APPENDIX G

Example Application: Ferrous Metal Foundry and Recycler

DRAFT

EPA Contract EP-D-05-096, Assignment 4-07
EPA Project Manager: Daniel G. Bivins

MACTEC Work Order No. 201001192
MACTEC Project No. 688009S509

Submitted To:
MACTEC Federal Programs
Research Triangle Park, NC

Prepared By:
John A. Cooper and Aaron Siemers
Cooper Environmental Services, LLC
Portland, OR

December 3, 2010

Summary

This hypothetical example describes how the Guide for Developing a Multi-Metals, Fence-Line Monitoring Plan for Fugitive Emissions Using X-Ray Based Monitors (Guide) can be applied to develop a Multi-Metals Monitoring Plan for an urban residential airshed surrounding a ferrous metal recycler and foundry. Ferrous metal foundries are generally urban mid-sized industrial facilities that recycle discarded iron and scrap metal for casting and commercial resale. Primary ambient metals contaminants of concern include, in order of higher concentration, iron, manganese, chromium, nickel, zinc, copper and lead.

The U.S. Congress amended the Federal Clean Air Act (CAA) in 1990 to regulate and control specific hazardous air pollutants (HAPs) that are known to cause adverse effects to human health. Metals represent eight of the HAPs that the United States Environmental Protection Agency (U.S. EPA) specifically identified as posing the greatest potential human health threat in urban areas. These metals include arsenic, beryllium, cadmium, chromium, lead, manganese, mercury, and nickel.

While the existing regulations of ferrous metal foundries work to limit HAP emissions, significant amounts of metals are still released from fugitive and stack emissions. Recent scientific studies on the health impact of metals in particulate matter strongly suggest that even short-term exposures to metals can be harmful to human health. Concerns from neighbors about odors and metals exposure health effects may also prompt a facility or environmental regulators to assess and reduce both fugitive and stack emissions into the surrounding airshed.

Due to erratic fugitive emissions sources and shifting wind conditions, traditional 24-hour averaged ambient metal monitors do not accurately characterize short-term ambient metals concentrations, which may vary as much as several orders of magnitude within the space of a few hours. Near-real-time (NRT) multi-metals ambient air sampling devices provide quality, high resolution data that can be used to fully characterize short-term and long-term metals exposure, assess potential risks to human health, and alert regulators, plant operators, and community leaders of problematic emissions.

Table of Contents

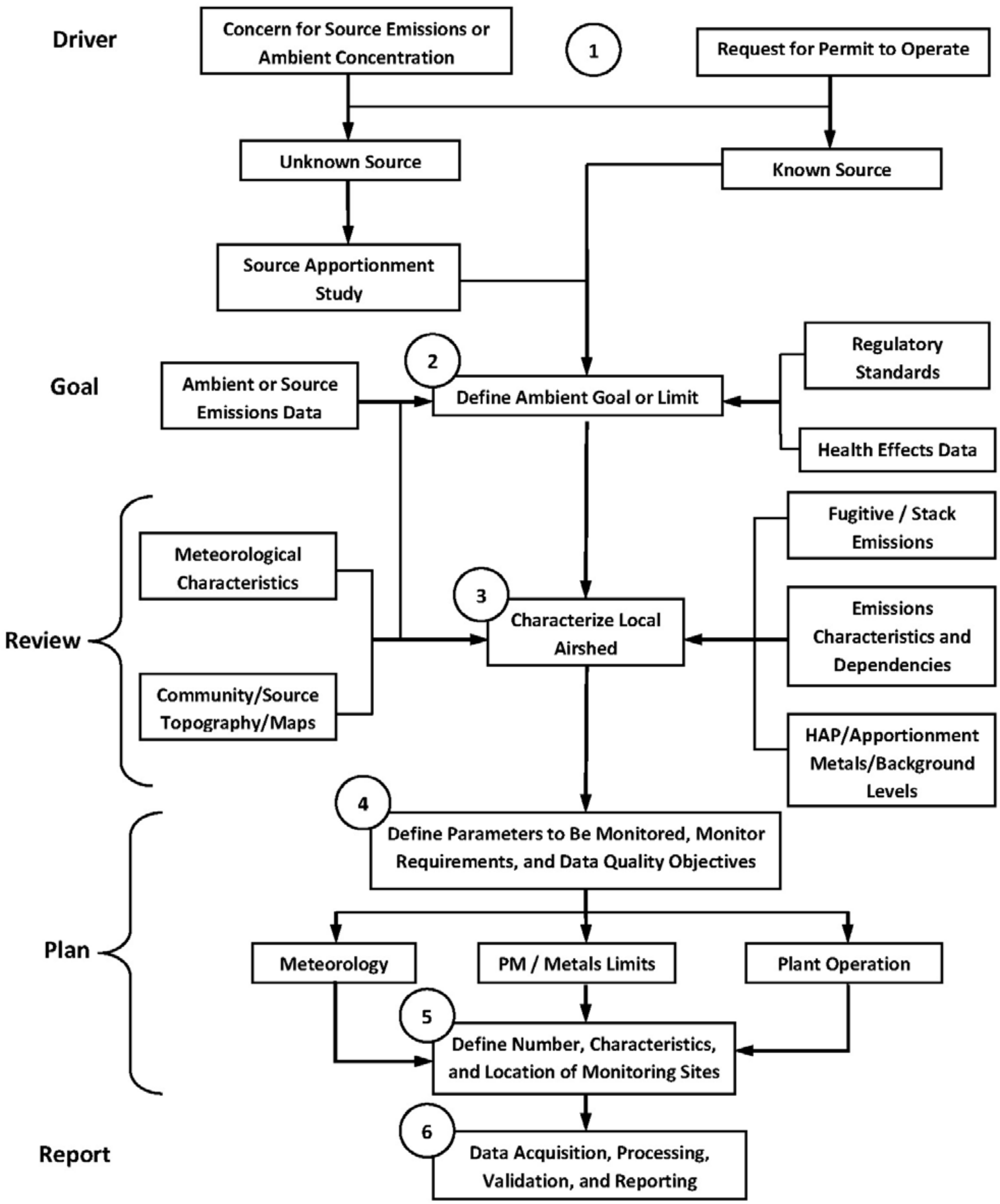

Figure 1. Procedure Flow Diagram

1.0 Driver – Ambient HAP Emissions and Neighborhood Issues

For this hypothetical example, the Guide will be applied to establish a Multi-Metals Monitoring Plan (Plan) for a hybrid residential/industrial airshed containing a ferrous metals foundry and recycler located in Portland, Oregon. The ferrous metals foundry (The Foundry) is located in an industrial area in the northwest part of the city, within a mile of the Willamette River and less than two miles northwest of downtown Portland. The area is closely bordered by residential neighborhoods and an elementary school to the south, and additional residential areas across the Willamette River to the north.

The Foundry is a global manufacturer of engineered metal components for the aerospace, mining, power generation and construction industries, and has been in operation since 1913. The facility recycles ferrous material, refines the molten iron alloy into steel and casts it into industrial components. The basic steel production process begins as raw materials such as steel scrap and foundry returns are transported to the facility by truck, along with fluxes such as carbonates and fluoride, and carbide components which are introduced to improve the strength and durability of the finished steel.

The scrap metal and the charge is then transferred to the furnaces where it is melted and tapped. The Portland facility also utilizes argon-oxygen decarburization (AOD) vessels for further refinement of the steel. Alloys such as nickel may be added to the metal to enhance strength and other desired properties. When the metal has reached tapping temperature, the molten steel is separated and transferred into overhead cranes which pour it into the AOD or a specific mold depending upon the end product. The operation continues as the metal cools to a workable temperature and the sand casts and molds are removed in a process known as the shakeout. After cooling the casting may go through additional heat treatment to strengthen the metal before final finishing and painting.

Metals emissions can potentially occur throughout The Foundry's operations; from fugitive particles associated with raw materials unloading, storage, transfer, and scrap preparation; to the furnace operations such as tapping and mold pouring; to casting, shakeout, and cooling. The Foundry's metal melting and refining processes result in the majority of metal emissions. The introduction of oxygen during refining periods produces a significant amount of particulate matter, and dust concentration in exhaust gas can be near 23,000 mg/m^3 (Davis, 2000). Iron and ferrous compounds such as Fe_2O_3 and FeO are the main components of metals foundry particulate matter emissions. However Cr_2O3, CaO, MnO, PbO and Al_2O_3 are also contributors. Manganese, chromium, nickel and lead are the primary HAPs of concern.

Metals emissions from ferrous metals recyclers are regulated by the Clean Air Act Title 40 CFR 63, National Emission Standards for Hazardous Air Pollutants, subpart EEEEE, which establishes emission rates for iron and steel foundries. The regulations have specific emissions limits for particulate matter (PM), and total metal HAPs. Compliance is based off the Maximum Achievable Control Technology (MACT) approach, which consists of periodic performance testing that establishes production through-put values based on emission factors. Stack or ambient air monitors are not required by existing regulations.

Due to the proximity of The Foundry to neighborhoods and schools in the northwest and north Portland area, the facility has been the center of significant public controversy and debate concerning toxic metals emissions for some time. In 2008, the Northwest District Association Health and Environment Committee in Portland, Oregon, responded aggressively to a U.S.A. Today article and study titled The Smokestack Effect that ranked air quality near Chapman School and other local northwest and north Portland schools in the bottom 5% of all U.S. primary and secondary schools. The study's results were based off of dispersion models related to EPA toxic release inventory (TRI) data. Numerous industrial manufacturing firms operating in the area were listed as the primary sources of elevated toxic pollutants, with The Foundry prominently identified as a main contributor. Coincidentally, recurrent odors in the neighborhood also spurred increased media attention and residential concern. The state environmental regulatory agency investigated the odors, but was not able to locate the specific source. Groups formed such as Neighbors for Clean Air, and joined the Northwest District Association to pressure The Foundry and state and local officials to address the air quality concerns in the neighborhood. While The Foundry's operations bore the most scrutiny in the media and in the public meetings, numerous other industrial facilities operate in northwest Portland, including other steel foundries, and also contribute to elevated metals concentrations in the area. Specifically, the groups petitioned state regulators to characterize the threats to the local airshed and identify sources.

2.0 Goals: Defining Ambient Goals and Compliance

For this hypothetical example, as a part of a permit renewal process and evaluation, the state environmental regulatory agency develops an ambient metals monitoring plan to characterize the human health risks within the airshed. *The goals of the Plan are to characterize the health risks to north Portland schools and neighborhoods and to gather data on the various ambient metals sources in the airshed.* In order to address the local community's concerns and ensure the protection of human health, an NRT multi-metals monitor will be used to gather comprehensive data on the airshed and assess local health risks. The Plan is based on the process illustrated in the Procedure Flow Diagram **(Figure 1)**.

An NRT multi-metals monitor will be utilized to identify the contributions of local emission sources. In February 2009 Cooper Environmental Services was able to successfully identify The Foundry's emissions chemical fingerprint and differentiate the metals concentrations from background air quality data based on well-established industry source profiles. Similar methods can be used to differentiate additional metals sources within the airshed. Further, and outside the scope of this Plan, a chemical mass balance receptor model could be developed to enforce emission standards.

Local airshed ambient air monitoring using NRT multi-metals monitoring is a viable air quality monitoring and regulatory approach due to number of issues and concerns:

1) Due to the number of industrial emission sources in the area, ambient air monitoring will provide the broadest data on the overall health of the airshed, adequately assess risks to human health and the environment, and help identify contributing sources

2) The primary receptors for air-born particulate metals contamination are the residents of north Portland and northwest Portland

3) An NRT multi-metals monitor can differentiate the metals contribution to PM and accurately assess the short-term and long-term exposure risk within an airshed.

2.1 Ambient Emissions/Primary Elements of health/regulatory concern

The primary metals of concern in northwest Portland are related to industrial emissions in the area. The HAP metals emissions associated specifically with The Foundry include manganese (Mn), lead (Pb), chromium (Cr) and Nickel (Ni).

2.1.1 Secondary Elements of Potential Health Concern

Other HAP metals include cadmium (Cd), cobalt (Co), arsenic (As), antimony (Sb), mercury (Hg), and selenium (Se). In addition, metals such as Iron (Fe) and zinc (Zn) have been identified as potential metals of concern.

2.1.2 Source Apportionment Elements

In 1979 a Portland Aerosol Characterization Study was conducted for state environmental regulators. The results found that the greatest local contributions to total suspended particulates (TSP) in northwest Portland were soil and road dust at 20.1%, followed closely by primary industrial at 7.3%. The primary industrial source chemical fingerprint used to identify ferrous metals industrial sources is similar to the ambient metals concentrations detected recently in northwest Portland, with elevated concentrations of iron, manganese, zinc, chromium, nickel and lead.

2.2 Goals: Regulatory Standards, Oregon Benchmarks and Human Health Risks

2.2.1 Regulatory Standards

Metals emissions from ferrous metals recyclers are regulated by the Clean Air Act Title 40 CFR 63, National Emission Standards for Hazardous Air Pollutants, subpart EEEEE, which establishes emission rates for iron and steel foundries that emit or have the potential to emit any single HAP greater than 10 tons per year, or a combination of HAPs at a rate of 25 tons per year. The Foundry's permit requires it to report emissions of metal HAPs including nickel, chromium, manganese, lead, cadmium, cobalt, arsenic, antimony, mercury and selenium. To model HAP emissions, the facility utilizes industry standard emission factors and actual steel production volumes. As of 2010 The Foundry is currently in the process of renewing its Title V CAA permit.

2.2.2 Goals: Oregon Benchmarks and Human Health Risks

Recent scientific studies strongly suggest that even short-term exposure to concentrations of metals associated with foundry emissions such as nickel, chromium and manganese can have adverse human health effects, and children are especially at risk. **Appendix C** provides an overview of metals health effects as well as further discussion of recent research. The state regulatory agency's Oregon Air Toxics Program (OATP) is required to periodically review health-based ambient benchmarks and develop new ambient air quality standards based on their findings. In 1995, 2000, and 2005 the state environmental agency conducted extensive air quality sampling throughout the Portland area using 24-hour average PM_{10} samples. The studies concluded that ambient concentrations of arsenic and cadmium were above Oregon health benchmarks, while lead, manganese, mercury and chromium were all below the established levels. However, air quality in northwest and north Portland was consistently worse than the rest of the metro area. While some concerns were raised, the data did not fully characterize ambient metals concentrations, as the monitors were not located near areas of potentially high impact, and as 24-hour average samples the concentrations did not represent the full expression of short-term ambient metals spikes that can occur in an airshed.

In February 2009, Cooper Environmental Services conducted a feasibility study for a NRT multi-metals ambient air monitoring device. The monitor was located near The Foundry and sampled ambient PM_{10} metals on a one-hour time interval. During the study, the multi-metals NRT monitoring device recorded one-hour ambient chromium concentration over 25 times the national urban average; one-hour nickel was detected over 25 times the national urban ambient average; and one-hour manganese concentrations were over 125 times the national urban ambient average (**Appendix C**). Additionally, many of the OATP health benchmarks were surpassed by orders of magnitude. That being the case, the multi-metals NRT monitor data represents one-hour concentration spikes. OATP health benchmarks and national urban ambient averages are generally based on 24-hour averaged samples, which are typically lower due to dynamic airshed conditions. However, while there are no enforceable national or state ambient standards for these metals, it is clear that the local airshed is significantly impacted by the region's industrial operations, including those of The Foundry, which in turn has the potential to adversely affect the health of the local community.

While the OATP benchmarks are not enforceable, they provide a standard to assess air quality based on accepted health risk scenarios. See **Table 1** for select Oregon Air Toxics Program Ambient Benchmark metals concentrations and results from recent air quality studies in north and northwest Portland.

Table 1. Oregon Air Toxics Program Health Benchmarks in ng/m³

	Ni	Cr	Mn	Pb	Cd	Co	As	Hg
OATP Chronic Benchmarks	50	0.08 (CrVI)	90	150	0.6	100	0.2	300
OATP 24-hour average in N and NW Portland	4.24	n/a	41.9	11.7	2.57	n/a	1.74	n/a
NRT 1-hr Multi-Metals *High*	542	502 (Cr)	2560	339	n/a	n/a	1.8	3.08

2.3 Goals: Action Levels

For this hypothetical example, in order to meet Plan goals, a continuous multi-metal ambient air monitoring device will be located at critical areas of high metals impact and at sensitive nearby locations within the airshed such as local schools. Without comprehensive federal or state ambient air regulations, Oregon Benchmarks, California Acute Reference Exposure Limits (RELs), NAAQS Air Quality Standards, Agency for Toxic Substances and Disease Registry (ATSDR) standards, and Occupational Safety and Health Administration (OSHA) standards can be utilized. These standards provide a health and safety, as well as risk-based frame of reference by which regulators can determine Compliance Goals and Action Levels.

2.5 Demonstrating Compliance

The continuous Multi-Metals Ambient Air Monitoring Plan for the north and northwest Portland, Oregon, airshed is an un-mandated environmental program developed by regulators to address local air quality concerns, identify potential polluters, and protect human health and the environment. Compliance will be demonstrated by comparing data emerging from the multi-metals ambient air monitors to the stated Compliance Levels and Action Levels in the Plan. Compliance Levels and Action Levels should each have a specific form or particle size, a specific time average, and an associated concentration value. The NRT multi-metals ambient air monitoring devices can remotely communicate which allows for ongoing monitoring of the air quality within the airshed. In the event that Action Levels are triggered, the emissions source would be identified and corrective action would commence.

Compliance Levels are risk-based standards which delineate potential risk to human populations within the airshed. For this example, they are taken from Oregon Air Toxics Program benchmarks and should be considered life-time or chronic exposure values, based upon at the least 24-hour exposure data except in the case of chromium and cobalt, where EPA RSLs are used because Oregon benchmarks did not exist **(Table 2)**. Theoretically, at concentrations below Compliance Levels, no quantifiable risk due to ambient hazardous metals pollution is present in the local airshed. At concentrations above Compliance Levels, health risks, while not imminent, begin to increase within the airshed. If a Compliance Level is surpassed by a monitored parameter, the parameter would go into an assessment monitoring period. Levels would continue to be closely monitored and potential sources should be assessed. **Figure 2** illustrates the Action Level, Assessment Monitoring, and Compliance Level relationships for a general Plan parameter; nickel, in this case.

Action Levels are acute exposure levels and are taken from a variety of sources, including the ATSDR, OSHA, U.S. EPA, and California regulatory bodies. They can be used as reference points and guidelines to assess acute health risks within an airshed. In many cases, short-term residential exposure limits have not been adequately researched. In these instances, OSHA 8-hour average values were used. However, residential levels should not approach levels allowed in industrial workplace settings, therefore regulators have developed Action Levels for chromium, manganese, and cobalt at concentrations 10% of industrial standards **(Figure 5).**

Utilizing real-time meteorological and air quality data, as well as general chemical fingerprint knowledge of potential sources, regulators should be able to identify or disqualify potential sources of the emissions. Upon identification of the source, regulators will notify the probable polluter. In the event it is The Foundry or other metals fabricator in the area, regulators would meet with plant management and evaluate the emissions control technology in operation at the facility. An emissions control corrective action plan would be developed to mitigate future metals releases. Regulators would report the full incident to federal, state, and local authorities.

General assumptions on source identification will be drawn from the historic scientific literature. Real-time meteorological data will also play a significant role in identifying local sources. In the event identifying a potential source(s) proves difficult and data readings approaching or surpassing Action Levels remain persistent, a comprehensive regional chemical mass balance source apportionment study would be initiated to identify and fingerprint the local sources of air emissions, and to help evaluate the data emerging from the air monitoring devices. Regulators would sponsor the regional source apportionment study and develop a chemical fingerprint library for air pollution sources in the region.

Table 2. Multi-Metals Monitoring Plan Compliance Levels ng/m³/24 hr

Compliance Levels	As	Cd	Co	Cr	Hg	Ni	Mn	Pb
OATP/NAAQS /RSL	**0.2**	**0.6**	**26.3** RSL	**10** RSL	**300**	**50**	**90**	**150** NAAQS

Table 3. Multi-Metals Monitoring Plan Action Levels ng/m³

Action Levels	As	Cd	Co	Cr	Hg	Ni	Mn	Pb
	200 CA Acute 1 hr	**30** ATSDR Acute 1 hr	**10** 10% OSHA 8 hr TWA	**100** 10 % OSHA 8 hr TWA	**600** CA Acute 1 hr	**6000** CA Acute 1 hr	**5.0 e5** 10 % OSHA ceiling	**150** NAAQS

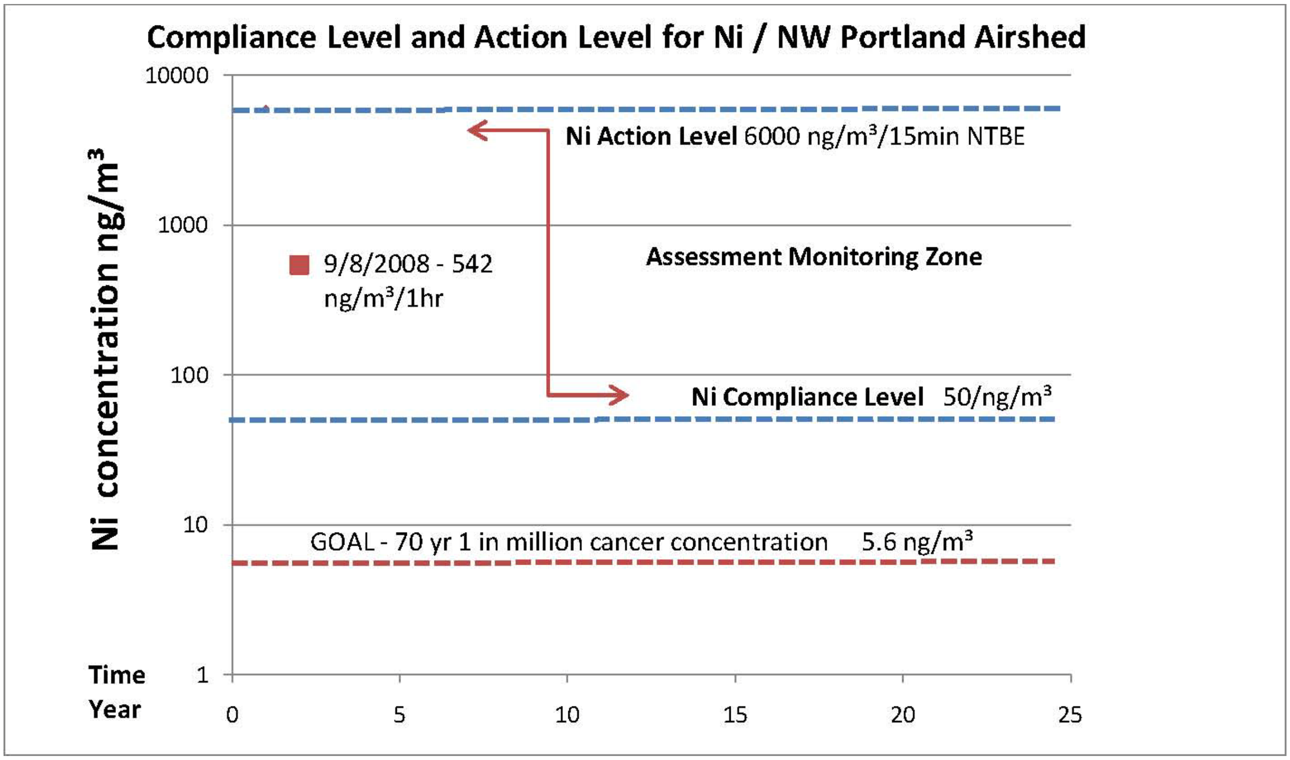

Figure 2. Hypothetical compliance Plan for The Foundry airshed using Ni as general parameter

3.0 Local Airshed Characteristics

3.1 Meteorological Characteristics

The climate of Portland, Oregon, is classified as Marine West Coast type, which is characterized by warm, dry summers and rainy, temperate winters. Summertime highs, occurring in July and August, average around 26.2 °C (80 °F). Temperature averages rarely fall beneath freezing in winter months, however the area does experience occasional major snows and ice storms due to cold winter air flowing west from the nearby Columbia Gorge. Cold snaps are short lived. The Pacific Northwest is on-average the rainiest region in the continental United States. Portland averages 941 mm (37 inches) of precipitation per year, with the majority of occurring from November thru March.

The Foundry is located near the confluence of the Willamette River and the Columbia River, in the northern reaches of the Willamette River valley and the western extent of the Columbia River Gorge. Topography increases out of the valley to the south and west. Local elevation in downtown Portland is 15.2 m (50 ft) **(Figure 3)**.

Figure 3. Map of The Foundry's Airshed in Portland, Oregon

Wind conditions near The Foundry are highly variable and seasonal, influenced by the topography of the area and the Columbia Gorge. However, winds are generally from the northwest with an average speed of 8 mph **(Figure 4).**

3.2 Source Characteristics – Ferrous Metals Foundry

U.S. EPA's Toxic Release Inventory (TRI) data states that in 2009 the facility emitted 834 lbs of manganese compounds, 124 lbs of lead, 91 lbs of chromium, 69 lbs of nickel and 62 lbs of molybdenum. These metal totals were calculated by the through-put of the facility and the total steel volumes production. Metals concentration data emerging from the ambient multi-metals sampling devices should proportionally reflect TRI data.

Metals emissions at The Foundry occur through the stacks and as fugitive emissions from foundry processes. Generally, emissions can be divided into primary emissions occurring during the melting and refining of the metal, and secondary emissions associated with charging, tapping and slagging. Emissions may also occur through handling and preparation of raw materials. The vast majority of emissions occur as primary emissions.

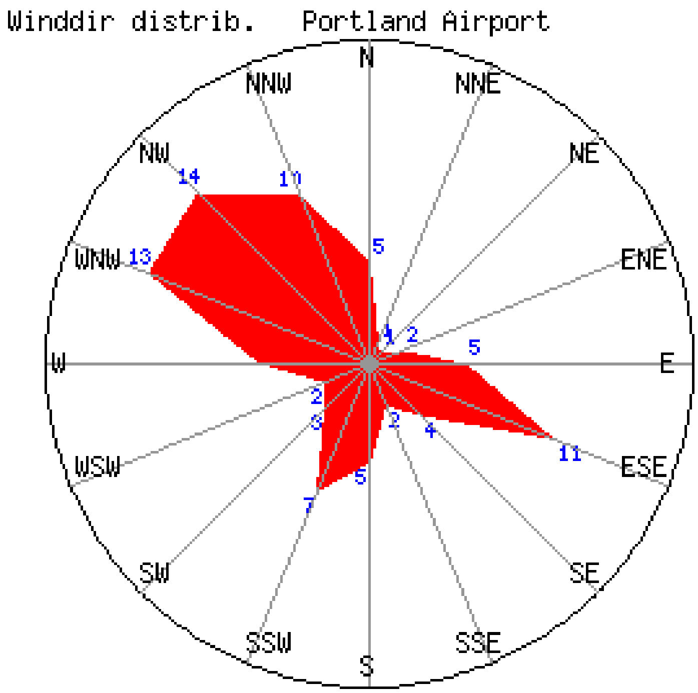

Figure 4. Annual wind direction diagram from Portland International Airport

The Foundry utilizes one 15 ton and one 9 ton electric arc furnace for the majority of the steel melting process. Upon introduction of the scrap metal and charge to the furnace, additional alloys such as nickel, molybdenum or silicon may be added depending upon the specifications of the end product. A full charge in the 15 ton furnace takes at least 2 hours to reach optimal tapping temperature at 3,200 °F.

A significant amount of metals emissions occurs during the melting process, and exhaust gas concentration may exceed 23,000 mg/m³ PM. Emissions control devices and technology like direct furnace evacuation, roof mounted hoods and canopy hoods are designed to direct airflow into baghouses and wet scrubbers before emission through the stack and into the airshed. However, the stacks at The Foundry are less than one hundred feet high, and under certain conditions may fumigate high-metal emissions into the local airshed. Additionally, a portion of the particulate matter escapes capture by the hood and is released into the local airshed untreated as fugitive emissions. See **Figure 5** for an aerial map of The Facility.

The scientific literature on metals foundry processes shows that a degree of source apportionment is possible based upon the unique particle size and chemistry of the metals air sample. For instance, a sample high in the smaller $PM_{2.5}$ range indicates high temperature fugitive or stack emissions. Samples in the coarse fraction between $PM_{2.5}$ and PM_{10} are more likely to be from mechanical or metals dust sources.

Through analysis of the TRI data, The Foundry is the largest source of metals contributing to elevated concentrations in the residential neighborhoods south of the facility. However, since there are a wide variety of industries in the north and northwest Portland airshed, including additional foundries, an area wide source apportionment could assist in further characterizing ambient metals data in the region.

Figure 5. Ferrous Metals Foundry Aerial Map

4.0 Monitoring Plan

4.1 Parameters to Monitor

4.1.1 Meteorology

Real-time, comprehensive meteorological data will be gathered in conjunction with the metals data in order to fully characterize sources and receptors. Variable wind speeds and direction make consistent, comprehensive air monitoring more complex. Local, real-time meteorological wind and precipitation data is be necessary to characterize any potential contaminant transport in the area and will be used in close conjunction with the continuous ambient metals data to analyze potential emissions sources.

4.1.2 Elements, PM and Sampling Frequency

The ambient air multi-metals monitoring devices will monitor for the primary and secondary elements of health and regulatory concern, as well as accompanying metals.

Primary Elements of Health and Regulatory Concern: The primary elements of concern from Foundry emissions include manganese (Mn), lead (Pb), chromium (Cr) and Nickel (Ni).

Secondary Elements of Health and Regulatory Concern: cadmium (Cd), cobalt (Co), arsenic (As), antimony (Sb), mercury (Hg), and selenium (Se).

Accompanying metals: potassium (K), calcium (Ca), barium (Ba), titanium (Ti), vanadium (V), copper (Cu), zinc (Zn), silver (Ag), gallium (Ga), iron (Fe), bromine (Br), tin (Sn), and antimony (Sb)

The ambient air metals FLM devices will be outfit with a PM_{10} inlet to limit particle size of the sample matter. A ten micrometer inlet samples both the fine and coarse particle fraction of ambient metals. In general, smaller size fraction in metals emissions indicates a high heat, melting and refining process, and therefore can be utilized for basic source apportionment of emissions. However, since the focus of the Plan is based on community health concerns, the larger size fraction is appropriate to capture the full extent of HAP emissions. As the study progresses, if finer particle size inlets are deemed necessary for source apportionment, a $PM_{2.5}$ inlet size can be employed as well.

Because of the Multi-Metals Monitoring Plan financial constraints, the specific contaminants of concern, and historic data that indicates no immediate threat to human health, multi-metals samples will initially be collected on a two-hour time interval. Two-hour sampling intervals can more accurately characterize ambient metals concentrations than 24-hour sampling, while not requiring as much financial inputs as one-hour sampling. If data emerging from the instrument indicates that more frequent sampling is necessary, the sampling interval would be adjusted.

4.1.3 Plant Processes and Events

The general processes at The Foundry include the melting, refining and casting of ferrous metals into industrial components. The majority of fugitive and stack emissions are directly related to metals melting in the electric arc furnace and refining in the argon-oxygen decarburization (AOD) vessels. Plant processes and events will be monitored closely and detailed records of Foundry operations will be kept by plant managers.

If Action Levels are exceeded and the emission is traced to The Foundry, regulators would meet with Foundry managers to discuss emission control options and a corrective action plan. If ambient metals concentrations pose an immediate threat to human health, operations would be suspended until The Foundry's emissions control technology can be repaired or replaced, or until the source of the emissions is understood and controlled.

4.2 Monitoring Sites

Multi-metals ambient air monitoring devices will be located utilizing established site guidelines for air sampling promulgated by the U.S. EPA (EPA, 1987). For this example, three sampling sites have been established to characterize ambient metals exposure in The Foundry's airshed.

The primary factors influencing multi-metals ambient air monitor locations are the variable wind regime in Portland, Oregon **(Figure 4),** sensitive receptors within the community like homes and schools, the project's financial limitations, and ease of access.

4.2.1 Ambient Metals Monitoring Site Locations

A primary driver of the Multi-Metals Monitoring Plan is the need to address community concerns over ambient metals exposure associated with The Foundry. Metals concentrations at Chapman Elementary school, located less than seven blocks from The Foundry, have especially been of concern. The goals of the plan are to characterize short-term metals emissions in the airshed near The Foundry and to assess risks to human health. That being the case, monitoring location **AMM #1** is located at Chapman Elementary School in northwest Portland.

In order to confidently apportion metals concentrations in northwest Portland to The Foundry, characterize metals concentrations, and assess impacts in the neighborhoods immediately downwind of the facility, another monitoring site location **AMM #2** is located directly south east of the facility, which is the majority downwind direction, at the corner of NW 24th Ave. and NW Vaughn St.

To assess the metals fumigation further from the facility in the center of the northwest neighborhoods, another multi-metals sampling site **AMM #3** is located at Metropolitan Learning Center, 2033 NW Glisan St. This school was also ranked in the bottom 5% for air quality in The Smokestack Effect article and study, and modeling shows impact from The Foundry and other northwest Portland industrial facilities.

These three sampling locations will sufficiently characterize the metals emissions from The Foundry as well as assess the emissions and health impacts in northwest Portland neighborhoods. **(Figure 6)**

4.3 Monitoring Plan

For this hypothetical example, a Monitoring Plan has been developed which involves a one-year study utilizing a mobile NRT multi-metals sampler, and is designed to assess ambient metals concentrations in the northwest Portland airshed without accruing large operational costs. One NRT multi-metals ambient air monitoring device will be deployed at each monitoring site, AMM #1, #2, and #3, for a period of 4 months. NRT continuous ambient metals data will be gathered and analyzed at each site to determine local health risks. After the 4 month period is over, the monitor will be relocated to the next site. In order to characterize The Foundry's metals emissions, AMM #2 will be the first monitored site, followed by AMM #1 and AMM #3. If concentrations of metals are detected above Plan Action Levels, the number of air monitors and sampling locations could be increased. The Monitoring Plan provides essential monitoring capability with a relatively small footprint and lower associated costs to assess if consistent air quality risks are present in the north Portland airshed surrounding The Foundry.

Figure 6. NRT multi-metals sampling site location s in northwest Portland

4.4 Monitoring Protocol

Multi-metals ambient air continuous sampling devices can be programmed to sample at a range of intervals from high resolution data such as sampling every fifteen minutes, to lower resolution data like sampling once every four hours. Higher data resolution provides more information to regulators to assess and protect worker and public health, and to more fully characterize industrial operations on emissions. Air samples are collected on a tape medium that is relatively expensive. In this case, due to the duration of the study (1 year), the number of monitors (1), and the toxicology of the metals in question, the multi-metals ambient air sampling device will initially be programmed to sample every two hours. After three months of ambient air sampling, data will be analyzed to determine if a change in sampling frequency will maintain the data quality goals of the project while reducing associated costs.

Data will be available within two hours of the sampling event, streamed via wireless or cabled connection to regulators, and stored on the on-board computer system. Sampling tape will be changed out periodically as necessary by trained technicians. Samples will be collected, labeled with location, time interval and sampler identification information, and stored and preserved by regulators.

The NRT multi-metals ambient air monitors will be protected from weather conditions with a shelter and rain guard. A PM_{10} inlet will funnel particulate to the sampler, and electrical lines and data acquisition cables will run from the shelter to the nearest phone/internet connection.

If emerging data indicates that a more comprehensive ambient air monitoring approach is necessary to achieve project goals, additional multi-metals ambient air monitoring devices can be located taking into account the general wind regime in the region (see figure 4) and potential public receptors.

4.4 Data Processing and Reporting

4.4.1 Quality Assurance

Multi-metals ambient air sampling devices are initially calibrated by the manufacturer using thin film standards which are inserted into the monitor to provide a control metals concentration from which calibrations can be based. Periodic audits of the monitors are conducted using a Quantitative Reference Aerosol Generator (QAG) to test the machines X-ray fluorescence and sample analysis components. The QAG is an effective quality assurance tool and can be utilized to ensure accurate data is provided by the device. The QAG disperses a control metals aerosol sample to the device, which is then compared against the recorded value analyzed by the monitor. The QAG individually tests a wide range of metal concentrations against the monitoring unit, and the accuracy is determined by testing the relative bias of the monitor. The multi-metals ambient air sampling devices will be audited and serviced by trained technicians consistent with the device manufacturer’s recommendations (See Appendix B).

4.4.2 Regulators

For this example, the Multi-Metals Monitoring Plan is a sampling program managed by environmental regulators to characterize threats to the local airshed, address the local community’s request for more comprehensive air quality data, and to further regulators, engineers and scientist’s understanding of hazardous metals emissions, pollutant dispersion, and industrial processes. While open to comment from local interest groups and industry, regulators at the state and federal level will have full control and responsibility for the continuous multi-metals ambient air monitoring plan.

Regulators will maintain contacts with representatives from the city governments of Portland, Oregon, local radio and television stations, representatives from relevant local industry, and potential sensitive local receptors such as hospitals and schools. Regulators will compile quarterly multi-metals ambient air sampling data and provide a report summarizing the data to the public, as well as appropriate state, federal, and local authorities.

4.4.3 Plant

Near real-time data emerging from the ambient metals-air monitoring system will be provided to The Foundry and other potential sources of metals emissions. Upon exceedence of an action level, regulators will analyze the meteorological and metals data emerging from the monitors to attempt to determine a source. If a source is identified, the probable polluter would be notified and corrective actions would ensue. In the event that multi-metals ambient air sampling data indicates that The Foundry's operations are resulting in emissions dangerous to human health and the environment, regulators would request that the facility's operations be suspended until the cause of the exceedence is determined and the issue is addressed. The Foundry would suspend operations using established safety and shut-down protocol.

4.4.4 Internet and Public

Regulators will maintain a public internet location that details the ambient air multi-metals monitoring program goals, shows the data emerging from the monitoring location(s), and provides a venue for regulators to answer any questions that the public or industry may have over the monitoring program and local industrial operations. Data on the site will be updated daily to ensure quality assurance of the reported values.

In the event a multi-metals ambient air monitoring Action Level is exceeded, regulators would notify local television and radio, as well as sensitive receptors such as schools and hospitals. Recommendations would be given for those at elevated risk like children, asthmatics and pregnant women to remain indoors until the issue is addressed or the concentrations dissipate. A full report of the incident would be written and forwarded to the state, local and federal authorities.

5.0 References

1) Davis, Wayne, ed. Air Pollution Engineering Manual. New York: John Wiley & Sons, Inc., 2000

2) U.S.EPA (1987) *PM10 State Implementation Plan Development Guideline*. Report No. EPA450/2-86-001**,** U.S. Environmental Protection Agency, Research Triangle Park, NC.

3) U.S. EPA (1984) *Optimum Sampling Site Exposure Criteria For Lead*. Report No. EPA 450/4-84-012, U.S. Environmental Protection Agency, Research Triangle Park, NC.

4) U.S. EPA (1982) *Basic Air Pollution Meteorology*. Report No. EPA 450/2-82-009, U.S. Environmental Protection Agency, Research Triangle Park, NC.

5) Yanca, et al. *Validation of Three New Methods for Determination of Metal Emissions Using a Modified Environmental Protection Agency Method 301,* Air and Waste Management Association,Vol. 56. December 2006.