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MAKE IT SAFE VANCOUVER

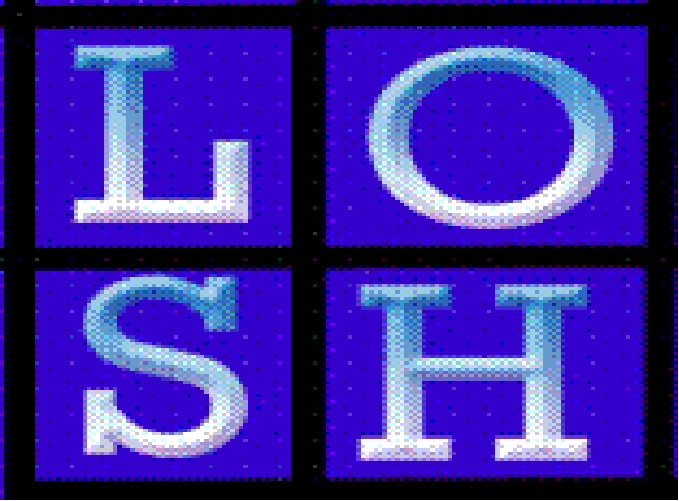
WELDING HAZARDS AND PREVENTION

OCTOBER 9 — 11:05 AM

KENT HILLMAN

President, Liaison OSH Consulting

» makeitsafe.ca



Welding Fume Exposure Control Project

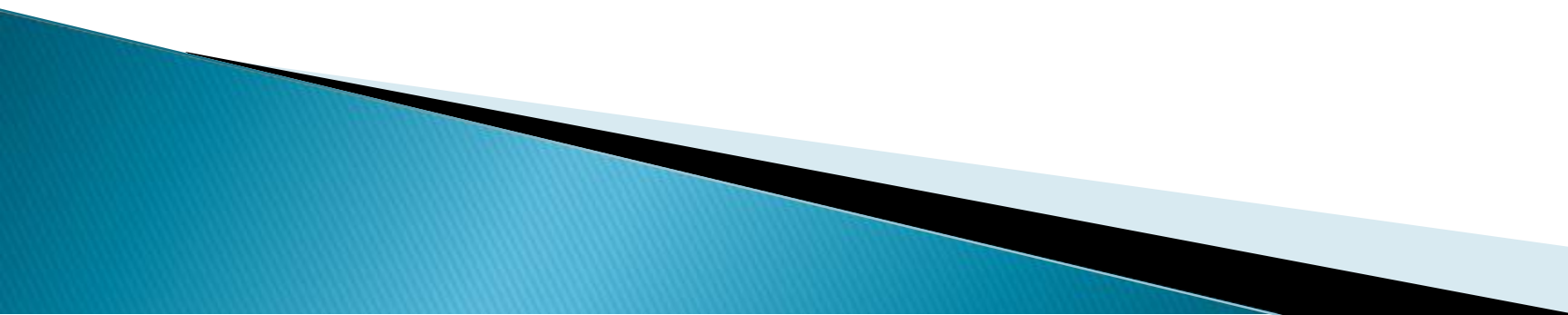
Kent Hillman CIH

Liaison OSH Consulting

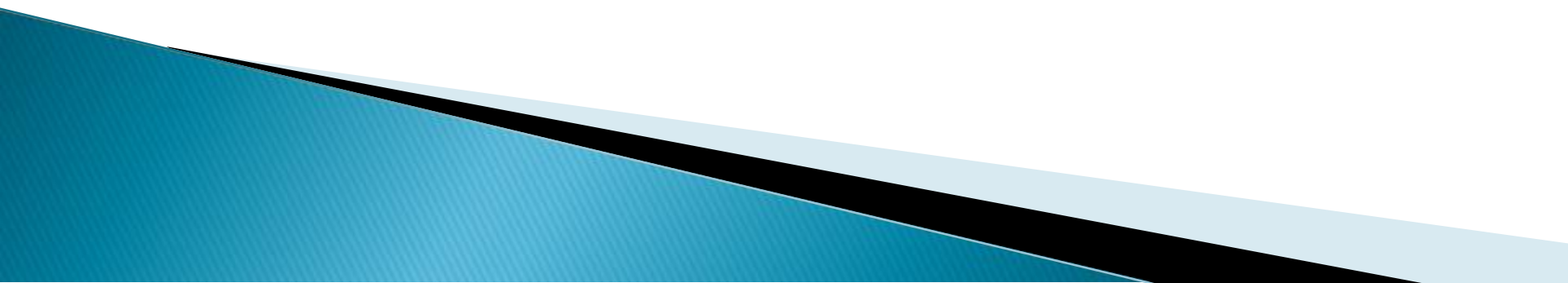
For Make it Safe

Anvil Centre – October 9th, 2024

The Mn ECP Validation Project

- ▶ Sponsored by WorksafeBC's Risk Assessment Unit
 - ▶ Personal exposure and area monitoring in representative workplaces conducting the most common carbon steel welding practices
 - ▶ Analysis of the data in the context of the anticipated 2018 adoption of a new (10X lower) Mn fume exposure limit.
 - ▶ Evidence-based recommendations for Exposure Control Plan requirements.
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Key Project Questions

1. How do common B.C. industry exposures to manganese welding fume compare with current and proposed exposure limits?
 2. What would standardized and evidence-based ECP requirements for Mn welding fume look like?
 3. How should WorksafeBC, welding employers and workers collaborate to manage compliance with the exposure limit?
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Legal Responsibilities

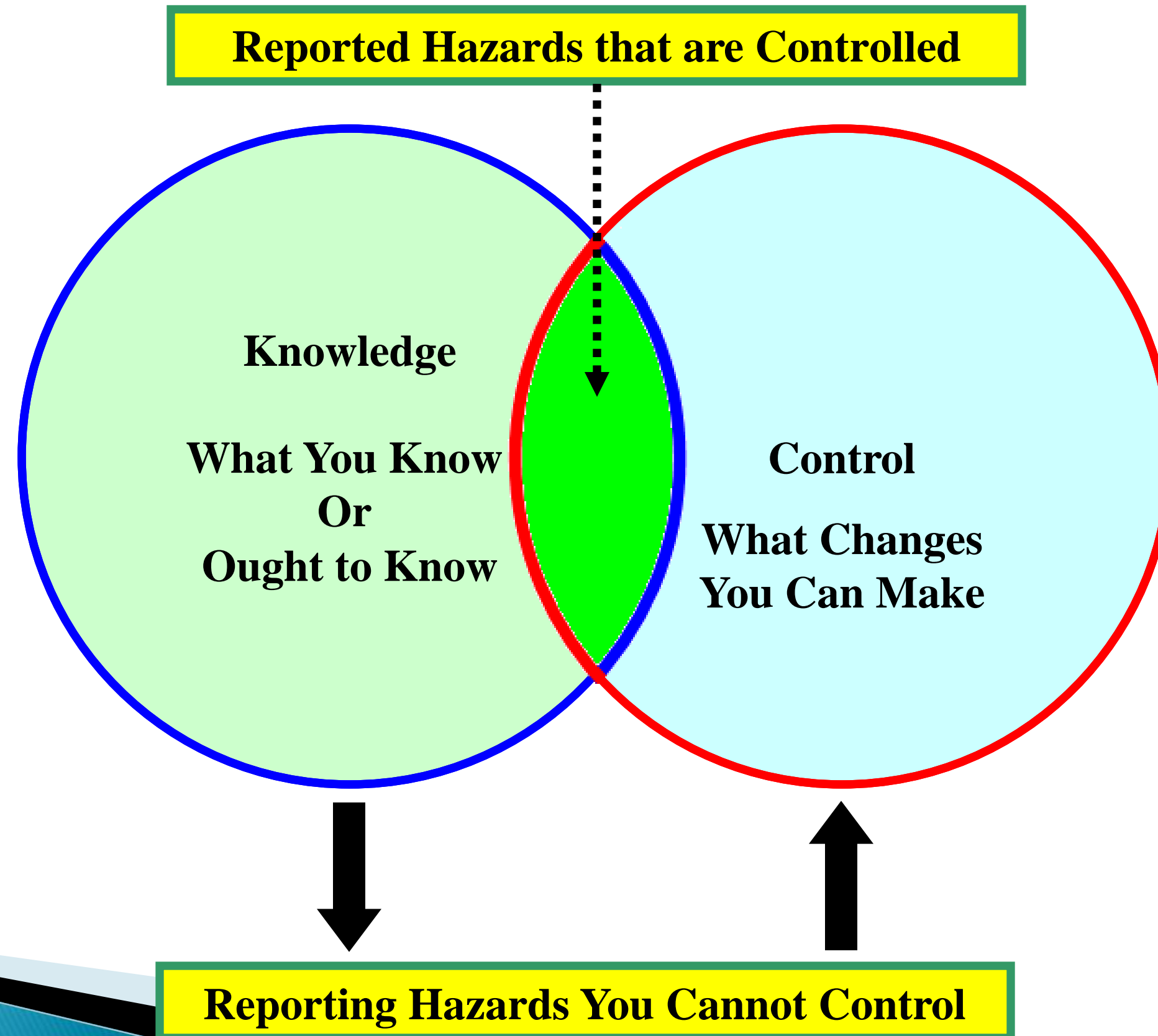
▶ BC Workers Compensation Act, Part 3—Occupational Health and Safety, Division 1—Interpretation and Purposes

Section 14—Purposes of Part

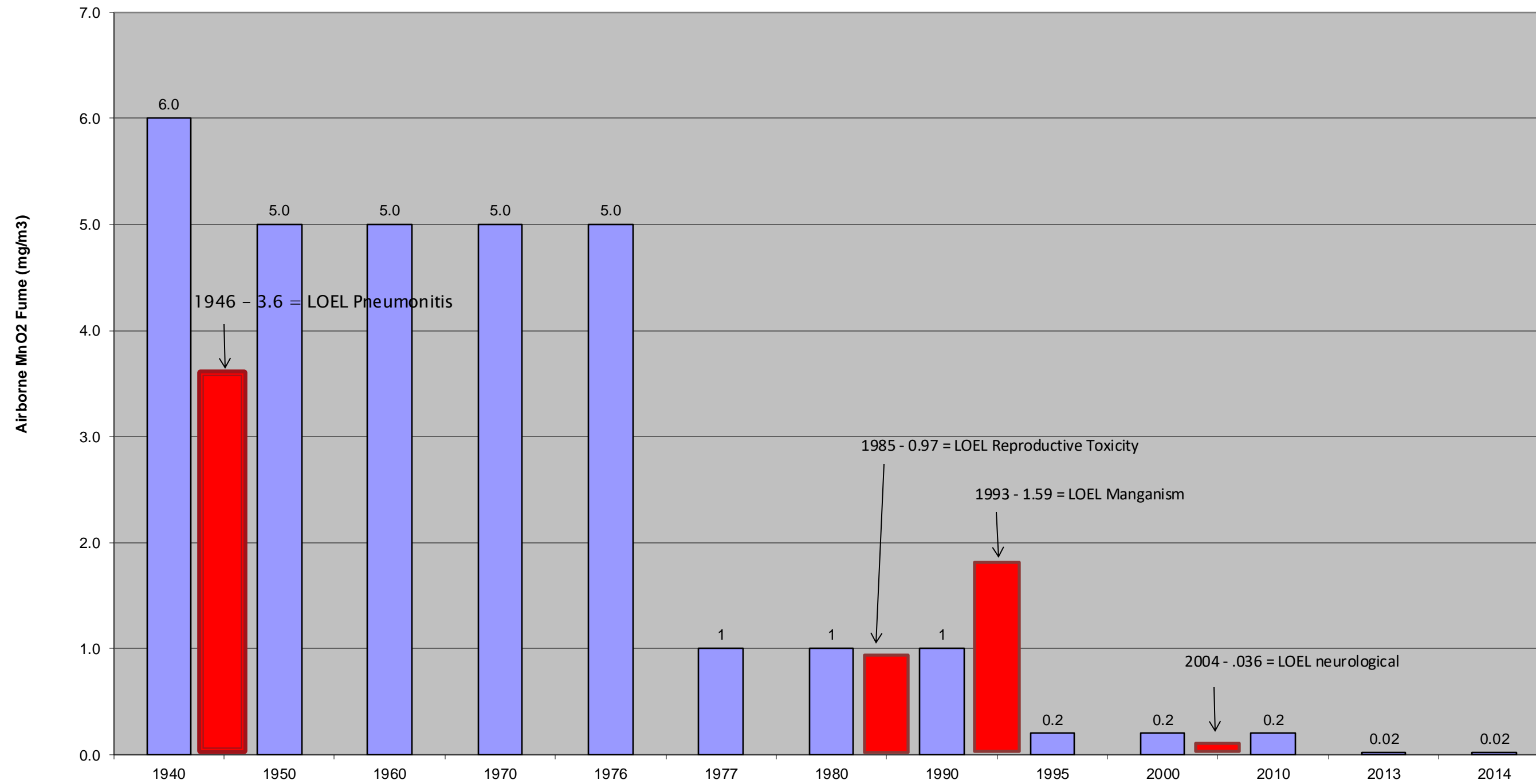
(2) The specific purposes of this Part are to:

- a. promote a culture of commitment on the part of employers and workers to a high standard of occupational health and safety
- b. prevent work related accidents, injuries and illnesses
- c. encourage the education of employers, workers and others regarding occupational health and safety
- d. ensure an occupational environment that provides for the health and safety of workers and others
- e. ensure that employers, workers and others who are in a position to affect the occupational health and safety of workers share that responsibility to the extent of each party's authority and ability to do so
- f. foster cooperative and consultative relationships between employers, workers and others regarding occupational health and safety, and to promote worker participation in occupational health and safety programs and occupational health and safety processes, and
- g. minimize the social and economic costs of work related accidents, injuries and illnesses, in order to enhance the quality of life for British Columbians and the competitiveness of British Columbia in the Canadian and world economies

Practical Responsibilities



ACGIH Threshold Limit Values for MnO2 Fume vs Time



Was the 2013 Mn Fume TLV based on Credible Health Data?

- ▶ Yes – the neurological health effects data underpinning the 2013 Mn fume TLV are compelling and reproducible

IARC Monograph vol. 118

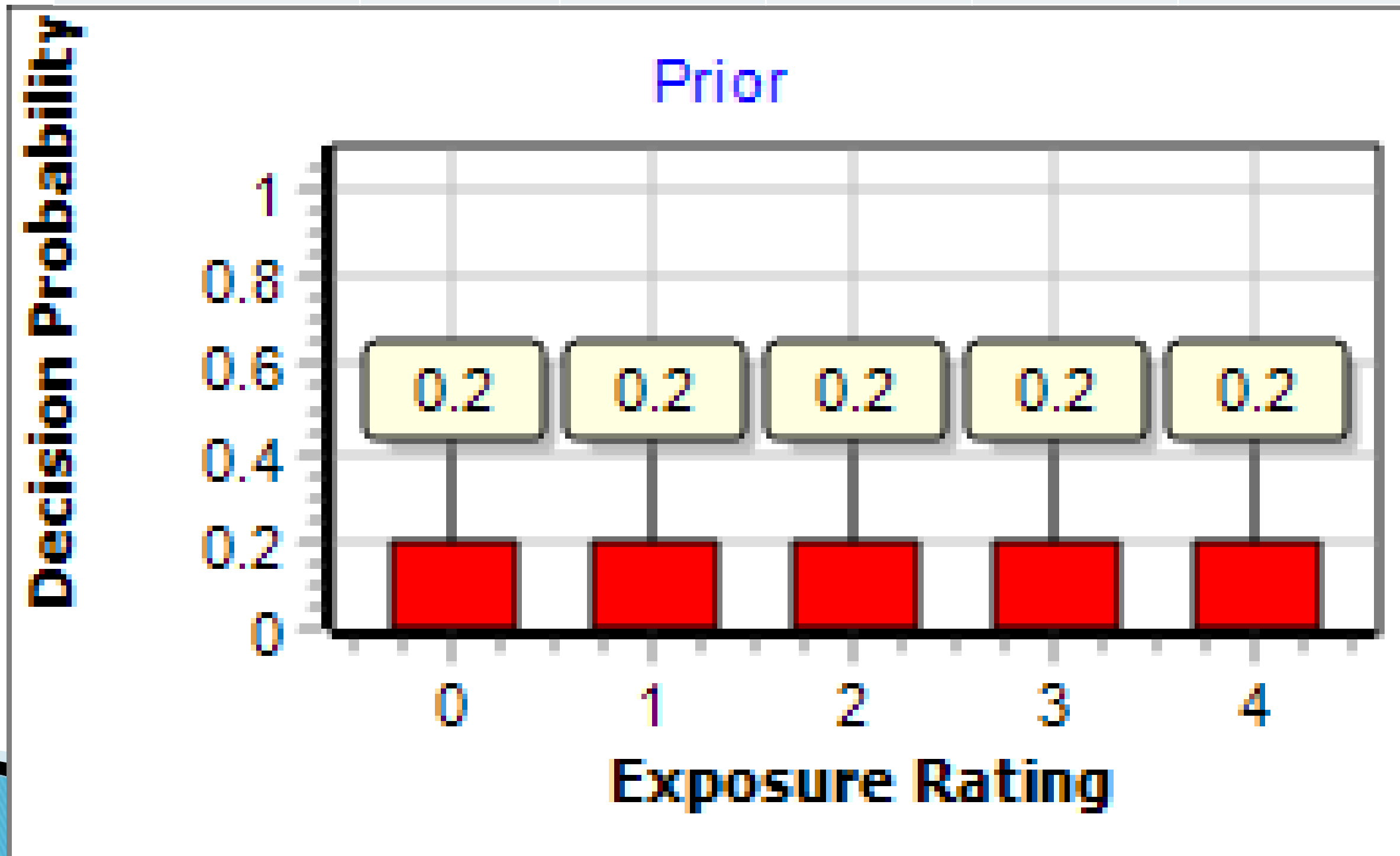
- ▶ In July 2018, the International Agency for Research into Cancer published monograph 118 reporting the reclassification of carbon steel welding fume from Group 2B (possibly carcinogenic) to Group 1 (carcinogenic to humans).

The Mn Fume Sampling Survey

- ▶ Ten Surveys
- ▶ Each survey included 4 personal + 3 area samples during GMAW, FCAW, SMAW and TIG welding
- ▶ The intention was to sample the exhaust from 20 portable LEV filtration units. We found only 2 in use during the survey.
- ▶ Three similarly exposed groups (SEGs) – welders, fabricators and students
- ▶ Data analysis using the IHDA software from Exposure Assessment Solutions Inc.

AIHA Exposure Rating Categories

Exposure Rating	0 - Trivial	1 - Highly Controlled	2 - Well Controlled	3 - Controlled	4 - Poorly Controlled
Cutoff – Mn (mg/m3)	0.0002	0.002	0.01	0.02	>0.02
Cutoff % EL	1	10	50	100	>100



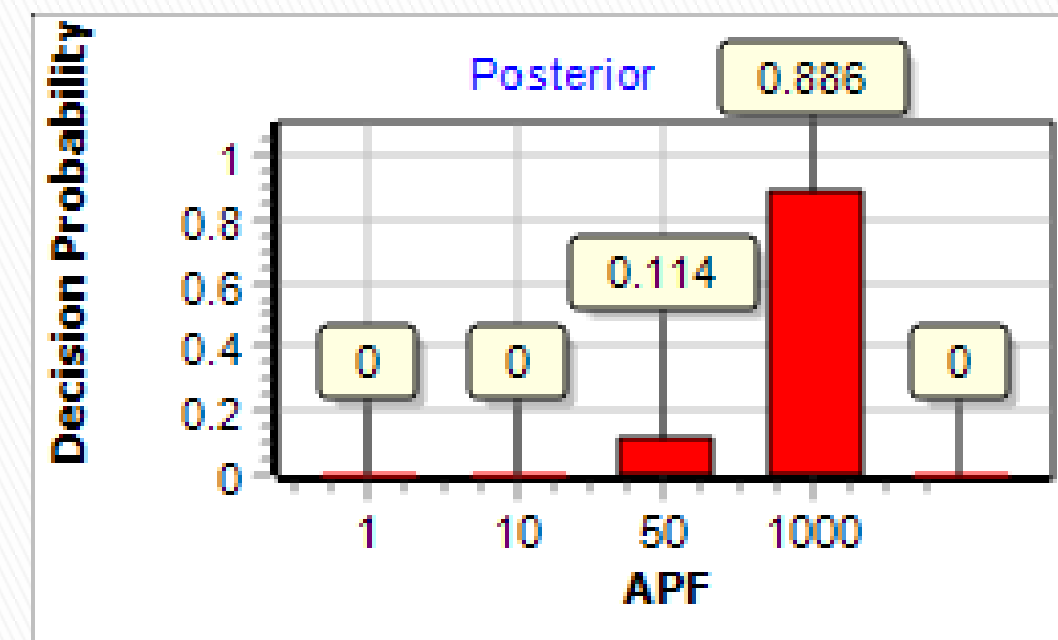
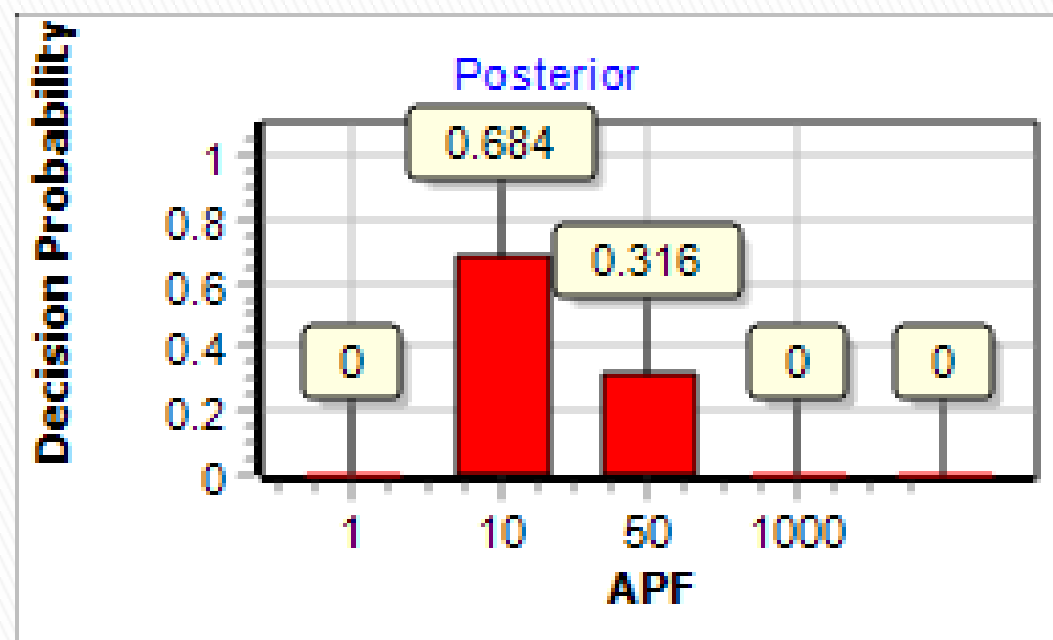
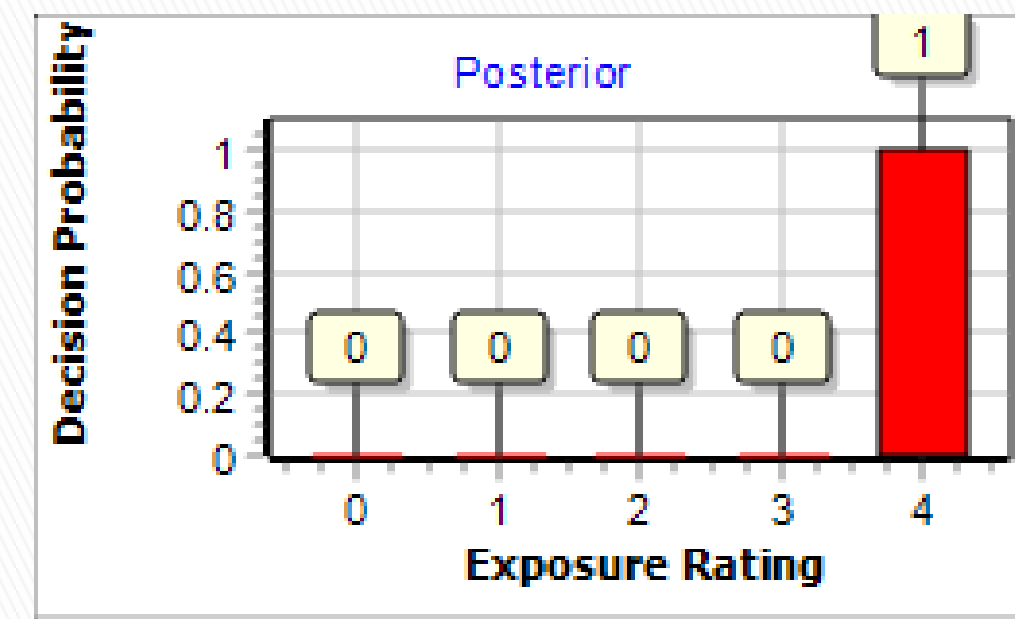
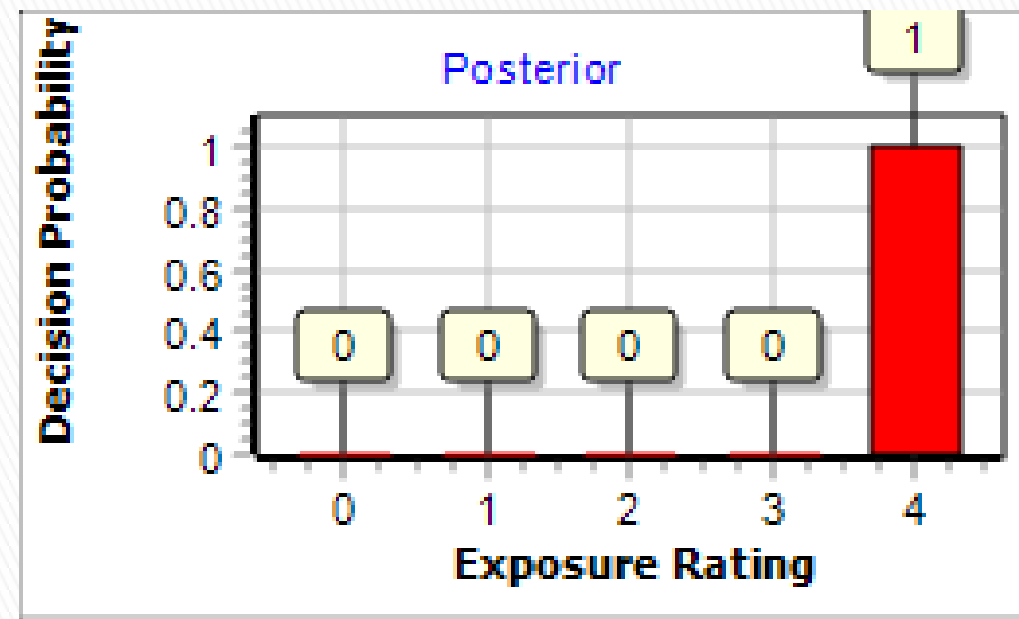
SEG #1 – Welders – Personal

N = 11 over 3 workplaces

GM = 0.3 GSD = 2.71

▶ Past EL – 0.2mg/m³

▶ 2018 EL – 0.02 mg/m³



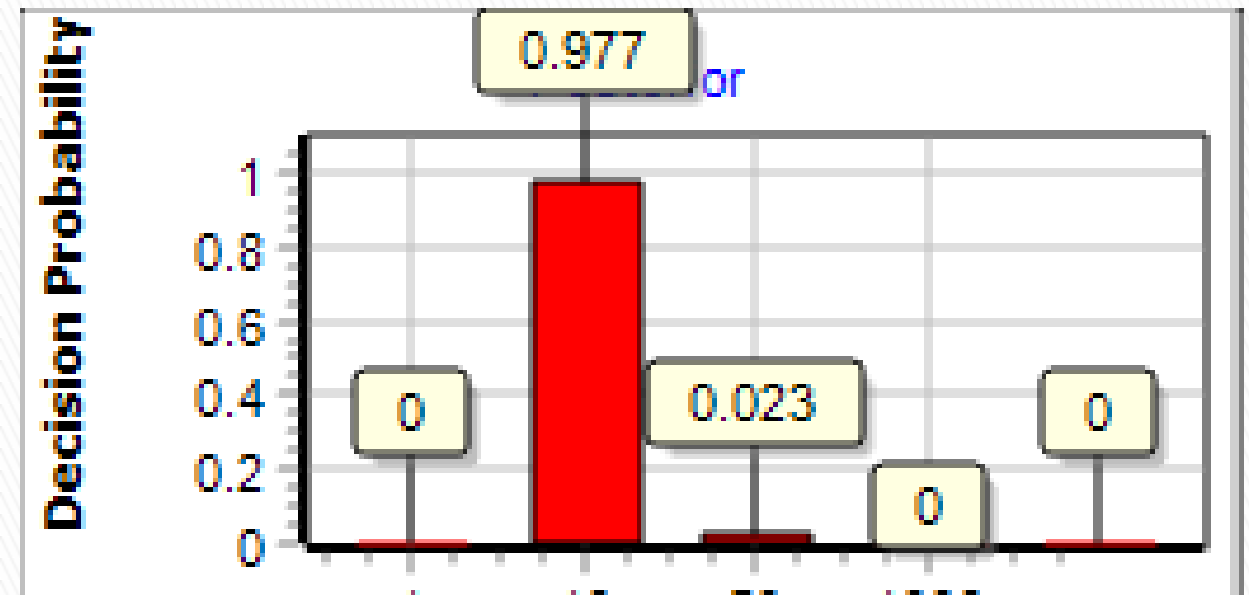
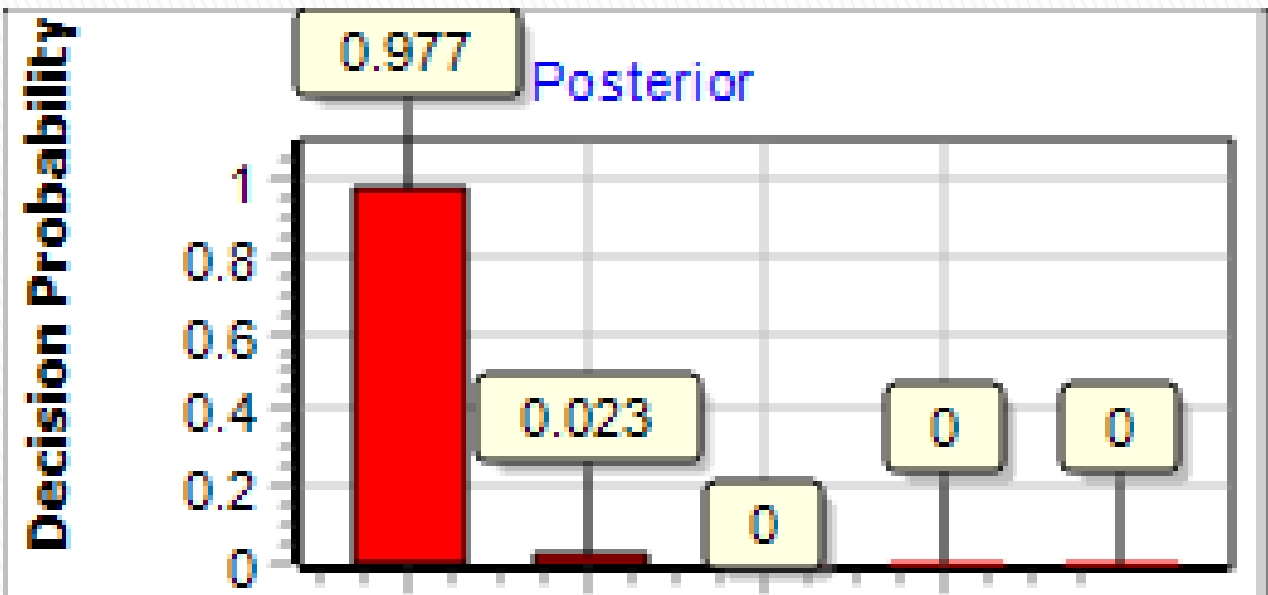
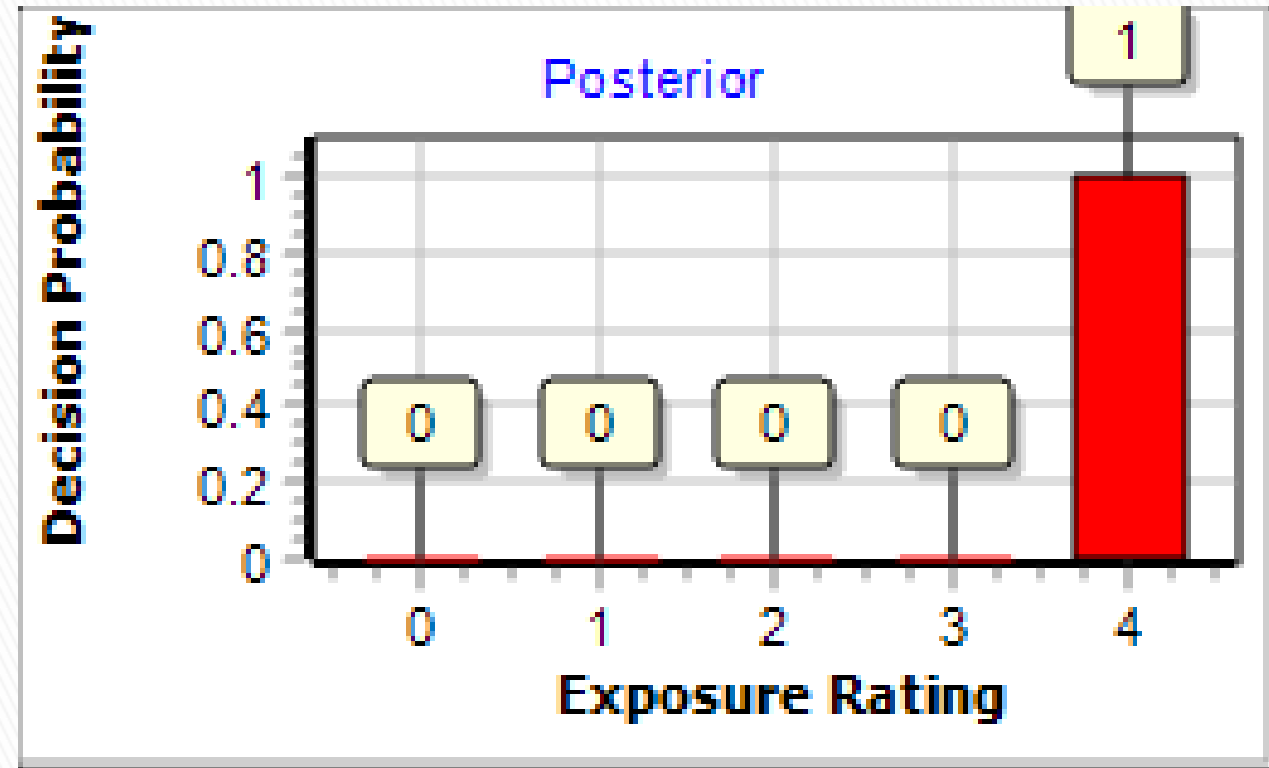
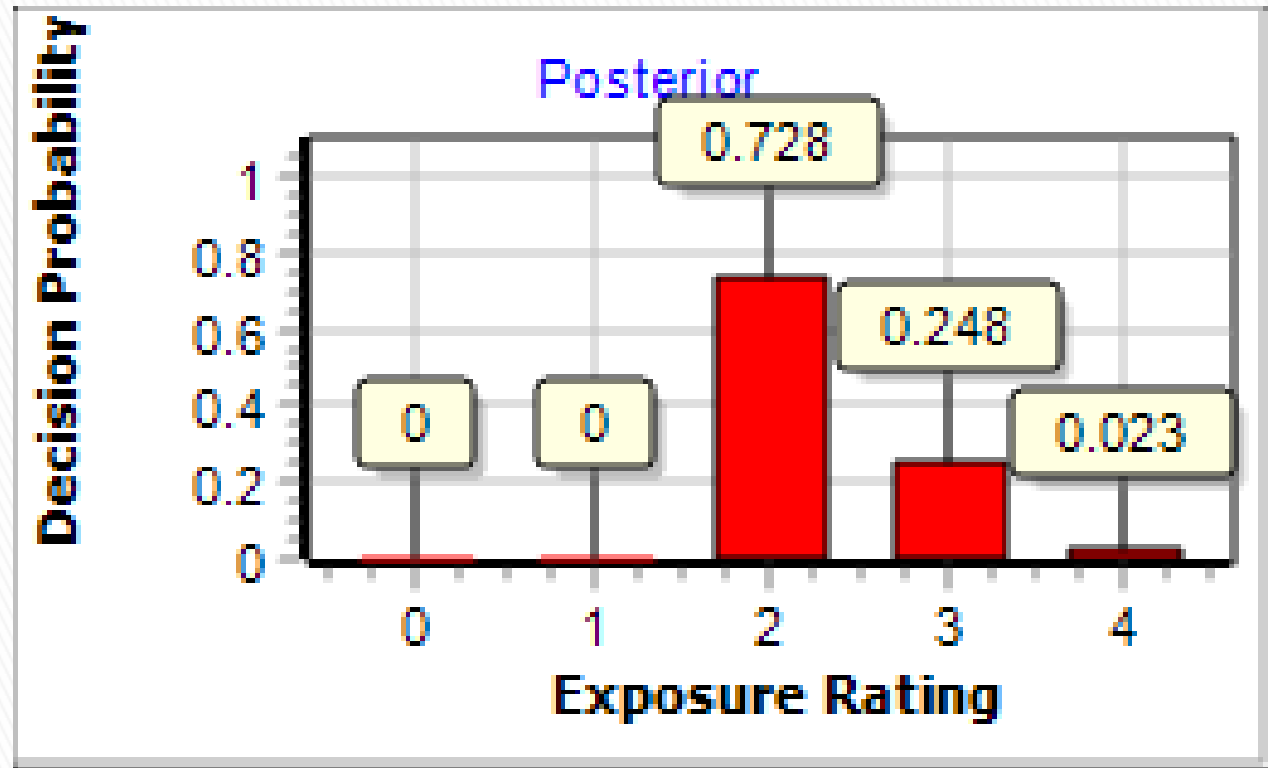
SEG #1 – Welders Area Samples

N = 9 over 3 workplaces

GM = 0.036 GSD = 1.56

▶ Past EL – 0.2mg/m³

▶ 2018 EL – 0.02 mg/m³



SEG #2 – Fabricators Personal

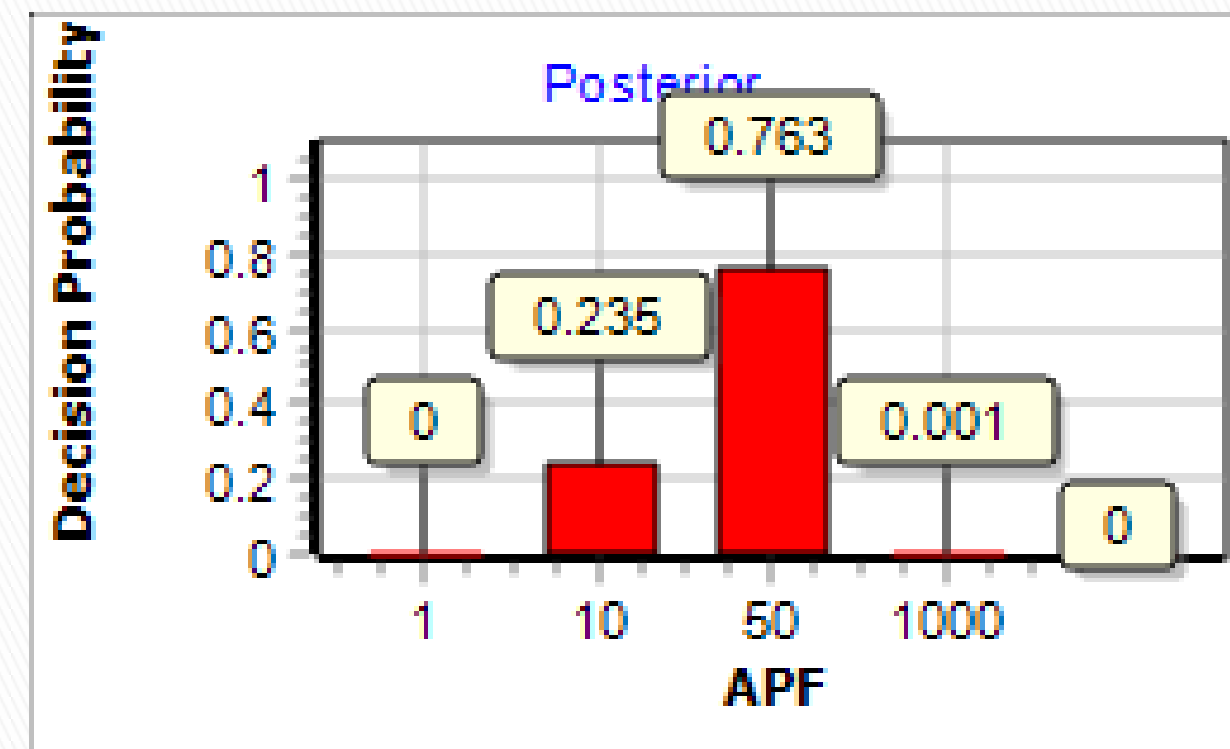
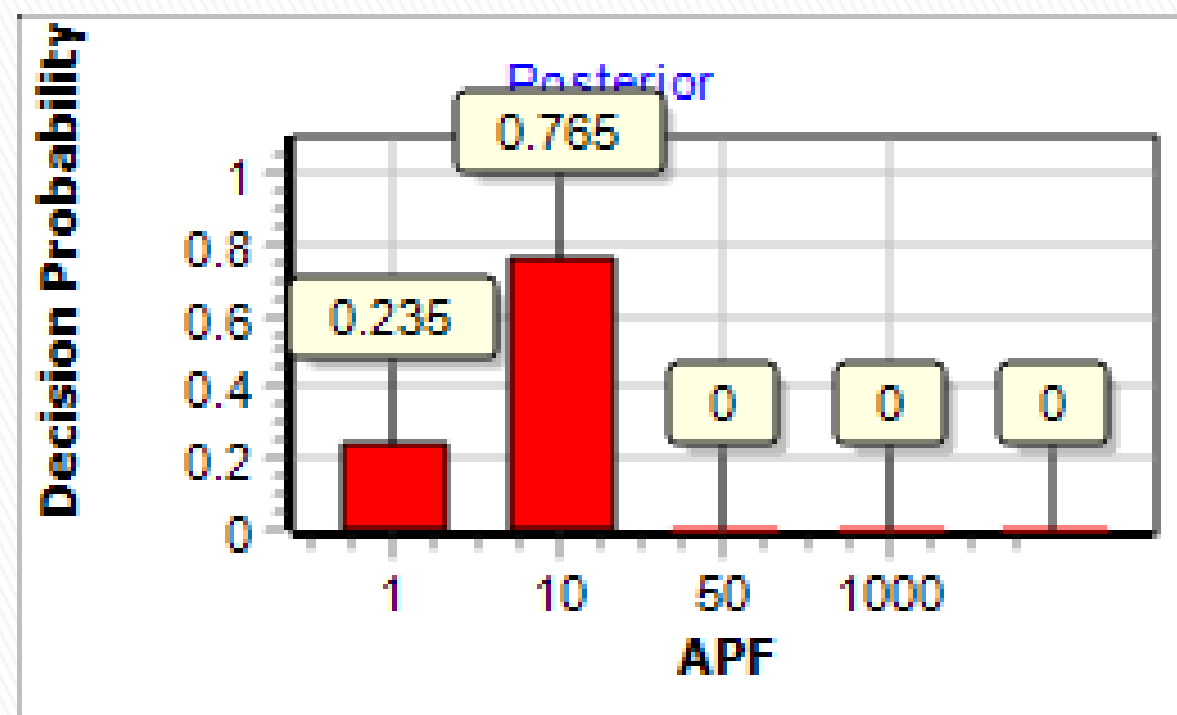
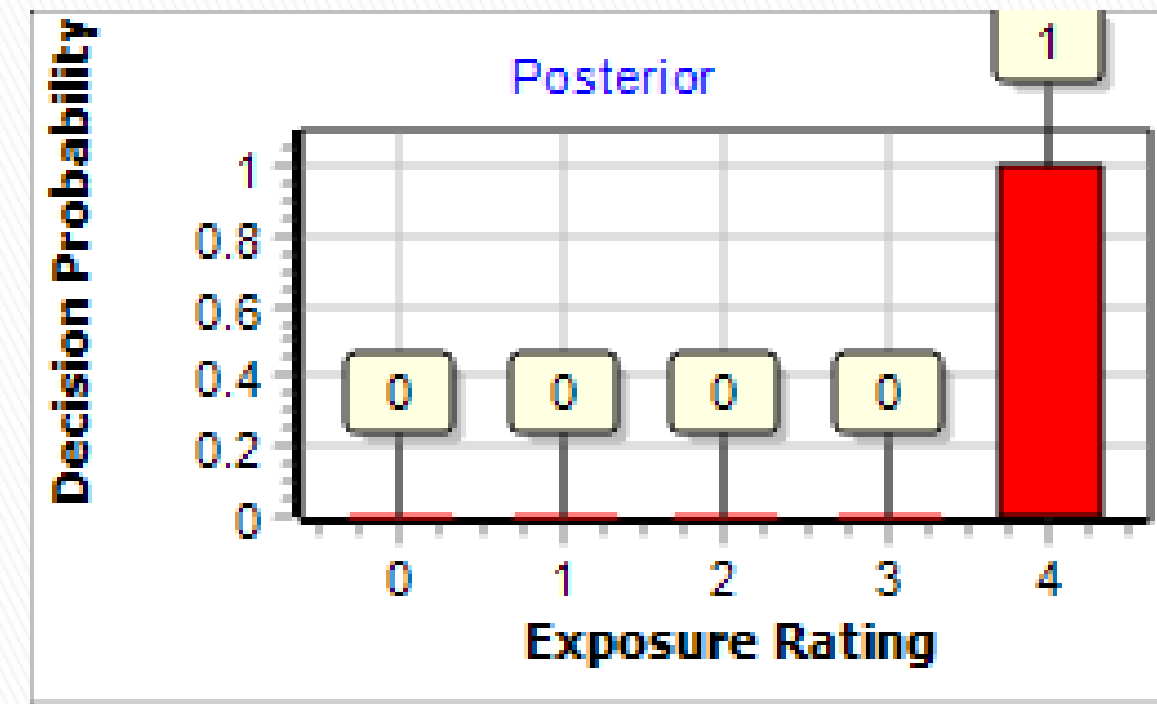
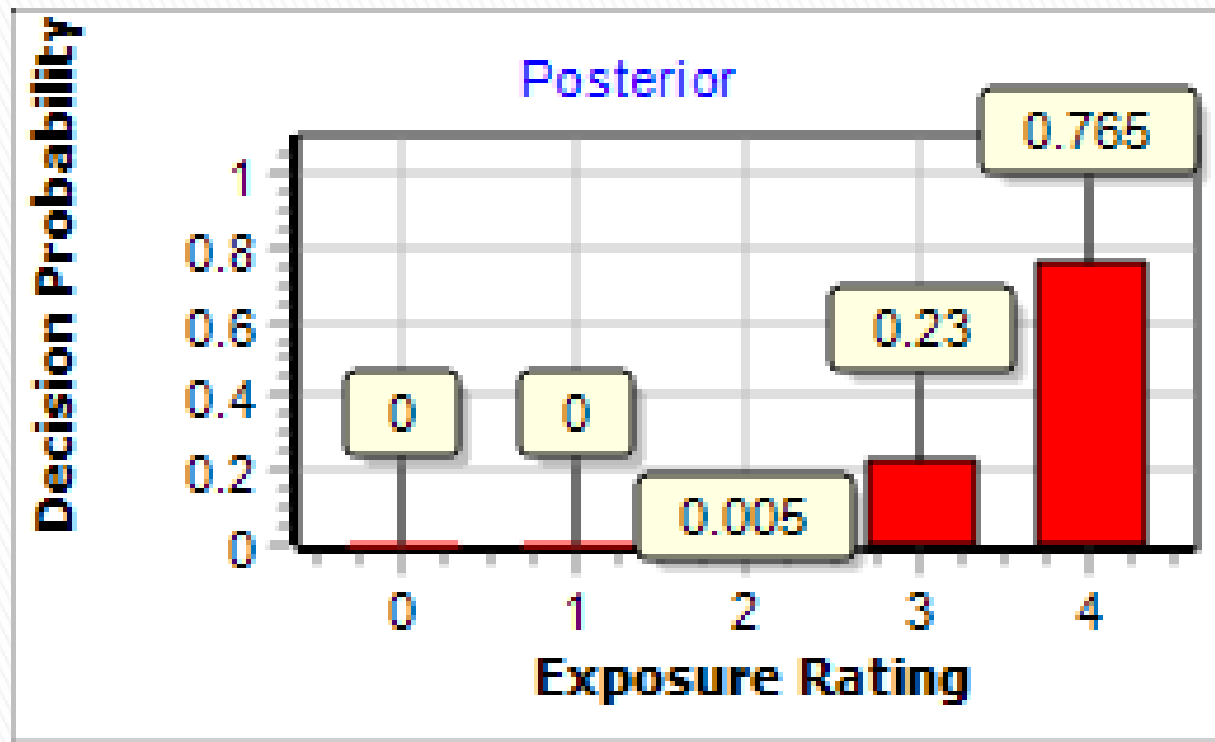
N = 11 over 4 workplaces

Mean = 0.08 SD = 0.09

GM = 0.037 GSD = 4.09

▶ Past EL – 0.2mg/m³

▶ 2018 EL – 0.02 mg/m³



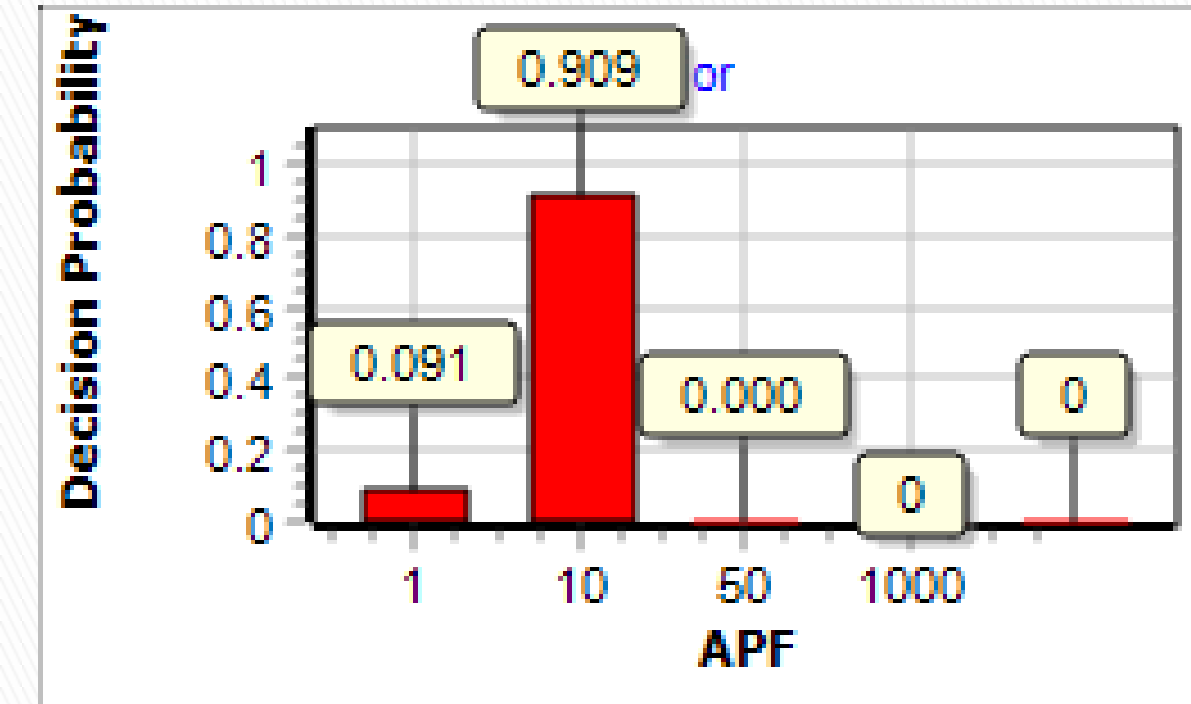
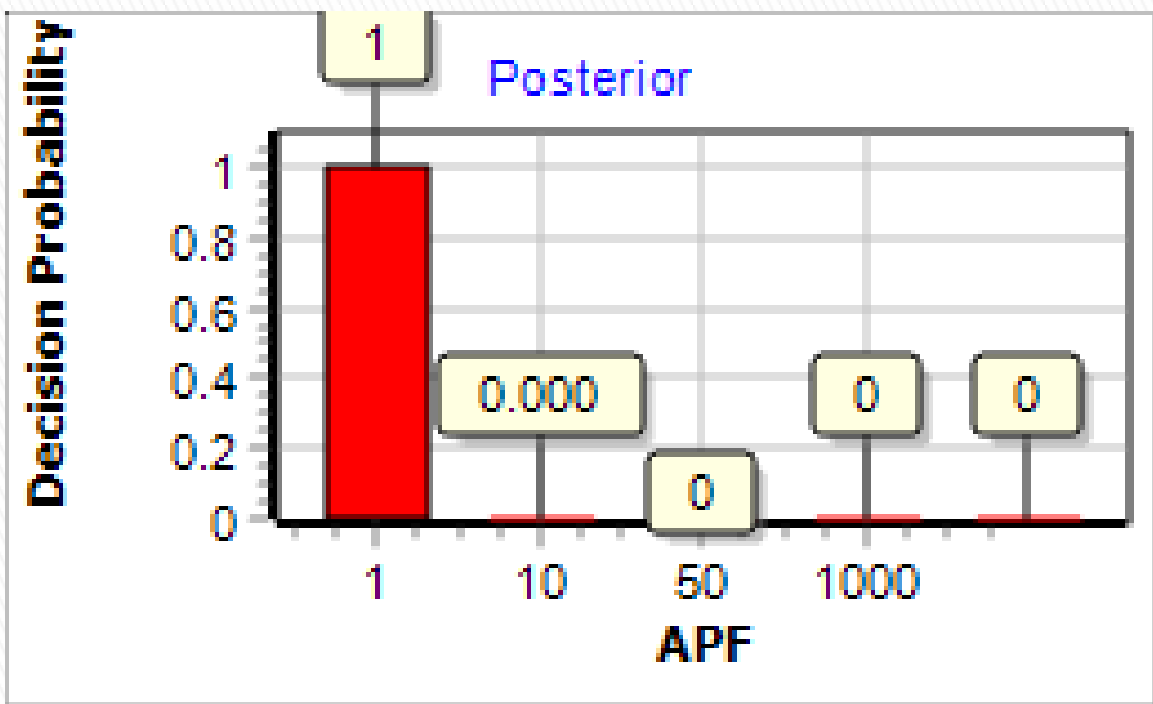
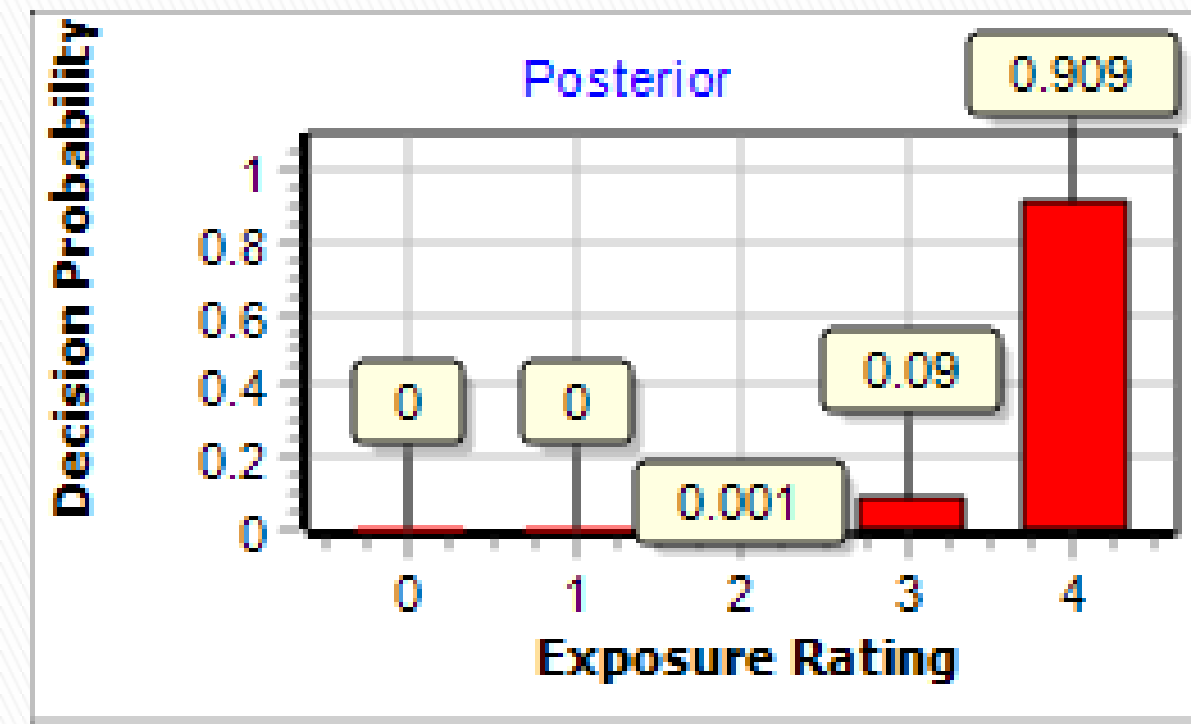
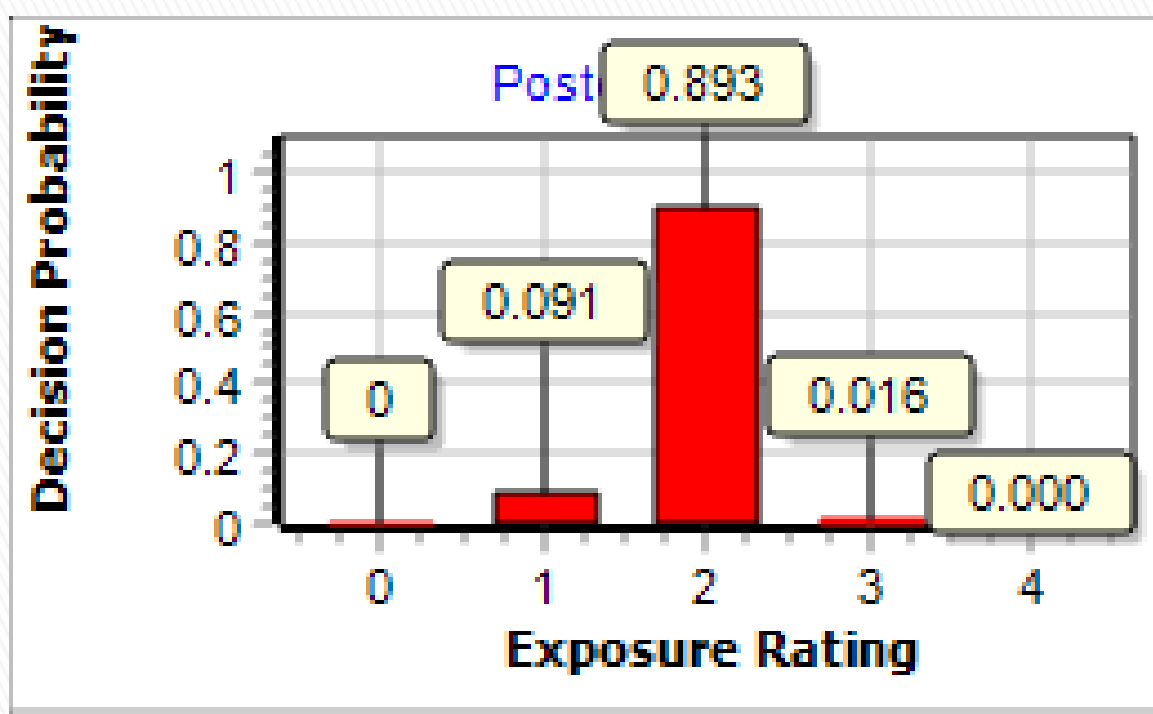
SEG #2 – Fabricators Area Samples

N = 9 over 3 workplaces

GM = 0.005 GSD = 3.97

▶ Past EL – 0.2mg/m³

▶ 2018 EL – 0.02 mg/m³

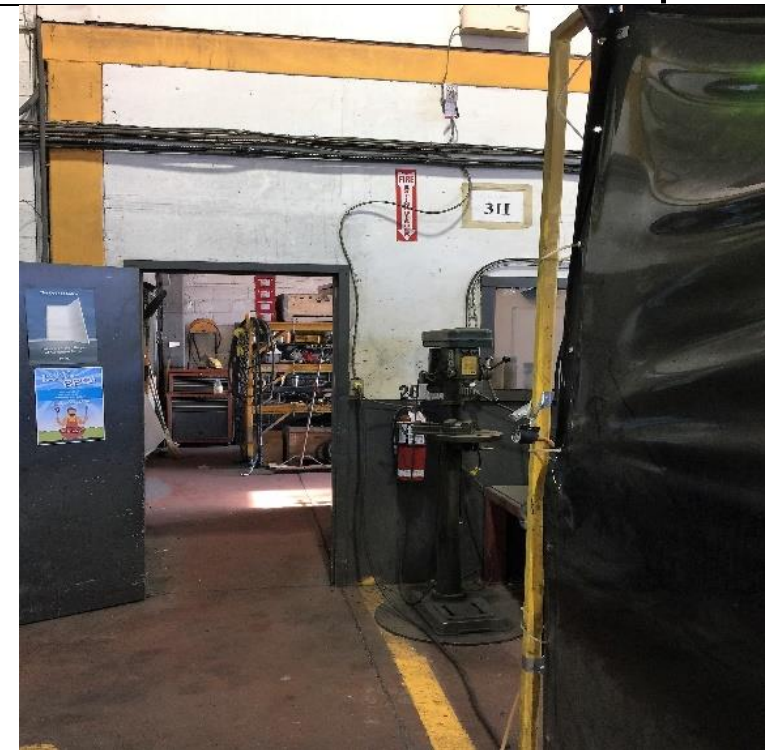




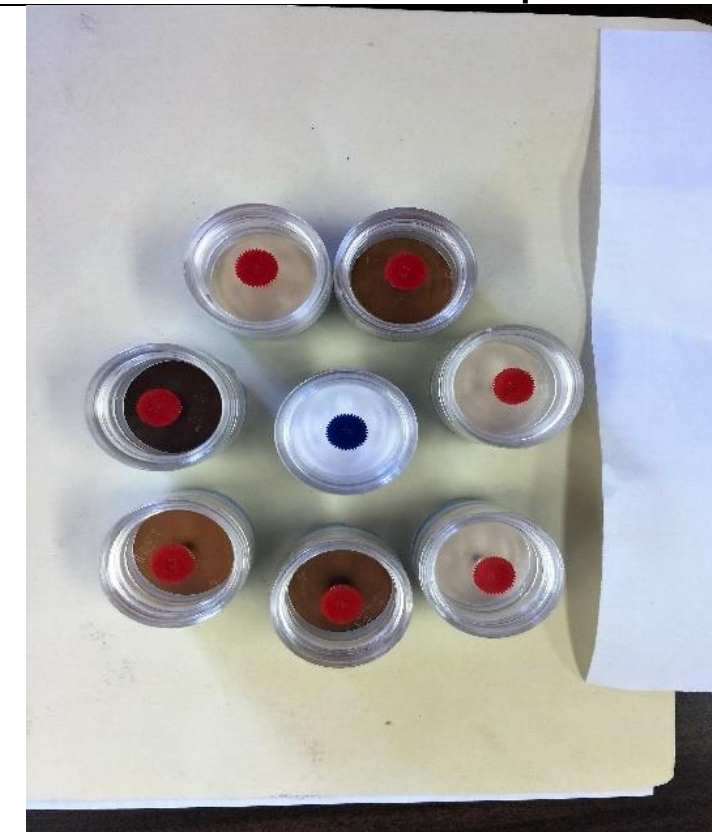
Personal and Area Sample



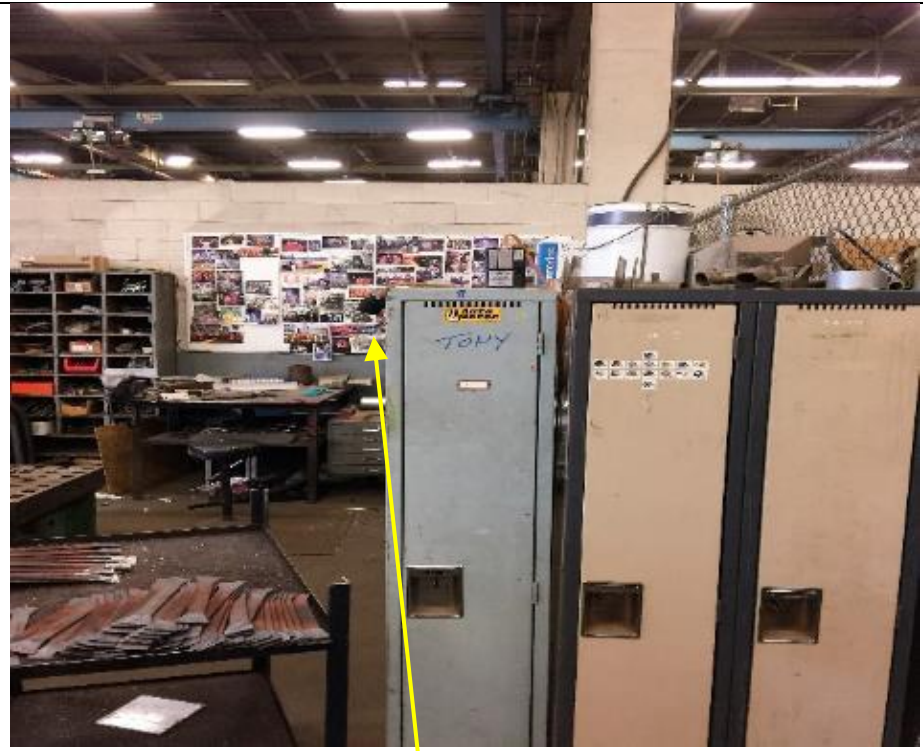
Personal Sample



Area Sample on Curtain (shop 3)



Used Sample Cassettes



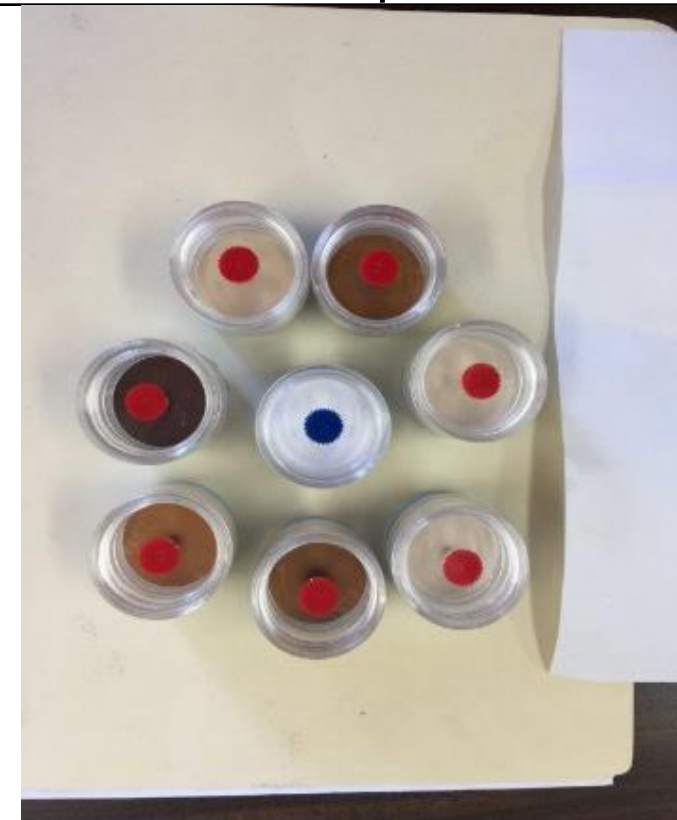
Area Sample on Locker



Portable LEV Filtered Exhaust Sample



Personal Sample -Aluminum Welding with LEV

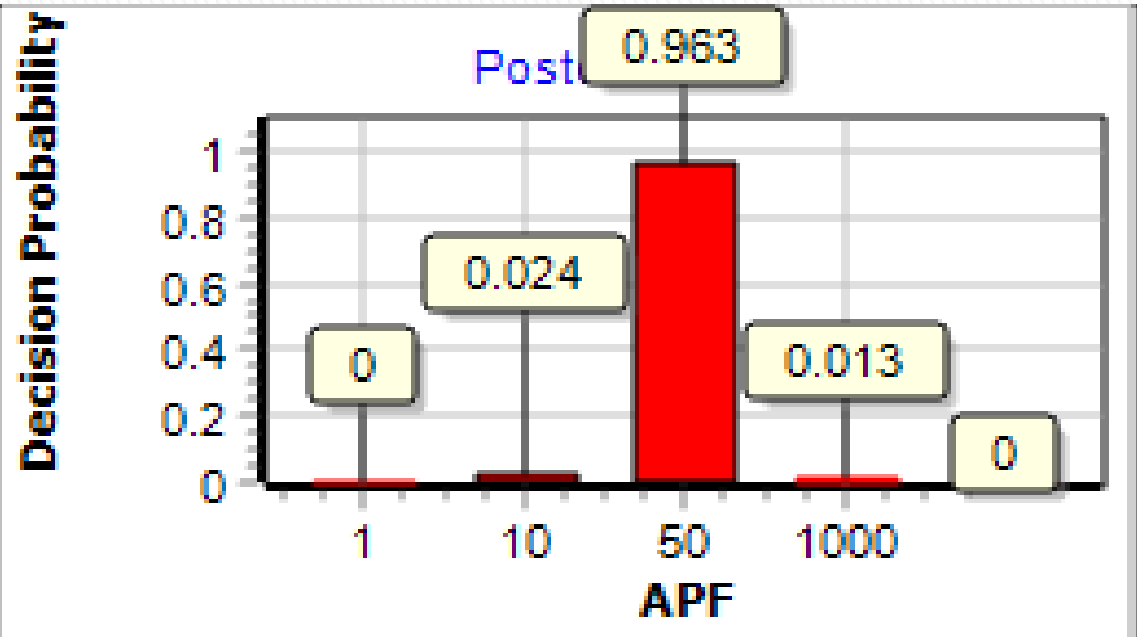
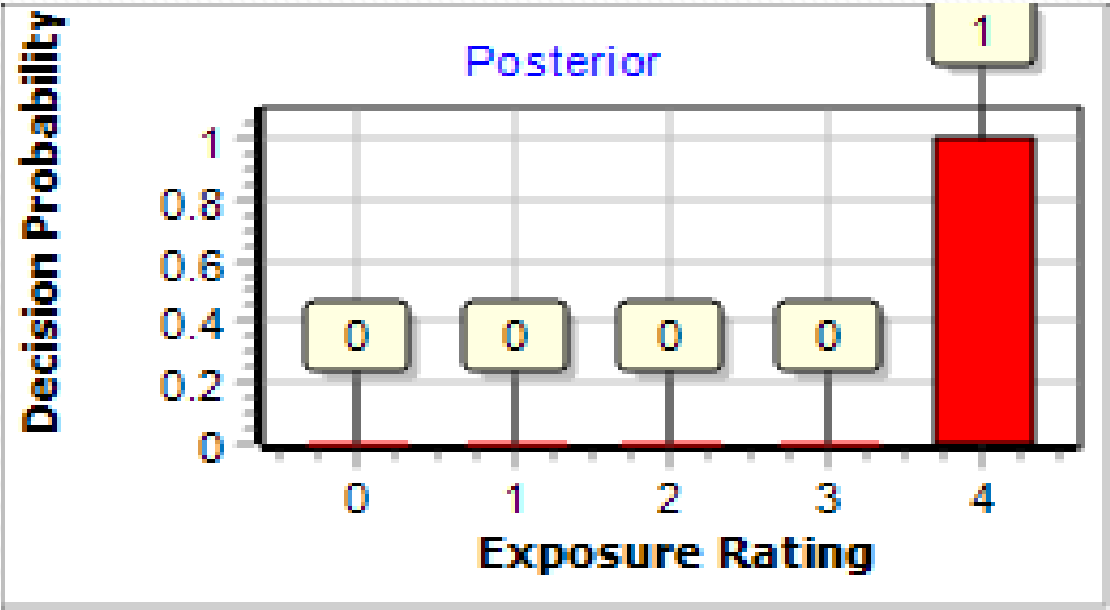
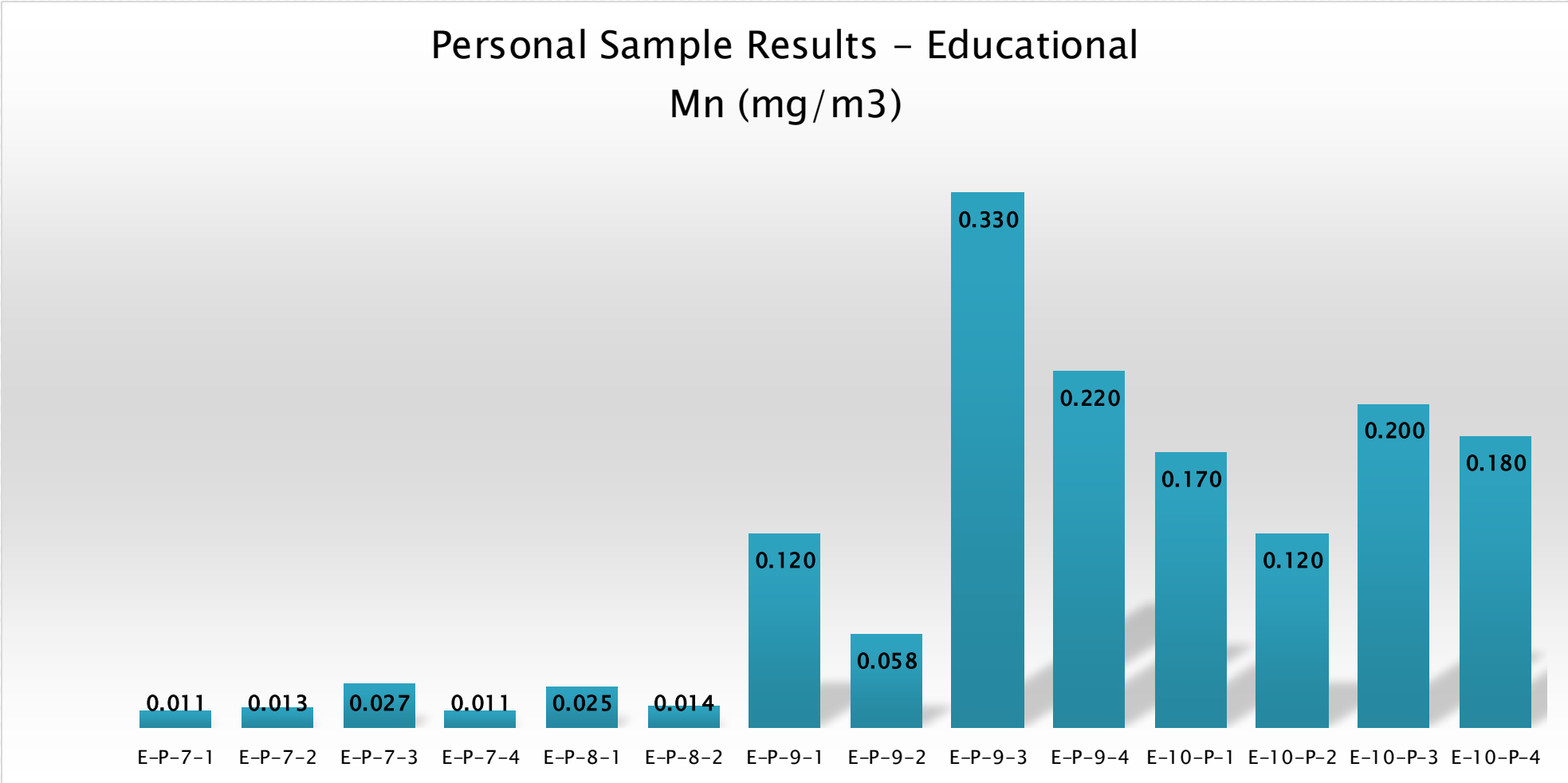


Cassettes after Sampling

SEG #3 – Students – Personal

N = 14 over 2 facilities

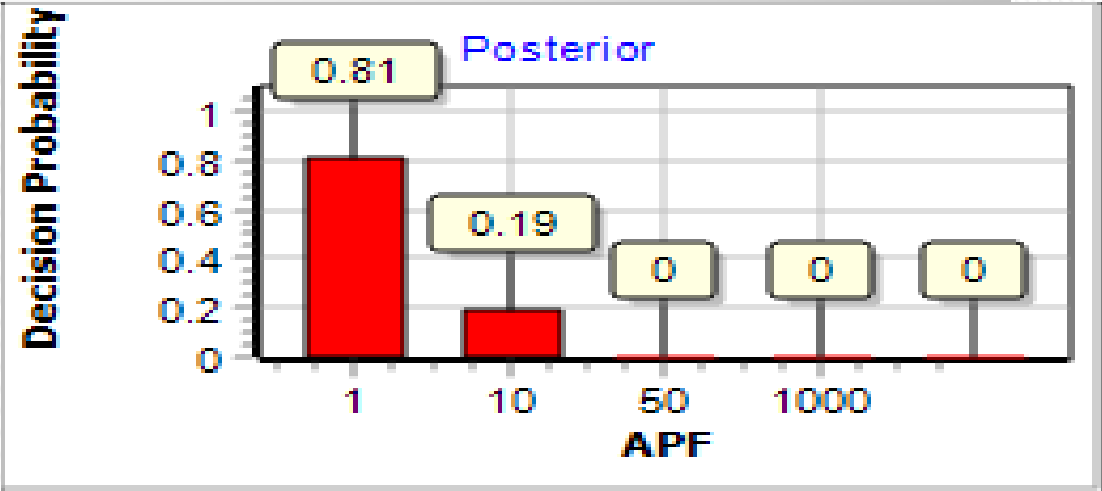
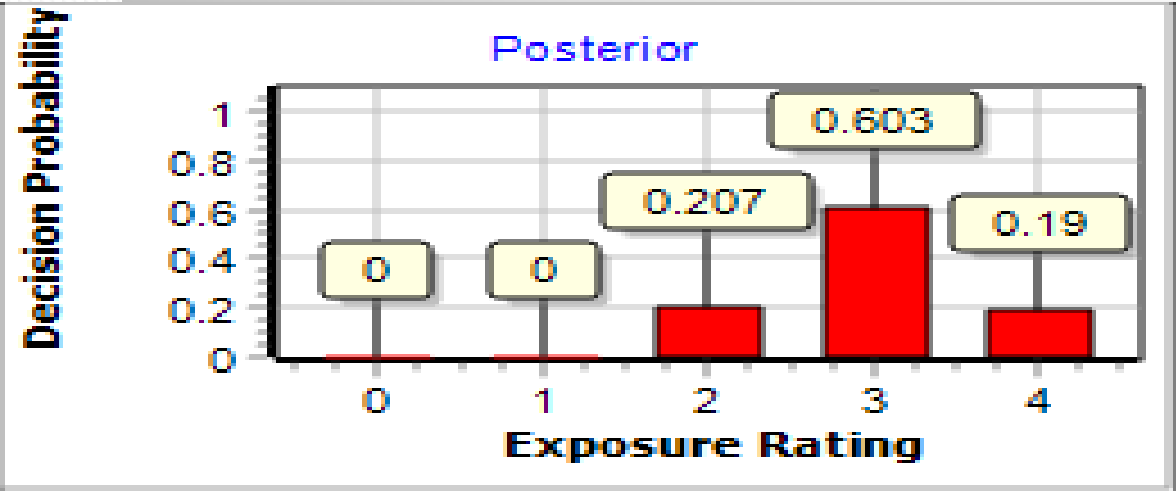
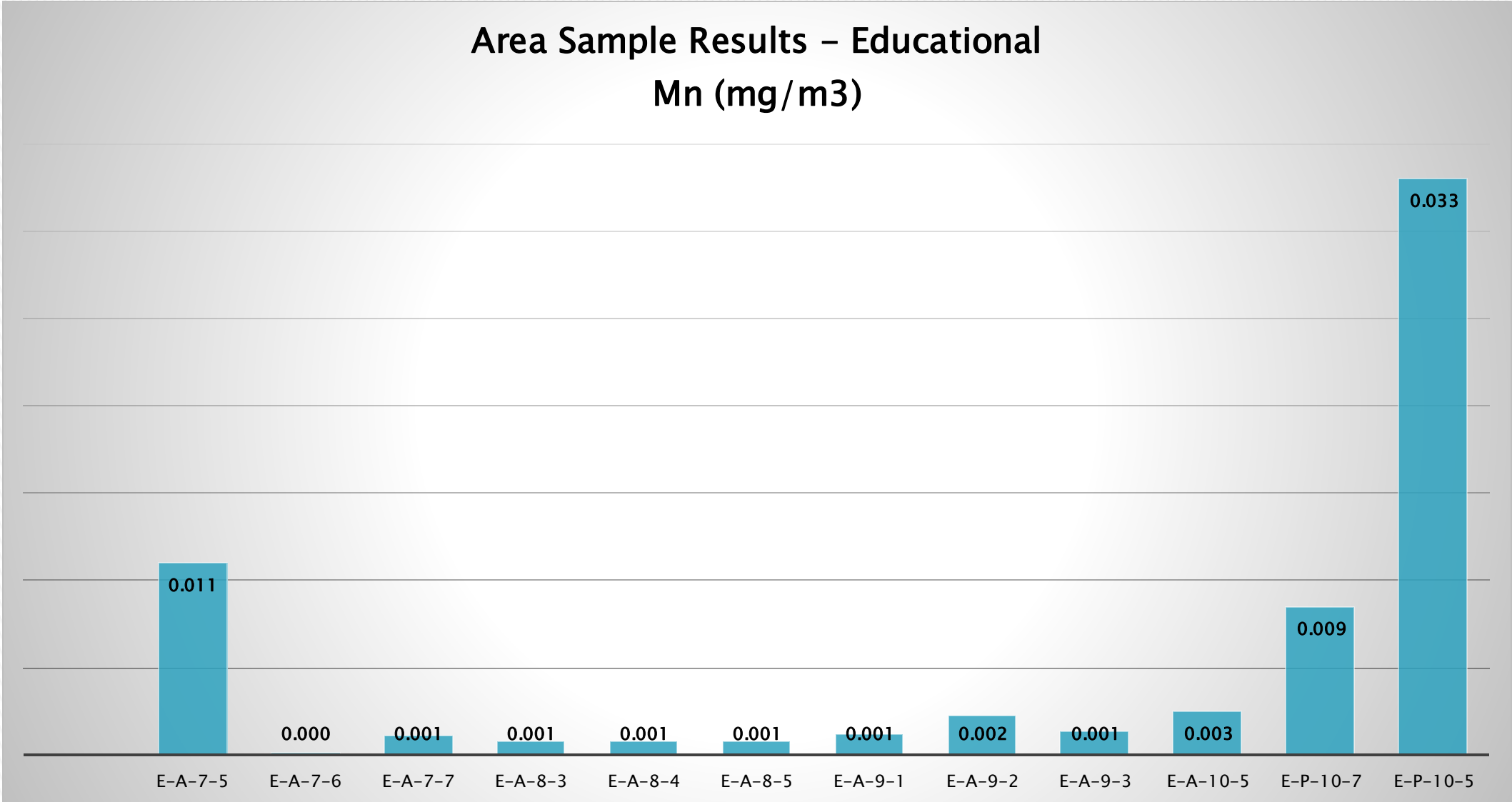
GM = 0.0585 GSD = 3.55



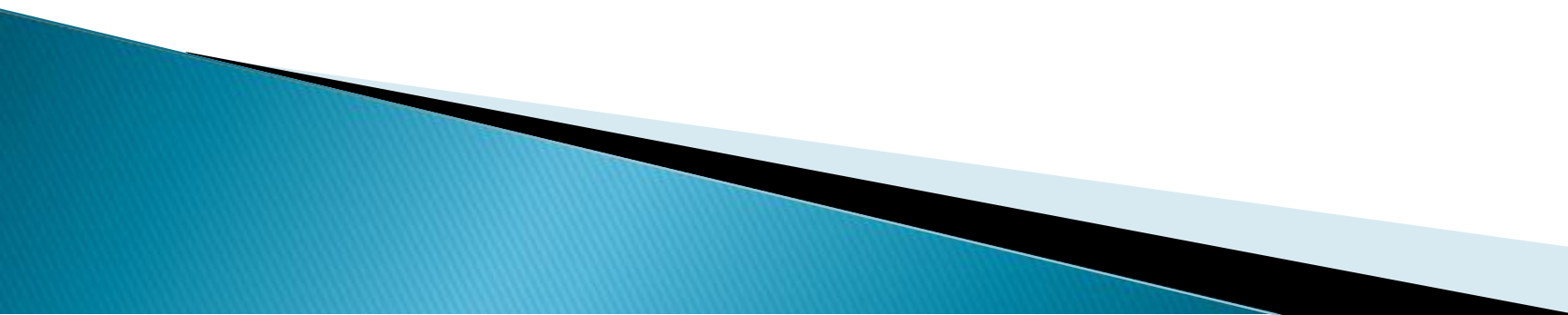
SEG #3 – Students – Area Samples

N = 14 over 2 facilities

GM = 0018 GSD = 4.23



Mobile, Filtered LEV Units

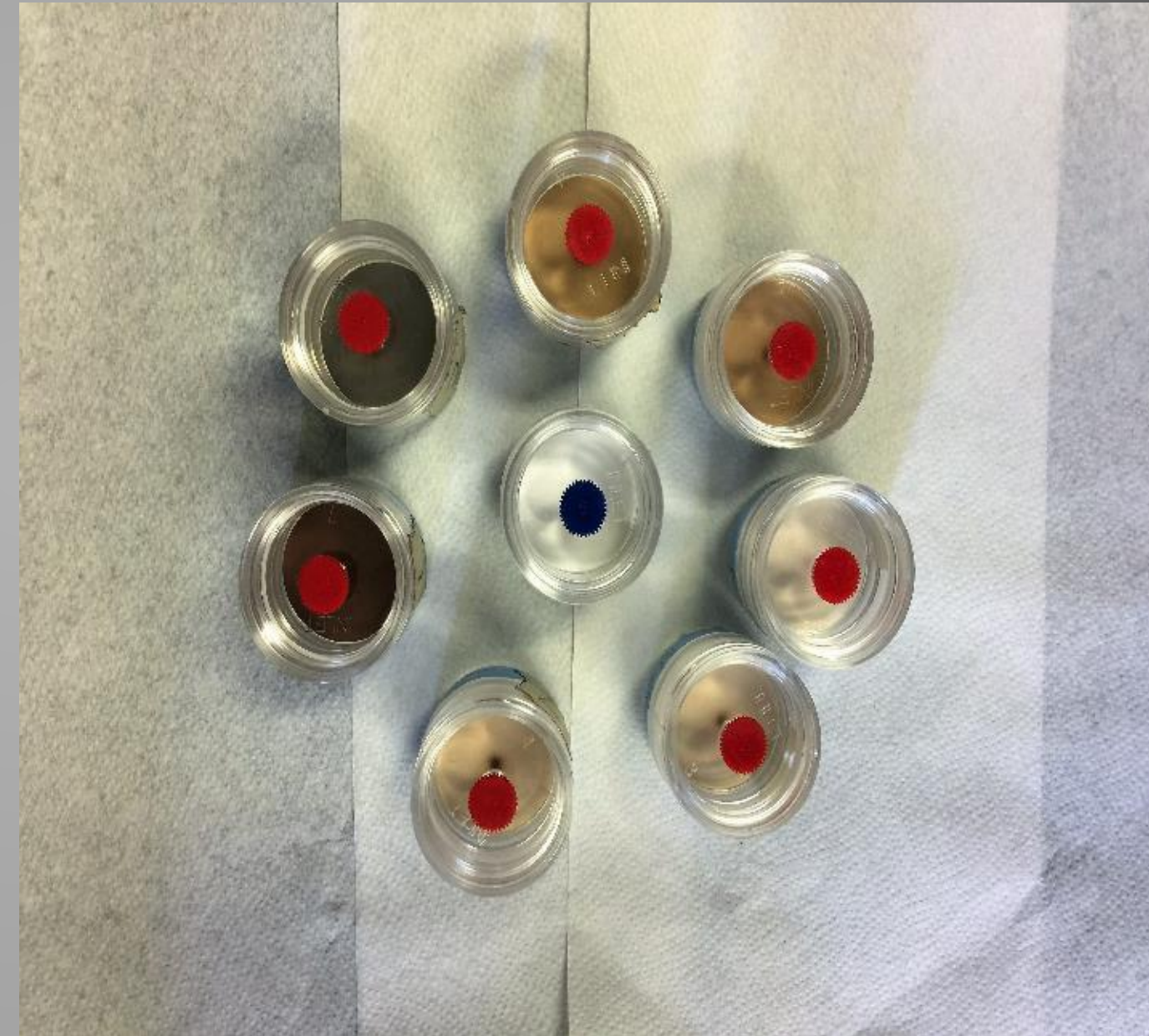
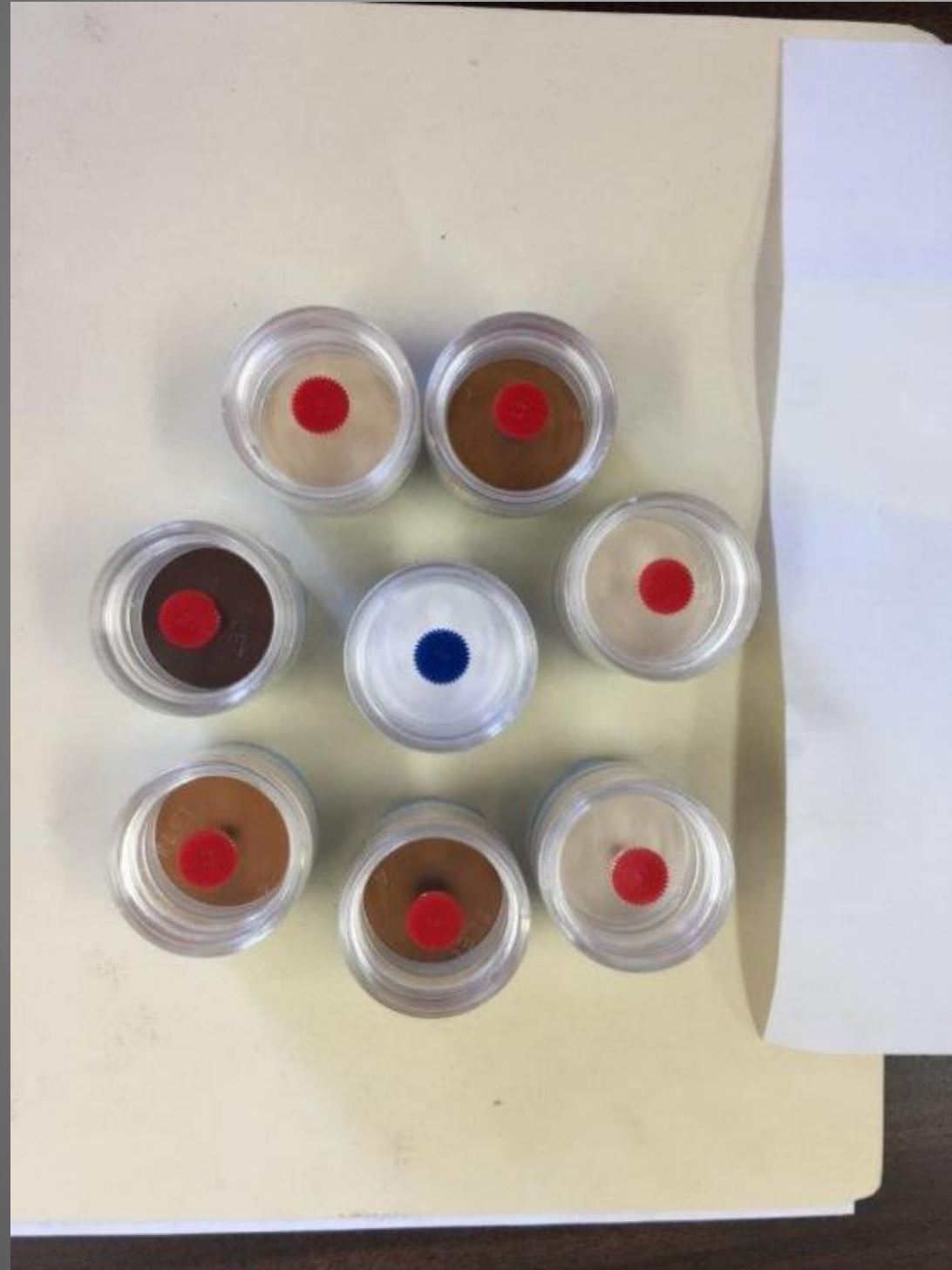
- ▶ Only 2 units were being used during the survey. Test results for both were below limits of detection for all 32 metal fumes reported in NIOSH ICP Metals in Air.
 - ▶ Previous exhaust air testing of 2 similar units produced similar results demonstrating the effective filtration of welding fume to levels safe to recirculate into workplace air.
- 

Testing Mobile, Filtered LEV Units

- ▶ The exhaust stream of mobile welding LEV units was tested using a high-temperature silicone kitchen funnel attached to an area sampler and stabilized by a 10 cm Teflon ring.



Motivational Photo Included in Each Report



A Few Words About B.C. Workplace Mn Fume Exposures

- ▶ Workplace welding fume exposures commonly exceed the pre-2018 WSBC Mn fume exposure limit of 0.2 mg/m³. Personal samples nearly always exceed the current exposure limit of 0.02 mg/m³.
- ▶ Regardless of the degree of exposure, Part 5.57 of the OHSR requires that every employer conducting carbon steel welding develops and follows a welding fume exposure control plan.

What Controls are Currently Required?

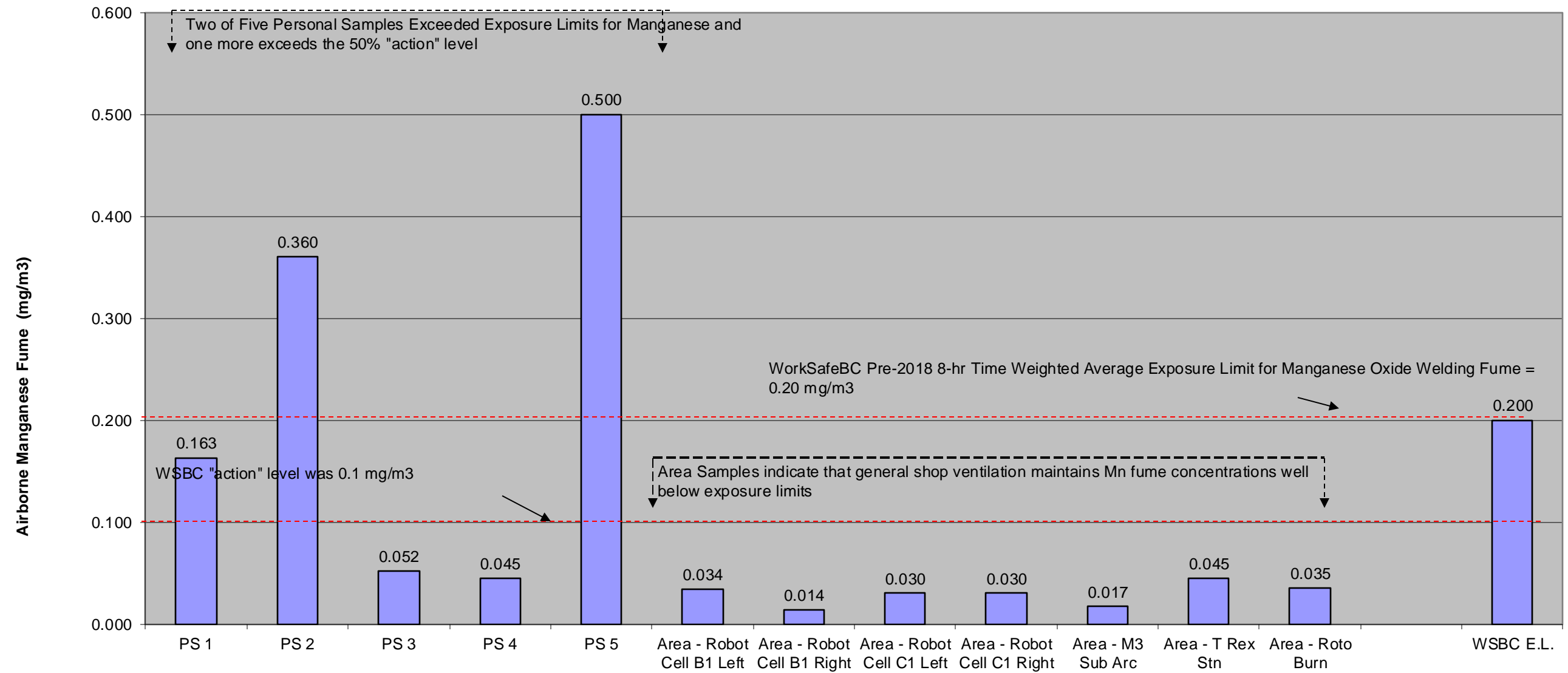
- ▶ Under the current Mn fume EL of 0.02 mg/m^3 respiratory protection is required for all welders and fabricators conducting carbon steel welding. It is arguable that half-face respirators are insufficient in many cases.
- ▶ At current fume control levels, ambient Mn fume levels in welding workplaces often exceed the current Mn fume EL.

Mn Fume EL vs. B.C. Workplace Mn Fume Exposures

- ▶ At measured welding fume control levels, the current Mn fume exposure limit of 0.02 mg/m³ requires that:
 1. Carbon steel welders use respiratory protection with assigned protection factors of 50 or greater.
 2. Fabricators wear respirators with an assigned protection factor of 10 or greater.
 3. Employers without effective LEV prohibit the entry of unprotected workers into shops during carbon steel welding.
 4. Combinations of welding fume exposure controls be adopted by most employers to improve exposure control.

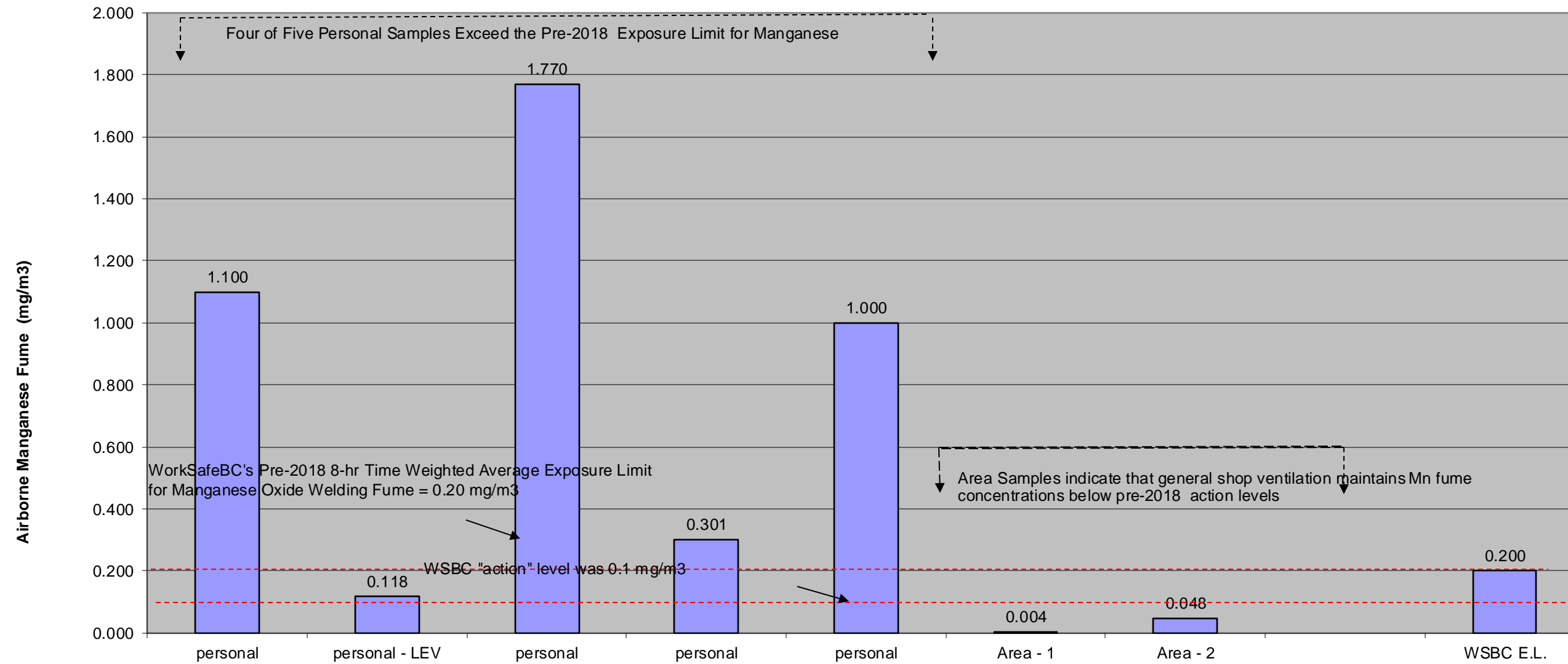
Example – Ultra Clean Shop

Airborne Manganese Fume Measurements (Pre-2018)



Example – Regular Clean Shop

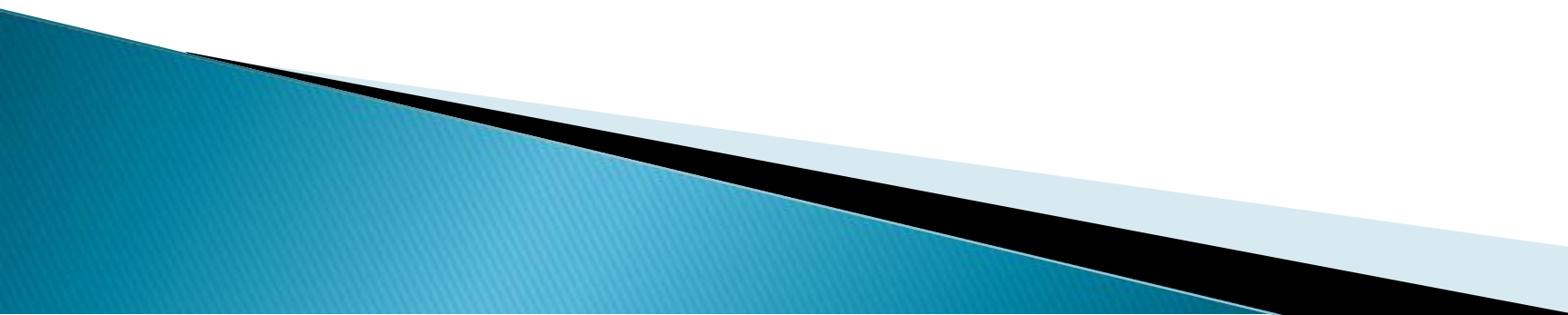
Airborne Manganese Fume Measurements (Pre-2018)




Elimination/Substitution

1. Substitute with low manganese consumables
2. As much as 95% of generated Mn fume arises from wire/rods
3. Moving away from 100% CO₂ to Argon blends
4. Mn fume reduction by a factor of 3 has been demonstrated

Engineering Control

1. Local Exhaust Ventilation
 2. Gun-mounted Extraction Systems
 3. Pulsed vs steady current welding
 4. General Exhaust Ventilation
- 

Administrative Controls

1. Changing Technique/orientation
 2. Rotating Jigs
 3. Adjustable Tables with Clamps
 4. Lowering current
 5. Lowering voltage
 6. Larger diameter electrodes
- 

Personal Protective Equipment

1. Effective if properly used
2. Varying Assigned Protection Factors
 - Half-mask respirator – APF = 10
 - Full-face respirator – APF = 50
 - PAPR with tight cowl – APF = 1000
3. Worker Acceptance Problems
4. Employer are obliged to enforce respirator use

Combining Control Options

Control Option	% Reduction	Comment
Lower Mn welding wire	20-70	Essentially zero cost, proven effective
Local exhaust ventilation	80	High initial cost, high level of control
Gun extraction system	55-60	Somewhat less effective than above
Pulse setting	30-40	Zero cost, still gives good weld
Voltage Reduction	20-40	Zero cost
Change work position	80	Rearrange work station so worker is out of plume
Respiratory protection	90	High ongoing costs and comfort issues

Summary : Three Key Qs & As

1. Q. How do common industry exposures to manganese welding fume compare with past and current exposure limits?
 - A. Exceedances are common.

2. Q. What would evidence-based Exposure Control Plan (ECP) requirements for Mn welding fume look like?
 - A. Mandatory respiratory protection during welding and much greater use of LEV and additional control methods to prevent ambient exceedances of the current EL.

3. Q. What are the key issues that WorksafeBC, welding employers and workers must address when applying the ACGIH/WSBC exposure limit for Mn fume?
 - A. Developing standardized ECP expectations, promoting industry awareness/education and integrating ECP concepts into trades training.

Questions??

Commonly Tested Welding Metals

Substance	ACGIH TLV-TWA (ug/m ³)	Comments
Fe ₂ O ₃	5000	Siderosis
ZnO	2000	Metal Fume fever (also Mg & Cu)
Al ₂ O ₃	1000	Pneumoconiosis, irritation (O ₃ issue)
MnO ₂	20	CNS impairment, lung damage, rep. toxin
NiO	200	50 ug/m ³ in BC A1 carcinogen (lung/sinus) sens.
Cr ⁺⁶	50	Lung cancer, nasal septum damage, sens. dermatitis
Co ₃ O ₄ /CoO	20	Asthma, cardiac eff.
CdO	2	Pneumonitis, lung cancer, kidney damage
BeO	2	CBD and Lung Cancer

Recommended Resources



Some optional training to further support theories and information shared today

01

Respiratory Protection

Offered as an e-Learning course, this awareness level course introduces learners to how respiratory protection is used, inspected, and maintained in the workplace. This is a basic awareness course to help workers better understand how to protect their own health and safety.

02

Hearing Protection

This e-Learning awareness level course will introduce learners to the importance of hearing conservation and how to protect themselves from hearing impairment.