a canopy hood system[xlii]. Extracted fumes are then conveyed through ductwork where excess CO is usually removed with additional combustion. Large particulate may be separated by gravity and finer particulate are passed through a fabric filter after cooling[xxxix]. However, fugitive emissions from EAFs are difficult to capture. A study of dust emissions from German EAF steel plants showed that approximately 66% of total emissions are fugitive[xliii]. This study also estimated that 70% of total chromium emissions are fugitive from German EAF steel plants[xliii]. Fugitive emissions from low level sources, as opposed to point sources, can have a greater impact on the environment[xliii].

4.7.1.2 Fugitive Emissions from EAFs

Fugitive emissions can be defined as any type of emission that is not discharged through a stack, chimney, vent or other type of opening[xliv]. Fugitive emissions of particulate matter are generated from indoor operations such as operation of the furnaces and AODs from the melt shop and are emitted into the environment through building openings and general building exhaust, but not through stacks as depicted in Figure 15[xliv]. Metal fume and particulate are emitted from EAFs during all phases of the melting process, as a result of molten iron vaporization with non-ferrous metals, bursting bubbles of CO, and the ejection of particulate from the molten steel and slag phases[xlv]. An effective air pollution control system is needed to address emissions from the EAF melt shop. In addition, the particle sizes of EAF dusts are mostly less than 10 µm in diameter, with some estimates around 60%[xlv xlvi]. As much as 40% of the particulate matter (PM) emitted has a diameter of less than 2.5 µm;

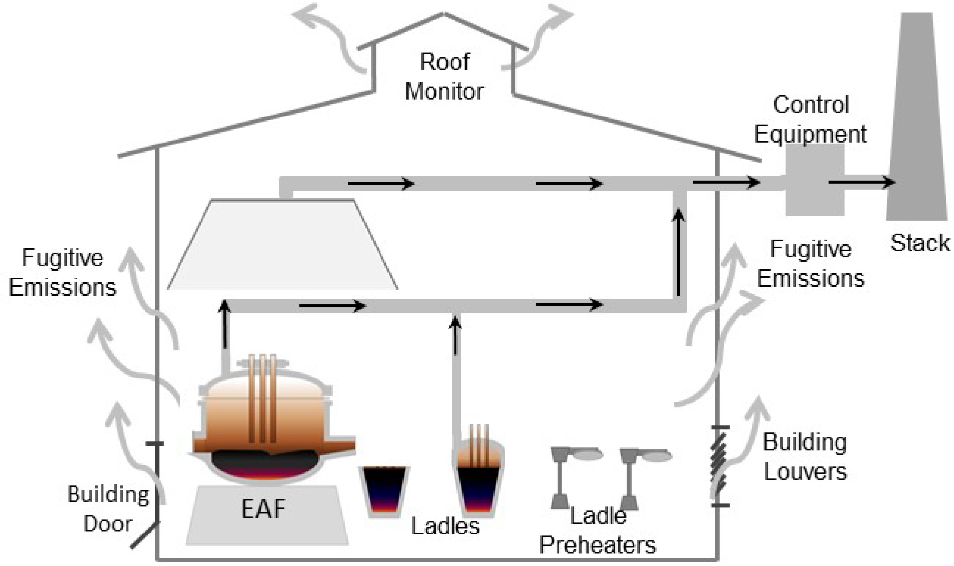

Figure 15: Depiction of fugitive emissions in mini mill melt shops

4.7.1.3 Industrial Ventilation Systems for Air Pollution Control

The scope of this paper is limited to fugitive emissions from EAFs and other furnaces in the melt shop that are not captured by industrial ventilation systems. The following subsections will describe the most common industrial ventilation systems that are used to capture and convey emissions to air pollution controls used in North American mini mills.

4.7.1.4 Direct Evacuation Control Systems

Direct Evacuation Control (DEC) systems are part of the state of the art industrial ventilation system for EAFs[xlvii xlviii]. In a DEC system, fumes are extracted from the EAF through the "4th hole" located on the roof of the furnace, where the other three holes usually house the graphite electrodes[xlvii]. The DEC includes a fume extraction duct, as can be seen in Figure 14. Fume extraction ducts that directly come off the side of the EAF without bends typically capture more emissions than goose neck fume extraction ducts[xlix]. Fumes are then passed through a combustion chamber to remove excess CO which is supplied with dilution and combustion air in order to ensure complete combustion of the process gases[xlviii]. The combusted fumes then typically pass through water-cooled ducting to a gravity separator (sometimes called a dropout box), where larger particulate fall out due to their weight[xlviii]. More ducting takes the remaining finer particulates where they are passed through a fabric filter baghouse[xxxix]. A DEC can capture over 90% of the process emissions (i.e. melting and refining) before leaving the EAF[l]. The typical capture efficiency of a properly operated DEC system has been estimated to be 99% of the melting and refining emissions[l].

4.7.1.5 Secondary Evacuation Systems

Anything that is used to evacuate the air of an EAF melt shop that is not a DEC is generally considered to be a secondary evacuation control system[xxxix]. These methods include canopy hoods, close-fitting hoods, side draft hoods and tapping hoods, partial or total enclosures and scavenger duct systems[li] .These ventilation systems capture the fugitive emissions from the EAF and other sources that were not captured by the DEC[xlviii].

Canopy hoods are often used for capturing secondary emissions, though they may also be used for capturing process emissions in the absence of a DEC[xlix]. A close-fitting hood is a movable hood that is placed directly over the EAF or other furnace or vessel during melting and blowing, but cannot be used during charging or tapping[xlix]. A canopy hood is suspended from the melt shop roof over the EAF, leaving enough clearance for the movement of the electrodes and for cranes that may be used to charge the furnace[xlix]. The overall capture efficiency of fugitive emissions for canopy hoods is estimated to be over 80%. Factors which can reduce the capture efficiency of canopy hoods include deflection due to the crane and bucket during charging, building cross-drafts (e.g. open doors), other building openings, movement of melt shop vehicles, temperature gradients in the melt shop, other ventilation hooding in the melt shop, low-pressure weather systems, high humidity, and strong winds[xlix]. The side draft hood is connected to the EAF roof but is open on one side so as to leave the movement of the electrodes unrestricted[xlix]. The side draft hood is only functional when the roof of the EAF is in place and when the furnace is upright[xlix]. The estimated particulate emission capture efficiency of a side draft hood is 90-99.9% of refining and melting emissions, typically estimated to be 99%[l].

A tapping hood is generally used in conjunction with other secondary control methods and consists of a movable or stationary hood that is located above the tapping ladle[xlix]. This is done especially when the melt shop configuration prevents the capture of emissions through the canopy hood during tapping[xlix]. Local tapping hoods located right above the ladle are considerably more efficient than a canopy hood located farther away; however, no specific capture efficiency was documented[l]. Close-fitting and side draft hoods are also used with other types of furnaces including ladle refining furnaces, annealing furnaces and AODs[l]. All of these types of hoods and ventilation systems may be used independently or concurrently typically within the melt shop. Partial furnace enclosures (PFE) as a secondary evacuation system are composed of walls on three sides of the furnace that act as a chimney to direct furnace emissions to other parts of the control system, while still leaving space for the roof of the furnace to swing open during charging and tapping[xlix]. The purpose of the PFE is to direct emissions towards ventilation capture equipment. For example, the walls or curtains of a PFE help to reduce the impact of cross drafts but crane operations can still deflect emissions away from ventilation capture equipment.

A total furnace enclosure, sometimes referred to as a doghouse as illustrated in the middle drawing of Figure 16 surrounds the furnace on all four sides with a metal shell to capture emissions from charging, melting, refining, slagging and tapping to a small area while also reducing the amount of heat and noise radiation to the rest of the mill[xlix]. Air flow is reduced in melt shops with total furnace enclosures, which also reduces the size of other secondary controls required[xlix]. The estimated capture efficiencies of total furnace enclosures can range from 90 to 99%. Scavenger duct systems are a number of small, auxiliary ducts that are placed above the roof canopy and near the shop roof[xlix]. They have low flow rates, usually 10% of the total flow rate of the canopy hood and are used to capture any fugitive emissions that escape the canopy hood[xlix]. Scavenger ducts can only be used with furnaces that have some form of a roof[xlix].

Total building evacuation involves the complete enclosure of all metal emitting processes into a single sealed building and utilizing some form of particulate removal ventilation system[l] as illustrated in the right drawing of Figure 16. Total building evacuation systems are typically kept at below atmospheric pressure to prevent metal dusts and other emissions from escaping when access doors are opened[l]. These systems can be prohibitively expensive for operators due to their large size especially when used to achieve complete removal of particulates from the melt shop, typically 25% greater air flow than a well-operated canopy hood[l]. The capture efficiency of total building evacuation is estimated at 95-100%.

AODs also emit metal fume and particulates, especially during blowing and stirring operations[l]. There are different approaches to capture emissions from AODs including the use of canopy hoods or close-fitting hoods which have better capture efficiency.

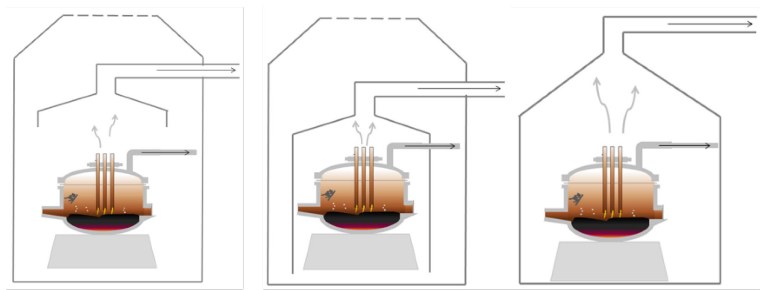

Figure 16: Typical air pollution control systems for EAFs in mini mills

4.7.1.6 Capture Efficiency

Capture efficiency, in the context of PM emissions from EAFs, is a measure of how effective a ventilation system is at capturing contaminants from the air and conveying it through ducting to the air pollution control devices and the ultimate discharge point[lii]. Capture efficiency can be affected by: the layout of the melt shop building, ventilation system efficiency, process temperatures and pressures, exhaust temperatures and pressures, downstream equipment, mobile equipment and weather conditions such as strong winds, low pressure weather systems and high humidity[l liii]. A ventilation system must be sized appropriately in order to function as desired, as will be discussed in later sections of this paper[xlvii]. Thus, an efficient ventilation system will be located close to the EAF, with a volume appropriate to the exhaust rate and melt shop size. One way of increasing capture efficiency is to increase the exhaust rate through the canopy[xlvii]. It is also possible to increase the capture efficiency of a control device by reducing the air volume that must pass through it[xlvii]. Determining the optimal capture efficiency is often a balance of regulatory requirements, typical technical protocols and economic considerations[xlvii]. Table 13 summarizes the numerical capture efficiencies found for EAF and AOD ventilation systems.

Table 13: A summary of numerical capture efficiencies for EAF and AOD ventilation systems

Carbon and Specialty Steel EAF[(a)]		**EU EAFs[(b)]**		**Specialty Steel AOD[(a)]**	
Ventilation System	***Estimated Capture Efficiency***	***Ventilation System***	***Estimated Capture Efficiency***	***Ventilation System***	***Estimated Capture Efficiency***
DEC[(d)] and Single Canopy Hood Open Roof Monitors	75-85%	Canopy hood[(c)]	Up to 90% of primary emissions	Close-fitting hood[(c)] and Single Canopy Hood and Open Roof Monitors	75-85%
DEC[(d)] and Segmented Canopy Hood and Closed Roof over EAF and Open Roof Monitors elsewhere	85-95%	DEC and Canopy hood[3]	Up to 98% of primary emissions	Close-fitting hood[(c)] and Single Canopy Hood and Closed roof over AOD and Open Roof Monitors elsewhere	85-95%
DEC[(d)] and Segmented Canopy Hood and Scavenger duct and Cross-draft partitions and Closed roof over EAF and Open roof monitors elsewhere	90-95%	DEC and Furnace Enclosure	97-100% of total emissions	Close-fitting hood[(c)] and Single Canopy Hood and Scavenger duct and Cross draft partitions and Closed Roof over AOD and Open roof monitors elsewhere	90-95%
DEC[(d)] and Single Canopy Hood and Total Furnace Enclosure Closed Roof	90-95%	Total building Evacuation	Practically 100% of total emissions	Close-fitting hood[(c)] and Single Canopy Hood and Scavenger duct and Cross draft partition and Closed Roof	95-100%
DEC[(d)] and Segmented Canopy Hood and Scavenger Duct and Cross-draft partition and Closed Roof	95-100%				

[(a)] Capture efficiency estimates are based on technology observations and engineering judgement from 1983 US EPA document[xlix].

[(b)] Capture efficiency values are taken from EC 2013 document that also references other articles dated from 1994-2007[l].

[(c)] Indirectly collected fumes from EAF during charging, melting, slagging and tapping including both primary and secondary emissions[l].

[(d)] DEC system was used for process emissions capture of melting and refining[xlix].

[(e)] Close-fitting hood was used for AOD process emissions capture[xlix].

4.7.2 Jurisdictional Review of EAF Fugitive Emissions Quantification Methods

4.7.2.1 US EPA Regulation and Quantification Methods

Currently, some legislation and regulation has been created by the United States Environmental Protection Agency (US EPA) with respect to managing the emissions from EAFs in particular and fugitive emissions in general. These regulatory requirements will be discussed in the next subsections.

4.7.2.2 Particulate Matter

In 2007, the US EPA introduced the National Emission Standard for Hazardous Air Pollutants for Area Sources (NESHAP) for Electric Arc Steelmaking Facilities[liv]. This standard is mostly focused on reducing and eliminating the emission of mercury to the air, but it also puts a limit on the opacity of fugitive emissions that may be vented to the atmosphere[liv]. This requires fugitive emissions from any steelmaking electric arc furnace to have an opacity of less than 6%[liv]. The emission limit of particulate matter in mini mill exhaust is tied to the total annual production of steel of that facility and the type of steel[liv]. The emission limits represent the Generally Available Control Technology (GACT) for those sources. Facilities that produce less than 150,000 short tons of stainless or specialty steel per year have an emissions limit of 0.8 lbs. of particulates per ton of steel[liv]. Any other facility must limit their particulates emissions to 0.0052 grains of particulates per dry standard cubic foot[liv]. This NESHAP was aimed at reducing the emissions of mercury, lead, manganese, nickel and chromium and at the time of its writing was estimated to reduce toxic pollutants in the air by 57 short tons per year[liv]. The US EPA estimated that particulate emissions would be reduced by 865 short tons per year[liv] at that time.

The US EPA also requires that all EAF steelmaking facilities obtain Title V permits if they had not already been operating with them[lv]. As part of the Title V permit requirements, all EAF steelmaking facilities must have some form of compliance assurance monitoring (CAM), which may take the form of continuous emissions monitoring (CEM), continuous opacity monitoring (COM) or predictive emissions monitoring systems[lv]. This was done to verify that the emissions limits are being met[liv]. The US EPA requires that any and all monitoring data from the CAM system be reported on a regular basis, as determined by the state that issued the Title V permit[lv]. Any exceedences from the permissible emissions must also be reported to the US EPA and to the state, with a report detailing how and when the exceedance occurred, the steps taken to solve the compliance issue and a plan for preventing similar non-compliance events in the future[lv].

A review of a sample of permits issued by the US EPA for mini mills was conducted to better understand regulatory requirements for fugitive emissions. Table 14 outlines an example of capture efficiencies and maximum allowable emissions that the dust collection systems included in mini mill permits.

Table 14: Example Fugitive Permit Conditions[lvi]

Fugitive Permit Conditions				
	Operation	**Capture Efficiencies**	**Fugitive Filtrable PM/ PM10 limits (lb/ton)**	**Fugitive Filtrable PM 2.5 (lb/ton)**
EAF A	Melting and Blowing	99.93%	0.0177	0.0131
	Tapping and Charging	99.50%	0.0630	0.0466
EAF B	Melting and Blowing	99.98%	0.0059	0.0044
	Tapping and Charging	99.50%	0.0070	0.0052

4.7.2.3 Volatile Organic Compounds

The US EPA has not specified a test protocol for the capture efficiency of fugitive emissions of particulate matter, but it has created one for the capture efficiency of volatile organic compounds (VOCs)[lii]. This testing protocol was established in order to comply with the Hazardous Organics NESHAP (HON) that was published in 1992, mostly governing the fugitive release of benzene and vinyl chloride[lvii]. This HON was applied to the synthetic organic chemicals manufacturing industry (SOCMI), petroleum refineries, onshore natural gas processing plants and polymer manufacturing plants[lvii]. Fugitive emissions are defined in this regulation as any release from a source that is not a stack or other type of ducting that exceeds 10,000 ppm[lvii]. In order to estimate the capture efficiency of an air pollution control device such as a canopy hood, the US EPA recommends that temporary total enclosures (TTEs) be built around process units with VOC service[lii].

A TTE is constructed around the process unit for which capture efficiency is being estimated[lii]. This is done in various ways depending on the topography of the plant at this point. It is best to isolate the unit as much as possible, however this may not be possible for every unit[lii]. The process must be isolated sufficiently such that these openings will not be subject to contamination from emissions from other parts of the plant[lii]. The TTE must not interfere with the process to the point that the measured capture efficiency is not representative of the actual capture efficiency in the absence of the enclosure[lii]. If the process requires that workers be able to access the equipment within the enclosure, VOC levels must be kept below the permissible exposure limit (PEL) set by OSHA[lii].

The design protocol for a TTE specifies that the direction of air flow within the enclosure should be in the direction of the temporary fugitive emissions exhaust port and the control device[lii]. The temporary exhaust should thus be downstream of the control device[lii]. Natural draft openings (NDOs) must be included in the walls of the enclosure to ensure that there are no dead zones created and that the air will circulate relatively naturally[lii]. NDOs must be located a distance of at least 4 times their equivalent diameter from an emissions source[lii]. The exhaust point should be located at least 4 times the equivalent diameter of any duct or hood from each NDO. The average face velocity of the exhaust stream should be at least 200 ft/min[lii]. Lastly, all access doors and windows that have not been included as NDOs in the design of the TTE should remain closed for the duration of the testing[lii].

The capture efficiency for a control device (such as canopy hood) is calculated when average face velocity of the exhaust, captured emissions and fugitive emissions are known, with known background VOC concentrations[lii]. Test procedures for each required measurement can be found in the US EPA Method 204[lii]. The capture efficiency (*CE*) of a control device for VOC emissions due solely to the enclosed process can be summarized according to the following relationship[lii]:

$$CE= \frac{(C_g-C_b)Q_b}{(C_g-C_b)Q_b - (C_b-C_f)Q_f}$$

Where C_g is the captured gas concentration, C_b is the background VOC concentration, C_f is the fugitive emissions concentration, Q_g is the volumetric flow rate of the captured emissions stream and Q_f is the volumetric flow rate of the temporary exhaust stream for fugitive emissions capture[lii].

The average face velocity (FV) is not needed for the calculation of capture efficiency, however it is needed to ensure that the design of the TTE has been executed properly[lii]. The lower limit of 200 ft/min is used to ensure that the exhaust rate is sufficient to avoid the creation of dead zones, where VOCs may collect and artificially lower the capture efficiency[lii]. The face velocity cannot be too high either, as this will artificially raise the exhaust rate needed to demonstrate compliance[lii]. The average face velocity FV is the ratio of the net volumetric flow rate in and out (ΔQ) of the TTE and the sum of the area (A_i) of NDOs. It can be represented as follows[lii]:

$$\mathrm{FV} = \frac{\Delta Q}{\sum A_i}$$

4.7.2.4 European Environment Agency Quantification Methods

The European Environment Agency (EEA) was established under a regulation passed by the European Union in 1990[lviii]. The EEA has been setting standards and providing information on the state of the environment to the European community since 1994[lviii]. Prior to the creation of the EEA, the European Union passed Directive 80/779/EEC in 1980 that limited the emission of SO_2 and PM, among others[lix]. This directive, entitled *the Convention on Long-Range Transboundary Air Pollution* (LRTAP), has been extended through several other directives to further regulate emissions of other substances for a variety of sectors[lix].

4.7.2.5 Particulate Matter

With respect to fugitive emissions from EAFs specifically, the EEA recommends some abatement strategies as well as preferred modelling techniques[xxxix]. This recommendation was made as PM10 emissions from the iron and steel industries contribute about 9% of Europe's total PM10 dust emissions[xxxix]. Firstly, the EEA recommends that EAFs be enclosed in doghouses to limit the ability of fugitive PM from reaching the ambient air[xxxix]. Abatement technologies such as fabric filters, electrostatic precipitators and post-combustion chambers are recommended to reduce the amount of fugitive emissions from EAFs[xxxix]. The EEA believes that >95% capture efficiency is possible given good housekeeping in the mill[xxxix]. With proper abatement strategies, the fugitive emission of dust is believed to be around 0.64 kg/tonne of steel produced[xxxix].

When modelling the impact of emissions as part of submissions requirements under Directive 2008/50/EC, the EEA considers EAFs to be point sources[xxxix]. Emission factors and a three-tiered modelling approach and its steps are also prescribed by the EEA under LRTAP[xlvi].

In 2012, the European Commission updated and adopted a formal legal Decision on the Best Available Technologies (BAT) for iron and steel plants[xliii]. Under this decision, EAF facilities were obligated to update their permit conditions by March 2016, four years after the publication of the Decision, except for existing plants where certain factors such as available space can be considered when determining applicability[xliii]. The capture efficiency of the overall emissions capture system within an EAF melt shop must be >98%[lx]. Permits must include best available technology by using one of the following extraction technologies for EAF primary and secondary emissions that are conveyed to bag filters[lx]:

- Direct-evacuation control system combined with a hood system
- Direct-evacuation control system with a doghouse
- Direct-evacuation control system with a total furnace enclosure

The permitted dust emission, calculated on a daily average basis, is thus <5 mg/Nm^3 [lx].

4.7.3 Emission Control Quantification Methods

This next section will summarize the published information available regarding the quantification of fugitive emissions from EAFs.

4.7.3.1 DEC Evaluation Methods

Belous and Marz (2013) performed an audit of seven steel mini mills that utilized a DEC for primary exhaust gas extraction. Using Computational Fluid Dynamics (CFD) modelling, several process improvements were developed to enhance the capture efficiency of the DEC[lxi]. When the roof elbow connecting the DEC to the extraction ductwork was modified such that the elbow rested on the furnace roof ring instead of the roof lifting beams, both the required elbow size and the rate of uncontrolled air infiltration was minimized[lxi]. The roof elbow should have an inclination of between 55°-65° without long horizontal sections to prevent dust buildup within the elbow, thus reducing the likelihood of fugitive dust emissions[lxi]. An exhaust rate of <7500 ft/min (~38 m/s) reduces the entrainment of particulates in the exhaust stream as it is not high enough to carry heavier particles from the furnace[lxi]. Other process modifications included the proper sizing and placement of the water-cooled downcomer duct, minimizing the length of any horizontal sections and positioning it directly below the roof elbow to ensure proper exhaust flow through the ductwork[lxi]. In facilities that implemented the process modifications as specified, there was an increase in the capture efficiency of the DEC[lxi]. The summary table showing DEC performance before and after process modifications can be seen in Table 15.

Table 15: Comparison of DEC systems before and after process modifications to component design, adapted from [lxi]

		Plant #1		Plant #2		Plant #3		Plant #6	
Parameter	**Unit**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Tapping Weight	Tonnes	50	50	84.4	112	112	112	113	115
Tap-to-Tap Time	Min	125	55	60	49	60	39.5	80	35.7
Power-On Time	Min	92	44	50	39	50	28.5	68	27.7
Production	tonnes/h	24.0	54.4	84.4	135.5	112	168.1	85.1	193.6
Combustion Air Volume	m^3	19.1	103.4	651.3	736.2	453.1	1170	407.8	857.1
4th Hole Off-Gas Volume	m^3	278.4	375.5	608.8	1020.6	906.1	1389.1	775.6	1985.6
Elbow Diameter	M	0.85	1.16	1.4	1.6	2.1	1.8	1.8	1.8
Elbow Cross-Sectional Area	m^2	0.572	1.05	1.5	2.0	3.3	2.6	2.5	2.6
Fixed Water Cooled Duct Diameter	M	1.0	1.7	1.8	3.0	2.1	3.0	2.3	3.2
Fixed Water Cooled Duct Area	m^2	0.8	2.2	2.6	7.0	3.3	7.1	4.2	8.0
Duct/Elbow Ratio		1.38	2.13	1.78	3.52	1.00	2.69	1.65	3.06

Els et al. (2008) showed the correlation between DEC extraction efficiency and furnace exhaust temperature through experimental data obtained from a South African mini mill. The experiments were conducted at a facility where a 30% increase in production without an upgrade of the air pollution control system in the melt shop had created ventilation problems and health concerns for staff[xlii]. In the extraction experiments, the velocity, static pressure, temperature and CO_2 content of the extracted DEC exhaust were recorded in real-time as the booster fan was run at 800 or 900 rpm where the design of the system was originally specified as 1000 rpm[xlii]. The fan speeds were limited due to the temperature limitation of 120 °C at the inlet of the fabric filter baghouse. It was found through the experiments that the normalized volumetric flow rate (and thus the extraction) decreased with increasing exhaust temperatures[xlii]. This effect was especially noticeable at the booster fan speed of 800 rpm, whereas the normalized volumetric flow rate was relatively constant at around 180,000 Nm³/h for the 900 rpm trial[xlii]. However, this trial also had reduced cooling through the trombone coolers due to a faster extraction rate and singed the fabric filter[xlii]. Els recommended increasing the allowable exhaust temperature by switching to high temperature filter bags to achieve more consistent extraction[xlii].

A German steel mill reported to the EEA that shortly before the adoption of the 2012 BAT for iron and steel plants, a retrofitted DEC system was installed and increased the extraction volume within the facility from 630,000 to 1,250,000 Nm³/h, a new lining of the roofs of the steelwork and the melt shop, renewal of the primary waste gas duct from the EAF and the addition of a bag filter, three fans and a new stack[l]. These measures also reduced the fugitive particulate emissions from the roof by 60%[l]. The reduction in dust emissions can be seen below in Table 16.

Table 16: Reduction in metal dust emissions after a DEC upgrade at a German steel plant, adapted from [l]

Parameter	Concentration (mg/m³)	Mass Flow Rate (kg/h)
Metal dust emissions from stacks, daily average values prior to August 2006	4.5 – 5	3.25
Metal dust emissions from stacks, daily average values after September 2006	0.35	0.44
Percent reduction in emissions (%)	93	87

A Ukrainian study of a 120 ton EAF equipped with DEC that had a large annular suction elbow was performed in computer-aided design (CAD) software SolidWorks using transport phenomena principles and the software package CosmosFloWorks[lxii]. The annular space between the elbow's walls was so large that it was possible to model it as a linear system. Flow through the elbow was modelled in order to predict where the fugitive emissions would exit the EAF and the ductwork. This was shown analytically using a velocity flow field through the horizontal duct. This can be seen in Figure 17.

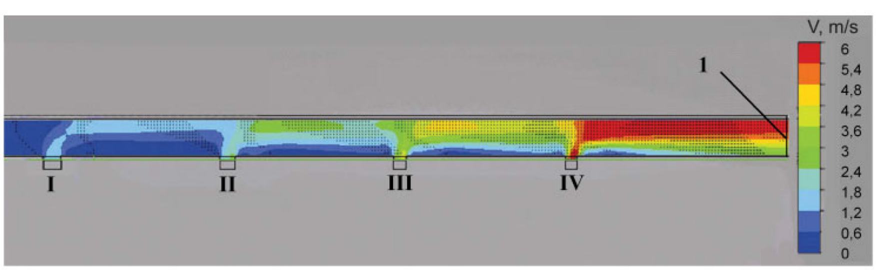

Figure 17: Velocity field of exhaust gas stream through DEC roof elbow from 120t EAF, reproduced from[lxii]

As can be seen from Figure 17, the exhaust velocity drops significantly in four zones of the ducting, indicating that particles are falling out of the stream under gravity, which can create fugitive emissions and other problems within the ducting itself. In order to reduce this occurrence, it was proposed that a smaller annular duct be used. This was also modelled with CosmosFloWorks with the same boundary conditions. The smaller annular elbow showed a 40% reduction in fugitive emissions when a submodel showing particle flow was applied to both. The results of the submodel calculations can be seen below in Table 17.

Table 17: Modeled fugitive emissions reductions from DEC elbow redesign for 120t EAF, adapted from[lxii]

Model Design Case	Fugitive Emissions from EAF (%)			Particles that Re-enter Molten Metal Bath (%)
	Through Electrode Gaps	Through DEC Elbow	Total	
Traditional	5	50	55	45
Proposed	3	34	37	63
Efficiency Improvement (%)	40	32	33	40

4.7.3.2 Secondary Extraction Evaluation Methods

Edward R. Kashdan, David W. Coy and James J. Spivey from Research Triangle Institute in North Caroline along with Tony Cesta and Howard D. Goodfellow of Hatch Associates in Toronto developed a Technical Manual: Hood System Capture of Process Fugitive Particulate Emissions for the U.S. Environmental Protection Agency (EPA/600/7-86/016, April 1986)[lxiii] (the "Manual"). This document is developed as a reference guide on the design and evaluation of hood systems for regulatory officials that are reviewing hood systems for capture of process fugitive emissions from various industrial sources. It specifically outlines the design methods for local capture of buoyant sources, remote capture of buoyant sources (canopy hoods), and enclosures for buoyant and inertial sources. This study reviews various texts and papers concerning general hood design. The texts, manuals, and ventilation handbooks discuss general principles of ventilation, design of hoods, exhaust systems design, but they fail to deal with the problem of capture of buoyant plumes. However, several papers addressing certain aspects of hood design such as remote capture of buoyant plumes, evaluation of hoods, enclosures for materials handling operations, and computer-aided design were also reviewed. They outline procedures based on empirical observations and developing correlation equations to estimate plume width as a function of height and establishing a plume rise theory. Other techniques are described for estimating the plume flow rate such as movie scaling, stopwatch clocking of the plume, and anemometer measurements at the roof truss level. A more sophisticated evaluative technique reviewed consists of scale modelling hood source interactions in a water tank or air system. Provided that the flow in the scale model is turbulent and the Froude number of the model equals the value of this dimensionless parameter for the actual hood system, scale models permit convenient testing of hood designs and evaluation of fugitive emissions in existing systems. The papers discuss the application of computational fluid dynamics and computer graphics to the design of hood systems for non-buoyant sources. Computational fluid dynamics (CFD) offers the potential for more exact solutions; computer graphics allows designers to conveniently observe the effects of modifying hood designs or changing process conditions.

The above Manual discusses the design methods for local, remote and enclosure capture of buoyant plumes as well as presents case studies of process fugitive particulates hood systems for various industries including mini mills and their EAFs. These methods include:

- Design by analytical methods: conservation of mass, momentum, and energy equations are applied to the source of emissions to estimate the plume flow rate arriving at the hood face, and therefore the required exhaust rate. The values of the source parameters used in the resulting design equations may be calculated or obtained directly as part of a field measurement program on an existing site.
- Design of hood systems by fluid modelling: a scale replica of the proposed hood is placed in a suitable fluid environment (e.g., water tank), and the required hood exhaust rate is estimated by scaling up from the performance of the model.
- Design by diagnosis/measurement of an existing hood system: In design by diagnosis of an existing site, measurements of source parameters are obtained. Direct measurements of the plume flow rate, and therefore the required hood exhaust rate, also may be obtained hood exhaust rate, also may be obtained.

Becht, Safe and Russell (2017) used a combination of CFD modelling and video plume analysis to gauge the capture efficiency of a canopy hood during charging and melting operations. The model was first created to capture normal operating conditions, which was validated with a video plume analysis study[lxiv]. Plume analysis is used to estimate the diameter and velocity of the exhaust plume and is used to quantify its flow rate during EAF operations[lxiv]. The exhaust plume is tracked frame by frame[lxiv]. When it was found that the CFD model matched the plume video analysis reasonably well, three different design scenarios were assayed: increased exhaust rate, increased canopy hood volume, increased circulation through opening louvers and doors, and increased circulation through additional ventilation[lxiv]. The first two scenarios were preferred as they do not necessarily increase pollution to the atmosphere[lxiv]. From these design scenarios, a capture efficiency curve was generated and can be seen below in Figure 18.

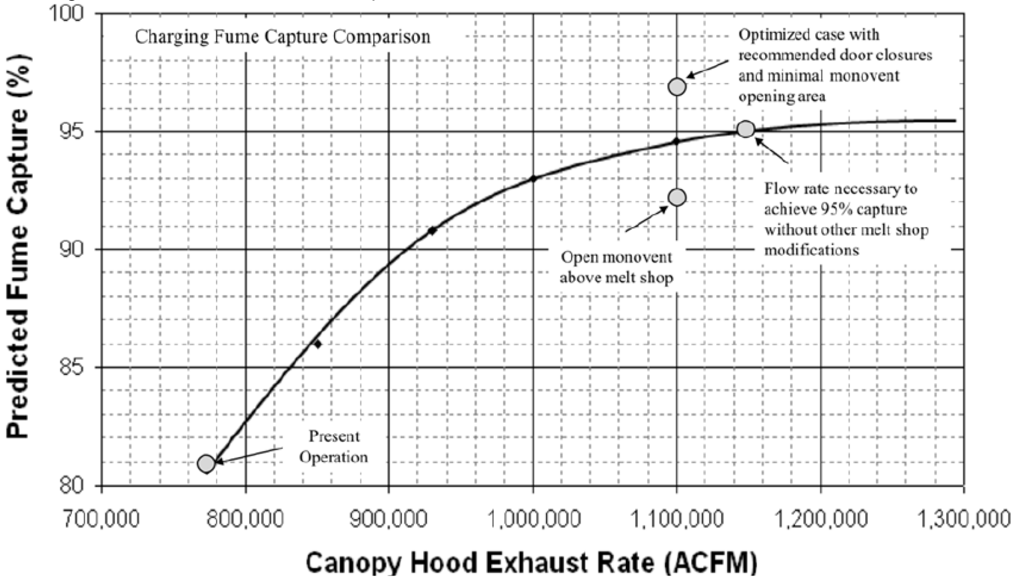

Figure 18: Capture efficiency curve generated with CFD for canopy hood at an EAF melt shop, reproduced from [lxiv]

Another study was performed with CFD to assess the adequacy of three canopy hoods in an EAF melt shop that were sized using US EPA guidelines[liii]. The CFD model was generated, then calibrated at typical operating conditions with video plume analysis[liii]. At these operating conditions, the model showed that the canopy was too shallow and deflected the plume of metal fumes back into the melt shop where they collected around the canopy lip[liii]. The crane used to charge the EAF also caused deflection of the plume away from the canopy[liii]. Various exhaust rates were used in the model to assess the capture efficiency of the canopies, represented as percentage of the melt shop filled with metal fumes (MS_{fume})[liii]. This relationship is outlined in the following equation.

$$MS_{fume} = \frac{volume\ with\ fume\ concentration\ \geq 1\%}{total\ meltshop\ volume} \times 100\%$$

The model showed that the highest canopy exhaust rate possible under the current operation was not sufficient to achieve >95% capture efficiency[liii]. Capture efficiency curves were generated for blowing, tapping and charging operations, which can be seen below in Figure 19. Plikas, Woloshyn and Johnson (2007) showed that the canopy exhaust rate would need to increase significantly in order to achieve the desired level of metal fume removal[liii].

Another CFD modelling study used temperature as a metric for gauging the capture efficiency of the canopy hood instead of calculating capture efficiency directly[xlii]. It was assumed in this model that the only source of hot and dirty gases was the EAF, and that the DEC in the system was functioning at its design efficiency[xlii]. Three design cases were used in this study: increased energy production from the furnace by increased charging capacity, maximum extraction at a temperature limit of 120 °C, and maximum possible exhaust extraction for high temperature fabric filter bags[xlii]. The latter case captured the most of the exhaust stream, as shown by the temperature maps below in Figure 20[xlii]. Regions in blue depict air temperatures of <25°C and areas in red depict temperatures of >100 °C [xlii].

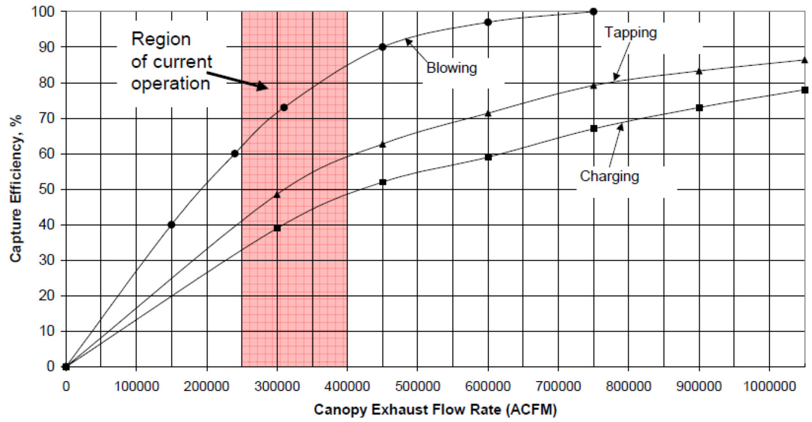

Figure 19: Capture efficiency curves generated through CFD modelling of EAF furnace operations, reproduced from [liii]

In contrast to the other studies presented here, a physical dynamic model was utilized to investigate possible solutions to ventilation issues stemming from the inadequate canopy hood design at the Mini Mill in Texas[xlvii]. A CFD evaluation had been performed at this facility before this study was completed, and yielded results that were economically infeasible, requiring an emission control system that removed 1,200,000 acfm (~566 m³/s) where the designed capacity was 700,000 acfm [xlvii]. Thus, a fluid dynamic model was used to simulate the building's ventilation behaviour by inverting a scaled down plastic model of the melt shop building in water and using coloured saline water to mimic the buoyancy of hot exhausts[xlvii]. This analysis showed only marginal increases in capture efficiency by the canopy hood, given that the exhaust stream is still deflected by the crane over the furnace during tapping and charging[xlvii]. Belous, Anawate and Lahita (2013) recommend an updraft velocity of at least 50 ft/min (0.25 m/s), and the solution provided by the results of the CFD model obtained for the Texas Mini Mill only delivered 8.5 ft/min (0.04 m/s). Given that the expense of the first proposed solution was already infeasible, the authors increased the capture efficiency of the canopy hood by decreasing the air volume and added a curtain wall around the EAF[xlvii]. Performance of the canopy hood was already greatly enhanced with this addition, but simulated results with the physical model showed that winds coming from the west side of the plant through the scrap charging door would have a negative effect on capture efficiency[xlvii]. The canopy exhaust rate was increased from 700,000 acfm (~330 m³/s) to 900,000 acfm (425 m³/s) to compensate for this[xlvii].

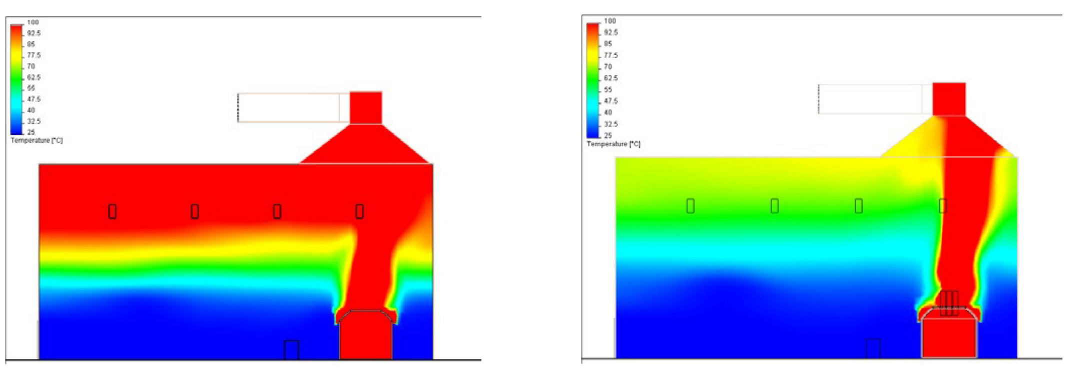

Figure 20: Temperature map of the EAF melt shop with increased production but no increase in exhaust rate (left) and with exhaust rate increased to meet 120 °C temperature limit (right), reproduced from [xlii]

4.7.3.3 DEC, Secondary System and Furnace Enclosure Evaluation Methods

In order to prove that the primary and secondary extraction systems were working properly in two Japanese steel mills, Zrelec (2017) utilized Tenova Technologies software packages to model the furnace conditions, as well as composition and behaviour of the exhaust stream. The Tenova EFSOP and iEAF software packages are used as a complement to other CFD modelling techniques[lxv]. iEAF was formerly called DECSIM[lxvi]. Using the oxygen content of the downstream exhaust as a measure of metal particulate entrainment, it was possible to optimize the furnace conditions to minimize excess air in-leakage[lxv]. This was done to minimize the size of the extraction systems required, which would ideally increase their operational efficiency[lxv].

A 2011 study at a Romanian mini mill with a 100 tonne EAF was performed where the DEC was not operated in an effort to gauge the efficiency of the unit itself[lxvii]. Dusts were collected inside the total furnace enclosure using a high volume sampler placed near various charging buckets[lxvii]. The total particulates were measured and compared against the PARCOM-ATMOS recommended values for metal fumes resulting from an EAF[lxvii]. Heavy metals were also quantified later in the lab from the obtained metals dust samples[lxvii]. A summary of the results obtained can be seen below in Table 18. The authors of this study note that the capture efficiency of the total furnace enclosure appears to be low and they believe that this was due to poor design and age of the enclosure[lxvii].

Table 18: Fugitive emissions from a Romanian mini mill as compared to PARCOM-ATMOS values, reproduced from [lxvii]

Elem.	Emissions level at melting, g/t				PARCOM – ATMOS
	Bucket I	Bucket II	Bucket III	Bucket IV	
Dust	2883	243	108	109	60 – 200
As	0.59	0.06	0.027	0.027	0.06-14
Cd	0.29	0.029	0.013	0.013	0.03-1.5
Cr	9.53	0.97	0.43	0.44	0.3-2.0
Cu	15.25	1.56	0.69	0.7	0.3-1.0
Ni	1.66	0.17	0.076	0.076	0.1-0.6
Pb	30.75	3.13	1.39	1.41	5-20
Zn	38.6	3.94	1.75	1.77	20-90
Mn	59	6.05	2.69	2.71	-
Co	0.16	0.017	0.008	0.008	-

In Japan, it is common practice to use doghouses to limit the fugitive emissions of metal particulates from EAFs[lxviii]. However, inefficient operation of the EAF produces some fugitive emissions which are hazardous to the health of workers. For that purpose, The Japanese Mini Mill performed an indoor air quality assessment to quantify the amount of metal particulates in the air during EAF operations. This was performed using a portable dust monitor mounted on a tripod at several key points on the shop floor. Air was aspirated through the monitor into a dark box, where a laser was used to irradiate the air sample. Particulate concentration was measured through a correlation with light scattering. The change in air concentration of particulates as a function of time during different furnace operations can be seen below in Figure 21. This study demonstrated fluctuating levels of fugitive particulate concentrations around the EAF and a higher correlation between injections and high particulate concentrations than charging or tapping at the shop floor.

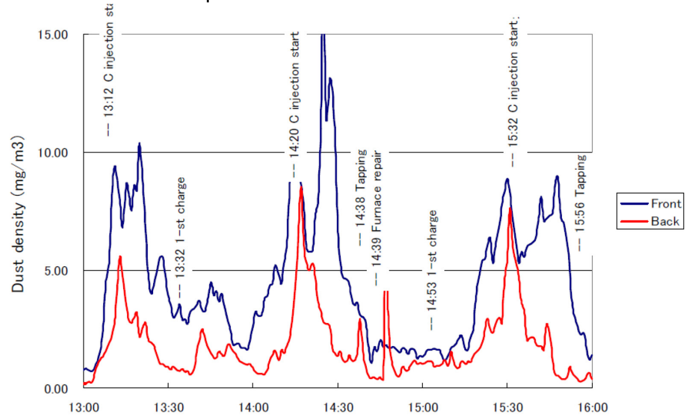

Figure 21: Time dependent SPM concentration during EAF operations at JP Steelplantech Co., reproduced from [lxviii]

4.7.4 Conclusion

This section offers a review of available measures and methods for determining fugitive emissions from mini mill melt shops. The major contributor to these fugitive emissions is the operation of EAFs and refining furnaces inside the melt shop. Due to the nature of the operation of these sources, total capture of these fugitive emissions is difficult to achieve. The methods used by regulatory agencies and air pollution control designers to quantify fugitive emissions in mini mills range in complexity from simple empirical equations, to modern tools such as plume video analysis, physical, and CFD modelling analysis.

Existing information on ranges of capture efficiency is varied and often specific to particular combinations of capture and control techniques.

Many mini mill fume control systems were designed using conventional approaches that rely heavily on industrial ventilation empirical formulas and experience. They use equations that assume point sources of heat to estimate the plume width, vertical rise velocity, and total volume flow rate at different vertical heights, to calculate volume flow rate at the canopy hood which defines the total ventilation flow required to be exhausted from the hood. Historically, these methods lead to incorrect sizing of fume control systems thus causing the mini mills to exceed indoor and outdoor air quality regulatory requirements.

Lately, in order to evaluate the performance of fume control systems in mini mills and to improve collection efficiencies, many studies have resorted to advanced calculation methods involving scaled-down physical models where water is used to represent the ambient air and a dyed saline solution for the fumes, and complex CFD models. Plume video analysis is used to supplement these models with real behaviour and provide a means of calibration. Of the CFD studies presented, there was no consensus on how to correlate the release of particulates from the molten steel bath in the furnace to an easily measurable parameter. The only explicitly stated correlation used was that of temperature and particulate emission creation.

In one study, CFD modelling of the DEC system was used in conjunction with a furnace conditions model as well as continuous measurements of the composition and behaviour of the exhaust stream in order to optimize the furnace operations and minimize excess air in-leakage. This was done to minimize the size of the extraction systems required, which would ideally increase their operational efficiency and minimise fugitive emissions from the

EAF. CFD analysis was used to optimize the structural design of the DEC system in order to reduce the emission of fugitive fumes from the EAF. In one study, a 40% reduction in fugitive emissions using a redesigned smaller elbow duct was achieved.

Finally, a conventional indoor air quality assessment to quantify fugitive emissions from EAF operations in enclosures has been used in a pair of studies as a method of evaluating the performance of fume control systems. Dust concentration measurements were conducted using high volume samplers or special dust monitors mounted on a tripod at several key points on the shop floor.

In summary, based on a review of available studies collected in this section, it appears that there is no simple method to quantify the amount of fugitive emissions that are released from EAFs. That is mainly due to the complexity nature of the various reactions that occur in the EAFs and the intricate air movement in melt shops during the different stages of steelmaking such as furnace charging, tapping, and refining and interferences. However, there has been a significant amount of work done to optimize emissions from capture systems while using advanced measurement and modelling techniques of EAF fume control systems. This approach can help to reduce the amount of fugitive emissions which include metal particulates that would be released from steel mini mills.

5.0 PUBLIC CONSULTATION

5.1 Summary of Public Consultation Efforts

The mini mills sectors is comprised of four facilities across southern Ontario, of which only 3 are currently operating as mini mills that melt scrap steel, so the ministry is taking a more generalized approach to engagement and public consultation on the proposal for this sector.

Similar to other technical standards, the ministry used a technical committee with members from the Canadian Steel Producers Association (CSPA) and ministry staff to engage the sector on various technical questions regarding contaminants, processes and environmental methods to better control or manage emissions. The technical committee included representatives from mini mill facilities, slag management service providers, consultants and Environment and Climate Change Canada. Meetings were held between 2014 and 2018.

The ministry also participates on the Air Standards/Local Air Quality External Working Group (EWG) which has members from various industry associations, public health agencies, environmental non-governmental organizations and some members of First Nations. The EWG provides general feedback and recommendations to the ministry on a broad range of issues related to the Local Air Quality Regulation (O.Reg.419/05). Status updates have been given to the EWG regarding the development of the proposed Mini Mills – Industry Standard and more discussion will be offered during the public comment period. Input from the EWG is typically at a general program level (as opposed to sector-specific technical issues).

6.0 PROPOSED MINI MILLS INDUSTRY STANDARD

6.1 Proposed Structure

The proposed Mini Mills – Industry Standard will apply only to NAICS code 331110activities that primarily produce carbon steel, steel alloy, specialty steel or stainless steel from steel scrap using an Electric Arc Furnace. Requirements are proposed to manage and control emissions from metal melting, metal refining, casting, rolling, metal scrap and slag management.

In order to prevent, reduce or minimize emissions of metals (chromium compounds (hexavalent), chromium and chromium compounds (metallic, divalent and trivalent), nickel and nickel compounds, and manganese and manganese compounds), suspended particulate matter, and Dioxins, Furans and Dioxin-like PCBs the proposed Mini Mills – Industry Standard includes specified technologies and practices that must be used, operational, monitoring, recordkeeping and reporting requirements.

The proposed requirements are summarized into 17 parts as follows:

- Part I: General
- Part II: Technology Specification
- Part III: Capture Efficiency Assessment
- Part IV: Source Testing for Dioxins, Furans and Dioxin-like PCBs
- Part V: Industrial Ventilation
- Part VI: Monitoring of Operating Parameters
- Part VII: Inspection and Maintenance
- Part VIII: Slag Management Area requirements
- Part IX: Alloy Additive Storage and Handling Requirements
- Part X: Scrap Management
- Part XI: Roads
- Part XII: Outdoor Originating Source and Meteorological Monitoring
- Part XIII: Visual Inspection Summary Table
- Part XIV: Site Plan and Best Practice
- Part XV: Community Monitoring
- Part XVI: Requirement to continue the use of management methods to manage emissions
- Part XVII: Complaints, Annual Summary reports and Records

Requirements related to the use of specific best available technologies for all contaminants mentioned above are listed in Part II including:

- Use of a direct evacuation control system and a secondary ventilation system in the emissions management system that is used to capture and control emissions resulting from the operation of each electric arc furnace at the mini mill;

- Use of a baghouse to which the emissions management system shall convey captured emissions to;
- The direct evacuation control system shall include:
  - An elbow if the electric arc furnace is a bucket fed EAF;
  - A continuous feed tunnel if the electric arc furnace is a continuous fed EAF;
  - A combustion and dilution air gap;
  - A combustion chamber; and
  - A cooling chamber.
- The secondary ventilation system shall include:
  - A canopy hood located above the electric arc furnace;
  - A doghouse that encloses the electric arc furnace; or
  - A system that provides total building evacuation.

Requirements related to the use of specific technologies for all contaminants mentioned above resulting from the operation of each ladle refining furnace and argon oxygen decarburization vessel are also listed in Part II including:

- Use of a canopy hood or a close fitting hood;
- Use of a baghouse control the emissions that are captured by the above hoods and conveyed to the baghouse.
- Use of a leak detection system in the baghouse; and
- Use of a stack that is of a height that follows good engineering practice.

Requirements related to the use of specific technologies for Dioxins, Furans and Dioxin-like PCBs, when certain criteria are met are also listed in Part II including:

- Use of a rapid quench chamber as a cooling chamber required in the direct evacuation control system;
- Use of technology to inject adsorption agents into the stream of captured emissions to absorb dioxins and furans before the captured emissions enter the baghouse; or
- Use of Selective Catalytic Reduction technology to control dioxins and furans in the stream of captured emissions before the captured emissions enter the baghouse.

Specified technologies are more stringent for new Mini Mills, existing Mini Mills with increased production, and existing Mini Mills where the electric arc furnace is replaced by a furnace with greater rated capacity are also listed in Part II and III including:

- Prepare a capture Efficiency Assessment Report (listed in Part III) that involves using Computational Fluid Dynamics or Physical modelling;
- Use of a leak detection system in the baghouse; and
- Use of a stack that is of a height that follows good engineering practice.

Requirements for the source testing of dioxins, furans ad dioxin-like PCBs are specified in Part IV including report requirements, the frequency and scope of source testing. In addition this part includes requiring operational adjustments if the concentration is greater than 100pg/m3 in the baghouse exhaust and corrective action process that triggers a study to optimize equipment in order to reduce this contaminant if the facility measure concentrations greater than 100 pg/m3 three consecutive years in a row.

Part V describes the requirements related to industrial ventilation including the appointment of a ventilation coordinator with defined responsibilities, a ventilation program with specified records and the management of changes to the ventilation equipment.

The requirements related to ensuring that key equipment required in the technical standard are operated appropriately are described in Part VI, including the monitoring of operating parameters of those equipment and to make operational adjustments when there are deviations from the normal operating range and when the ministry must be notified of deviations as well as inspection and maintenance requirements.

This part also includes the one performance limit in the proposed technical standard that specifies a baghouse shall not be operated for more than 4 continuous hours with the differential pressure outside the normal operating range. This duration was proposed based on information provided by industry that it takes approximately 4 hours to safely shut down melt shop operations and that the contaminants of concern coming from baghouse are generally not acute in nature.

Like Part VI, the requirements of Part VII are proposed to help reduce the potential for elevated emissions from key equipment in the technical standard by requiring certain inspection and maintenance actions.

There are also best management practice requirements that apply to all contaminants except Dioxins, Furans and Dioxin-like PCBs for outdoor sources listed in Part VIII, IX, X, and XI for:

- Slag Management Area such as watering storage piles;
- Alloy Additive Storage and Handling such as alloy additive conveyors to be curtained or covered if not in an enclosed building;
- Scrap Management such as operating shredder equipment inside an enclosed building; and
- Roads such as posted speed limits

Parts XII and XIII describe requirements that are proposed to monitor, inspect and track the performance of best practices for outdoor activities and sources that can generate fugitive emissions such as slag management, scrap management and roads and drive continual improvement when performance is not maintained.

The proposed best management practices to address emissions from outdoor activities and sources are specified in Part XIV.

In some situations, mini mills can be located within one kilometer of areas where people may live or stay such as a health care facility, in these situations, it is proposed that the facility must conduct community monitoring. The proposed requirements in Part XV include how the monitoring is to be conducted and measurements calculated and when the ministry must be notified.

Part XVI is a general requirement for facilities to maintain existing control equipment and best practices to ensure "no backsliding" or degradation the use of equipment or best practices that may be specific to a certain facility that are in place at the time of registration.

Parts XVI and XVII proposed requirements are related to complaints records, internal annual summary reports to be provided to the Highest-Ranking Employee, external notifications to the ministry and the availability of certain information to the public. This approach is similar to parts of the other Industry Standards published prior to this standard.

6.2 Rationale for Requirements and Timing

6.2.1 Part II – Technology Specifications for All contaminants

Mini Mill facilities exceed some air standards that came into effect in July 2016. Based on the ministry's assessment, the dominant sources of the contaminants are the operation of the EAFs, fugitive emissions through the melt shop general ventilation (e.g. roof vents above EAFs) and outdoor activities (e.g. Slag Handling, Scrap Handling, and Roads).

The proposed specified technologies are consistent with the best available control requirements of US EPA identified in the jurisdictional review. The proposed technologies of direct evacuation control system, a secondary ventilation system and a baghouse are very similar to US EPA requirements.

Three of the four facilities have been using this equipment for several years. The fourth has some of the equipment and is in the process of implementing the remaining proposed industrial ventilation under the technical standard.

6.2.2 Specified Technologies for Dioxins and Furans

The ministry worked with industry and Environment and Climate Change Canada on the development of this proposal. Efforts were made to harmonize the proposed specified technologies with the requirements of the Canada Wide Standard for Dioxins and Furans (CWS). The CWS includes an emission limit at the stack and periodic stack testing to confirm the emission limit (not to exceed 100 pg/m^3), which was typically included as a condition of Environmental Compliance Approvals. For a wholistic approach and a level playing field for the sector, those requirements are proposed in the technical standard.

The stack testing provides a snapshot of performance but may not be reflective of day to day performance. The proposed Mini Mills – Industry Standards proposes in addition to the periodic stack tests that daily operational parameters be monitored to ensure effective operation and control of dioxins, furans and dioxin-like PCBs.

The jurisdictional review found other Canadian jurisdictions allow for a longer duration than one year between source testing for dioxins and furans if the facility has maintained emissions significantly lower than the CWS of 100pg/m^3.

6.2.2 A What duration between source testing should be considered when facilities are significantly below the CWS?
6.2.2 B What threshold should be used to demonstrate the facility is significantly below the CWS and for how long should facilities have to demonstrate this before relief is given to reduce the frequency of testing? For example, should the ministry consider reducing the frequency of dioxin and furans source testing to every two years as long as at least three consecutive annual source tests measure below 100 pg/m^3 for as long as subsequent results remain below 100pg/m^3?

Similar to the specified technologies for all contaminants, the proposed dioxin, furans and dioxin-like PCBs requirements for new mini mills and existing mini mills are consistent with best available technologies identified in the jurisdictional review including the injection of adsorption agents and selective catalytic reduction or other technology that captures as effectively or better than those.

6.2.2 C The ministry is seeking input on selective catalytic reduction technology and the its ability to reduce dioxins and furans over time. The ministry is considering the inclusion of a minimum reduction of dioxins and furans prior to emissions entering the baghouse and feedback on a minimum concentration that is reasonable.

6.2.3 More Stringent Requirements for New and Expanded Facilities

The proposal for more stringent air pollution control devices for new facilities and facility expansions was based on two drivers: the desire for continuous improvement and cost effectiveness. The ministry believes that more stringent requirements for new and expanded facilities will drive continuous improvement over time and do so in a more cost-effective manner. It is anticipated that there would likely be both technical and economic constraints to retro-fitting existing facilities and operations with more stringent requirements. In some cases, due to available floor space, it is not possible to install local exhaust ventilation or certain types of air pollution control devices and the cost for retrofitting systems is much greater than designing it from the beginning. Based on initial feedback with the technical committee, a three-year phase-in of this requirement has been proposed to allow the phase-in to align with typical capital planning cycle of the Mini Mill sector. This approach is consistent with other Industry Standards.

6.2.3 A What is the capital planning cycle for the Mini Mill sector when planning new facilities or expansions?
6.2.3 B Is the proposed three years a reasonable timeframe for planning to account for more stringent air pollution control devices?
6.2.3 C Should a shorter time period be considered and if so, why?

6.2.4 Melt Shop Processes

The purpose of Part III is to specify requirements to assess and maintain the performance of equipment that captures and conveys emissions from melt shop processes at "as-built" levels so that performance does not deteriorate over time and a process to drive improvements if it's not adequate. The fugitive emissions from the melt shop are a dominant source contributing to potential concentrations in the community, so the ministry wants to ensure facilities are maintaining their performance. It is recognized that the types of assessments proposed can be costly but once set up it can be less costly to update and re-assess.

The ministry selected an increase of 50% production because typically there would need to be major modifications to the equipment that should be re-assessed.

6.2.4 A The ministry is seeking feedback on if the reports should be triggered sooner or if there are equally rigorous alternate methods of assessment that may be conducted in the short term to justifiably delay capture efficiency assessments beyond an increase in 50% production.
6.2.4 B In order to describe when assessments are required, two defined terms were used to clearly communicate the thresholds. The ministry is seeking feedback on how to ensure the definitions of "50 factor" and "modification threshold" are clear and understandable.
6.2.4 C The requirements related to capture efficiency assessment are detailed. The ministry would like feedback on another approach that could considered: a technical bulletin on capture efficiency assessment that may be updated more frequently but outside the technical standard. A technical bulletin could be included in an Environmental Compliance Approval so that some very technical details of these assessments could be removed from the technical standard. In general, although encouraged, facilities are not required to update their ECA at the time of registration to a technical standard which could lead to gaps in the legal requirements until an ECA is updated.

6.2.5 Operational Adjustments to Reduce Dioxin and Furans

Part IV incorporates requirements for source testing for dioxin and furans from Environmental Compliance Approvals where CWS requirements were placed. Based on input from the sector, the ministry created a common set of requirements for the sector to help ensure a level playing field and drive continual improvement if the 100pg/m^3 threshold is exceeded.

One of the proposed requirements in Section XIII is for the facility to make one or more operational adjustments to reduce the emissions of the dioxins and furans if the source testing measures more than the 100pg/m^3 threshold within 12 months of the source testing report. An example of operational adjustments may include adjusting the temperature drop in a rapid quench chamber. Some adjustments may be more involved and require more time. The proposed language is not intended to prevent more significant changes but to drive at least one short term adjustment intended to reduce emissions in a 12 month timeframe.

Section 14 proposes that after 3 years of source testing reports that exceed the 100pg/m3 threshold, a facility is required to conduct a study similar to technology benchmarking report that gives recommendations specific to the facility on how to optimize existing equipment and other specified best available technology to reduce emissions of dioxins and furans that could involve longer term changes.

6.2.5 A The ministry is seeking feedback on if 12 months is an appropriate length of time to make at least one operational adjustment as a short term action and why.

6.2.6 Industrial Ventilation

The proposed requirements under Part V – Industrial Ventilation is similar to other technical standards who have dominant sources that are related to the performance of industrial ventilation equipment. Best practices include greater accountability for ventilation with the identification of a ventilation coordinator, current drawings and specifications and regular monitoring of the performance of ventilation systems. An approach similar to the Foundries – Industry Standard is proposed for the Mini Mill sector including a ventilation program that has a ventilation coordinator, current ventilation records such as drawings and system specifications, regular monitoring of ventilation systems.

Based on discussions with various industry sectors change management is one area that can be an ongoing challenge. In particular, when changes are contemplated to a ventilation system to address a process-related issue, potential environmental consequences may not be considered. Section 16 proposes specific requirements that would require that consideration of how a change could impact the ability of a ventilation system to capture emissions before it occurs to prevent potential issues. The ministry is aware of some industry already doing this in ways that are as simple as requiring the environmental or ventilation coordinator's initials on updated drawings to ensure there is communication and an evaluation of the proposed ventilation change. The purpose to is help ensure that performance is maintained and focused on pollution prevention.

6.2.6 A The ministry is seeking feedback on if there is potential duplication between the proposed requirement to evaluate potential changes before they are implemented versus periodic melt shop capture efficiency reports that certain facilities conduct and how it could be better addressed.

6.2.7 Operating, Monitoring, Inspections and Maintenance

Improving and maintaining performance of process equipment and air pollution control devices on a regular basis with regular monitoring, inspections and maintenance help to ensure emissions are well controlled on an on-going basis. Monitoring this equipment can help to track performance and identify potential issues early - allowing a facility to self-correct before it becomes a problem. Most of the process equipment and air pollution control devices are customized to each Mini Mill which makes using a professional's recommendation on determining appropriate operating ranges a reasonable approach.

Similar to most technical standards the proposed monitoring of operating parameters as a measure of ongoing performance includes certain requirements that require continuous or regular monitoring of operating parameters such as pressure drop across a baghouse compartments or static pressure in a duct section. It is proposed that the facility must track and make operational adjustments (e.g. self-correct) if the operating parameter is not in the normal operating range. In addition, it is proposed that if the operating range is above the notification range, such as operating outside a normal operating range of baghouse differential pressure for four continuous hours, the ministry must be notified. This could highlight a potential problem to the ministry for potential follow-up. The rationale for this approach is that some excursions from normal operating range does not necessarily result in a measurable environmental impact, but excursions can serve as an early warning that a problem could arise if it is not corrected.

This type of continuous improvement cycle is common to management approaches used in industry such as the ISO (International Organization for Standardization) quality and environmental management systems and can allow for alignment with a facility's existing systems.

Similarly, regular inspections and maintenance also help to keep air pollution control devices and process equipment working properly and identify potential issues before they become problems that potentially increase emissions. The proposed inspection and maintenance tasks are based on recommended practices by the US EPA and other technical standards. In order to give facilities some flexibility, it is proposed that facilities could alter the frequency of inspections and maintenance based on a professional's recommendation but not the specified tasks. For example, a proposed key inspection is to verify that monitoring devices are measuring accurately on an annual basis. Facilities would be given the flexibility to use a different frequency based on a professional recommendation, so based on a professional's recommendation the frequency could be once every two years but would not the flexibility to change or ignore the requirement to verify the monitoring devices are measuring accurately. Most of the process equipment and air pollution control devices are customized to each Mini Mill which makes a professional's recommendation on appropriate inspections and maintenance is useful. In cases where Mini Mills have sophisticated inspection and maintenance programs in place, some flexibility has been proposed. If there is no record of a professional's recommendation, the proposed inspection and maintenance schedules must be followed.

The ministry discussed and incorporated feedback from the sector in the proposed inspection and maintenance requirements.

The ministry is seeking feedback on the proposed inspection and maintenance activities listed in the Inspection and Maintenance Summary Table as it would applies to the Ontario mini mill sector including:

6.2.7 A Is it a practical requirement to check for visual evidence of damage to bags, cleaning mechanisms or damper given the large number of bags, cleaning mechanisms and dampers that may need to be individually checked and if not what would be a reasonable alternate and why?

6.2.7 B In inspections, maintenance staff may check for signs of excessive wear of various components, often this is the based on their knowledge, expertise, and experience. Does the term "excessive wear" in regard to baffle plates and tube sheets need to be better defined?

6.2.8 Slag Management

Part VIII describes the proposed best practice requirements for management of slag which is a by-product of the metal melting process. In order to provide flexibility to different facilities, it is proposed that facilities implement at least one method from a set of best practices.

Once slag is cool enough to be removed from the melt shop it is generally moved to a different location for storage and processing and shipping. Slag is typically stored outside. Given that the phrase "cooled slag" in section 34 could be subjective.

6.2.8 A The ministry is seeking feedback on how the term the cooled slag should more clearly described or defined.

6.2.8 B

Transfer points can be a source of fugitive emissions if the distance from the drop height to landing are too large. The ministry is seeking input on if maximum drop heights or other additional practices should be included as a requirement under sections such as section 35 slag conveyors in addition to proposed requirements for slag loading under section 37 and section 54 as an operational adjustment if there are elevated dust fall measurements above normal ranges.

6.2.9 Roadway Fugitive Emissions

In Part XI many best practice requirements are included to mitigate fugitive emissions from road, since roads are a dominant source of fugitive metal emissions. The ministry would like input on the following:

6.2.9 A It is proposed that there are two methods of assessing the performance of road dust management methods though measurements such as dust fall or silt content and silt loading at least 4 times between April 1 and October 31st each year. Some may say that these may be onerous for silt content and silt loading. Should the ministry allow for less frequent measurements and why is that more appropriate?
6.2.9 B Are there alternate approaches should be used to as regular objective measurements of performance for the management of road dust to identify an early issue before it becomes a problem?

6.2.10 Performance of Outdoor Originating Sources

Part XII describes proposed requirements to monitor and measure the performance of outdoor originating sources like slag management areas or roads in controlling fugitive emissions from these activities similar to operating parameter summary tables for indoor equipment and processes. This approach is similar to what has been used in other technical standards. The rationale is to require facilities to regularly monitor certain outdoor sources to identify potential issues early and make operational adjustments to prevent problems.

6.2.10 A In section 51, it is proposed that the normal operating range is based on a calculation using what are called annual averages. These annual averages are meant to reflect the year's average even if it only includes 7 months due to the monitoring season or four road silt loading and content samples as representative for that year. Is further guidance or clarity needed for the term Annual Averages which are called annual averages in the section 53 but may only include seven months of data from April and October or only 4 road silt samples is there any suggested terminology that may be more appropriate?

Part XII also includes requirements for meteorological monitoring that is proposed to be collected such as forecasted minimum temperature and maximum wind speed. In addition to maximum wind speed should average wind speed also be collected and recorded

6.2.10 B The ministry is seeking confirmation to ensure that 45 days is a sufficient amount of time to carry out analytical testing of monthly samples.

6.2.11 Community Ambient Air Monitoring

In Part XV, Community ambient air monitoring requirements are proposed to be ongoing as long as the facility is within 1km of certain receptors. The purpose behind this ongoing requirement is to provide an objective measure of the mini mills' overall performance to manage their emissions and to drive continuous improvement when that performance is not maintained while providing public transparency to the community by making summaries of the results available to the public.

6.2.11 A Given that on-going ambient monitoring for some contaminants may be costly, will the proposed frequency of the ambient monitoring requirements be achievable and beneficial for the sector and provide the community with measures of the facility's environmental performance? If not, please provide feedback on more appropriate frequency with supporting rationale.

6.2.12 External Reporting Requirements

In Part XVII an effort was made to focus on key areas that require external reporting such as:

- Exceedances of the baghouse performance limit;
- Exceedance of notification ranges of certain operating parameters;
- Certain annual reports including implementation and performance summaries and community monitoring in section 78

6.2.12 A The ministry is seeking feedback on the balance of ministry oversight, public transparency and regulatory burden in the proposed reporting requirements.

Similar to other technical standards there are general record keeping and retention requirements in sections 79 and 80 for a number of records specified in the proposal. These requirements are proposed to confirm compliance and support the facilities ability to self-check.

6.2.12 B In section 79, the ministry proposed that facilities have 45 days after information has been made available to calculate averages. The ministry is seeking feedback on if this is a reasonable amount of time to conduct this work and still be relevant to drive continual improvement if needed, please provide rationale and alternate durations. For clarity, the proposal is intended to be 45 days after results are available.

6.2.12 C We are interested in feedback to streamline recordkeeping while ensuring there are records to confirm compliance, drive continuous improvement and support the self-checking process.

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[ii] ENV1283MC-2013-2238, Minister of the Environment’s response letter on 12-Sep-2013 to request for development of Technical Standard (footnote # 1)

[iii] Ontario Regulation 419/05, Air Pollution – Local Air Quality, http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_050419_e.htm

[iv] Environmental Code of Practice for Non-Integrated Steel Mills, EPS 1/MM/8 – March 2001, Environment Canada

[v] Canadian Steel Producers Association, Steel Facts 1992-1998, 29-Mar-1999

[vi] http://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=307532&CVD=307539&CPV=33111&CST=01012017&CLV=4&MLV=5

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[viii] Environmental Code of Practice for Integrated Steel Mills, EPS 1/MM/7 – March 2001, Environment Canada

[ix] Prevention of Significant Air Quality Deterioration Review Conducted by State of Georgia – Department of Natural Resources, AIRS Number: 04-13-075-00034, Application Number: 19537, Nov. 2010

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