Effectiveness of Engineering Controls:

Formaldehyde Exposure in Anatomic Pathology

California Industrial Hygiene Council Annual Conference
December 8, 2015

National Environmental, Health &Safety NEH&S

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Gen Y Hygienist

Can you spot him/her?

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Formaldehyde Data

- 1984 - 2014
- N = 2,163 → n = 307
- 36 Path Labs
- OSHA 52, NIOSH 2541 only
- Short-term (15-minute)
- Large specimen grossing
- 5 Analytical laboratories
- Multiple LODs

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Anatomic Pathology Engineering Controls

Engineering control type	Sample size	Sample size: percentage of total samples (%)	Maximum Concentration (ppm)	Percent data censored (%)
Slot ventilation	176	57	2.5	27
Ducted backdraft station (D1)	38	12	0.35	79
Ducted backdraft station (D2)	25	8	0.74	44
Canopy receiving hoods	24	8	1.6	13
Recirculating backdraft Station (R1)	14	5	2.2	7.1
In-house designed hoods	12	4	0.22	75
Lab hoods	10	3	0.29	90
Downdraft stations	3	1	<0.14	100
Snorkel	3	1	2.2	67
Recirculating station (R2)	2	1	0.26	50

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Slot Exhaust

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Ducted Backdraft (D1)

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Ducted Backdraft (D2)

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Canopy Hood

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Recirculating Backdraft (R1)

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In-House Design Hood

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Fume Hood

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Downdraft

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Snorkel

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Recirculating Backdraft (R2)

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Summary Statistics

Engineering control type	Concentration (ppm)					
	median	mean	sd	gm	gsd	95th
Canopy	0.70	0.65	0.44	0.49	2.3	1.9
R1	0.48	0.60	0.54	0.43	2.4	1.8
Slot	0.27	0.40	0.44	0.25	2.7	1.2
D2	0.18	0.14	0.13	0.12	1.8	0.30
D1	0.14	0.10	0.056	0.090	1.6	0.19

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p-Values for Non-Parametric H_o Testing

Engineering Control Types	Canopy	R1	Slot	D2	D1
Canopy	--	0.70	5.9E-04	2.9E-06	9.4E-09
R1	0.70	--	0.043	4.2E-06	7.9E-09
Slot	5.9E-04	0.043	--	0.010	2.2E-04
D2	2.9E-06	4.2E-06	0.010	--	0.76
D1	9.4E-09	7.9E-09	2.2E-04	0.76	--

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Bayesian Control Bands (% OEL)

	0	1	2	3	4
Not significant	0-10%				
Well Controlled		10-50%			
Controlled			50-75%		
Unsure				75-100%	
Not Controlled					>100%

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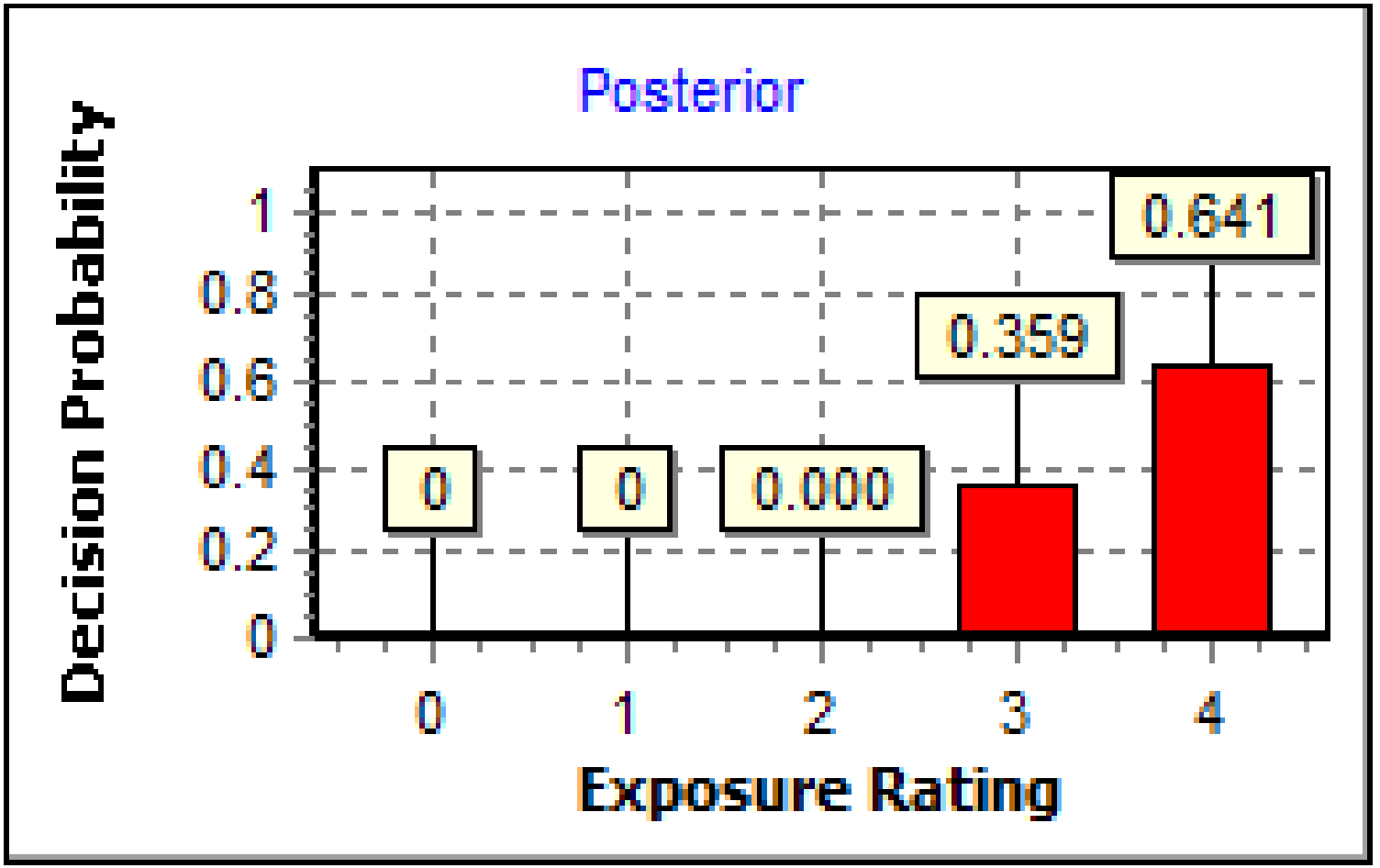
Canopy



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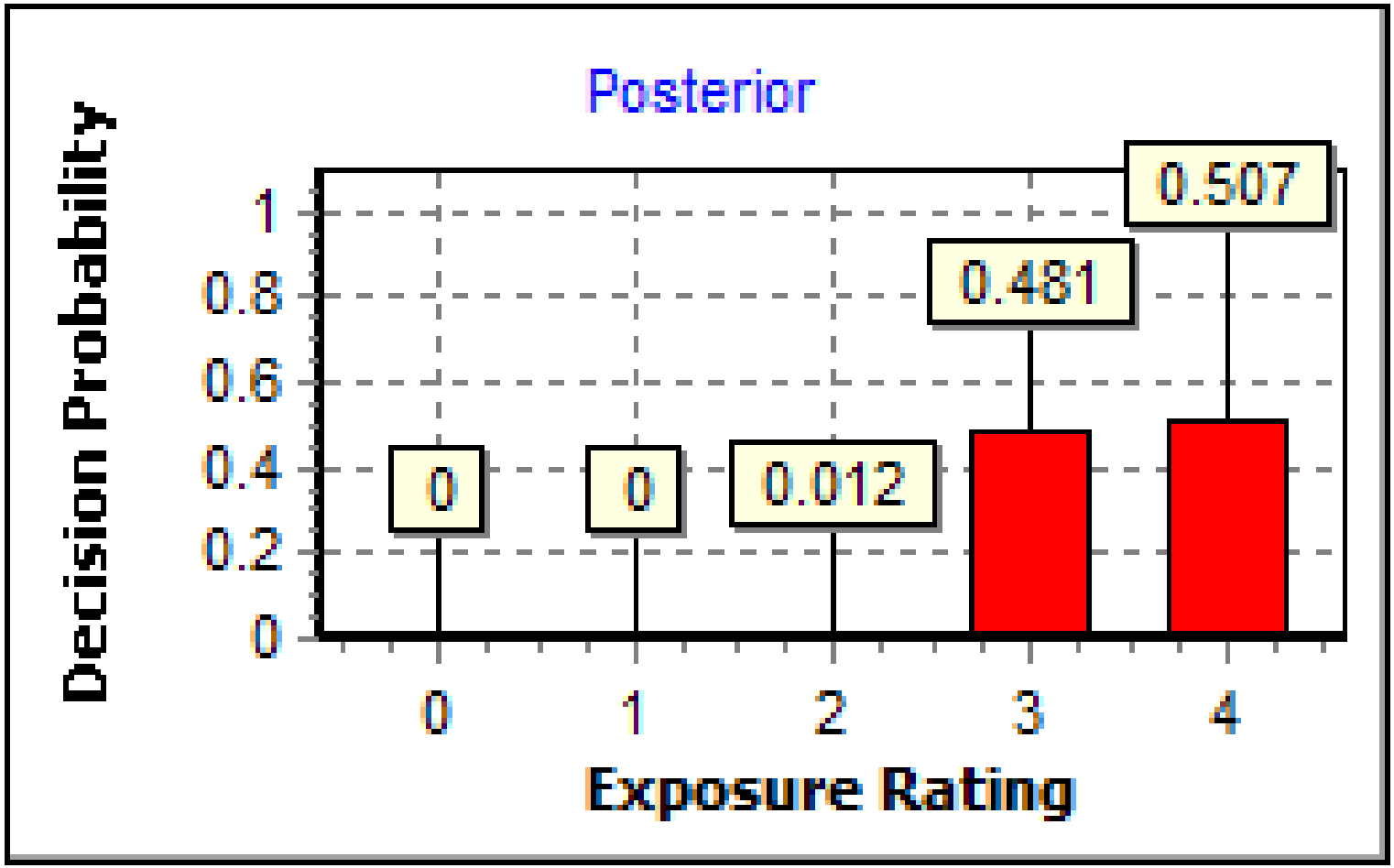
Recirculating Backdraft (R1)



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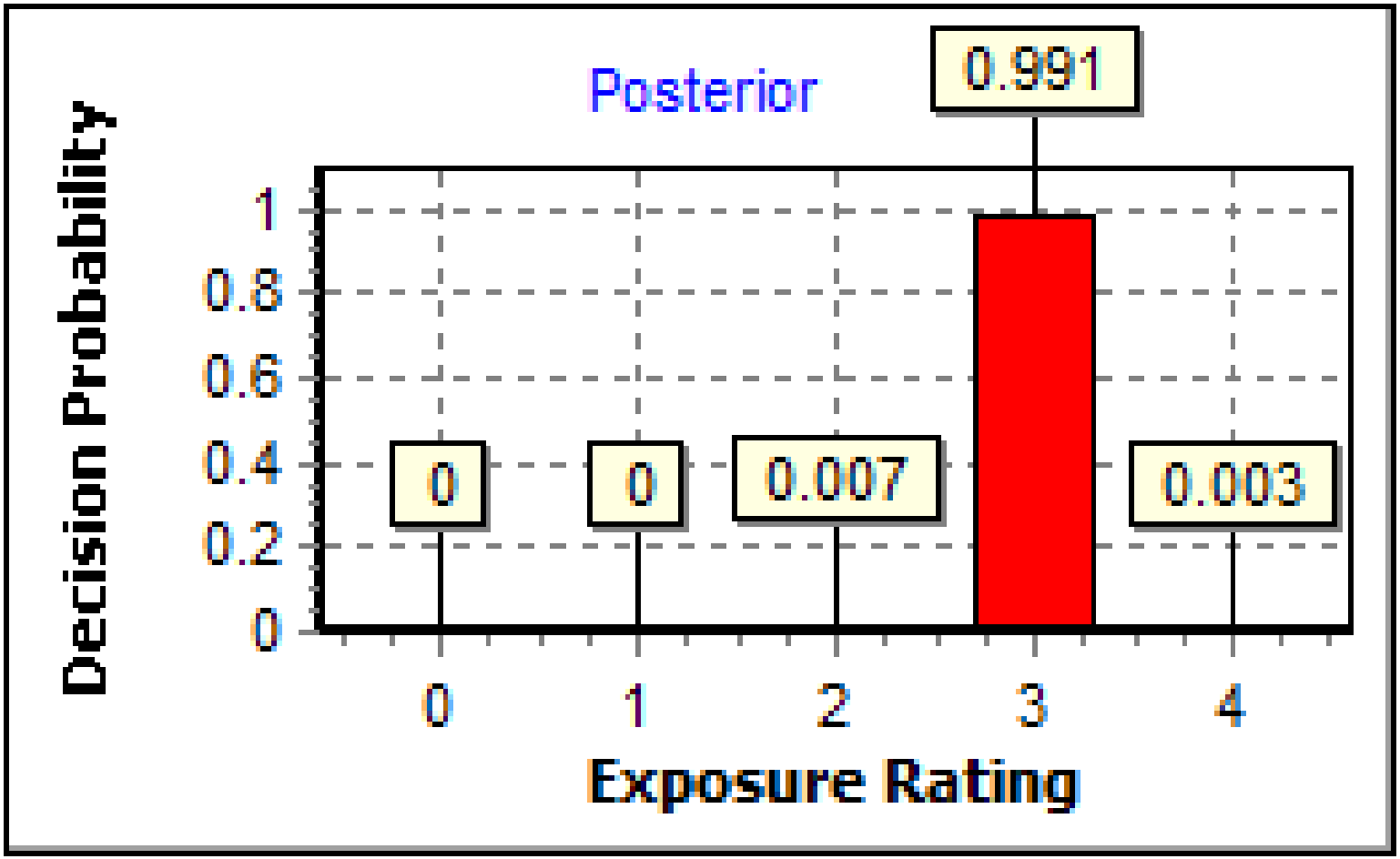
Slot



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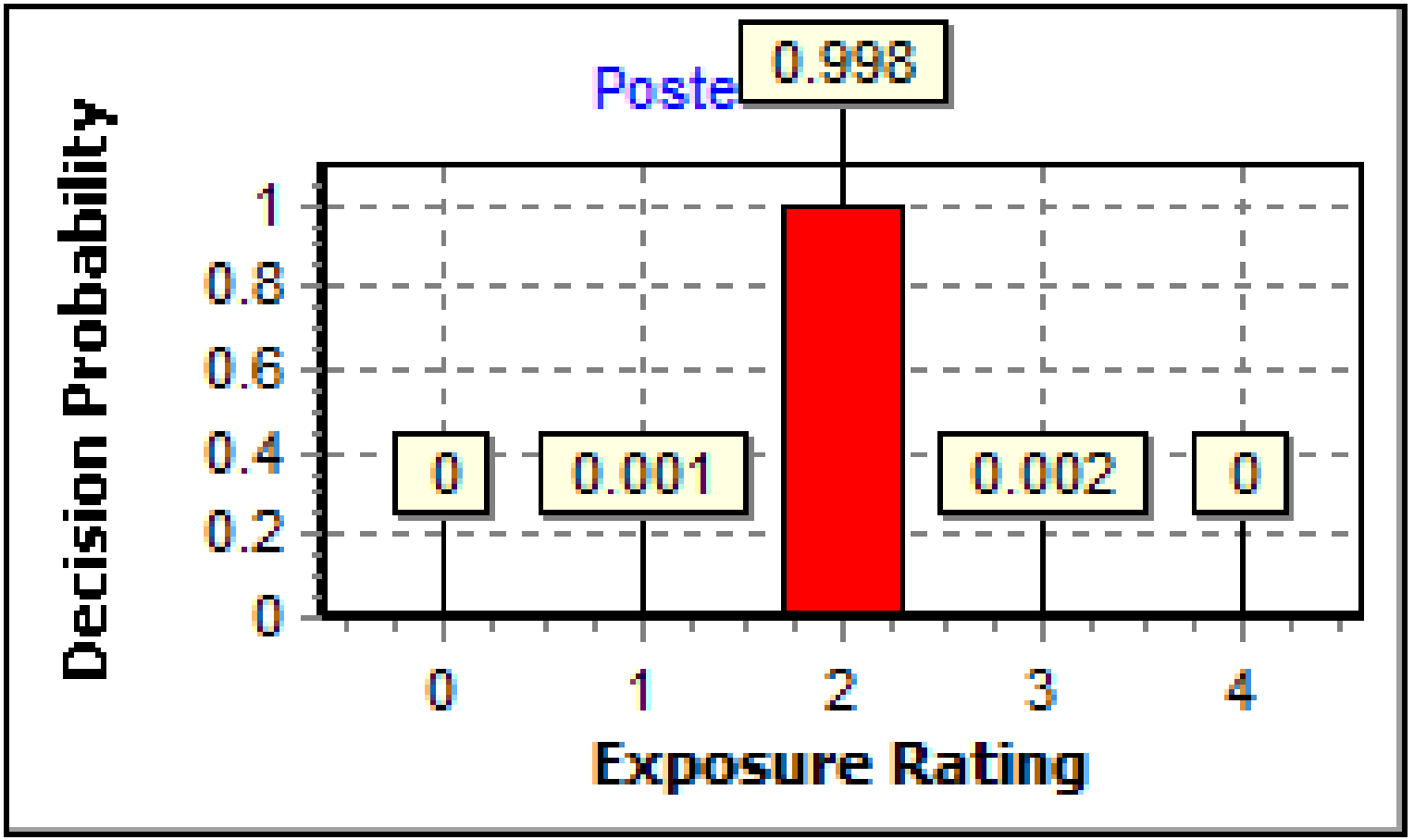
Ducted Backdraft (D2)



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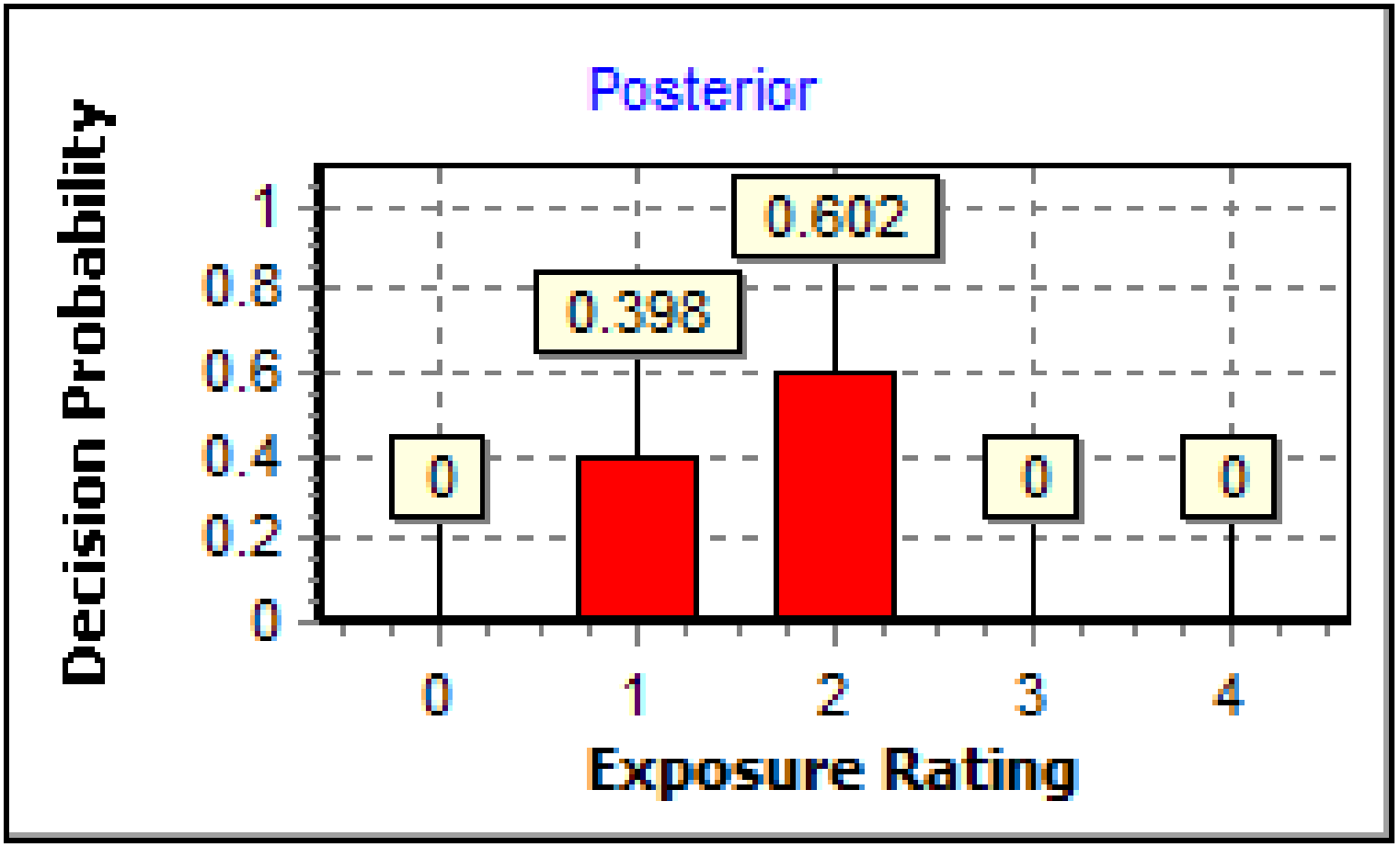
Ducted Backdraft (D1)



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Discussion

- Left censored and complex censored sampling data is a major challenge for data analysis
- 117 samples less than LOD (38%)
- Censored data analysis using Robust Maximum Likelihood Estimation for multiple LOD to calculate mean, gsd, sd and 95th percentile estimates for each control measure
- Non-parametric testing for significant difference between control measures was done by substituting highest LOD for censored data and performing Wilcoxon rank-sum testing

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Limitations

- Remaining five types of engineering controls, which account for only 10% of the total samples, were not examined in this work due to the small sample sizes and inherent variability in designs
- Did not examine the effects of room configuration, general ventilation, tissue types, and other factors that may affect the exposure levels
- Full-shift exposures not considered due to wide variations in workload and specimen type

Conclusions

Data	Performance	Significance
▪ Slot ventilation, canopy, and ducted and recirculating pre-fabricated backdraft stations most prevalent controls at KP ▪ All STEL exposures <2 ppm, regardless of control measure ▪ 38% left-censored	▪ Exposures poorly controlled with canopy and recirculating backdraft stations ▪ Controlled with slot ▪ Well-controlled with the ducted backdraft stations	▪ Ducted stations performed significantly better than slots ▪ Slots performed significantly better than canopies and recirculating stations ▪ Canopies, recirculating station should be avoided

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Recommendations for Future Research

- Standardized test methodologies for commissioning control methods
- Epidemiology studies for assessing correlation between exposure and adverse health outcomes

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Thank You

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