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APPENDIX A.--OSHA PELs, NIOSH RELs, and ACGIH TLVs for selected chemicals and physical agents associated with welding processes

Hazardous agent	OSHA PEL	NIOSH REL[a]	ACGIH TLV[b]
Acetylene	2,500 ppm (10% of lower explosive limit) (specific conditions: see 29 CFR 1915.12)	No exposure >2,500 ppm (2,662 mg/m^3), TWA	Gas acts as a simple asphyxiant without other significant physiologic effects. A TLV may not be recommended for each simple asphyxiant because the limiting factor is the available oxygen.
Aluminum	None	None	Aluminum as welding fume: 5 mg/m^3, 8-hr TWA
Arsenic, inorganic	10 μg/m^3, 8-hr TWA	2 μg/m^3, ceiling (15 min)[c] (carcinogen)	200 μg/m^3, 8-hr TWA
Beryllium	2 μg/m^3, 8-hr TWA; 5 μg/m^3, acceptable ceiling; 25 μg/m^3, maximum ceiling (30 min)	Not to exceed 0.5 μg/m^3[c] (carcinogen)	2 μg/m^3, A2
Cadmium	Fume: 0.1 mg/m^3, 8-hr TWA; 0.3 mg/m^3, ceiling Dust: 0.2 mg/m^3, 8-hr TWA; 0.6 mg/m^3, ceiling	Lowest feasible limit[c] (carcinogen)	Cadmium oxide fume as Cd, 0.05 mg/m^3, ceiling

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See footnotes at end of table.

APPENDIX A (Continued).--OSHA PELs, NIOSH RELs, and ACGIH TLVs for selected chemicals and physical agents associated with welding processes

Hazardous agent	OSHA PEL	NIOSH REL[a]	ACGIH TLV[b]
Carbon dioxide	5,000 ppm (9,000 mg/m^3),[c] 8-hr TWA	10,000 ppm (18,000 mg/m^3), TWA; 30,000 ppm (54,000 mg/m^3), ceiling (10 min)[c]	5,000 ppm (9,000 mg/m^3), 8-hr TWA[c]; 30,000 ppm (54,000 mg/m^3), STEL
Carbon monoxide	50 ppm (55 mg/m^3), 8-hr TWA;	35 ppm (40 mg/m^3), TWA; 200 ppm (229 mg/m^3), ceiling (no minimum time)[c]	50 ppm (55 mg/m^3), 8-hr TWA; 400 ppm (440 mg/m^3), STEL
Chromium(VI)	100 μg/m^3, ceiling	Carcinogenic Cr(VI): 1 μg/m^3 TWA	Water soluble: 50 μg/m^3, 8-hr TWA
		Other Cr(VI): 25 μg/m^3, TWA; 50 μg/m^3, ceiling (15 min)[c]	Certain water insoluble: 50 μg/m^3, 8-hr TWA, A1
Cobalt	0.1 mg/m^3, 8-hr TWA[c]	NIOSH has concluded that there is insufficient evidence to warrant recommending a new PEL	Metal, dust, and fume 0.05 mg/m^3, 8-hr TWA
Copper fume	0.1 mg/m^3, 8-hr TWA[c]	None	0.2 mg/m^3, 8-hr TWA; dusts and mists as Cu, 1 mg/m^3
Fluorides, inorganic	2.5 mg/m^3, 8-hr TWA	2.5 mg F/m^3 TWA	2.5 mg/m^3, 8-hr TWA

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See footnotes at end of table.

APPENDIX A (Continued).--OSHA PELs, NIOSH RELs, and ACGIH TLVs for selected chemicals and physical agents associated with welding processes

Hazardous agent	OSHA PEL	NIOSH REL[a]	ACGIH TLV[b]
Hot environments	None	Sliding scale limits based on environmental and metabolic heat loads[c]	Sliding scale limits based on work-rest regimen and workload
Inert or nuisance dust	Total dust: 15 mg/m^3 Respirable dust: 5 mg/m^3 Note: these apply only to mineral dust	None	Nuisance particulates: total dust, 10 mg/m^3, 8-hr TWA; respirable dust, 5 mg/m^3, 8-hr TWA
Iron oxide fume	10 mg/m^3	None	5 mg/m^3, 8-hr TWA (welding fumes)[c]
Lead, inorganic	50 μg/m^3, 8-hr TWA; determine >8-hr exposure by formula (29 CFR 1910.1025)	<100 μg Pb/m^3, TWA; maintain air level so that worker blood lead remains ≤60 μg/100 g	150 μg/m^3
Magnesium oxide fume	15 mg/m^3, 8-hr TWA	None	10 mg/m^3, 8-hr TWA[c]

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See footnotes at end of table.

APPENDIX A (Continued).--OSHA PELs, NIOSH RELs, and ACGIH TLVs for selected chemicals and physical agents associated with welding processes

Hazardous agent	OSHA PEL	NIOSH REL[a]	ACGIH TLV[b]
Manganese	5 mg/m^3, ceiling	None	Dust and compounds: 5 mg/m^3, 8-hr TWA
			Fume: 1 mg/m^3[c]
Molybdenum	5 mg/m^3 (soluble), 8-hr TWA; 15 mg/m^3 (insoluble), 8-hr TWA	None	Soluble compounds: 5 mg/m^3, 8-hr TWA
		None	Insoluble compounds: 10 mg/m^3[c]
Nickel, inorganic and compounds	1 mg Ni/m^3, 8-hr TWA	0.015 mg Ni/m^3, TWA[c] (carcinogen)	Metal: 1 mg/m^3 Soluble compounds (as Ni): 0.1 mg/m^3, 8-hr TWA
Nitrogen oxides	NO_2: 5 ppm (9 mg/m^3), ceiling	NO_2: 1 ppm (1.8 mg/m^3), 15 min ceiling	NO_2: 3 ppm (6 mg/m^3), 8-hr TWA; 5 ppm (10 mg/m^3), STEL
	NO: 25 ppm (30 mg/m^3) 8-hr TWA	NO: 25 ppm (30 mg/m^3), TWA[c]	
Noise	90 dBA, 8-hr TWA	85 dBA, TWA; 115 dBA, ceiling[c]	85 dBA, 8-hr TWA; 115 dBA, ceiling
Ozone	0.1 ppm (0.2 mg/m^3), 8-hr TWA	None	0.1 ppm (0.2 mg/m^3), 8-hr TWA; 0.3 ppm (0.6 mg/m^3), STEL

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See footnotes at end of table.

APPENDIX A (Continued).--OSHA PELs, NIOSH RELs, and ACGIH TLVs for selected chemicals and physical agents associated with welding processes

Hazardous agent	OSHA PEL	NIOSH REL[a]	ACGIH TLV[b]
Phosgene	0.1 ppm (0.4 mg/m^3), 8-hr TWA	0.1 ppm (0.4 mg/m^3), TWA; 0.2 ppm (0.8 mg/m^3), ceiling (15 min)[c]	0.1 ppm (0.4 mg/m^3), 8-hr TWA
Silica, crystalline	Respirable quartz: $\frac{250 \text{ mppcf}}{\% \ SiO_2+5}$ or $\frac{10 \text{ mg/m}^3}{\% \ SiO_2+2}$	Respirable free silica, 50 μg/m^3 TWA	Respirable dust for quartz and fused silica: 100 μg/m^3 Contained respirable quartz dust for tripoli: 100 μg/m^3 Respirable dust for cristobalite and tridymite: 50 μg/m^3
Silver	0.01 mg/m^3, 8-hr TWA[c]	None	Metal: 0.1 mg/m^3, 8-hr TWA Soluble compounds (as Ag): 0.01 mg/m^3, 8-hr TWA
Tin, inorganic compounds except oxides	2 mg/m^3, 8-hr TWA[c]	None	Metal: 2 mg/m^3, 8-hr TWA Oxide and inorganic compounds, except SnH_4 (as Sn): 2 mg/m^3, 8-hr TWA
Titanium dioxide	15 mg/m^3, 8-hr TWA	None	Nuisance particulate, 10 mg/m^3 of total dust

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See footnotes at end of table.

APPENDIX A (Continued).—OSHA PELs, NIOSH RELs, and ACGIH TLVs for selected chemicals and physical agents associated with welding processes

Hazardous agent	OSHA PEL	NIOSH REL[a]	ACGIH TLV[b]
Tungsten and cemented tungsten carbide	None	Insoluble tungsten: 5 mg/m^3, TWA Soluble tungsten: 1 mg/m^3, TWA Dust of cemented tungsten carbide containing ≥2% cobalt: 0.1 mg Co/m^3, TWA Dust of cemented tungsten carbide containing >0.3% nickel: 15 μg nickel/m^3, TWA[c]	Insoluble compounds: 5 mg/m^3, 8-hr TWA; 10 mg/m^3, STEL Soluble compounds: 1 mg/m^3, 8-hr TWA; 3 mg/m^3, STEL
Ultraviolet radiation	None	315–400 nm: 1.0 mW/cm^2 for periods >1,000 sec; total radiant energy shall not not exceed 1,000 mWsec/cm^2 (1.0 J/cm^2) for exposure times ≤1,000 sec 200–315 nm: see requirements in in NIOSH [1972a][c]	Prescribed time periods of allowable exposure based on measurements of effective irradiance
Vanadium	Vanadium pentoxide: dust, 0.5 mg/m^3 ceiling; fume, 0.1 mg/m^3, ceiling Ferrovanadium: 1 mg/m^3, 8-hr TWA	Vanadium compounds: 0.05 mg V/m^3, ceiling (15 min) Metallic vanadium and vanadium carbide: 1 mg V/m^3 TWA[c]	Respirable dust and fume: 0.05 mg/m^3, 8-hr TWA

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See footnotes at end of table.

APPENDIX A (Continued).--OSHA PELs, NIOSH RELs, and ACGIH TLVs for selected chemicals and physical agents associated with welding processes

Hazardous agent	OSHA PEL	NIOSH REL[a]	ACGIH TLV[b]
Welding fumes	None	None	Total particulate that is not otherwise classified: 5 mg/m^3, 8-hr TWA
Zinc oxide	5 mg/m^3, 8-hr TWA	5 mg/m^3, TWA; 15 mg/m^3, ceiling (15 min)	Fume: 5 mg/m^3, TWA; 10 mg/m^3, STEL

[a]NIOSH TWA recommendations are based on time-weighted average (TWA) concentrations for up to a 10-hr workday and a 40-hr workweek over a working lifetime, unless otherwise noted.
[b]Definitions for ACGIH TLVs: A1--confirmed human carcinogen; A2--suspected human carcinogen; short term exposure limit (STEL)--a 15-min TWA exposure that should not be exceeded at any time during a workday even if the 8-hr TWA is within the TLV; ceiling--the concentration that should not be exceeded during any part of the workday.
[c]Denotes the lowest of the three exposure limits (OSHA PEL, NIOSH REL, or ACGIH TLV) listed for the given hazardous agent.