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Department of Corrections

Industrial Hygiene Evaluation

Welding Air Sampling in L-Shop at the MCF-Stillwater

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APPENDICES

Executive Summary

At the request of Minncor management, air sampling was conducted at the MCF-Stillwater on October 14, 2014. The purpose of the industrial hygiene evaluation was to characterize the exposure of employees and offenders to OSHA regulated welding fumes during typical daily welding activities while working in the L-Shop. The sampling was conducted under the direct observation of Arthur Dana Dickson, Safety Administrator, MCF-Stillwater, MIS, CIH, CSP or Mary Berg, Safety Intern, working under the direction of Mr. Dickson.

Results of the evaluation indicate that one or more of the occupational exposure limits for five (5) of the seven (7)chemicals quantified were above the Threshold Limit Value (TLV) or Minnesota Permissible Exposure Limits (MN PEL)for all airborne metals tested.

Recommendations

1.) Until effective engineering controls are in operation respiratory protection should be provided for the welder operators. The exposure issues include gases and low oxygen levels, so a supplied air respirator or a Powered Air Purifying Respirator with an intake out of the welding plume is necessary. The respiratory protection should be provided within the framework of a respiratory protection program compliant with OSHA regulations and manufacturer recommendations.

2.) Local exhaust engineering control of welding fume should be installed for all welding stations in Building 20. Multiple options for welding local exhaust ventilation are found in "Industrial Ventilation- A Manual of Recommended Practice". The ventilation system should be designed by a ventilation engineer familiar with welding ventilation systems and approved by a Certified Industrial Hygienist. It should be noted that the exhaust will need to be discharged outside of the building and that make up air will be needed. Options that are most likely to be feasible are, replacing the welding machines with welding machines with local exhaust built into the welding gun coupled with general exhaust ventilation or, an overhead plenum system with snorkel tube drops to the welding stations.

3.) An ongoing air sampling program should be instituted and maintained for all operations with the potential for personnel exposure. These would include various metal working and coating operations.

Please contact me with any questions regarding this project report at Arthur.Dana.Dickson@state.mn.us or 651.779.2743.

Arthur Dana Dickson
MCF-Stillwater, Safety Administrator, MIS, CIH, CSP

2/25/15
Date

Appendix A

Description of Operations

The welding operators were building 58 inch 3M racks. The work area normally has six (6) people working: three (3) assemblers welding ends; one (1) primary assembler connecting the ends and stringers; one (1) secondary assembler/finish welder welding additional components on the racks; one (1) quality control worker. On the day of the sampling two welders were absent. The primary and secondary assemblers moved between end assembly, primary assembly and secondary assembly workstations. The operators wearing the sampling pumps were assigned to primary assembly and secondary assembly.

The work area was located in the northeast corner of L-Shop, Second Floor, Building 20. Pillars 8, 17, 18, and 9 approximately bound the work area for primary and secondary assembly. The north and east exterior walls and pillar 9 approximately bound the north end assembly area; pillars seven, eight and the east exterior wall approximately bound the two south end assembly areas. Ventilation for the welding operation was general dilution ventilation exhausted through 3 ceiling level hoods. The air is filtered for particulate removal and recycled into the shop. The ventilation system serves L and M Shops. A drawing showing the shop layout and approximate work area sampling locations is located in Appendix F.

The welding process was Metal Inert Gas, MIG welding on mild steel. The wire used was 0.035, Prostar S-6 with a copper surface, conforming to AWS A5.18 ER70S-6. The Stargon® shielding gas was a mixture of Argon (>66.5%), Oxygen (<23.5%) and Carbon Dioxide (<10%). The lubricant was Prostar Antispatter Nozzle Dip. Safety Data Sheets (SDS) for all three materials are in the MCF-STW SDS Database.

Appendix B

Air Sampling and Analysis Methods

Welding Fume was sampled using closed face, two-part cassettes with 37mm MCE filters. The sample flow rate was approximately 2 Liters per Minute for both samples. The laboratory report gives the actual sampling flow rate. The sampling pumps were calibrated by the analytical laboratory. The samples were analyzed for total welding fume and metal content profile. Flow rates during sampling were field verified with a rotameter. One sample cassette was placed under the operator's welding mask to obtain a breathing zone sample. The second sample cassette was placed on a welding screen near pillar 8 to obtain an area sample. The breathing zone sample was intended to be representative of the exposure for the welding operator. The area sample was intended to be representative of the exposure for workers in the welding booth other than the welders. A third sample cassette was used as a field blank.

Gas sampling was conducted to quantify exposure to Oxides of Nitrogen. The sampling pumps were calibrated by the analytical laboratory. Flow rates during sampling were not field verified. A three piece tube assembly was used to sample for Oxides of Nitrogen, the first tube captures Nitrogen Dioxide, Nitric Oxide in the air passes through an oxidizing tube where it is oxidized to Nitrogen Dioxide and captured on the third tube in the sampling assembly. As with the welding fume, one sampling assembly was placed with the open end under the operator's welding hood to obtain a breathing zone sample. The second sampling assembly was placed on a welding screen near pillar 8 to obtain an area sample. A third sampling train was used as a field blank.

Sampling for Carbon Monoxide and Oxygen concentration was conducted using a calibrated QRAE 4-gas meter, Model PGM-50-4P, Serial No. 270-423409, connected to a pickup tube for remote sampling. Grab samples of the operator exposure and area samples were taken with one instrument.
The sampling was conducted under the direct observation of Arthur Dana Dickson, Safety Administrator, MCF-Stillwater, MIS, CIH, CSP or Mary Berg, Safety Intern working under the direction of Mr. Dickson.

Appendix C

Sampling Results

Welding Fume

Sample 141014STW-4 was a personal sample worn by an offender welder. The sample cassette inlet was located in his breathing zone, under his welding helmet. The sampling records identifying the individual offender are retained in the Safety Administrator's files. Quantifiable concentrations of Cobalt, Copper, Iron Oxide, Lead, Manganese, Molybdenum and Zinc Oxide were found on this sample cassette. Of these, the Iron Oxide, Copper, and Manganese are notable, as is the Total Welding Fume.

In the personal sample noted above, the airborne concentration of Iron Oxide was 14 milligrams per Cubic Meter (mg/M^3). The 2014 Threshold Limit Value (TLV) and the Minnesota Permissible Exposure Limit (PEL) for Iron Oxide are 5 mg/M^3.

In the personal sample noted above, the airborne concentration of Manganese was 1.1 mg/M^3. The TLV for Manganese is 0.02 mg/M^3, as respirable dust. The MN PEL for Manganese 1 mg/M^3.

In the personal sample noted above, the airborne concentration of Copper fume was 0.12 mg/M^3. The TLV for Copper fume is 0.2 mg/M^3. The MN PEL for Copper fume is 0.1 mg/M^3.

Sample 141014STW-5 was an area sample. The cassette was placed on a welding screen in the work area. Quantifiable concentrations of Copper, Iron Oxide, Lead, Manganese and Total Welding Fume were found on this sample.

On the area sample, only Manganese exceeded an applicable standard, the airborne concentration of Manganese was 0.092 mg/M^3, approximately 4 and one-half times the TLV for Manganese, 0.02 mg/M^3. It should be noted that the Total Welding Fume concentration was at one-half the applicable Threshold Limit Value.

Appendix C (continued)

Sampling Results

Gases

Oxides of Nitrogen

Sample 141014STW-8 was a personal sample for Nitrogen Dioxide. Sample 141014STW-9 was a personal sample for Nitric Oxide. Both samples were taken as part of a single sampling train worn by an offender welder. The intake was located in his breathing zone under his welding helmet. The concentrations of both gases were below the limits of detection. The TLV for Nitrogen Dioxide is 0.2 ppm (Parts Per Million v/v). The MN PEL for Nitrogen Dioxide is 1 ppm (STEL). A STEL is a 15 minute exposure limit. The MN PEL and the TLV for Nitric Oxide are both 25 ppm.
The area samples for Nitric Oxide, Sample 141014STW-7 and Nitrogen Dioxide, Sample 141014STW-6 both showed airborne concentrations below the applicable exposure limits.

Carbon Monoxide

A personal sample for Carbon Monoxide was taken in the breathing zone of the offender welder operator. The sample was a short-term sample taken for the duration of several welds. The average and peak readings were observed on the meter. The peak Carbon Monoxide concentration was greater than 100 ppm. The estimated average was 20 ppm. It was noted that the Oxygen concentration under the welding helmet was less than 19% during the welding operations. 19% Oxygen is the regulatory limit for low oxygen environments.

The area sample for Carbon Monoxide did not find a detectable concentration of Carbon Monoxide.

A summary table of these sampling results is attached. The laboratory report is available in the Safety Administrator's files.

Appendix D

Data Analysis

One or more of the occupational exposure limits for five (5) of the seven (7) chemicals quantified were exceeded. Engineering controls to reduce airborne concentrations of welding fume, welding fume constituent metals and carbon monoxide are necessary.

Total Welding Fume is the fine dust released when the melted weld metals combine with oxygen and other gases. Welding fume can, with a large enough dose, cause metal fume fever, eye irritation or, respiratory irritation. The component metals may have other effects that should be evaluated along with the effects of the total welding fume.

Iron oxide was the primary component metal in the welding fume. Iron oxide fume (fine particles) deposited in the lungs remains in the lungs resulting in a benign condition known as Siderosis.

Manganese, with excessive exposure can cause metal fume fever or manganism. Copper, with excessive exposure can cause metal fume fever, eye irritation, upper respiratory irritation, and changes in taste perception. Carbon Monoxide displaces oxygen in the blood of exposed individuals and can cause increased cardiovascular stress.

Appendix E

Chemical Concentrations

Sample ID	Job	Iron Oxide (mg/M^3)	Manganese (mg/M^3)	Copper (mg/M^3)	Total Welding Fume (mg/M^3)	Nitrogen Dioxide (ppm)	Nitric Oxide (ppm)	Carbon Monoxide (ppm)
Sampling Media		Welding Fume Cassette				Nitrogen Oxides Tubes		QRAE 4 Gas Meter
TLV		5	0.02 resp.	0.2 fume	3 PNOC Respirable	0.2	25	25
MN PEL		5	1	0.1 fume	5	1 STEL	25	35
141014STW-1								
141014STW-2								
141014STW-3								
141014STW-4	Welder	14	1.1	0.12	22			
141014STW-5	Welding Booth (Area Sample)	1.2	0.092	0.011	1.5			
141014STW-6	Welding Booth (Area Sample)					<0.1		
141014STW-7	Welding Booth (Area Sample)						<.09	
141014STW-8	Welder					<0.1		
141014STW-9	Welder						<0.1	
CO Meter	Welding Booth (Area Sample)							0
CO Meter	Welder							Estimated Average while welding 20 ppm Peak >100 ppm (Atmosphere inside mask at low oxygen for entire sample period.)

Appendix F

Shop Layout Drawing