

Chapter Ch#: Plasma Arc and Laser Metal Cutting

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AQMD

Disclaimer

This chapter constitutes internal guidance and does not have the force of law. It is not intended to and does not establish new mandatory requirements beyond those required by applicable laws and regulations. Conversely, omissions or discrepancies with current requirements do not limit or excuse the obligation of entities to fully comply with applicable laws and regulations.

This chapter may be subject to changes and updates. Although South Coast AQMD staff initiated rulemaking on **Proposed Rule 1445 - Control of Toxic Air Contaminant Emissions from Laser and Plasma Arc Metal Cutting**, this rule has not been adopted by the Governing Board. Therefore, this chapter does not take into account any potential requirements from the proposed rule and is based on the toxic air contaminant list in the currently approved Rule 1401 (September 1, 2017). This chapter will be updated, as needed, based on future rules that affect the information contained herein.

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Ch#.1 General Description

Metals in sheet, pipe, or other forms can be cut by thermal and mechanical methods that include the following:

- Plasma Arc Cutting
- Laser Cutting
- Thermal Cutting
- Waterjet Cutting
- Saw Cutting
- Abrasive Cutting
- Grinding
- Shearing
- Chemical Etching

This chapter is restricted to plasma arc and laser metal cutting equipment and their particulate matter control devices. The analysis of and requirements for plasma arc or laser cutting of non-metallic materials, such as plastics, are not included in this chapter. Internal combustion engines that may be used to power the cutting equipment also are not discussed in this chapter, please see the separate internal combustion engine chapter.

Most methods of metal cutting cause particulate emissions (PM/PM10/PM2.5) that may include toxic air contaminant (TAC) metal particulates depending on the composition of the metal being cut, and thermal cutting methods can cause a change of state of some fraction of metallic chromium to hexavalent chromium. Table Ch#-1 provides a list of the Rule 1401 TACs of greatest concern.

Table Ch#-1. Toxic Air Contaminants of Concern

TAC	Notes
Chromium VI	Hexavalent Chromium typically drives the long-term risk, both cancer risk and non-cancer chronic risk, with the cancer risk being the more limiting long-term risk factor.
Copper	
Nickel	Nickel typically drives the non-cancer acute health risk.
Manganese	
Lead	

Several other TAC metals may be present in lesser amounts for certain metal alloys, including but not limited to: arsenic, beryllium, cadmium, selenium, and vanadium. Trivalent chromium and cobalt have recently been added to the OEHHA/CARB list of approved risk assessment health values¹, but are not included in the current version of Rule 1401. When Rule 1401 is updated to include these new health values these two TACs will be considered TACs of concern.

Thermal metal cutting methods can also emit other criteria pollutant emissions (primarily NOx from plasma arc cutting, directly emitted ozone (O3), and small amounts of CO, SOx,

and potentially VOCs). Plasma arc and laser cutting methods do not use hydrocarbons as fuels and so do not directly emit substantial amounts of greenhouse gases; however, both plasma arc and laser cutting can emit negligible amounts of CO₂ from the oxidation of the carbon in the metal being cut. Indirect GHG emissions from energy use or other indirect emissions sources are not a permitting concern.

Ch#.2 Permit Units

The types of metal cutting-related permit units included in this chapter are the following:

- Plasma Arc Cutters
- Laser Cutters
- Particulate Control Devices (cartridge filters/baghouses/HEPA filters)

While not all currently permitted plasma arc and laser cutters are vented to control devices, new stationary plasma arc and laser cutters are likely to be required to be vented to particulate controls to comply with the health risk requirements of Rule 1401.

Rule 219(d)(5)(H) exempts certain hand-held plasma arc cutters and low power laser cutters, specifically:

Welding equipment, oxygen gaseous fuel-cutting equipment, hand-held plasma-arc cutting equipment, hand-held laser cutting equipment, laser etching or engraving equipment and associated air pollution control equipment. This exemption does not include cutting equipment described in this paragraph that is used to cut stainless steel, or alloys containing 0.1 percent by weight or more of chromium, nickel, cadmium or lead, unless the equipment is used exclusively for maintenance or repair operations. In addition this exemption does not include laser cutting, etching and engraving equipment that are rated at more than 400 watts.

There is an exception to this exemption that applies if the equipment may cause health risks above Rule 1401 thresholds. Please see Attachment A for further discussion and guidelines for assessing when this exception applies.

Ch#.2.1 Plasma Arc Cutters

Plasma arc cutters use a superheated jet of plasma to cut through various electrically conductive materials, such as metals. There are several types of gases used to create plasma, which include compressed air, nitrogen, oxygen, and argon-hydrogen mixtures. The type of plasma gas can influence the emissions rate of NO_x and particulate matter (PM); however, the information regarding these effects is limited. A second gas, called a shield gas, is used to reduce oxidation during the cutting process, and shield gases are typically compressed air, carbon dioxide, nitrogen, or water.

There are several types of plasma arc cutting machines, including:

- Conventional Plasma Arc Cutters
 - Handheld
 - Portable table
 - Stationary table
- Precision Dowlraft Plasma Arc Cutters (all are Stationary tables)
 - Computer Numerical Control (CNC)
 - High Definition (HD)

Additionally, stationary table plasma arc cutters can be operated wet, semi-dry, or dry. Wet plasma arc cutters cut the metal under a liquid surface, which is a water-based coolant mixture. Semi-dry plasma arc cutting performs the cut a small distance above a water-based coolant. Dry plasma arc cutting uses no water-based coolants, and all handheld cutters are dry cutters. Dowlraft tables are often used with dry plasma arc cutting, particularly for small bench size tables and for large table CNC and HD systems. The PM and NO_x emissions levels are lowest for wet plasma arc cutters and highest for dry plasma arc cutters.

The equipment descriptions, for permits, should include the following information:

- 1) Equipment type (i.e., Dry, Semidry, or Wet)
- 2) Model Name and Number (e.g., Hypertherm, Model No. HPR260)
- 3) Serial Number (e.g., Serial No. 2022053121A)
- 4) Table Dimensions (e.g., 5'-10" W. x 27'-10" L. x 5'-10" H.)
- 5) Power rating of the equipment (e.g., 2.5 kW)
- 6) Note if the cutter is portable
- 7) Note if the cutter system includes a dowlraft table, and if the dowlraft table includes zoned ventilation controls, include the brand, model number, and dimensions
- 8) Note if the equipment is vented to a dust collector or other air pollution control equipment

Three examples of complete equipment descriptions, for permits, are provided below.

Plasma Arc Cutting System consisting of:

1. Plasma Arc Cutter, Semidry, System No. 2, Hypertherm, Model No. HPR260, 45.5 kW, vented to a Dust Collector.

2. Plasma Arc Cutting Table, Two Sections, each 5'-11.5" W. x 13'-0.75" L. x 2'-10" H., containing 715 Gallons of Coolant in each Section.

Plasma Arc Cutter, Wet, ESAB-AS with a Robotic Head and 2,710 Gallon Capacity Water Table, 10'-0" W. X 30'-0" L. X 4'-0" H., 25 kW.

Plasma Arc Cutter, Hypertherm XPR300, 66.5 kW, ARC Pro 30 Downdraft Table Model AC30G1020D, 6'-0" W. X 10'-0" L. X 3'-6" H., vented to a Dust Collector.

The process description within the engineering evaluation should also include the following specific information:

- 1) Types of plasma arc and shield gases
- 2) Maximum Kerf for the cutter
- 3) Maximum metal thickness to be cut
- 4) Maximum cutting speed
- 5) Types of metals to be cut, including TAC and TAC precursor (Cr) elemental compositions. Note that this information may not be available for cutters used for repair

An example of the engineering evaluation process description is provided in the Sample Evaluation provided at the end of this Chapter.

Ch#.2.2 Laser Cutters

Industrial laser metal cutters are machines that use a focused laser beam that is directed onto the metal, causing it to heat up and vaporize or melt, creating precise cuts or etchings.

There are several types of lasers used in cutting machines, including:

- CO2 Lasers
- Fiber Lasers
- Nd:YAG (neodymium-doped yttrium aluminum garnet) Laser
- Nd:YVO (neodymium-doped yttrium vanadate) Laser
- Direct Diode Lasers

Laser cutters are often computer controlled and larger industrial laser cutters are often enclosed within a housing that serves as a total enclosure for the purposes of emissions capture. Large industrial laser cutters may also use downdraft tables for emissions capture. There are hand-held lasers cutters, but they are often lower power non-industrial models. The type of laser is not known to affect the emissions potential for laser cutting. The speed and kerf of the laser cut, that are related to the power of the laser, are what affect the emissions potential.

The equipment descriptions, for permits, should include the following information:

- 1) Equipment type (e.g., Laser Cutter or Laser Cutting Machine)
- 2) Model Name and Number (e.g., Model No. TruLaser Tube 7000 T3)
- 3) Serial Number (e.g., Serial No. 2022053121A)
- 4) Dimensions (e.g., 5'-10" W. x 27'-10" L. x 5'-10" H.)
- 5) Power rating of the equipment (e.g., 2.5 kW)
- 6) Note if the cutter is portable
- 7) Note if the cutter system is enclosed
- 8) Note if the cutter system includes a downdraft table and if the downdraft table includes zoned ventilation controls, include the brand, model number, and size
- 9) Note if equipment is vented to a dust collector or air pollution control equipment

An example of a complete equipment description, for permits, is provided below.

Laser Cutting Machine, Haas, Model No. 2008 OL-1, Serial No. 3081803, 4'-8" W. x 6'-0" L. x 6'-0" H., 1.5 kW, Vented to an Air Pollution Control System.

The process description within the engineering evaluation should also include the following specific information:

- 1) Type of laser (CO₂, Fiber, etc.)
- 2) Maximum Kerf for the cutter
- 3) Maximum metal thickness to be cut
- 4) Maximum cutting speed
- 5) Types of metals to be cut, with TAC and TAC precursor (Cr) elemental compositions. Note that this information may not be available for cutters used for repair

Ch#.2.3 Particulate Control Devices

Particulate control devices can include cartridge or baghouse dust collectors and HEPA filters. Electrostatic precipitators are currently listed as BACT for controlling PM₁₀ emissions from plasma cutting, but their use, unlike dry filtration, is limited or non-existent for particulate emissions control for plasma arc and laser cutters. The types and amounts of metal being cut and the related TAC emissions will determine whether HEPA filters are necessary for new permit units. Other particulate control device types, such as scrubbers and cyclones, are not suitable to control metal fume emissions.

Cartridge or baghouse dust collectors often have guaranteed efficiencies that are 95 percent or better. These devices may use shaking or air pulses to clean the filter media surfaces. Specific emission control guarantee levels, along with the corresponding particle size distribution or reference particle size, need to be obtained for the emissions calculations.

HEPA filters have control efficiencies rated at a minimum of 99.97% for 0.3-micron particles. Note that HEPA filters must be individually tested and certified to meet this efficiency; nominal or manufacturer-stated efficiencies without individual filter certification are not sufficient. HEPA filters may be used alone or in combination with cartridge filters or baghouses that are used as prefilters to reduce the particulate loading into and extend the life of the HEPA filters; however, the combined use of prefilters and HEPA filters does not increase the assumed efficiency beyond that assumed for the HEPA filter.

The total filter control efficiency needs to be determined and used in the emissions calculations. In addition to the filter efficiency, the emissions capture rate needs to be determined. If the cutter design is fully enclosed, the capture rate can be assumed to be 100 percent. Emissions not captured should be considered fugitive emissions that are added to the controlled emissions and included in the emissions totals and in a health risk assessment (HRA), if required. Capture efficiency is discussed in greater depth in Section #3.3.

The equipment descriptions, for permits, should include the following information:

- 1) Control equipment type (e.g., cartridge, baghouse, HEPA) and order if two or more are used in series
- 2) Model Name and Number (e.g., Donaldson Torit, Model No. DFE)
- 3) Dimensions of the filter housing and of the filters for cartridge filters or baghouses
- 4) Number of filters and total filter area for each dust collector
- 5) Filter dimensions and the air-flow rating for HEPA filters
- 6) Horsepower of the exhaust system blower(s)
- 7) Note what is vented to the control equipment, including if it is a laser or plasma arc cutter and if the ventilation is attached to a downdraft table

Two examples of a complete equipment description, for permits, are provided below.

Air Pollution Control System consisting of:

1. Dust Collector, Cartridge Type, Donaldson Torit, Model No. DFE, 4'-0" W. x 8'-5" L., x 13'-4" H., with Sixteen Cartridge Filters, each 2'-2" L. x 1'-1 3/4 Dia., Total Filter Area of 4,064 Sq. Ft., equipped with a Pulse Jet Type Cleaning System.
2. Exhaust System with a 15 H.P. Blower venting a Plasma Arc Cutter.

Air Pollution Control System consisting of:

1. Dust Collector, Cartridge Type, SIDEROS, Model No. ECO 4 HCS, 4'-3" W. x 4'-8" L. x 8'-6" H., with Six Cartridge Filters, each 2'-2" L. x 1'-1" Dia., Total Filter Area of 226 Sq. Ft., equipped with a Pulse Jet Type Cleaning System.
2. One HEPA Filter, Sideros, V Type Absolute Filter, 24" x 24" x 12", rated at 2,354 CFM.
3. Exhaust System with a 3 HP Blower venting a BLM Group Model No. LT5.10 Laser Cutter (Maximum 1,800 CFM).

The control equipment and ventilation description within the engineering evaluation should also include the following specific information:

- 1) Control equipment flow rates and the filter areas to confirm proper design
- 2) Emission control guarantees for each control device
- 3) Ventilation design (type of enclosure, downdraft table, hood, etc.) with adequate information to support the capture efficiency assumption
- 4) Building design information as necessary to determine modeling parameters in the case that fugitive emissions modeling out of building openings is necessary

Care must be taken in assigning control equipment efficiencies, most importantly where metals with TACs will be cut. Specifically, the following assumptions and guidance should be followed when assigning control equipment efficiencies:

- Plasma and laser cutting PM emissions are predominantly fine and ultrafine (largely submicron in size). Given that health risk is driven by metal TACs associated with these fine particulates, it is generally conservative to assume emissions are primarily submicron for evaluation purposes.
- Filtration efficiencies should be evaluated as a function of particle size, with particular attention to performance in the submicron range. Manufacturer specifications should be reviewed to confirm that claimed efficiencies correspond to the appropriate particle size range and airflow conditions.
- Manufacturer-stated efficiencies over 99% should not be used without supporting information on the test method and particle size range. Individual or batch testing and certification of the filters at relevant particle size should be provided.
- In the absence of particle size-specific efficiency data representative of these emissions, the use of conservative default control efficiencies (e.g., 90% or lower) is recommended.

When manufacturer guarantees are used at the request of the permit applicant, and those guarantees are less health protective than standard assumptions, additional verification

may be required. Since filtration efficiency is not typically verified through source testing, any required testing should demonstrate post-control emissions consistent with the claimed control performance, or be supported by adequate certification data and engineering justification.

Ch#.2.4 Application Completeness

The following forms and additional information are necessary for applications to be complete:

Basic Forms

- 1) Form 400-A
- 2) Form 400-CEQA
- 3) Form 400-PS – Plot Plan and Stack Information Form

A separate Form 400-A is required for each basic and control equipment item being permitted, a separate Form 400-PS is required for each exhaust stack (although a single plot plan showing all exhaust stacks can be supplied), and only one Form 400-CEQA is required for the permit applications from the entire project.

Supplemental Application Forms (as necessary based on equipment being permitted)

- 1) Form 400-E-1a – Particulate Matter Control Fabric Filter (Baghouse)/Cartridge Collector
- 2) Form 400-E-20 – Plasma Arc/Laser Cutter

These two supplemental forms should have completed entries throughout each form as relevant for plasma arc and laser cutters, as well as the requested attached information items. For Form 400-E-20 the metal alloy composition data, with worst case metal TACs and TAC precursor (Cr) compositions, **for all metal alloys to be cut**. Worst case assumptions for alloy types are acceptable, such as worst case chromium and nickel concentrations for stainless steels to be cut.

The permit application package may also include Form 400-XPP – Express Permit Processing Request, if the applicant would like the permit application to be processed using overtime dependent on staff availability.

Appropriate permit fees must be paid for the application to be deemed complete. The following fee schedules should be used for these permit applications.

- Schedule B1 for “Plasma Arc Cutting”.
- Schedule B1 for “Laser Cutting” (based on proposed 2026 amendment to Rule 301 that adds this equipment category).

- Schedule B1 for “Control Systems, Venting Plasma Arc Cutters” that may be applied to both plasma arc cutter and laser cutter control systems. This only applies for metals that do not contain Rule 1401 TACs (e.g., aluminum).
- Schedule C for “Dust Collector/HEPA, other Rule 1401 toxics.” This is applicable for dust control systems controlling plasma arc or laser cutters when cutting metals containing Rule 1401 TACs or their precursors (e.g., alloys of iron that contain nickel, cadmium, manganese, or chromium).

Currently, the initial permitting fees for Schedule B1 and C are identical, while the annual operating permit fees are higher for Schedule C.

Ch#.3 Emissions

Plasma arc and laser cutters do not use combustion fuels and therefore do not emit products of combustion. These cutters emit metal fumes from the metals being cut, and plasma arc cutters are also known to create NO_x emissions during the cutting process. The metal fume can also contain metal TACs (hexavalent chromium, nickel, etc.) when those TACs or their precursors are present in the metals being cut. The emissions of particulate matter and metal TACs are related to the amount of material cut/removed using material balance-based emissions calculations. One exception is hexavalent chromium, where a specific conversion fraction is used to calculate the amount of chromium converted to hexavalent chromium from the cutting process.

These cutting processes may also emit negligible amounts of CO and SO_x from the carbon and sulfur in the metals being cut and are not estimated. VOC is not normally emitted by these cutting processes but can be emitted if the cutting is done on surfaces that have not been cleaned of machine oils, degreaser liquids, or other organic-based materials. For this chapter it is assumed that the cutting surfaces are clean and that VOC emissions do not occur in substantial quantities.

Ch#.3.1 Emission Factors

There are several source test-related emission factor sources for plasma arc cutter PM, PM TACs, and NO_x emissions. These sources include:

- Emissions of Fume, Nitrogen Oxides and Noise in Plasma Cutting of Stainless and Mild Steel (aka Swedish Study)². This reference is linked through the U.S. EPA AP-42 Chapter 12: Metallurgical Industry webpage as a related emissions factor document.
- Hypertherm, Fume emissions testing for plasma arc cutting³

- Source tests performed by South Coast AQMD permit applicants, or other agency permit applicants, or completed by South Coast AQMD (PM and PM TAC emissions only).

The emission factor sources for laser cutters are more limited with no established emission factor references other than permit related source tests. These source tests are limited to PM and/or PM TAC emissions. A critical review of the source tests finds that many cannot be used for uncontrolled emission rate or emission factor determinations since they either only present the controlled emission rate data necessary for compliance determination related to permit emission limits or they do not have the necessary operating data compiled to properly determine emission factors. However, a few of these source tests do provide uncontrolled emission rates along with the breadth of operating information necessary to determine uncontrolled emission rates.

A literature search and use of South Coast AQMD compiled references found that several other agencies and education institutions have developed emission factors or emission factor calculators for plasma arc and/or laser cutters. These include:

- Iowa Department of Natural Resources⁴
- Kansas State University, Pollution Prevention Institute⁵
- Environment and Climate Change Canada⁶
- Texas Commission on Environmental Quality⁷
- Oklahoma Department of Environmental Quality, Air Quality Division⁸

The main commonality among the emission factors used by these agencies is that most of them used the Swedish Study-developed PM emission factors. The Oklahoma Department of Environmental Quality used the Hypertherm reference for semi-dry tables, and it is unclear which references were used by Environment and Climate Change Canada. The issue of emissions capture is not included in the other agencies' emission calculators or in the other agency permits that have been reviewed. Some of these agencies also complete TAC emission estimates based on a linear metal composition mass balance approach. Some agencies (Texas, Oklahoma, and Arkansas⁹) also include NOx emission estimates, where some are based on the NOx emission values presented in the Swedish Study.

The Hypertherm source test study, which included more plasma arc cutting cases than the Swedish Study, was in general agreement with the Swedish Study results, with the exception of the particulate emissions reduction when using semi-dry plasma arc cutting tables. The Hypertherm source test study indicated a 75 percent reduction in the uncontrolled PM emissions from semi-dry water tables, not the 90 percent reduction suggested by the Swedish Study. This more conservative PM emissions assumption is recommended for semi-dry plasma arc cutting tables.

Several source test reports submitted to South Coast AQMD, completed by South Coast AQMD, or submitted to other agencies for both plasma arc cutters and laser cutters were compiled and reviewed for their usefulness in determining emissions factors. None of these source tests included NO_x testing. There were several issues that were screened to determine if the tests may be useful, including:

- 1) Was there sufficient throughput related data (i.e., data to establish cut rate) included in the source test report?
- 2) Was there sufficient metal composition data to determine the TAC emissions and cut rates?
- 3) Did the source test include total particulate emission testing or just chromium/hexavalent chromium testing?
- 4) Did the source test include uncontrolled emissions, both uncontrolled and controlled emissions, or only controlled emissions?
- 5) Did the source test for plasma arc cutters identify if the cutter was dry, semidry, or wet?
- 6) Did the source test include other TAC emissions data?

Many of the source tests were performed in a manner to strictly provide data for permit compliance, and did not provide useful information for uncontrolled particulate emissions factors.

Source tests that had a full range of TAC emissions data indicated that the TAC emission rates were less than proportional to their metal composition. This indicates that some of the emissions captured may have been from other sources (i.e., dust already suspended in the workspace air) or perhaps that certain metals partition more into the metal fume. There were no source tests that were conducted in a manner that determined how much of the total PM was strictly from the metal removed in the cutting process. Therefore, assuming proportionality of metal TAC emissions to metal composition is considered a conservative assumption.

A few of the source tests provided data that was considered useful for total particulate emissions rate determination. This was particularly important for laser cutters since the available literature references are strictly for plasma arc cutters. Several of the tests provided useful information to support determination of recommended hexavalent chromium/total chromium ratios. However, the source tests had extremely high variability for all determined emission factors. This variability is as follows:

- Plasma Arc Cutters PM Emissions – 0.0001 to 0.858 lb/lb of cut
- Laser Cutters PM Emissions – 0.076 to 0.62 lb/lb of cut

- Plasma Arc Cutters Hexavalent Chromium/Total Chromium Ratio – 0.00022 to 0.95
- Laser Cutters Hexavalent Chromium/Total Chromium Ratio – 0.0000148 to 0.688

Care was taken to only use source tests that had methods, parameters, and results that seemed reasonable in comparison with the literature references and with the majority of the other source tests.

A discussion of the emission factor data resources for plasma arc cutters and laser cutters are provided in the following two subsections Ch#.3.2 and Ch#.3.3, respectively, and a summary of the recommended emission factors for both are presented in Table Ch#.-2 Emissions Factors in Ch#.3.5.

Ch#.3.2 Plasma Arc Cutters

The emissions from plasma arc cutters are related to the type and quantity of metals cut. Therefore, the cutting speed, depth, and kerf (width), converted into the amount of metal removed, are critical to the emissions calculations. Additionally, the type of plasma arc cutter (dry, semi-dry, and wet) affects the emissions rates of PM, PM TACs, and NO_x.

Ch#.3.2.1 Criteria Pollutants

The criteria pollutant emissions that need to be estimated for plasma arc cutters are limited to PM and NO_x. The following emissions factor bases are recommended:

- For PM emissions it is recommended to use the standardized Swedish Study reference emission factor values for dry plasma arc cutters, with a control factor of 99% for wet plasma arc cutting, and an adjusted 75 percent control factor, from 90 percent control noted in the Swedish Study, for semidry plasma arc cutters based on Hypertherm³ reference information. It is further assumed that all PM emissions are PM₁₀ and PM_{2.5}.
- For NO_x emissions it is recommended that the average of the range of emissions determined in the Swedish Study, and confirmed by the Hypertherm reference, be used based on cutter type and metal cut. A reduction of 20 percent is recommended if both the plasma gas and shield gas do not contain oxygen or air. The NO_x emissions are calculated assuming all NO_x is NO₂. However, if NO₂ modeling is required, then a starting fraction of 92 percent NO can be used as allowed by approved South Coast AQMD NO_x modeling guidance methods.

Controlled PM emissions will also have to include an analysis of any added emissions capture device efficiency and the efficiency of any proposed particulate control device(s). Control of NO_x emissions is not expected from typical particulate control devices used for these operations.

The uncontrolled emission factors for plasma arc cutters are presented below in Table Ch#-2 within Ch#.3.5.

Ch#.3.2.2 TACs

The TAC pollutants from plasma arc cutting are dependent on the metal alloy composition of the metal being cut. It is recommended that all metal emissions, except hexavalent chromium, be estimated in proportion to their metal alloy composition, relative to the total PM emissions rate.

The hexavalent chromium emission factor was developed through the review of available source test data and is assumed to be 6.22×10^{-2} lb Cr⁺⁶/lb Cr emitted.

Ch#.3.3 Laser Cutters

The emissions from laser cutters are related to the type and quantity of metals cut. Therefore, the cutting speed, depth, and kerf (width), converted into the amount of metal removed, are critical to the emissions calculations. Laser cutters have a thinner kerf than plasma arc cutters and so generally have a lower total cut volume/weight per hour. There are no known emissions rate differences based on the type of laser (CO₂, Fiber, etc.).

Ch#.3.3.1 Criteria Pollutants

The criteria pollutant emissions that need to be estimated for laser cutters are limited to PM. The recommended uncontrolled PM emissions factor determined after a review of source test data is 11.43 percent of the weight of the cut. As noted above, laser cutters are not known to be a substantial source of other criteria pollutants, including NO_x.

Ch#.3.3.2 TACs

The TACs from laser cutting are limited to metal TACs and metal TAC precursors that are in the metals being cut. For all metals except hexavalent chromium the metal emissions are recommended to be assumed to be linear by metal alloy composition with the total PM emissions rate.

The hexavalent chromium emission factor was developed through a review of available source test data and is assumed to be 7.23×10^{-4} lb Cr⁺⁶/lb Cr in the cut. The data available in the source tests completed for laser cutters provided more information for the recommended emission factor unit basis than for fraction of total chromium emissions (the latter being the basis used for the plasma arc cutter Cr+6 emissions factor).

Ch#.3.4 Emission Capture

The metal fume emissions from plasma arc and laser cutters need to be captured before they can be controlled. There are several fume capture methods that can be used which depend on the type and size of the cutter. The primary methods of emissions capture include:

- Full Enclosures
- Downdraft Tables
- Water Tables
- Local Exhaust Ventilation

Ventilated full enclosures are the only emissions capture method that can be guaranteed to be 100 percent efficient. Fume emissions not captured by the collection system are considered fugitive and are not routed to control equipment. The fugitive emissions will be emitted through the building openings, such as doors and roof vents; or for portable plasma arc cutters that are used outside of buildings, will be emitted into the ambient air at the cutting site.

Care must be taken in assigning emission capture efficiencies, most importantly where metals with TACs will be cut. Specifically, the following assumptions and guidance should be followed when assigning emissions capture efficiencies:

- Plasma and laser cutting are high energy processes that can cause emissions to be dispersed rapidly away from the cutting surface, such as emissions associated with sparks.
- When emissions will be captured by local exhaust ventilation, the exhaust system design needs to meet design standards set forth in the American Conference of Governmental Industrial Hygienists, *Industrial Ventilation: A Manual of Recommended Practice for Design*.
- Manufacturer-stated control efficiencies should not be used without supporting information on test results and the test methods used. Capture efficiency is dependent on system design and should not be assumed; it should be supported by site-specific data or engineering analysis. See Table Ch#-3 for recommended default capture efficiencies.

Ch#.3.4.1 Full Enclosures

Full enclosures are used most often with computer operated cutting systems, mostly laser cutters. A properly operated and ventilated fully enclosed cutting system can be assumed to have a 100 percent emission capture efficiency.

Operating the cutter inside a building is not equivalent to a full enclosure, as buildings normally have multiple openings (doors, roof vents, etc.). Full enclosure designs need to be verified using U.S. EPA Method 204 and operation consistent with the evaluated enclosure configuration should be included in a permit condition.

Ch#.3.4.2 Downdraft Tables

Downdraft tables draw down the metal fumes and vent them to the particulate filters contained within the table or to separate control devices. Downdraft tables can be partially enclosed or include above table partitions to separate workspaces. Downdraft tables require a higher ventilation rate in comparison to local exhaust ventilation systems.

Large downdraft tables may be partitioned into individual sections or zones below the table. Each zone has its own damper that allows or restricts airflow, and the dampers automatically open or close based on where the cutting is being performed above the table. The zoned design ensures that only the relevant section is open for extraction to optimize efficiency. Zoned downdraft tables are most often used with gantry-style plasma arc cutting machines.

Downdraft tables can have extremely high emissions capture rates, with one zoned downdraft table manufacturer¹⁰ noting a capture and collection efficiency of 99 percent.

Ch#.3.4.3 Local Exhaust Ventilation

Local exhaust ventilation (LEV) can include diverse types of hoods and hood shapes, such as slot hoods, round hoods, covering hoods, and flexible hoods that move with the cutter. The hoods should have bell shapes, or similar, to reduce friction losses, and increase flow and capture efficiency. The LEV design may also include partial enclosures to increase capture efficiency. The capture efficiency of these LEV hoods is dependent on the exhaust flow rate, the hood design, and most importantly, the distance and location of the hood relative to the cutting surface. Other work area factors such as crossflow air currents or, when work is performed outdoors, ambient weather conditions affect the capture efficiency for LEVs.

Ch#.3.5 Emission Factors and Emission Capture Summary

The recommended plasma arc and laser cutter emissions factors (EFs) are summarized in Table Ch#-2:

Table Ch#-2. Emission Factors

Cutter	Type	Metal Cut	Pollutant	Emission Factor	Units	Notes
Plasma Arc	Dry	Stainless	PM	0.07	lb/lb cut	1
		Mild Steel	PM	0.05	lb/lb cut	1
		Brass	PM	0.05	lb/lb cut	1
		Aluminum	PM	0.05	lb/lb cut	1
		Thick Cut	PM	EFs above divided by 7	lb/lb cut	1,2
	Dry	All	NOx	0.017	lb/lb cut	3
	Semidry	All	NOx	0.01	lb/lb cut	3
	Wet	All	NOx	0.004	lb/lb cut	3
	All	Thick Cut	NOx	EFs above times 5	lb/lb cut	3
	All	All	Cr6+	6.22×10^{-2}	lb Cr+6/lb Cr emitted	4
	All	All	Other TACs	PM EF x TAC Comp%	lb/lb cut	5
Laser	All	All	PM	0.1143	lb/lb cut	4
	All	All	Cr6+	7.23×10^{-4}	lb Cr6+/lb Cr cut	4
	All	All	Other TACs	PM EF x TAC Comp%	lb/lb cut	5

Notes:

- 1) Based on Swedish Study². Please see Table Ch#-3 for PM emissions capture rates for semidry and wet cutting tables.
- 2) Thick Cut = metal thickness greater than 1 inch, for all metal types.
- 3) From Swedish Study², confirmed with Hypertherm³ data (as NO₂).
- 4) Based on the review of available source test data.
- 5) TAC emissions are assumed to be proportional to the PM emissions based on the metal TAC composition.

Emission factors for other metal alloys such as brass or aluminum are assumed to be the same as shown above for mild steel. Alternative emission factors provided by the permit applicant may be accepted when the source of the emission factor can be verified. Note that emission factors that are lower than those in Table Ch#-2 will need to be verified with a source test.

The recommended emissions capture efficiencies (η_{cap}) for plasma arc and laser cutters, with or without LEVs, are summarized in Table Ch#-3:

Table Ch#-3. Capture Efficiency Assumptions

Ventilation and Operations Scenario	η_{cap}	Notes
Total Enclosure	100%	1
Wet Plasma Arc Cutting Table with LEV	99.9%	2,4
Downdraft Table with LEV	99.5%	3,4
Semi-Dry Plasma Arc Cutting Table with LEV	97.5%	2,4
Wet Plasma Arc Cutting Table	99%	2
Downdraft Table	95%	3
Local Exhaust Ventilation (indoor with no side draft or outdoors in enclosure)	90%	4
Semi-Dry Plasma Arc Cutting Table	75%	2
Local Exhaust Ventilation (indoors with uncontrolled side draft)	75%	4
Local Exhaust Ventilation (outdoors with no enclosure)	50%	4

Notes:

- 1) Defined as operating with negative pressure/inflow at all enclosure openings
- 2) Reference 2 for Wet plasma arc cutting, and Reference 3 for Semi-Dry plasma arc cutting.
- 3) Based on online manufacturer's data, including Reference 10, that indicated values between 95 to 99+ percent depending on the type of downdraft table. Value for simple non-zoned tables assumed here. Replace the capture efficiency assumption with a manufacturer emissions capture guarantee, if available.
- 4) Engineering assumption. Includes all types of local exhaust ventilation (downdraft tables, round hoods, slot hoods, etc.), and assumes that they are all properly designed and operated.

There are more potential combinations of downdraft tables and wet and semi-dry cutting tables with LEV than presented above, where the final capture efficiency is the combined (multiplicative) value for the table type capture efficiency and the assumed LEV capture efficiency. Some of the combinations provided above may not exist in practice, such as wet plasma arc tables with LEV.

Total enclosure designs must be verified, and manufacturer capture efficiency guarantees need to be requested and should be used, when available and reasonable. Local exhaust ventilation design and use must be verified and permit conditions specifying use requirements, including distances from cutting surface and minimum face flow velocities must be included. Manufacture guarantees should be subject to source testing requirements when those guarantees identify efficiencies greater than Table Ch#-3.

Ch#.4 Calculations

Plasma arc and laser cutter emission calculations, using the methods shown below, are based on the emission factors and capture assumptions provided above.

Ch#.4.1 Operations Data

Operations data necessary to complete emission calculations include the hourly cut rate, schedule of operation, and the specific gravity and composition data of the metals to be cut.

The cut rate is the volumetric amount of metal cut per hour, such as cubic inches, multiplied by the metal's specific gravity. The volumetric amount of metal cut per hour is calculated using the thickness of the metal to be cut (the depth of cut), the kerf (width of cut), and the speed of the cut. In equation form the cut rate is as follows:

$$CR = D \times K \times S \times DEN$$

Where:

CR = Cut Rate – lbs/hr

D = Depth of cut - in

K = Kerf - in

S = Speed of cut – in/hr

DEN = Density of the metal – lbs/in³

The composition data is used to determine the cut rate for each of the TACs contained in each of the types of metal to be cut.

Ch#.4.2 Plasma Arc Cutters

Emission calculations for plasma arc cutters include PM, NO_x, and PM TACs.

Ch#.4.2.1 Particulate Emissions

PM emissions for plasma arc cutters should be calculated using the following equations:

$$R1 \text{ (lbs/hr)} = CR \text{ (lbs/hr)} \times EF_{PM} \text{ (lb/lb cut)}$$

And

$$R2 \text{ (lbs/hr)} = R1 \times (\eta_{cap} \times (1 - \eta_{con})) + R1 \times (1 - \eta_{cap})$$

Where:

R1 = Uncontrolled Emission Rate - lbs/hr

CR = Cut Rate – lbs/hr

EF_{PM} = Particulate Matter emissions factor = See Table Ch#-2 above.

R2 = Controlled Emission Rate – lbs/hr

η_{cap} = Capture Efficiency – fraction = See Table Ch#-3 above.

η_{con} = Control Efficiency – fraction

The recommended particulate matter emission factors for the distinct types of plasma arc cutters and metals cut are listed in Section 3.3, Table Ch#-2.

Ch#.4.2.2 NO_x Emissions

NO_x emissions for plasma arc cutters should be calculated using the following equations:

$$R1 \text{ (lbs/hr)} = CR \text{ (lbs/hr)} \times EF_{NO_x} \text{ (lb/lb cut)}$$

And

$$R2 \text{ (lbs/hr)} = R1 \text{ (lbs/hr)}$$

Where:

R1 = Uncontrolled Emission Rate - lbs/hr

CR = Cut Rate – lbs/hr

EF_{NO_x} = NO_x emission factor = See Table Ch#-2 above.

R2 = Controlled Emission Rate – lbs/hr

The recommended NO_x emission factors for the distinct types of plasma arc cutters are listed in Section 3.3, Table Ch#-3.

Ch#.4.2.3 Rule 1401 TAC Emissions

The PM TAC emissions for plasma arc cutters for all but hexavalent chromium should be calculated based on the composition data for the metal being cut as follows:

$$R1_{TACi} = R1_{PM} \times C_{TACi} / 100$$

and

$$R2_{TACi} = R2_{PM} \times C_{TACi} / 100$$

Where:

R1_{TACi} = Uncontrolled Emission Rate for TACi (lbs/hr)

R2_{TACi} = Controlled Emission Rate for TACi (lbs/hr)

R2_{PM} = Controlled Emission Rate for PM (lbs/hr)

C_{TACi} = TACi Composition of Metal (%)

The calculation for hexavalent chromium is as follows:

$$R1_{Cr+6} = R1_{PM} \times C_{TACCr} / 100 \times EF_{Cr+6}$$

and

$$R2_{Cr+6} = R1_{Cr+6} \times (\eta_{cap} \times (1 - \eta_{con})) + R1_{Cr+6} \times (1 - \eta_{cap})$$

Where:

- R1_{Cr+6} = Uncontrolled Cr+6 Emission Rate (lbs/hr)
- R2_{Cr+6} = Controlled Cr+6 Emission Rate (lbs/hr)
- C_{TACCr} = Chromium Composition of Metal (%)
- EF_{Cr+6} = Hexavalent Chromium Emission Factor (6.22x10⁻² lb Cr⁺⁶/lb Cr emitted)
- η_{cap} = Capture Efficiency – fraction = See Table Ch#-3 above.
- η_{con} = Control Efficiency – fraction

Ch#.4.3 Laser Cutters

Emission calculations for laser cutters are limited to PM and PM TACs.

Ch#.4.3.1 PM Emissions

PM emissions for laser cutters should be calculated using the following equations:

$$R1 \text{ (lbs/hr)} = CR \text{ (lbs/hr)} \times 0.1143 \text{ (EF}_{PM} \text{ lb/lb cut)}$$

And

$$R2 \text{ lb/hr} = R1 \times (\eta_{cap} \times (1 - \eta_{con})) + R1 \times (1 - \eta_{cap})$$

Where:

- R1 = Uncontrolled Emission Rate - lbs/hr
- CR = Cut Rate – lbs/hr
- EF_{PM} = Particulate Matter emission factor = 0.1143 lb/lb cut
- R2 = Controlled Emission Rate – lbs/hr
- η_{cap} = Capture Efficiency – fraction = See Table Ch#-2 above.
- η_{con} = Control Efficiency – fraction

Ch#.4.3.2 Rule 1401 TAC Emissions

The PM TAC emissions for laser cutters for all but hexavalent chromium should be calculated based on the composition data for the metal being cut as follows:

$$R1_{TACi} = R1_{PM} \times C_{TACi} / 100$$

and

$$R2_{TACi} = R2_{PM} \times C_{TACi} / 100$$

Where:

- R1_{TACi} = Uncontrolled Emission Rate for TACi (lbs/hr)
- R2_{TACi} = Controlled Emission Rate for TACi (lbs/hr)
- R2_{PM} = Controlled Emission Rate for PM (lbs/hr)

C_{TACi} = TACi Composition of Metal (%)

The calculation for hexavalent chromium should be calculated as follows:

$$R1_{Cr+6} = R1_{PM} \times C_{TACCr} / 100 \times EF_{Cr+6}$$

and

$$R2_{Cr+6} = R1_{Cr+6} \times (\eta_{cap} \times (1 - \eta_{con})) + R1_{Cr+6} \times (1 - \eta_{cap})$$

Where:

$R1_{Cr+6}$ = Uncontrolled Cr+6 Emission Rate (lbs/hr)

$R2_{Cr+6}$ = Controlled Cr+6 Emission Rate (lbs/hr)

CR = Cut Rate (lbs/hr)

C_{TACCr} = Chromium Composition of Metal (%)

EF_{Cr+6} = Hexavalent Chromium Emission Factor (7.23×10^{-4} lb Cr⁺⁶/lb Cr in cut)

η_{cap} = Capture Efficiency – fraction = See Table Ch#-2 above.

η_{con} = Control Efficiency – fraction

Ch#.4.4 Health Risk Assessment

If the alloys being cut contain chromium or metal TACs, a HRA is required. For example, stainless steels contain chromium and nickel; during cutting, a portion of the chromium oxidizes to hexavalent chromium, which typically drives cancer risk, while nickel emissions are usually the main contributor to acute non-cancer health risk. Most new plasma arc and laser cutter permits, with the potential exception of handheld or portable units, will require the cutters to be vented to particulate emission controls. This is particularly true if the expected emissions contain TACs.

South Coast AQMD HRAs can be performed through a four-tiered approach as follows:

- 1) Tier 1 – Screening Emission Levels
- 2) Tier 2 – Screening Risk Assessment
- 3) Tier 3 – Screening Dispersion Modeling
- 4) Tier 4 – Detailed Risk Assessment

The HRA must follow guidelines and procedures provided in the most current South Coast AQMD Risk Assessment Procedures for Rules 1401, 1401.1 and 212¹¹. South Coast AQMD has developed a web-based Health Risk Assessment tool (HRA Tool¹³) that is recommended to be used for Tier 1 through Tier 3 health risk assessments. A Tier 4 health risk assessment using AERMOD may be required depending on the source emissions and/or receptor locations. The requirements for these HRA tier approaches are described in more detail below.

Rule 219(d)(5)(H) provides a permit exemption for hand-held plasma arc cutting equipment and hand-held laser cutting equipment rated at 400W or less. Equipment that is used exclusively for maintenance or repair operations are exempt from a permit regardless of the type of metals cut, while equipment used for other purposes are only exempt if the equipment does not cut any stainless steel, or alloys containing 0.1 percent by weight or more of chromium, nickel, cadmium, or lead. Rule 219(e)(2) provides an exception to this and other permit exemptions when:

- (A) The risk from uncontrolled emissions will be greater than identified in paragraphs (d)(1), (d)(2), or (d)(3) in Rule 1401;
- (B) The equipment may not operate in compliance with all applicable South Coast AQMD rules and regulations, including but not limited to Rule 402 – Nuisance; or
- (C) The equipment or the air pollution control system venting the equipment has been modified, operated, or maintained in a manner that:
 - (i) Is inconsistent with the applicable exemption under any provisions of this rule; or
 - (ii) Results in otherwise preventable excess emissions that have been detected or observed by the Executive Officer.

Given that equipment used for maintenance or repair operations could cut any metal or metal alloys, there is a possibility that the health risks from uncontrolled emissions would be greater than the Rule 1401(d)(1), (d)(2), or (d)(3) thresholds and the equipment would require a permit. Attachment A provides Tier 1 HRA based screening tables, with additional instructions for different alloys or multiple alloys, as a reference to determine whether equipment used for maintenance or repair operations would continue to qualify for the Rule 219(d)(5)(H) exemption or if a permit application is required pursuant to Rule 219(e)(3).

Ch#.4.4.1 Tier 1 HRA

A Tier 1 HRA is the most conservative screening level in the HRA Tool. These HRAs are limited to a single emission source and a single worst-case receptor distance, but does allow the multiple TAC emissions from the single emission source. The only information required to complete Tier 1 HRAs in the HRA Tool is as follows:

- 1) Worst case hourly and annual emissions rates for each TAC pollutant emitted; and
- 2) Worst case (nearest) receptor distance.

This HRA procedure is based on the most conservative concentrations from the different source types used for Tier 2 HRAs to develop pollutant emission thresholds which are not expected to produce a MICR greater than one in one million nor a hazard index greater than one. This HRA procedure does not differentiate the type of receptor, resident or

worker, nor emissions release mechanisms (point, volume, or area source releases), using the worst-case assumptions for each.

Tier 1 HRAs can be used by applicants to determine whether or not a higher Tier HRA will be required when applying for a permit. It can also be used by applicants and South Coast AQMD staff to determine whether a permit is required based on Rule 219(e)(2) (See Attachment A for more information).

Ch#.4.4.2 Tier 2 to 4 HRAs

In certain cases, the Tier 1 HRA screening tables may be too conservative, so a higher HRA tier will need to be conducted to demonstrate compliance. The information required to complete each HRA tier are as follows:

1) Tier 2 HRAs

- a. Maximum annual emissions and maximum hourly emissions of each TAC (due to operating schedules, it is not appropriate to divide annual emissions by the number of hours in a year to get the maximum hourly emissions);
- b. Distance from the permit unit's release point to the property line of the nearest off-site residential and worker receptor(s);
- c. Source release characteristics, stack height for point source releases and building dimensions for volume source releases; and
- d. Geographic location of the permit unit to determine the most representative South Coast AQMD meteorological data site.

Note that South Coast AQMD's HRA Tool can be used to conduct Tier 2 HRAs in limited circumstances. For plasma arc or laser metal cutting that occurs in a building, the captured and controlled emissions can use the "General Non-Combustion Point Source Equipment" source type; and the "General Non-Combustion Volume Source Equipment" source type can be used for the fugitive emissions that are not captured. The distances for the stack and building fugitive releases should be identified separately, and the separate health risk results should be added.

2) Tier 3 HRAs

- a. Information required for Tier 2 HRAs;
- b. Additional equipment information for point source releases such as stack gas temperature, stack gas exit velocity or flow rate, and stack inside diameter;
- c. Surface characteristics (albedo, Bowen ratio, and surface roughness) of the appropriate meteorological station; and

- d. The most recently approved version of U.S. EPA's screening dispersion model AERSCREEN.

Note that South Coast AQMD's HRA Tool can be used to calculate health risks for Tier 3 HRAs. The modeled concentration output, performed separately, can be input into the Emissions Calculator¹² spreadsheet's "Concentrations for Tier 3" tab that then can be fed to the HRA tool. Instructions for completing this Tier 3 HRA calculation approach are contained in the Emissions Calculator spreadsheet and the HRA Tool.

- 3) Tier 4 HRAs
 - a. Information required under Tier 3 HRA items a and b;
 - b. South Coast AQMD meteorological data for the most appropriate station;
 - c. Most recently approved version of U.S. EPA's AERMOD air dispersion modeling system including AERMAP; and
 - d. Surface elevation data to run AERMAP to assign terrain-based elevations to project site and receptor locations.

Tier 3 and 4 HRAs require air dispersion modeling expertise.

Ch#.5 Rules

The following rules are generally applicable to plasma arc and laser cutting equipment.

Rule 212 – Standards for Approving Permits and Issuing Public Notice

Rule 401 – Visible Emissions

Rule 402 – Nuisance

Rule 404 – Particulate Matter - Concentration

Rule 405 – Solid Particulate Matter - Weight

Rule 1155 – Particulate Matter (PM) Control Devices

Regulation XIII – New Source Review

Rule 1303 – Requirements

Rule 1313 – Permits to Operate

Rule 1401 – New Source Review of Toxic Air Contaminants

Rule 1401.1 – Requirements for New and Relocated Facilities Near Schools

Ch#.6 Policy Documents

There are no current Policy Documents for plasma arc or laser cutters.

Ch#.7 Sample Permit Conditions

The conditions have “X’s” or “Y’s” where permit specific information is necessary and embedded notes that are not to be kept in the conditions when finalized are provided in “[**Underline**].” Additional conditions may be necessary based on the specific permitting circumstances.

Ch#.7.1 Plasma Arc Cutters or Laser Cutters

1. Operations of this equipment shall be conducted in accordance with all data and specifications submitted with the application under which this permit is issued unless otherwise noted below.
2. This equipment shall be properly maintained and kept in good operating condition at all times.
3. This equipment shall not be operated unless it is vented to air pollution control equipment which is in full use, and which has been issued a Permit to Operate by the South Coast AQMD.
4. The operator shall limit the amount of metal cut to no more than XX,XXX feet in any calendar month. **[Multiple versions of this condition should be included when several alloys are cut and each need different cutting limits. Cut length limits can be in inches or feet. Also, the long term limit can be stated as cut length per year or month]**
5. Different alloys shall not be cut within the same hour. **[This condition is required when there are multiple alloys that require cut rate limits.]**
6. The thickness of the metal cut shall not exceed X.XX inches. **[also acceptable if listed in other units such as millimeters. Multiple versions of this condition should be included when several alloys are cut and each have different maximum cut thickness.]**
7. The width of the cut (aka the kerf) shall not exceed X.XX inches. **[also acceptable if listed in other units such as millimeters. Multiple versions of this condition should be included if different cutter heads with different kerfs are used for different alloy types.]**
8. Toxic Air Contaminants (TACs), or TAC precursors (Chromium), in stainless steel shall not exceed the following weight percentages:

TAC	WEIGHT PERCENTAGE	CAS NO.
Arsenic	0.09	7440-38-2
Beryllium	0.09	7440-41-7
Cadmium	0.01	7440-43-9
Chromium	20	18540-29-9
Copper	3.5	7440-50-8
Lead	0.04	7439-92-1
Manganese	16	7439-96-5
Nickel	12	7440-02-0
Selenium	0.9	7782-49-2
Vanadium	0.9	7440-62-2

The weight percents for each TAC shall be determined from the upper limit as listed on the Safety Data Sheets (SDS) for the metals that are cut at the facility. All SDS shall be kept on site.

Table above is an example, specific values and types of metals that need to be tabulated, and they need to match the worst-case assumptions used in the health risk assessment. Multiple conditions, one each per alloy, or a combined table providing information for each alloy are necessary if there are multiple alloy types containing TACs to be cut. Also based on upcoming changes to Rule 1401 Table 1 the metal cobalt should be addressed in these tables if present in the metals being cut. There is also the potential for other high risk TAC metals, such as beryllium to be present in certain metal alloys.

Condition 8 is not required if no metals with Rule 1401 TACs will be cut]

9. Materials cut in this equipment shall not contain any toxic air contaminants identified in Rule 1401 Table 1 with an effective date of September 1, 2017, or earlier, except for materials listed in Condition No. 8 in this permit. **[If no metals containing Rule 1401 TACs then this condition should be as follows:**

Materials cut in this equipment shall not contain any toxic air contaminant identified in Rule 1401 Table 1 with an effective date of September 1, 2017, or earlier.

Also, this will need to be updated periodically when the Rule 1401 Table date is updated, for permit applications received after each update].

10. Unknown metals shall not be cut by this equipment.
11. Records shall be maintained to demonstrate compliance with the conditions on this permit. Records shall be kept in a format acceptable to the South Coast AQMD, shall be retained for five years, retained at the facility for a minimum of two years, and shall be made available to South Coast AQMD personnel upon request.

[This condition is currently written for a major source, for a non-major source it should be revised to "...South Coast AQMD, shall be retained at the facility for a minimum of two years, and..."].

12. The metals to be cut shall be free of any cleaning fluids, degreasing fluids, oils, greases, other lubricants, etc., excluding water.

[This Permit to Construct condition requiring necessary equipment information that was not available at the time of the permit application needs to be specifically tailored to each permit].

Ch#.7.2 Particulate Control Devices

1. Operations of this equipment shall be conducted in accordance with all data and specifications submitted with the application under which this permit is issued unless otherwise noted below.
2. This equipment shall be properly maintained and kept in good operating condition at all times.
3. This equipment shall be in full use whenever the equipment it serves is in operation.
4. The downdraft table shall be covered by impermeable materials, in areas not directly in use, with at least **[XX]** percent coverage of the table to ensure that the flow rate at the operating area of the opening grating is a minimum of **[XXX]** feet per minute. **[This condition, for dry plasma cutting downdraft tables only, may be required for non-zoned downdraft tables to ensure the assumed capture efficiency]**
5. The equipment shall comply with all applicable requirements of Rule 1155.
6. Dust collected in the dust collector**[s]** shall be discharged into closed containers and shall not be handled in a manner that may result in the release of collected materials into the atmosphere.
7. The **cartridge filters** shall be cleaned by a **reverse flow pulse jet system** that operates at a frequency specified by the manufacturer. **[revise the filter type and cleaning type as necessary]**
8. A mechanical gauge shall be installed and maintained to indicate, in inches of water column, the static pressure differential across the cartridge filters.
9. In operation, the pressure differential shall be a minimum of **XXX** inches of water and shall not exceed **YYY** inches of water across the cartridge filters. All cartridge filters shall be replaced when the pressure drop across the filters exceeds **YYY** inches of water column.
10. A mechanical gauge shall be installed and maintained to indicate, in inches of water column, the static pressure differential across the HEPA filters.

11. In operation, the pressure differential shall be a minimum of XXX inches of water and shall not exceed YYY inches of water across the HEPA filters. All HEPA filters shall be replaced when the pressure drop across the filters exceeds YYY inches of water column.

[Conditions 7 through 11 will be used as necessary based on the actual filter controls used.]

12. Records shall be maintained to demonstrate compliance with the conditions on this permit. Records shall be kept in a format acceptable to the South Coast AQMD, shall be retained for five years, shall be retained at the facility for a minimum of two years, and shall be made available to South Coast AQMD personnel upon request.

[This condition is currently written for a major source, for a non-major source it should be revised to..."South Coast AQMD, shall be retained at the facility for a minimum of two years, and..."].

13. The owner/operator shall conduct a source test of the laser/plasma arc cutter vented to this equipment under the following conditions:

- A. The test shall be conducted and a written report submitted to the South Coast AQMD engineer identified below within 90 days after achieving the normal production rate at which the equipment will be operated, but not later than 180 days after initial startup unless otherwise approved in writing by the Executive Officer.
- B. A minimum of three test runs shall be performed to measure the particulates, total chromium and hexavalent chromium emissions at the outlet of the dust collector. The report shall present the emissions data in pounds per hour.

[The list of TACs included above should include others such as nickel, as necessary, based on the type of metal being cut]

- C. The thickness of the material, the linear cutting speed, and the kerf of the cut shall be monitored and recorded during each test run. The total cut rate in pounds per hour shall be calculated for each test run. A certified mill test of the material shall also be provided.
- D. A test protocol shall be submitted to the South Coast AQMD engineer identified below not later than 60 days before the proposed test date and shall be approved by the South Coast AQMD before the test commences. The test protocol shall include items as listed in the attached forms ST-1 and ST-2.
- E. The South Coast AQMD engineer identified below shall be notified of the date and time of the test at least 10 days prior to the test, or within a time period agreed upon by the South Coast AQMD engineer.

- F. Sampling facilities shall comply with the attached South Coast AQMD “Guideline for Construction of Sampling and Testing Facilities,” pursuant to Rule 217.
- G. The source test shall be conducted by a testing laboratory certified by the California Air Resources Board or approved by the South Coast AQMD under the Laboratory Approval Program (LAP) in the required test methods for each criteria pollutant to be measured and in compliance with South Coast AQMD Rule 304 (No Conflict of Interest).
- H. A smoke test shall be conducted and documented prior to the actual source test to demonstrate that the exhaust ventilation is working properly. Capture velocity measurements shall be taken at the plane of the product being cut. The source test will only be conducted if the results of these tests show that the emissions capture system is operating properly. The results of the smoke test(s) and capture velocity measurements shall be included in the source test report. The smoke test shall follow the procedures set forth within Appendix 1 of Rule 1430.
- I. A sample of the dust in the dust collector shall be collected after the completion of the required source test and analyzed for hexavalent chromium, total chromium, and nickel content. The results of the collected dust analysis shall be included in the source test report.
- J. The source test report shall be submitted to the South Coast AQMD within 45 days after the source testing date. The report shall include, at a minimum, all items listed in the attached forms ST-1 and ST-2 and all testing data required by this permit.

[This condition will be included when it is determined that a source test is required. This condition is normally not required if no metals with Rule 1401 TACs are cut and for plasma/laser cutters not vented to control devices.]

Ch#8 References

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3. Fume emissions testing for plasma arc cutting. Hypertherm. Prepared by GZA GeoEnvironmental, Inc. February 1999. File No. 22151.
4. Iowa Department of Natural Resources, Emissions Estimate Tools website,

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Attachment A - Rule 219 Exemption Screening Thresholds

Rule 219(d)(5)(H) exempts certain hand-held plasma arc cutters and low power laser cutters. The exact exemption language is:

Welding equipment, oxygen gaseous fuel-cutting equipment, hand-held plasma-arc cutting equipment, hand-held laser cutting equipment, laser etching or engraving equipment and associated air pollution control equipment. This exemption does not include cutting equipment described in this paragraph that is used to cut stainless steel, or alloys containing 0.1 percent by weight or more of chromium, nickel, cadmium or lead, unless the equipment is used exclusively for maintenance or repair operations. In addition this exemption does not include laser cutting, etching and engraving equipment that are rated at more than 400 watts.

There is an exception to this exemption that is partially triggered if the equipment may cause health risks above Rule 1401 thresholds. A Tier 1 HRA was performed for uncontrolled emissions from both a plasma arc cutter and a laser cutter for several different metal alloy types. This analysis determines the short-term (hourly) and long-term (annual) cut rates that would not result in health risks exceeding Rule 1401 thresholds¹.

The Tier 1 HRA assumes the worst-case modeled short-term and long-term dispersion results (highest X/Q values) based on a conservative outdoor 2-meter by 2-meter volume source release. The metal cut rate limits are based on the distance from the edge of the volume source to the nearest receptor, which is conservatively assumed to be a residential receptor. The modeling was performed using the most recent South Coast AQMD approved meteorological data sets (for a five-year period ending with 2023) for all meteorological stations.

Based on staff's review of the compositions of several types of metal alloys cut, and a review of the most used stainless steel and Inconel alloys, four different metal alloys were used to provide a representative range of metal alloys that could be cut. The alloy selection was made to show the broad range in health risk impacts for several types of metals alloys based on the relative toxicities of the component metals. For example, a sensitivity analysis showed that the cancer risk driver is hexavalent chromium (formed when chromium is subject to high heat and a portion converts to hexavalent chromium), and the acute risk driver is nickel. The metal alloys assessed, and their respective toxic metals composition values are shown in Table A-1.

Table A-1 Composition of Metal Alloys

¹ This evaluation assumes that any coatings that may be on the metals to be cut do not substantially impact the risk assessment. However, staff believes it is good practice to remove any coatings on the metals to be cut prior to cutting using plasma arc or laser cutters.

Metal	Metal Alloy Name, Composition %, and Density			
	EN24T Mild Steel	1045 Carbon Steel	Stainless 304	Inconel 718
Chromium	1.4%	0%	19.5%	18.5%
Nickel	1.7%	0%	10.5%	53.0%
Manganese	0.7%	0.9%	2.0%	0%
Density (lb/in ³)	0.289	0.284	0.286	0.287

The composition of each metal alloy was based on information from the following sources:

- The EN24T mild steel composition data is from ASTM SAE AISI 1018 Carbon Steel Chemical Composition, Mechanical Properties (theworldmaterial.com).
- The 1045 Carbon Steel composition data is from ASTM SAE AISI 1045 Carbon Steel Heat Treatment, Chemical Composition, Properties (theworldmaterial.com).
- The 304 stainless steel composition data is the 304 Stainless Steel Properties: SS304 Composition, Density, etc. (theworldmaterial.com).
- The Inconel 718, aka Ni718, composition data is from the VDM Metals 2015 SDS.

The densities for each of the metal alloys were determined using general internet queries.

For hand-held plasma arc cutting equipment, the following assumptions were used to determine the uncontrolled emissions rates²:

- Metal particulate fume emissions are 7 percent of the cut weight for stainless steel and nickel alloys and 5 percent of the cut weight for mild steel and aluminum alloys.
- Metal composition in the fume is proportional to the metal composition of the alloy being cut.
- Hexavalent chromium, which is created in the cutting process, is 0.0622 fraction of the total chromium emissions.
- The maximum kerf width of the cut for a hand-held plasma arc cutter is 10 millimeters (mm).

² Emission factors for plasma arc cutters, including the hexavalent chromium (Cr+6) conversion values, were determined through an evaluation of existing in house source test data, and additional limited third party source test literature. Source tests were reviewed and included in the evaluation if they had adequate testing condition data (cut rate and metal composition to determine conversion rates/emissions factors for Cr+6). Tests that only had controlled emissions test data were not used. Test results that were deemed out of range or that did not have enough information to determine an emissions factor were not used. Examples of out of range tests that were not used was one for plasma arc cutting that identified a conversion rate to Cr+6 of 96.21 percent. The particulate emissions factors for plasma arc cutting are from a reference attached to the AP-42 Section 12 (<https://www.epa.gov/sites/default/files/2020-11/documents/welding.pdf>).

- The maximum material thickness for hand-held plasma arc cutters is 16 mm for stainless steel, nickel alloys, and aluminum, and 30 mm for mild steel.

For hand-held laser cutting equipment, the following assumptions were used to determine the uncontrolled emissions rates³:

- Metal particulate fume emissions are 11.43 percent of the cut for all metal alloys.
- Metal composition in the fume is proportional to the metal composition of the alloy being cut.
- Hexavalent chromium, which is created in the cutting process, is 0.00723 fraction of the total chromium in the cut, which is equivalent to 0.0633 fraction of the total chromium emissions.
- The maximum kerf width of the cut for a 400 watt hand-held laser cutter is 1 mm⁴.
- The maximum material thickness for 400 watt hand-held laser cutters is 2 mm for aluminum, 3 mm for stainless steel and nickel alloys, and 4 mm for mild steel.

Using these assumptions, in order for health risks to stay below Rule 1401 thresholds (or be exempt from permitting pursuant to Rule 219 for a hand-held plasma arc cutter), the maximum allowable cut rates for a hand-held plasma arc cutter, with short-term rates that are based on acute health risk, and annual cut rates based on long-term cancer health risk are shown in Table A-2 below.

³ Emissions factors for laser cutters, including the hexavalent chromium (Cr+6) conversion values, were determined through an evaluation of existing in house source test data. No third party tests were found or used in the emissions factor determination for laser cutters. As noted above, the source tests that were determined to have results out of range were excluded, including one that provided a 0.62 fraction particulate emissions factor.

⁴ The 400 watt hand-held laser cutting kerf and material thickness assumptions are used a maximum for lasers that are less than 400 watts and may be covered under the Rule 219 permitting exemption.

Table A-2 Tier 1 Plasma Arc Cutting Rates Allowed

Receptor	EN24T Mild Steel		1045 Carbon Steel		Stainless 304		Inconel 718	
	in/hr	in/yr	in/hr	in/yr	in/hr	in/yr	in/hr	in/yr
@25M	2.67	18	No Limit	16,694	0.31	1	0.06	1
@50M	5.95	59	No Limit	30,933	0.70	3	0.14	3
@100M	15.06	116	No Limit	66,564	1.76	6	0.35	6
@200M	29.05	336	No Limit	142,123	3.40	18	0.67	18
@300M	57.60	721	No Limit	274,359	6.73	38	1.33	38
@500M	120.70	1,654	No Limit	553,531	14.10	87	2.78	88
@1000M	312.66	4,964	No Limit	1,460,706	36.54	260	7.21	263

Using these assumptions, in order for health risks to stay below Rule 1401 thresholds (or be exempt from permitting pursuant to Rule 219 for a hand-held laser cutter 400W and below), the maximum allowable cut rates for a hand-held laser cutter, with short-term rates that are based on acute health risk, and annual cut rates based on long-term cancer health risk are shown in Table A-3 below.

Table A-3 Tier 1 Laser Cutting Rates Allowed

Receptor	EN24T Mild Steel		1045 Carbon Steel		Stainless 304		Inconel 718	
	in/hr	in/yr	in/hr	in/yr	in/hr	in/yr	in/hr	in/yr
@25M	46.78	316	No Limit	292,105	10.20	31	2.01	31
@50M	104.07	1,009	No Limit	541,253	22.70	99	4.48	100
@100M	263.50	2,003	No Limit	1,164,721	57.48	196	11.35	198
@200M	508.35	5,784	No Limit	2,486,837	110.89	566	21.89	573
@300M	1007.79	12,404	No Limit	4,800,677	219.84	1,213	43.40	1,228
@500M	2111.91	28,464	No Limit	9,685,577	460.69	2,783	90.95	2,819
@1000M	5470.85	85,436	No Limit	25,559,162	1,193.40	8,353	235.60	8,460

The results in Table A-2 and Table A-3 show that the Rule 219(d)(5)(H) exemption allowable cut rates are higher for laser cutters due to smaller kerfs and thinner cuts for 400W and smaller hand-held laser cutters compared to hand-held plasma arc cutters. The cut rate limits for metals that contain considerable amounts of chromium or nickel are restrictive, particularly if there are receptors located near the cutting location. These results also show that steels that do not contain chromium or nickel have cut rate limits that would not be restrictive. This would also be true for aluminum alloys that do not contain chromium or nickel.

The Rule 219 exemption review for the cutting of unknown metals should use the most conservative values, from Inconel 718, that are presented in these two tables.

Each plasma arc cutter or laser cutter can have a different maximum kerf width, and the facility may not be cutting materials as thick as the maximum thicknesses assumed. To correct table values for different kerfs and/or different maximum cut thickness the following equation can be used:

$$\text{Allowable Cut limit} = \text{Table cut limit} \times \text{kerf width assumption/actual kerf width} \times \text{thickness assumed/actual thickness}$$

Metal alloys with known chromium and/or nickel contents that are different than the alloys assessed above can be addressed based on compositional content. Where the short-term cut rate limits can be determined based on a ratio of the nickel content difference between the alloy and Inconel 718 and the long-term cut rate limit can be based on a ratio of the chromium content difference between the alloy and 304 stainless. For non-ferrous alloys, such as aluminum and copper alloys, the ratio of the metal densities should also be addressed. The following equations can be used:

$$\text{Long-Term Cut Limit} = \text{SS304 cut limit} \times \text{SS304 } 19.5\% \text{Cr} / \text{Alloy X } \% \text{Cr} \times 0.286 \text{ lb/in}^3 / \text{Alloy density}$$

$$\text{Short-Term Cut Limit} = \text{Ni718 cut limit} \times \text{Ni 718 } 53\% \text{Ni} / \text{Alloy X } \% \text{Ni} \times 0.287 \text{ lb/in}^3 / \text{Alloy density}$$

For copper alloys that do not contain other TAC metals cut rate limits, there would be no long-term cut rate limits only a short-term limit and that limit can be determined based on the ratio of the acute REL for copper versus the acute REL for nickel using the following equation:

$$\text{Cu Alloy Short Term Cut Limit} = \text{Ni718 cut limit} \times 100/0.2 \times \text{Ni 718 } 53\% \text{Ni} / \text{Alloy X } \% \text{Cu} \times 0.286 \text{ lb/in}^3 / \text{Cu Alloy density}$$

For standard copper pipe, which is 99.9 percent copper and has a density of 0.325 lb/in³, this would result in a short-term cut rate limit that is 233 times higher than the short-term cut rate limits shown for Inconel 718.

The short-term risk and cut rate limits are dominated by the alloy's nickel content. If a source is cutting mild steel and/or aluminum with no more than a trace of nickel content, then as can be seen in the specific alloy tables there is no short-term risk concern for these two types of alloys.

The long-term risk and cut rate limits are predominately based on the chromium contents assumed, so if the source is cutting mild steel or aluminum with no more than a trace of chromium content, then the cut limits would not be restrictive.

Cutters that are cutting different alloys than the four types assumed may have compositions of different toxic metals than those evaluated or higher compositions than those evaluated, such as copper alloys that can include arsenic or beryllium or other alloys that may have high lead or cadmium concentrations. Tier 1 HRA and the exception

in Rule 219(e)(2) for these metal alloys will need to be evaluated on a case-by-case basis. To complete this case-by-case analysis the calculated emissions can be used in combination with the Tier 1 risk analysis tab in the South Coast AQMD HRA Tool¹³.

The health risks of additional toxic metals will need to be addressed in the future. Specifically, Rule 1401 is proposed to be amended to include additional toxic compounds added by OEHHA and CARB since the last rule approval date, which will include trivalent chromium and cobalt.

DRAFT

Attachment B - Sample Evaluation – Plasma Arc Cutter

EVALUATION FOR PERMIT TO CONSTRUCT/OPERATE

APPLICANT'S NAME (FACILITY NAME) (FACILITY ID XXXXXX)

MAILING ADDRESS (FACILITY MAILING ADDRESS)

EQUIPMENT LOCATION (FACILITY ADDRESS)

EQUIPMENT DESCRIPTION

APPLICATION NO. XXXXXX

Plasma Arc Cutter, Hypertherm, Powermax 1250, 12 kW, Downdraft Table 8'-0" W. x 25'-0" L. x 5'-0" H., Full Enclosure

APPLICATION NO. XXXXXX

Air Pollution Control System consisting of:

1. First Stage, Flanders Precisionaire, Model: Pre-Pleat 40, 2'-0" W. x 2'-0" L. x 0'-2" D. Each, 4 Panels Total
2. Second Stage, Aerostar, Model: M13, 2'-0" W. x 2'-0" L. x 0'-2" D. Each, 4 Panels Total
3. Final Stage, HEPA Filter, Flanders Precisionaire, Model: Alpha 2000, 2'-0" W. x 2'-0" L. x 1'-0" D. Each, 4 Panels Total
4. Exhaust System with a 5 hp Blower venting a Plasma Arc Cutter

BACKGROUND

(FACILITY NAME) is a facility that manufactures stainless and galvanized steel components for heavy equipment manufacturing. The facility submitted the above applications on XX/XX/XX for new construction of the plasma arc cutter and the dust collection system. (FACILITY NAME) is neither a RECLAIM facility nor a Title V facility. The facility currently holds active permits to operate several other pieces of equipment, including a surface preparation line, a boiler, an oven, and two spray booths.

The facility is in a commercial area where the nearest residence, on (XXXXXX STREET), is located approximately 500 meters to the west of the facility and the nearest commercial property, (NAME of NEAREST FACILITY), is located 250 meters east of the facility. A search for existing schools and schools under construction, as defined in Rule 1401.1 (c), found no school within 305 meters (1,000 feet) of the facility. The closest school is the XXXX Elementary School, which is located approximately 1,500 meters west of the facility.

NOV/NC HISTORY

A review of compliance records for this facility (ID XXXXXX) in the past two years indicate no Notices to Comply (NOC), no Notices of Violation (NOV), and no complaints.

PROCESS DESCRIPTION

The proposed dry plasma arc cutter, using computer numerical control (CNC), is operated on a gantry over a downdraft table. The metal sheets to be cut are placed on the downdraft table and the metal fume emissions are vented through the downdraft table to the dust control system. The cutter is operated inside of a full enclosure located within a permanent structure (building) and the control system is located outside of the building. The cutter downdraft exhaust collection is set up into 4' by 4' zones with a ventilation rate of 3,600 acfm. The cutter can cut metals up to one inch thick, a maximum cutting kerf (width) of 0.25 inches and has a maximum cutting speed of 8

inches per minute when cutting one inch metal. The metals cut will range from one eighth to one inch thick, and the cutting speed increases for thinner metal; however, the total maximum cutting volume rate occurs when cutting one inch thick metal. The cutter uses compressed air for the plasma gas and the shield gas. The proposed operating schedule is 8 hours per day, five days per week, 50 weeks per year.

The metals data, including Rule 1401 toxic air contaminant composition, for the metals to be cut is as follows:

Metals Composition Data (Max % from applicant’s SDS sheet)

Metal	Density (lbs/in ³)	Rule 1401 TACs Composition (%)		
		Cr*	Mn	Ni
Stainless Steel	0.29	20	2	12
Galvanized Steel	0.29	-	1.35	0.2

* - Chromium metal is not a listed TAC, but a portion of chromium in the cutting fume will be oxidized to hexavalent chromium (Cr+6) that is a listed TAC.

EMISSIONS

The plasma arc cutter is vented through a downdraft table to the dust control system. The plasma arc cutter is within a full enclosure; therefore, the capture efficiency is assumed to be 100%. The dust control system is comprised of two prefilters and a HEPA filter with a total control efficiency of 99.97% percent.

Plasma arc cutter emissions are comprised of metal fume particulate matter (PM) emissions that include metal TACs based on the composition of the metals cut and include NOx emissions that are created by this cutting method.

The facility is asking for a 6,000 foot per month metal cut limit. The maximum amount of cut, per calendar month, based on the requested operating schedule is as follows:

$$23 \text{ days/month} \times 8 \text{ hrs/day} \times 60 \text{ min/hour} \times 8 \text{ in/min} / 12 \text{ in/foot} = 7,360 \text{ feet/month}$$

Therefore, the requested monthly cut rate is lower than the maximum monthly potential cut rate for the 8 hour per day operating schedule. Additionally, the TAC emissions rates have been evaluated to determine additional necessary operating restrictions, by steel alloy type, to maintain the health risks below Rule 1401 limits. The permit conditions reflect the requested operating schedule and other health risk-based operations limitations.

The emissions for this amount of metal cut are calculated by as follows:

Cute Rate (CR):

$$CR = D \times K \times S \times DEN$$

Where:

- CR = Cut Rate – lbs/hr
- D = Depth of cut - in
- K = Kerf - in
- S = Speed of cut – in/hr
- DEN = Density of the metal – lbs/in³

The cut rate for one-inch-thick steel cut at 8 inches per minute with a 0.25-inch kerf and density of 0.29 lbs/in³ are:

$$CR = 1 \text{ in} \times 0.25 \text{ in} \times 8 \text{ in/min} \times 60 \text{ min/hr} \times 0.29 \text{ lb/in}^3 = \underline{\underline{34.8 \text{ lbs cut/hr}}}$$

Particulate (PM) Emissions:

$$R1_{PM} \text{ (lbs/hr)} = CR \text{ (lbs/hr)} \times EF_{PM} \text{ (lb/lb cut)}$$

and

$$R2_{PM} \text{ lbs/hr} = R1_{PM} \times (\eta_{cap} \times \eta_{con}) + R1_{PM} \times (1 - \eta_{cap})$$

Where:

$R1_{PM}$ = Uncontrolled Emissions Rate, lbs/hr

CR = Cut Rate, lbs/hr

EF_{PM} = Particulate Matter (PM) emissions factor (Where: PM = PM10 = PM2.5)

$R2_{PM}$ = Controlled Emission Rate, lbs/hr

η_{cap} = Capture Efficiency, fraction = 1

η_{con} = Control Efficiency, fraction = 0.9997

The uncontrolled particulate matter emissions factors for a dry plasma arc cutter are 0.07 lb/lb cut for stainless steel and 0.05 lb/lb cut for mild steel. For these calculations both steel alloys are assumed to have the stainless steel emissions factor.

$$R1_{PM} \text{ (lbs/hr)} = 38.4 \text{ lbs/hr} \times 0.07 \text{ (lb/lb cut)} = 2.44 \text{ lbs/hr}$$

and

$$R2_{PM} \text{ lb/hr} = 2.44 \text{ lbs/hr} \times (1 \times 0.9997) + 2.44 \text{ lbs/hr} \times (1 - 1) = 7.31E-04 \text{ lbs/hr} + 0 \text{ lbs/hr} = 7.31E-04 \text{ lbs/hr}$$

Nitrogen Oxides (NOx) Emissions:

The NOx emissions factor for a dry plasma arc cutter cutting thick stainless steel is 0.085 lbs/lb cut. Based on cutting for a full hour the NOx emissions would be as follows:

$$R1_{NOx} \text{ lbs/hr} = R2_{NOx} = EF_{NOx} \text{ lb/lb cut} \times CR \text{ lb/hr} = 0.085 \text{ lb/min} \times 34.8 \text{ lb/hr} = 2.96 \text{ lbs/hr}$$

Where:

$R1_{NOx}$ = Uncontrolled Emissions Rate, lbs/hr

CR = Cut Rate, lbs/hr

EF_{NOx} = NOx emissions factor = 0.085 lb/lb cut for dry plasma arc cutter thick cut.

$R2_{NOx}$ = Controlled Emission Rate, lbs/hr

R1401 TAC Emissions:

From the above data on the proposed work schedule, alloy types cut, percentages of Rule 1401 metals and other physical properties, a worst-case scenario metal composition for each material is created to calculate the TAC emissions to determine the health risk assessment MICR, HIC and HIA. The maximum weight percents of Rule 1401 metals in each alloy cut will be imposed as a permit condition for each TAC. In addition to the mass balance basis for most of the TAC metals the hexavalent chromium emissions are estimated using a separate emissions factor for the conversion/oxidation of chromium metal to hexavalent chromium. The calculations are as follows:

$$R1_{TACi} = R1_{PM} \times C_{TACi} / 100$$

and

$$R2_{TACi} = R2_{PM} \times C_{TACi} / 100$$

Where:

$R1_{TACi}$ = Uncontrolled Emissions Rate for TACi (lbs/hr)

$R1_{PM}$ = Uncontrolled Emissions Rate for PM (lbs/hr)

$R2_{TACi}$ = Controlled Emissions Rate for TACi (lbs/hr)
 $R2_{PM}$ = Controlled Emissions Rate for PM (lbs/hr)
 C_{TACi} = TACi Composition of Metal (%)

The calculation for hexavalent chromium (Cr+6) is as follows:

$$R1_{Cr+6} = R1_{PM} \times C_{TACCr} / 100 \times EF_{Cr+6}$$

and

$$R2_{Cr+6} = R1_{Cr+6} \times (\eta_{cap} \times (1 - \eta_{con})) + R1_{Cr+6} \times (1 - \eta_{cap})$$

Where:

$R1_{Cr+6}$ = Uncontrolled CR+6 Emissions Rate (lbs/hr)
 $R2_{Cr+6}$ = Controlled Cr+6 Emissions Rate (lbs/hr)
 $R2_{PM}$ = Controlled Emissions Rate for PM (lbs/hr)
 C_{TACCr} = Chromium Composition of Metal (%)
 EF_{Cr+6} = Hexavalent Chromium Emission Factor (0.0622 lb Cr⁺⁶/lb Cr emitted)
 η_{cap} = Capture Efficiency – fraction = 1.
 η_{con} = Control Efficiency – fraction = 0.9997

Emissions Summary:

Using the calculations noted above for the requested operating schedule the emissions summary by alloy type are determined as follows:

Stainless Steel Cutting Emissions

		PM	NOx	Cr+6	Mn	Ni
R1	lb/hr	2.44E+00	2.96E+00	3.03E-02	4.87E-02	2.92E-01
	lb/day	1.95E+01	2.37E+01	2.42E-01	3.90E-01	2.34E+00
	lb/yr	4.87E+03	5.44E+02	6.06E+01	9.74E+01	5.85E+02
R2	lb/hr	7.31E-04	2.96E+00	9.09E-06	1.46E-05	8.77E-05
	lb/day	5.85E-03	2.37E+01	7.27E-05	1.17E-04	7.02E-04
	30-day lb/day	4.06E-03	1.64E+01	-	-	-
	lb/yr	1.46E+00	5.92E+03	1.82E-02	2.92E-02	1.75E-01

Galvanized Steel Cutting Emissions

		PM	NOx	Mn	Ni
R1	lb/hr	2.44E+00	2.96E+00	3.29E-02	4.87E-03
	lb/day	1.95E+01	2.37E+01	2.63E-01	3.90E-02
	lb/yr	4.87E+03	5.44E+02	6.58E+01	9.74E+00
R2	lb/hr	7.31E-04	2.96E+00	9.87E-06	1.46E-06
	lb/day	5.85E-03	2.37E+01	7.89E-05	1.17E-05
	30-day lb/day	4.06E-03	1.64E+01	-	-
	lb/yr	1.46E+00	5.92E+03	1.97E-02	2.92E-03

The 30-day average emissions calculated for PM and NOx use the following calculation:

$$\text{Lbs/day 30-day average} = \text{lbs/year} / (12 \text{ months} \times 30 \text{ days/month})$$

HEALTH RISK ASSESSMENT

The health risk assessment for the plasma arc cutter was based on the worst-case scenario metal composition, with emissions calculated above for each of the two materials cut; stainless steel and galvanized steel. The controlled TACs emissions rates for galvanized steel are below the South Coast AQMD Risk Thresholds using the HRA Tool Health Risk Calculator, Tier 1 Screening Risk Assessment for manganese and nickel. Therefore, there are no additional permit restrictions, beyond the applicant requested schedule and cutting rates are required for the cutting of galvanized steel. The emissions from stainless steel cutting were input into the HRA Tool Health Risk Calculator, Tier 1 Screening Risk Assessment with a determination of the cancer risk being 10.9 in a million for the closest receptor distance of 250 meters. Therefore, a Tier 2 Risk Assessment was conducted with the following source assumptions:

- 1) Source location in SRA1
- 2) General Non-Combustion Point Source Equipment
- 3) Stack Height between 14 and 25 feet
- 4) Operations 8 hours per day and 5 days per week
- 5) Receptor distances of 250 meters for worker, 500 meters for residential, and 1,500 meters for school.

The following summarizes the results of the Tier 2 Screening Risk Assessment

Receptor	MICR per million	HI Chronic	HI Chronic 8hr	HI Acute
Residential	0.657	7.66E-04	7.23E-04	1.02E-02
School	0.194	2.26E-04	2.14E-04	3.90E-03
Worker	0.804	4.61E-03	4.35E-03	3.73E-02

Specifying the source type and specific receptor types and distances in the Tier 2 screening risk assessment determined cancer risk values that were under 1 in a million and chronic and acute health indices of well below 1.

Permit conditions will be imposed to restrict the maximum hours of operation and the maximum concentration of metals in any given alloy, to the conditions modeled, and to install non-resettable timers to measure operating time on the plasma arc cutter.

RULES/REGULATION EVALUATION

RULE 212, PUBLIC NOTIFICATION

SECTION 212(c)(1):

This section requires a public notice for all new or modified permit units that may emit air contaminants located within 1,000 feet from the outer boundary of a school. This facility is not located within 1000 feet from a school; therefore, public notice is not required under this section. The closest school is the XXXX Elementary School, which is located approximately 1,500 meters west of the facility.

SECTION 212(c)(2):

This section requires a public notice for all new or modified equipment and facilities that have emission increases exceeding any of the daily maximums as specified in subdivision (g) [see table below]. The emissions increases are well below the daily maximums; therefore, public notice is not required.

Pollutant	Daily Maximum (lb/day)	Rule 212(g) Threshold (lb/day)
VOC	-	30
NOx	23.7	40
PM10	0.00585	30
SOx	-	60
CO	-	220
Lead	-	3

SECTION 212(c)(3):

This section requires a public notice for all new or modified sources that have on-site emission increases resulting in a cancer risk of more than 1 in a million. The maximum MICR for all receptor types was determined to be less than one in a million. Therefore, public notice is not required.

SECTION 212(g):

This section requires a public notice for all new or modified sources that have equipment emission increases exceeding any of the daily maxima as specified by Rule 212 (g). The PM10 emission increase is less than the 30 lb/day limit and the NOx emissions increase is less than the 40 lb/day limit; therefore, public notice is not required.

RULES 401 & 402, VISIBLE EMISSIONS & NUISANCE

Visible emissions and odors from this equipment are not expected with proper maintenance and operation. Compliance is expected.

RULE 404, PARTICULATE MATTER - CONCENTRATION

The PM emissions are controlled by a high efficiency dust collection system, so the emissions concentration will be orders of magnitude below the concentration standards set by this rule and compliance is expected.

RULE 405, SOLID PARTICULATE MATTER - WEIGHT

The controlled PM emissions are 0.00073 lb/hr, which is lower than the lowest allowable limit for solid PM (Table 405(a) – 0.99 lb/hr for a process weight less than 220 lbs/hour), so compliance is expected.

REGULATION XI: SOURCE SPECIFIC STANDARDS**RULE 1155, PARTICULATE MATTER (PM) CONTROL DEVICES**

This dust collector is exempt from all parts of this rule except section (d)(1), which limits any visible emissions other than water vapor from the dust collector exhaust, since the total filter area is less than 100 sq. ft [Exemption (g)(1)].

REGULATION XIII**RULE 1303(a), BEST AVAILABLE CONTROL TECHNOLOGY (BACT)**

PM10 and NOx are the only criteria pollutants expected from this equipment. The uncontrolled PM10 and NOx emissions from the plasma arc cutter are greater than 1 lb/day, therefore BACT is triggered. The plasma arc cutter is vented to a high efficiency dust collection system with a 99.97 percent control efficiency that is considered above the efficiency for the current BACT guideline control method for plasma cutters (Water table and nozzle water shroud, or electrostatic precipitator); therefore, the PM10 BACT requirement is satisfied.

The current BACT guidelines for plasma arc cutters do not consider NOx emissions and emissions controls for NOx emissions from plasma arc cutters have not been achieved in practice, so a cost effectiveness analysis is required. This analysis has not been performed here, and when the first such cost effectiveness analysis is performed it may provide adequate information to show that NOx scrubbing is not cost effective for all plasma arc cutters.

RULE 1303(b)(1), MODELING

The emission increase from PM10 for the plasma arc cutter (0.00073 lbs/hr) is below the screening analysis threshold given in Table A-1 for noncombustion sources (0.41 lbs/hr); therefore, modeling for PM10 is not required.

The emissions increase for NO_x for the plasma arc cutter (2.96 lbs/hr) is above the screening analysis threshold given in Table A-1 for noncombustion sources (0.068 lbs/hr); therefore, modeling for NO_x impacts is required. *A modeling analysis for NO_x has not been completed as part of this sample evaluation but is required for an actual evaluation.*

RULE 1303 (b) (2), EMISSION OFFSETS

The emission increase for PM₁₀ and NO_x are below the 4 ton/year offsets emissions thresholds given in Rule 1304(d)(2)(B) Table A; therefore, offsets are not required.

RULE 1401, NEW SOURCE REVIEW OF CARCINOGENIC AIR CONTAMINANTS

As shown in the health risk assessment section, the MICR is less than 1-in-a-million and HIC and HIA are less than one. Therefore, the plasma arc cutter complies with this rule.

RULE 1401.1, REQUIREMENTS FOR NEW AND RELOCATED FACILITIES NEAR SCHOOLS

As noted in the Background discussion the nearest school is located approximately 1,500 meters (4,920 feet) from the facility, so this regulation that applies to new and relocated facilities located within 1,000 feet of a school does not apply to this facility.

CEQA

CEQA requires that the environmental impacts of proposed projects be evaluated and that feasible methods to reduce, avoid or eliminate identified significant adverse impacts of these projects be considered. A CEQA Applicability Form (400-CEQA) was submitted and indicates that preparation of a CEQA document is not required. Additionally, the PM and NO_x emissions from the project are below the applicable South Coast AQMD CEQA regional and localized emissions thresholds, and the project has no direct GHG emissions and so is below the South Coast AQMD CEQA emissions threshold for GHG emissions.

RECOMMENDATION:

Operation of the equipment (Plasma arc cutter and dust control system) is expected to comply with all applicable South Coast AQMD rules and regulations with the limitations contained in the draft permit conditions. Issuance of conditional Permits to Construct is recommended for the two permit units.