



Guidelines for Calculating and Reporting Emissions from Welding Operations

December 2024

This guideline was adopted from San Diego APCD’s document dated July 11, 2022, for reporting PM and hazardous metals emissions from welding operations. EPA’s AP-42 (1/95) Final Section Tables 12.19-1 for the welding rod fume generation rate and 12.19-2 for the trace metal component are also attached below.

Welding is the process of joining two metal parts by melting the parts at the joint and filling the space with molten metal. Most commonly frequently used welding methods are as follows:

- Gas Metal Arc Welding (GMAW) a. k. a. Metal Inert Gas (MIG) Welding
- Gas Tungsten Arc Welding (GTAW) a. k. a. Tungsten Inert Gas (TIG) Welding
- Shielded Metal Arc Welding (SMAW) a. k. a. Manual Metal Arc (MMA) Welding
- Flux Core Arc Welding (FCAW)

San Diego APCD default welding emission factors can be found at <https://www.sdapcd.org/content/sdapcd/permits/toxics-emissions/calculation-procedures.html#v1-2f8774f98a-item-0d2efbdb5d>. Procedures for these emission factors can be found at <https://www.sdapcd.org/content/dam/sdapcd/documents/permits/emissions-calculation/welding/APCD-Welding-Operations.pdf>

If default San Diego APCD emission factors are not available, the following San Diego APCD emission calculation methodology should be applied based on the TACs listed in the SDS. The methodology should also be applied if the TACs listed in the SDS deviate from those presented in the San Diego APCD emission factors.

Emission Calculations

The calculation method for estimating emissions for welding operations are primarily dependent on the emission factor, fume generation rate, and concentration of listed substance in each welding rod.

Case 1: If an emission factor is listed in EPA’s AP-42 (1/95) Final Section Table 12.19-1 for the welding rod fume generation rate with correct welding process, but not Table 12.19-2 for the trace metal component, the following procedure will be used:

$$Ea = Ua \times EF \times FCF \times Ci \times (1 - e)$$

Where: Ea = Annual emissions of each listed toxic air contaminant per rod, (lb/year)

Ua = Annual usage of each welding rod, (lb/year)

EF = Particulate (PM10) emission factor from AP-42 Table 12.19-1, (lb fume/lb rod consumed)

FCF = Fume correction factor per NASSCO, (lb metal/lb fume)

= 0.5464 for GMAW

= 0.2865 for SMAW

C_i = Concentration of listed substance in each welding rod per SDS, (lb substance/lb metal)

e = Control equipment PM10 overall collection and removal efficiency, (%)

If a hexavalent chromium emission factor does not exist, a Cr to Cr+6 conversion rate of 5% for GMAW, 55% for SMAW, 0.05% for SAW, and 10% for FCAW will be applied per AWMA Study (2012). It is assumed that MIG and TIG welding are similar to GMAW per ARB.

Case 2: If AP-42 (1/95) Final Section Tables 12.19-1 and 12.19-2 does not assess the type of welding process, but it is identified by a facility (i.e., GMAW, SMAW, etc.), the following procedure will be used:

$$Ea = Ua \times EF \times FCF \times Ci \times (1 - e)$$

Where: Ea = Annual emissions of each listed toxic air contaminant per rod, (lb/year)

Ua = Annual usage of each welding rod, (lb/year)

EF = Fume emission factor per ARB, (lb fume/lb rod consumed)

= 0.01 for GMAW / MIG / TIG

= 0.02 for SMAW / FCAW

FCF = Fume correction factor per NASSCO - Richard Bell, (lb metal/lb fume)

= 0.5464 for GMAW / MIG / TIG

= 0.2865 for SMAW / FCAW

C_i = Concentration of listed substance in each welding rod per SDS, (lb substance/lb metal)

e = Control equipment PM10 overall collection and removal efficiency, (%)

If a hexavalent chromium emission factor does not exist, a Cr to Cr+6 conversion rate of 5% for GMAW, 55% for SMAW, 0.05% for SAW, and 10% for FCAW will be applied per AWMA Study (2012). It is assumed that MIG and TIG welding are similar to GMAW per ARB.

Case 3: If no emission information is listed in AP-42 (1-95) Final Section 12.19 and the type of welding process is not identified by the facility (i.e., GMAW, SMAW, etc.), the following procedure will be used:

$$Ea = Ua \times EF \times Ci \times (1 - e)$$

$$Eh = Uh \times EF \times Ci \times (1 - e)$$

Where: Ea = Annual emissions of each listed toxic air contaminant per rod, (lb/year)

Eh = Maximum hourly emissions of each listed toxic air contaminant per rod, (lb/hour)

Ua = Annual usage of each welding rod, (lb/year)

Uh = Maximum hourly usage of each welding rod, (lb/hour)

EF = Fume emission factor, (lb fume/lb rod consumed)

= 0.05 for unidentified welding processes (default assumption)

Ci = Concentration of listed substance in each welding rod per SDS, (lb substance/
lb metal)

e = Control equipment PM10 overall collection and removal efficiency, (%)

If a hexavalent chromium emission factor does not exist, a Cr to Cr+6 conversion rate of 10% should be assumed for unidentified welding processes.

Example

8,000 lb of 308-type electrode used for GMAW for the year.

$$Ea = Ua \times EF \times (1 - e)$$

$$Ua = 8000 \text{ lb rod/year}$$

$$e = 0\%$$

Emission Factors

PM = PM10 = 5.40E-03 lb total fume/lb rod from AP-42 Table 12.19-1

Cr = 7.72E-03 lb/lb rod from SDAPCD

Cr6 = 2.84E-05 lb/lb rod from SDAPCD

Co = 1.00E-06 lb/lb rod from AP-42 Table 12.19-2

Mn = 3.46E-04 lb/lb rod from AP-42 Table 12.19-2

Ni = 1.84E-04 lb/lb rod from AP-42 Table 12.19-2

PM Emissions = 8,000 lb rod/yr * 5.40E-03 lb total fume/lb rod * (1-0) = 43.2 lb

Cr Emissions = 8,000 lb rod/yr * 7.72E-03 lb/lb rod * (1-0) = 61.8 lb

Cr6 Emissions = 8,000 lb rod/yr * 2.84E-05 lb/lb rod * (1-0) = 0.227 lb

Co Emissions = 8,000 lb rod/yr * 1.00E-06 lb/lb rod * (1-0) = 0.008 lb

Mn Emissions = 8,000 lb rod/yr * 3.46 E-04 lb/lb rod * (1-0) = 2.77 lb

Ni Emissions = 8,000 lb rod/yr * 1.84E-04 lb/lb rod * (1-0) = 1.47 lb

Entering Data into the AER Webtool

Click on Emission Sources (ES) on the menu on the left-hand side. Then click on the orange Add New Emission Source button

Facility ID: 999901

Facility Comments

- 1. Facility Information
- 2. Status Update
- 3. Combustion Fuels
- 4. Emission Sources (ES)**
- 5. Report Process/Emissions
- 6. Additional Toxic Substances Production and Usage
- 7. Perform Data Validation
- 8. Review Summaries
- 9. Print Facility Report
- 10. Report Submission

Build Reporting Structure

Emission Sources (ES) Classification

Summary: This section contains facility permit profile. Please make sure that every device has a specified Emission Source (ES). New emission sources can also be added.

Instruction: Add Devices (emissions sources) by clicking "Add New Emission Source". Edit devices by clicking "Profile" under the Emission Source (ES) Column. Add emission data by clicking "Open" under the Emissions column. Upload storage tank data by clicking on link "Click here" below.

Storage Tank Emissions Batch File Import - [click here](#) for more instructions.

Add New Emission Source

Enter data in the text boxes with the red asterisk, then click on the orange Categorize Emission Sources button.

Facility ID: 999006

Facility Comments

Abbreviated Reporting


- 1. Facility Information
- 2. Status Update
- 3. Combustion Fuels
- 4. Emission Sources (ES)
- 5. Report Process/Emissions
- 6. Additional Toxic Substances Production and Usage
- 7. Perform Data Validation
- 8. Review Summaries
- 9. Print Facility Report
- 10. Report Submission

Edit Emission Source

Instruction: Add new emissions sources using information found on permits, manufacturers specifications, or identifying placards. Select the Operating ES Status that best reflect the device's operation for this reporting period. All areas with a Red Asterisk (*) must be addressed. Note: Some devices have been pre-populated, verify that the information is correct

Abbreviated Reporting

Starting in Reporting Year 2022 some facilities can qualify for Abbreviated Reporting
Your eligibility to file Abbreviated Report depends in part on the types of Emission Sources used at your Facility.
Click [here](#) to find out more details about Abbreviated Reporting and its possible benefits.

Permitted	<input type="checkbox"/>
A/N	
PERP Equipment(CARB's Portable Equipment Registration Program)	<input type="checkbox"/> 
Permit No	
Permit Device ID	
Permit Equipment Description	
AER Device ID	will be assigned upon saving
ES Name	Welding *
Operating ES Status	Normal Operation *
Comment	<input type="text"/>
Emission Source Category	Categorize Emission Source *
Design Capacity	0 <input type="text"/>

Save or **Save and return to List of Emission Sources** or

Save and proceed to Process Reporting or [Cancel](#)

Optional: **Save and Mark as Completed**

[Click here to delete](#) this emission source and associated data.

Click on the Other Process check box and click save.

Categorize Emission Source ✕

Permitted	A/N	Permit No	Permit Device ID	Permit Equipment Description	AER Device ID	ES Name
No					ES7	Plasma Arc Cutting

1. External Combustion Equipment (e.g., boiler, dryer, oven, furnace, heater, afterburner, flare, kiln or incinerator) [click here](#) to select one of the following Equipment:
2. Internal Combustion Equipment (e.g., internal combustion engine (excluding vehicles), turbine or micro turbine) [click here](#) to select one of the following Equipment:
3. Spray Coating/Spray Booth (e.g., coatings, solvents, adhesives, etc.) [click here](#) to select one of the following Equipment:
4. Other Use of Organics (e.g., coatings, solvents, inks, adhesives, etc.) except in Spray Coating/Spray Booth, [click here](#) to select one of the following Equipment:
5. Liquid Storage Tank (e.g. Underground, Aboveground, Small Tanks, Dispensing Systems) [click here](#) to select one of the following Equipment:
6. Fugitive Components (Emission Leaks from Process Components per Rule 462, 1173 and 1176), [click here](#) to select all applicable Equipment:
7. Other Processes (does not fit in any of the groups mentioned above), click [click here](#) to mark "Other Process Equipment":

Other process equipment

Save
Cancel

Click on the orange Save and Proceed to Process Reporting button

Facility ID: 999006

Facility Comments

- Abbreviated Reporting
- 1. Facility Information
- 2. Status Update
- 3. Combustion Fuels
- 4. Emission Sources (ES)
- 5. Report Process/Emissions
- 6. Additional Toxic Substances Production and Usage
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Permitted	<input type="checkbox"/>
A/N	
PERP Equipment (CARB's Portable Equipment Registration Program)	<input type="checkbox"/> i
Permit No	
Permit Device ID	
Permit Equipment Description	
AER Device ID	will be assigned upon saving
ES Name	<input type="text" value="Welding"/> *
Operating ES Status	<input type="text" value="Normal Operation"/> *
Comment	<input style="width: 100%;" type="text"/>
Emission Source Category	Categorize Emission Source *
Design Capacity	<input type="text" value="0"/> <input style="width: 100px;" type="text"/>

Save or Save and return to List of Emission Sources or

Save and proceed to Process Reporting or [Cancel](#)

Optional: Save and Mark as Completed

Click here to [delete](#) this emission source and associated data.

Click on the blue Open link next to Process ID P1

Process References ✕

Emissions	A/N	Permit No	Permit Device ID	Permit Device Description	AER Device ID	ES Name	ES Group Name	Source Category	Emissions?	Equipment	PERP	Release Location Linked
Open					ES15	Welding		Other Processes	Y	Other process equipment	N	NR

Process ID	Source Group	Process/Material/Fuel Name	Status	Operation Type
Open P1	Other Process Emissions		Work in progress	routine

Add Process/Material/Fuel

OK

Click on the blue Open link in Step 1

[« Back to Emission Source Process Reference](#)

Other Processes

This reporting screen is for reporting activity data for other processes used in your facility which were not covered in previous reporting screens. Please provide specific information for every associated emission source. **Please start with Step 1, edits to Step 1 may cause data in the following steps to reset.** Combustion emissions need to be reported separately under external or internal combustion process categories. Combined emissions can also be reported here; however, it must be substantiated to avoid double reporting. Detailed instructions are available by clicking on Help icon in the tool bar.

Abbreviated Reporting

Certain combination of equipment code and fuel source may disqualify you from Abbreviated Reporting.

As part of Abbreviated Reporting, you **Must** only use AQMD Default Emission Factors.

If you select anything other than **AQMD Default Emission Factors** you will be disqualified from Abbreviated Reporting.

Click [here](#) to find out more details about Abbreviated Reporting and its possible benefits.

Step 1: Process Optional: Mark as Completed

	AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
Open	ES15			P1			

Click here to [delete](#) this process.

Step 2: Throughput

Annual Throughput	
Open	

Step 3: Criteria Emissions (lbs) Use [Default Emission Factors](#) if available.

Pollutant	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
Add New						

Step 4: Toxic (TAC/ODC) Emissions (lbs) Use [Default Emission Factors](#) if available.

TAC/ODC Group	CAS #	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
Add New							

[« Back to Emission Source Process Reference](#)

Choose the following options and click save.

Edit Emission Process - Other Processes ✕

AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
ES15			P1	405	Metals and Alloys : Fabricated : Machining Operations : Arc Welding: General	

AER Device ID	ES15	AER Device Name	Welding
NON-PERMITTED		Permit Device ID	
Process ID	P1	Process Name	<input type="text" value="Welding"/>
Process Comment	<input type="text"/>		
SCC	<input type="text"/>		

Activity Code * Sector:

Industry:

Operation:

Process:

Rule # [* Add Rule](#)

Click on the blue Open link in Step 2.

[« Back to Emission Source Process Reference](#)

Other Processes

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Step 1: Process Optional: Mark as Completed

AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
Open	ES15		P1	405	Metals and Alloys : Fabricated : Machining Operations : Arc Welding: General	

Click here to [delete](#) this process.

Step 2: Throughput

Annual Throughput
Open

Step 3: Criteria Emissions (lbs) Use [Default Emission Factors](#) if available.

Pollutant	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
<input type="button" value="Add New"/>						

Step 4: Toxic (TAC/ODC) Emissions (lbs) Use [Default Emission Factors](#) if available.

TAC/ODC Group	CAS #	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
<input type="button" value="Add New"/>							

[« Back to Emission Source Process Reference](#)

Add the throughput, throughput type, throughput origin, and throughput comment. Then, click the orange Save button.

Edit Throughput Information - Other Processes ✕

AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
ES15			P1	405	Metals and Alloys : Fabricated : Machining Operations : Arc Welding: General	
Annual Throughput						
8,000.00000000 lbs						
Annual Throughput	<input type="text" value="8,000.00000000"/>		* lbs		*	
Throughput Type	<input type="text" value="Input"/>		*			
Throughput Origin	<input type="text" value="Direct measurement"/>		*			
Throughput Comment	<input type="text" value="Logbook"/>					
<input type="button" value="Save"/> <input type="button" value="Cancel"/>						

Click on the orange Add New button in Step 3.

[« Back to Emission Source Process Reference](#)

Other Processes

This reporting screen is for reporting activity data for other processes used in your facility which were not covered in previous reporting screens. Please provide specific information for every associated emission source. Please start with Step 1, edits to Step 1 may cause data in the following steps to reset. Combustion emissions need to be reported separately under external or internal combustion process categories. Combined emissions can also be reported here; however, it must be substantiated to avoid double reporting. Detailed instructions are available by clicking on Help icon in the tool bar.

Abbreviated Reporting

Certain combination of equipment code and fuel source may disqualify you from Abbreviated Reporting.
 As part of Abbreviated Reporting, you **Must** only use **AQMD Default Emission Factors**.
 If you select anything other than **AQMD Default Emission Factors** you will be disqualified from Abbreviated Reporting.
 Click [here](#) to find out more details about Abbreviated Reporting and its possible benefits.

Step 1: Process

Optional: Mark as Completed

	AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
Open	ES15			P1	405	Metals and Alloys : Fabricated : Machining Operations : Arc Welding: General	

Click here to [delete](#) this process.

Step 2: Throughput

	Annual Throughput
Open	8,000.00000000 lbs

Step 3: Criteria Emissions (lbs)

Use [Default Emission Factors](#) if available.

	Pollutant	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
<input type="button" value="Add New"/>							

Choose PM as the pollutant, and the emission factor, and chose AP-42 for the emission factor data source. Then click the orange Save button.

Open Criteria Emission Information - Other Processes

AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
ES15			P1	405	Metals and Alloys : Fabricated : Machining Operations : Arc Welding: General	

Annual Throughput

8,000.00000000 lbs

Pollutant: PM *

Emission Factor (EF): 5.40000000e-3 * lbs/lbs

Controlled EF value
(mark checkbox if EF listed represents EF determined after control)

Overall Control Efficiency:

Emission Factor Comment:

If not using **AQMD default** emission factor please provide detailed references in the Emission Factor Comment box above or upload file with the information. Processes without this information are subject to audit.

Emission Factor Data Source: AP-42 *

Emissions: 4.32000000e+1 lbs

Save
Cancel

Click on the orange Add New button in Step 4.

Other Processes

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Step 1: Process

Optional: Mark as Completed

	AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
Open	ES15			P1	405	Metals and Alloys : Fabricated : Machining Operations : Arc Welding: General	

Click here to [delete](#) this process.

Step 2: Throughput

	Annual Throughput
Open	8,000.00000000 lbs

Step 3: Criteria Emissions (lbs)

Use [Default Emission Factors](#) if available.

	Pollutant	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
Open	PM	5.40000000e-3	lbs / lbs	No	AP-42		4.32000000e+1

Add New

Step 4: Toxic (TAC/ODC) Emissions (lbs)

Use [Default Emission Factors](#) if available.

	TAC/ODC Group	CAS #	EF	Unit	Controlled EF	EF Data Source	Overall CE	Emissions
Add New								

Choose Cobalt, enter the emission factor and choose AP-42 for the emission factor data source.

Open Toxic (TAC/ODC) Emission Information - Other Processes						
AER Device ID	Permit Device ID	A/N	Process ID	Rule #	Activity	SCC
ES15			P1	405	Metals and Alloys : Fabricated : Machining Operations : Arc Welding: General	
Annual Throughput						
8,000.00000000 lbs						
TAC/ODC Toxic Pollutants / Ozone Depleting Compounds						
Pollutant	96 - Cobalt, including compounds (insoluble)					*
TAC Group	-					
CAS # (Pollutant)	-					
Emission Factor (EF)	1.00000000e-6					* lbs/lbs
	<input type="checkbox"/> Controlled EF value (mark checkbox if EF listed represents EF determined after control)					
Overall Control Efficiency						
Emission Factor Comment	<div style="border: 1px solid gray; height: 30px;"></div>					
	If not using AQMD default emission factor please provide detailed references in the Emission Factor Comment box above or upload file with the information. Processes without this information are subject to audit.					
Emission Factor Data Source	AP-42					*
Emissions	8.00000000e-3 lbs					

Save **Cancel**

Repeat for the other TAC emissions.