

Exposure Assessment: A Statistical Validation of Mercury Exposures in the Workplace

*An Analysis of Potential Workplace
Exposure to Mercury from Broken Compact
Fluorescent Lamps*

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Overview

- Purpose of Study
- Study Hypothesis
- Study Design & Methodology
- Regulatory Background
- Exposure Assessment
- Cleaning Protocol Premises
- Findings
- Implications
- Recommendations



Purpose of Study

- *Assess potential exposures to mercury from broken Compact Fluorescent Lamps (CFL)*
- *Establish a controlled testing environment to ensure analytical results are scientifically defensible and statistically validated*
- *Develop safe work practices for Broken CFL cleanup*
 - *Focus on Postal Worker Cleanups*
 - *Identification of Contractor Response Strategies*



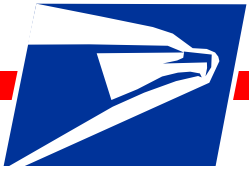
Study Hypothesis

Compact Fluorescent Lamps, whether broken or intact, are recyclable but may cause adverse health effects if not properly managed in an occupational setting.



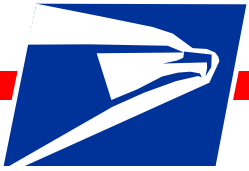
Study Design & Methodology

- *Focus on Outcome: Work Practice Development*
 - *Two driving factors:*
 - ↓ *Employee Safety in the workplace*
 - ↓ *Guidance for Product Take Back Pilot Program*



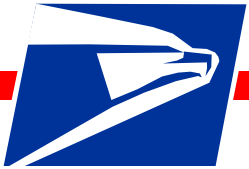
Study Design & Methodology

- *Critical Factors:*
 - 1) *CFL Lamp Mercury Exposure*
 - 2) *Quantity of CFLs Broken*
- *Physical design of test chambers (2)*
 - *8 by 12 by 11.5 feet - full double Poly containment over VAT covered concrete floors*
- *Regulatory & Industry Standards Review*
- *Statistical Validation – Price & Associates*
 - *Repetitive tests – 5 Independent Tests*



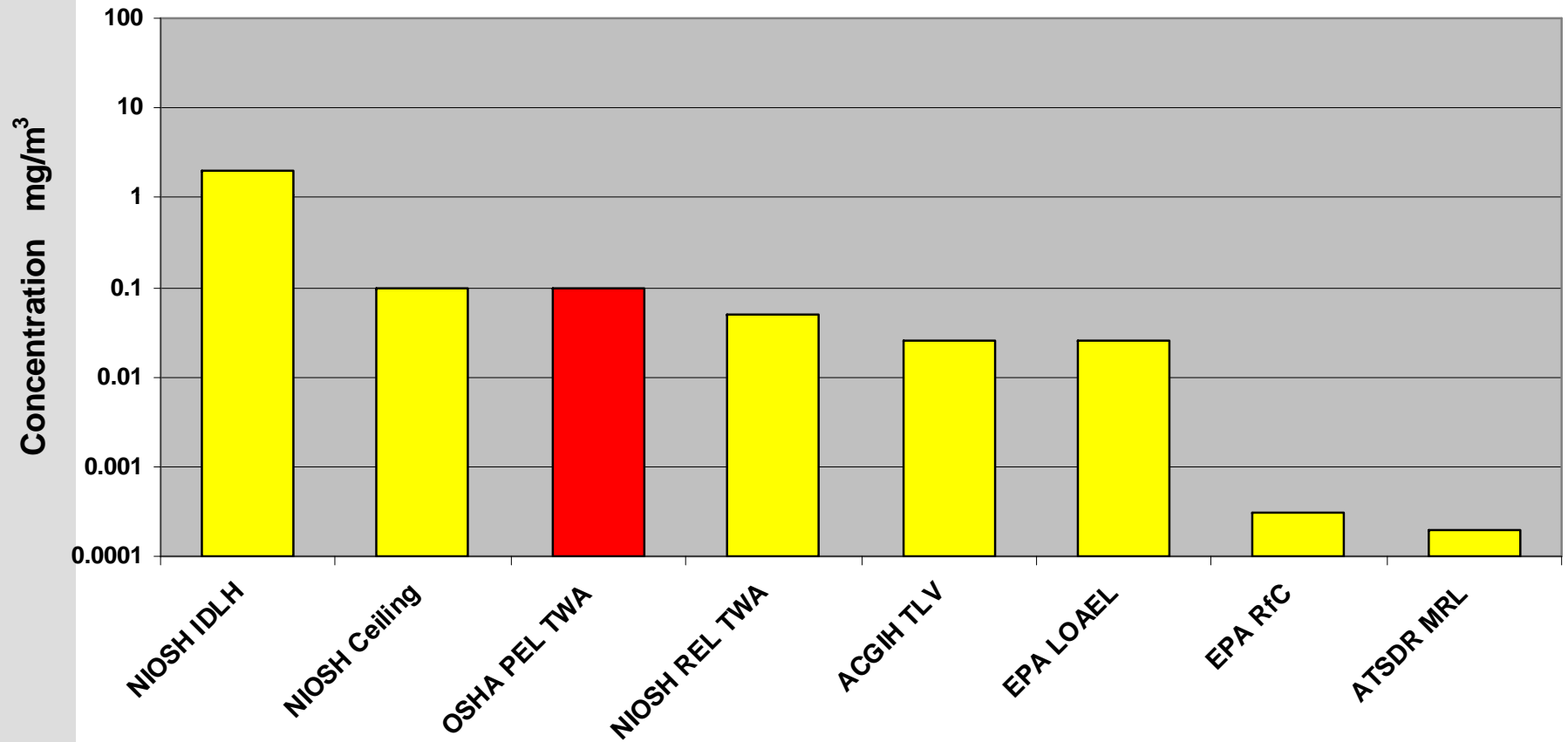
Regulatory Background

- *Occupational References Standards Drove the Analysis*
- *Mandatory Standards;*
 - *OSHA PEL of 100 ug/m³ (TWA over 8 hours)*
- *Industry and Government Exposure Guidelines*
 - *NIOSH REL and Ceiling Values*
 - ↓ *REL = .05 mg/m³ Time Weighted Average (TWA)*
 - ↓ *Ceiling Value .1 mg/m³*
 - ↓ *NIOSH Ceiling (ILDH) 1.0 mg/m³*
 - *ACGIH PEL and STEL*
 - ↓ *PEL = .025 mg/m³*
 - ↓ *STEL = Not Applicable*
 - *EPA Reference Concentration*

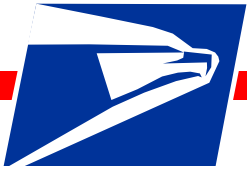


Mercury Standards/Advisories

Yellow = Advisories & Red = Mandatory OSHA PEL

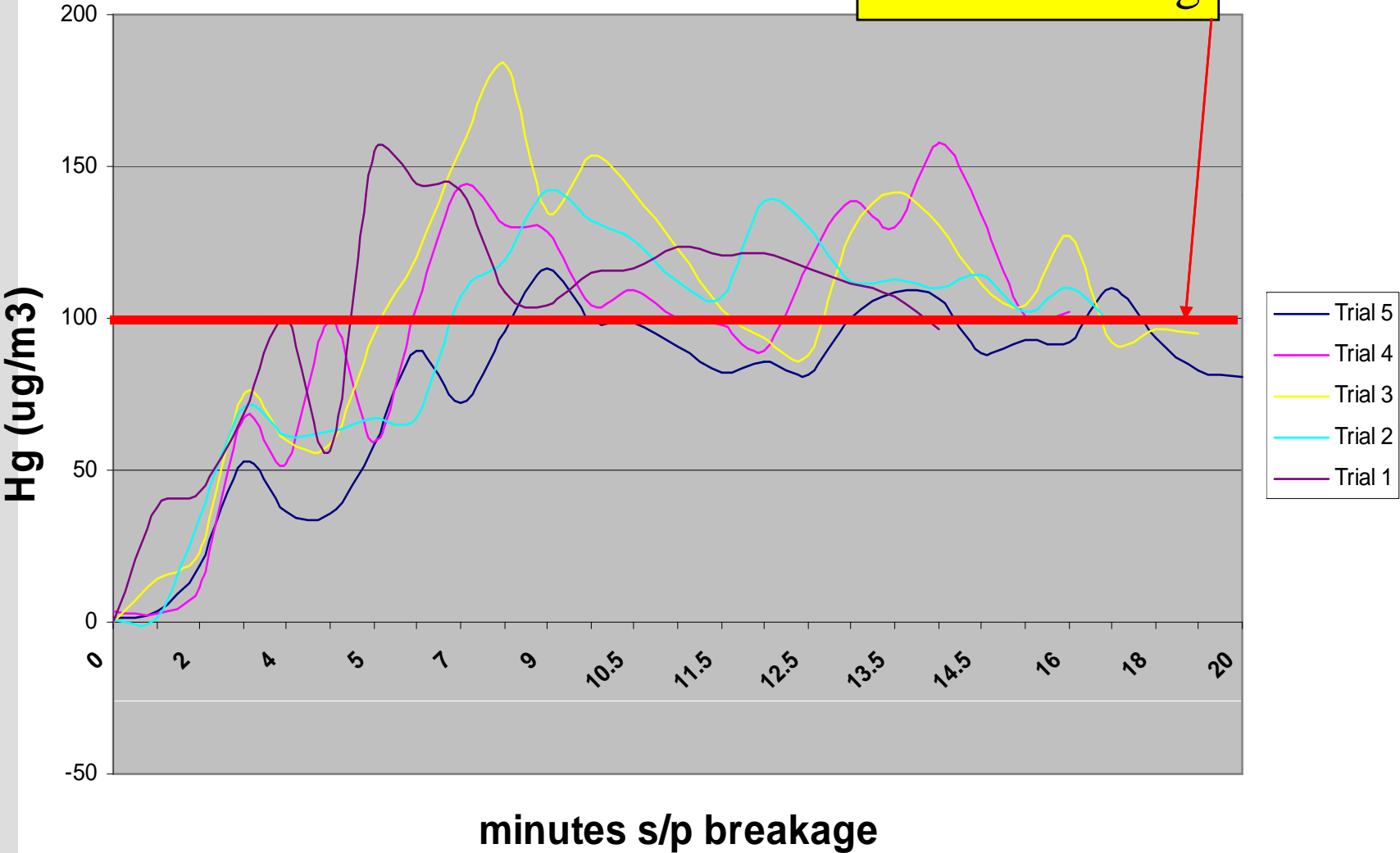


Continuous Exposure Data for Breakage of 30 CFLs: All Trials

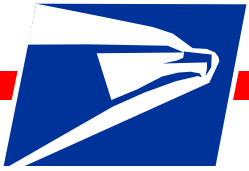


All trials 30 Bulb CFL

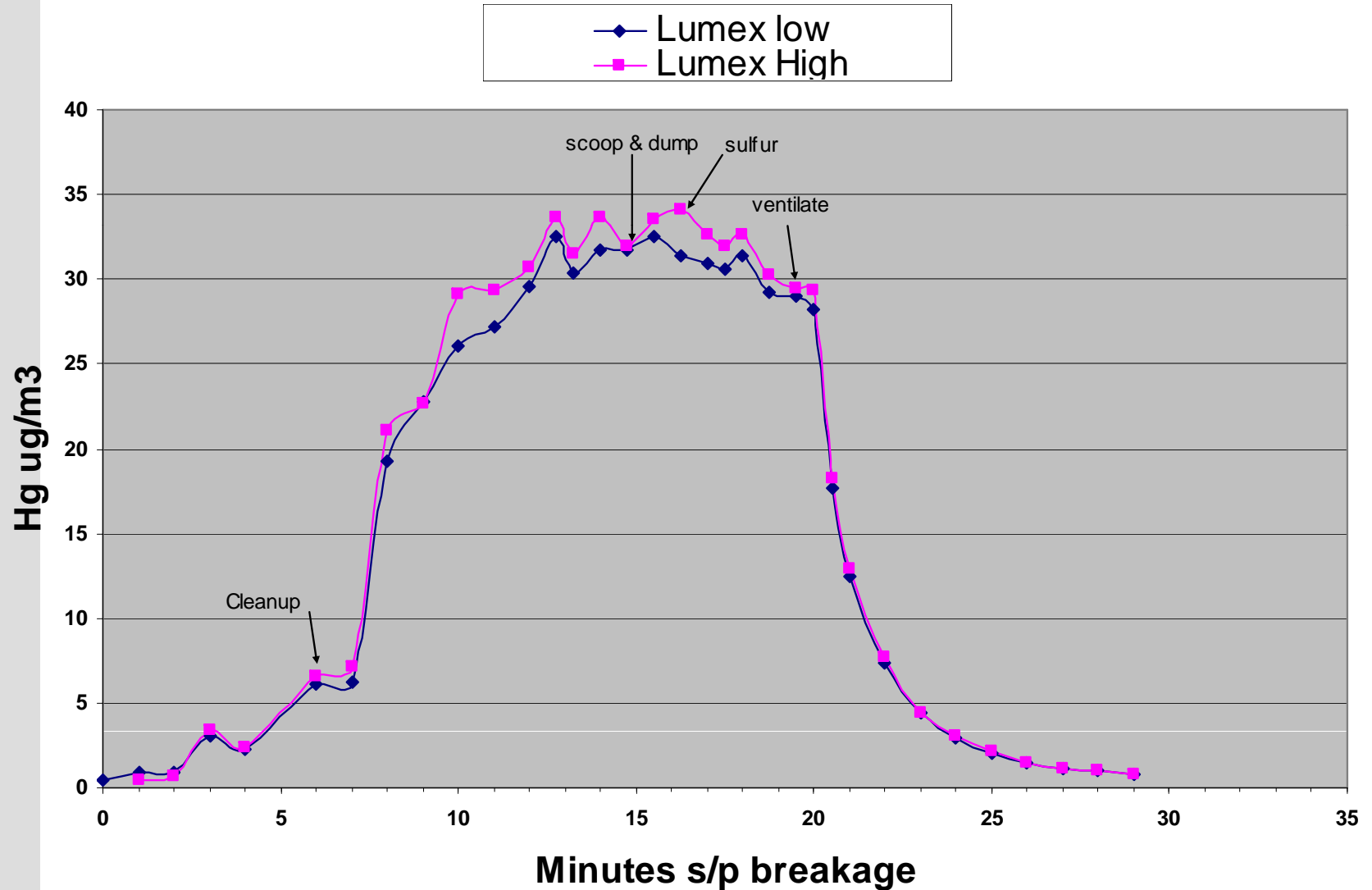
NIOSH Ceiling



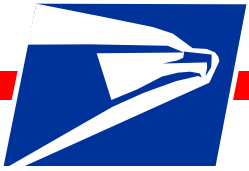
Continuous Exposure Data for Breakage of 4 CFLs: Run 2



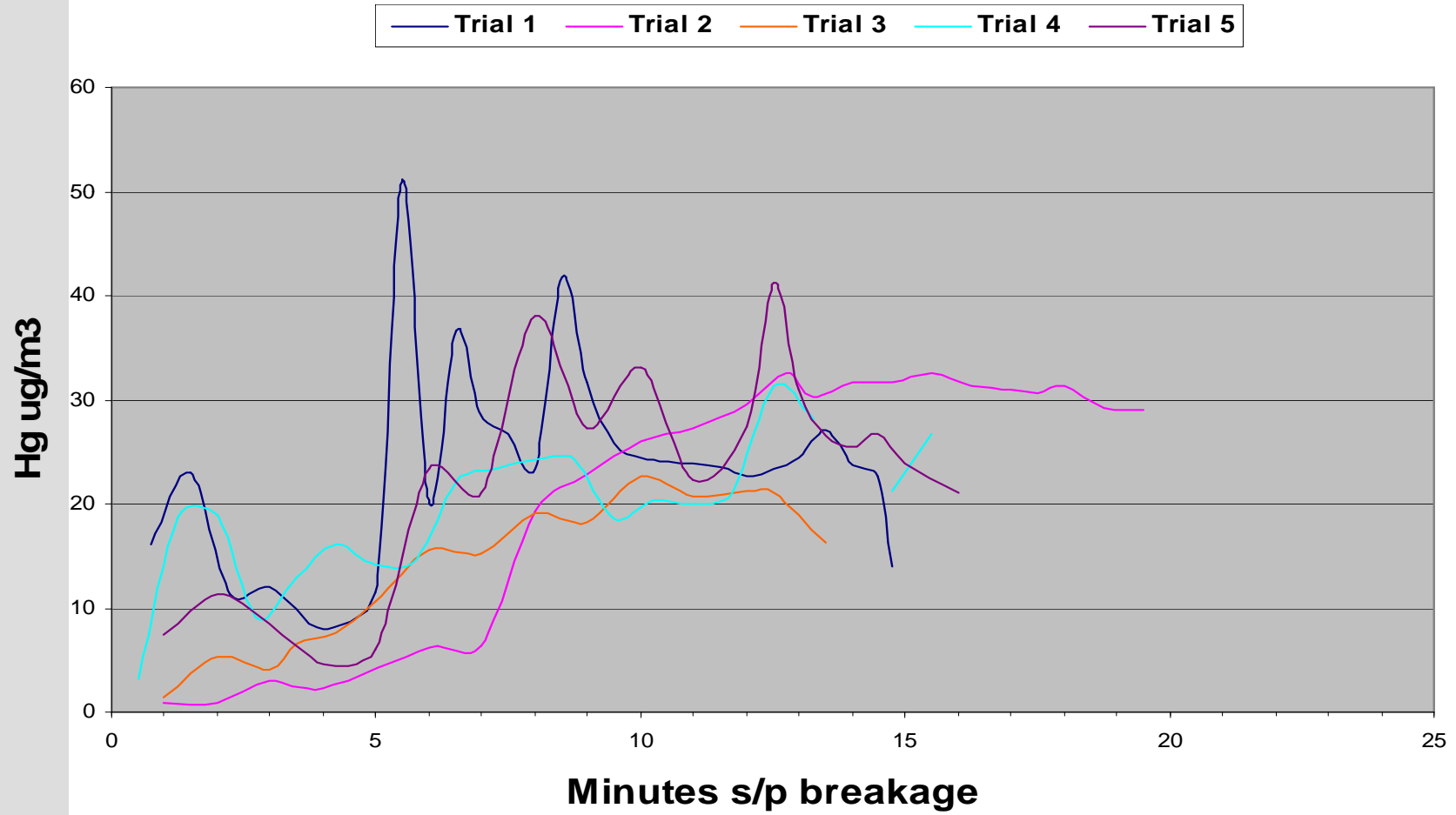
Run 2, 4 GE CFL

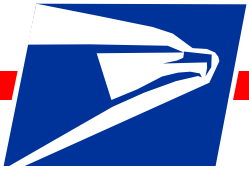


Continuous Exposure Data for Breakage of 4 CFLs: All Trials

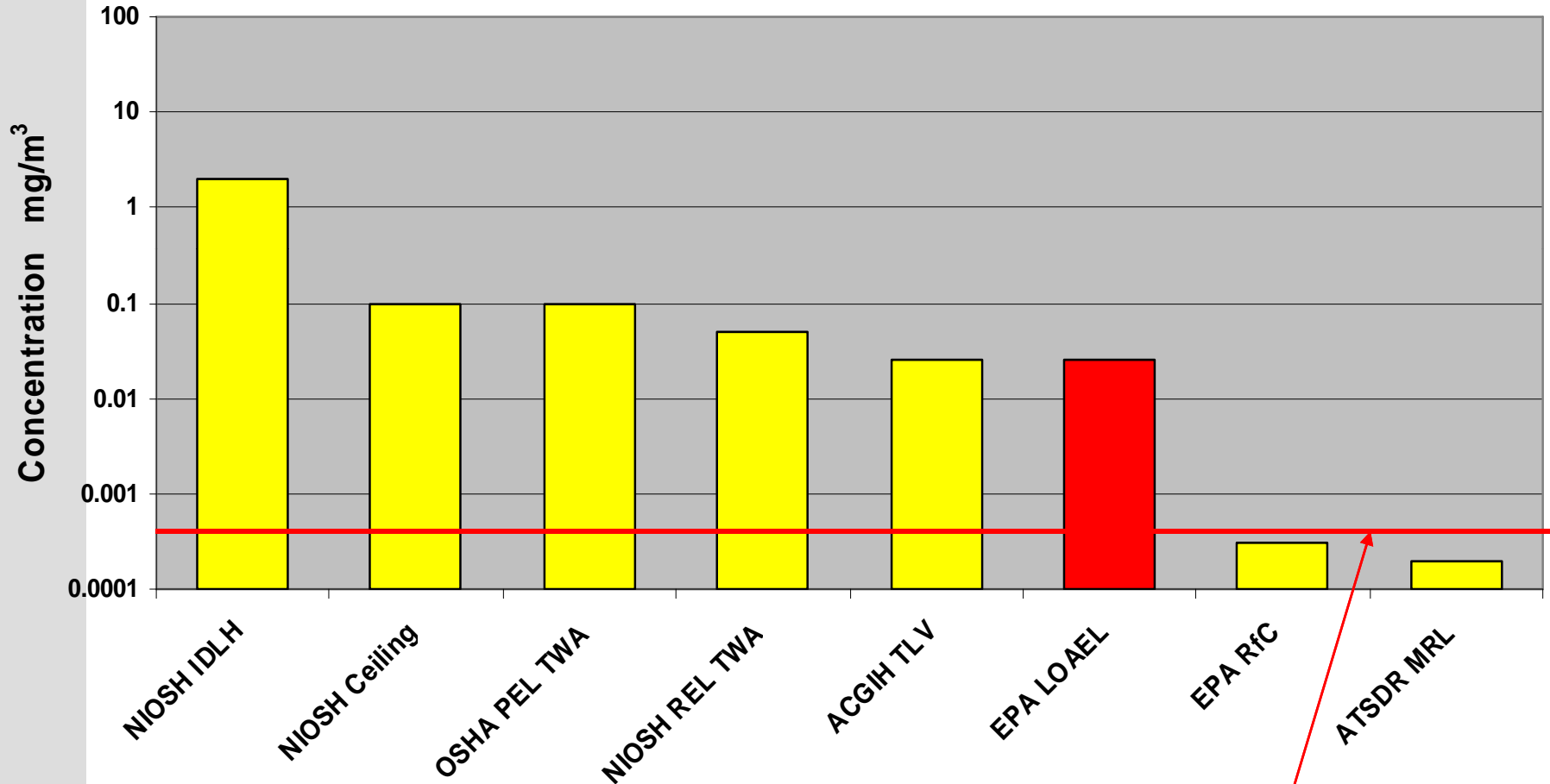


All trials 4 GE CFL





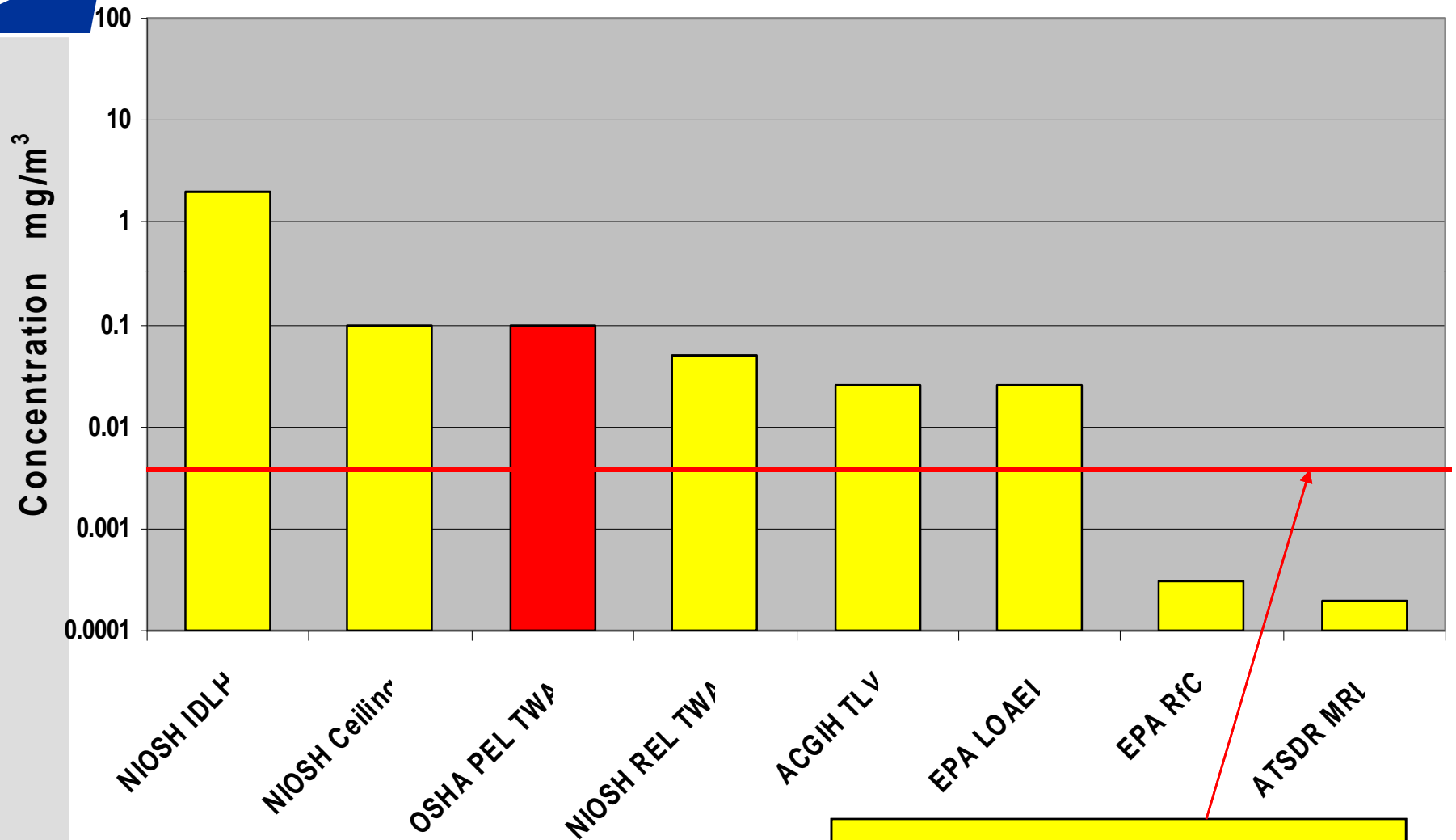
4 CFL Exposure Compared to Mercury Standards/Advisories



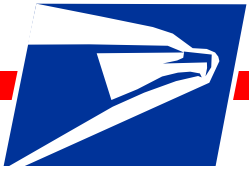
8 Hour TWA for 4 CFLs



30 CFL Exposure Compared to Mercury Standards/Advisories

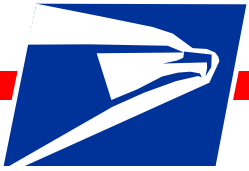


8 Hour TWA for 30 CFLs



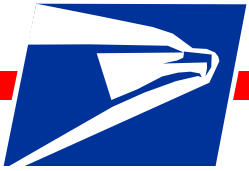
Exposure Assessment

- *Built on Previous Exposure Assessment in August 2004*
- *Two test chambers; One CFL type Tested (GE Energy Smart – 100 Watt)*
- *Lumex RA-915 Mercury Analyzer and Jerome 471 Mercury Analyzer meters used for real time readings*
 - *Covered the Spectrum of Exposures*
 - ↓ *Jerome used for > 100 ug/m³*
 - ↓ *Lumex used for < 100 ug/m³*
- *Exposures also analyzed with NIOSH test method 6009*



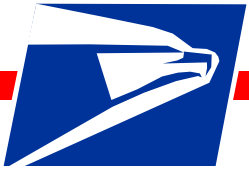
Exposure Assessment

- *Two Scenarios Investigated: - Each with 5 repetitions*
- *Scenario 1: 4 CFLs broken simultaneously*
- *Scenario 2: 30 CFLs broken simultaneously*
- *Exposure may be affected by the method of breakage and anomalies in mercury levels in manufacturing production*
 - *Statistical methods address this variation*



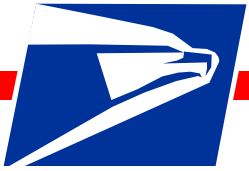
Cleaning Protocol Premises

- *Initial Approach Based on NEWMOA guidance*
- *Minimize costs – no mercury HEPA vacuums*
- *Assume breakage in a worst case confined area*
- *Manual cleaning and use of flowers of sulfur*
- *Ventilation and temperature controls if possible*
 - *Ventilation is a Key Exposure Variable*
 - *Time delay in response is also a key variable*
- *Proper Personal Protective Equipment (PPE)*
 - *Cleanups based on exposures below the need for respiratory protection*



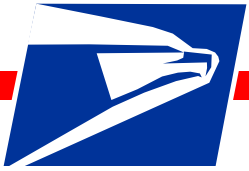
Cleaning Protocol Premises

- Key Cleaning Assumptions
 - 1 cleaning per day
 - 5 minute wait before response
 - Maximum of four broken CFLs
 - Cleanups limited to Impervious Surfaces



Findings

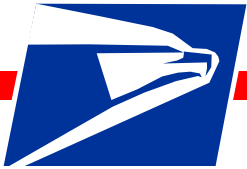
- 10 clean-up simulations conducted for GE CFLs
- The 4 GE CFLs when broken did not exceed 1 microgram per cubic meter for an 8 hr TWA
- The 30 GE CFLs when broken did not exceed 6 micrograms per cubic meter for an 8 hour TWA
- NIOSH REL Ceiling was exceeded three minutes after breakage when 30 CFLs were broken
- OSHA PEL TWA could be exceeded if cleanup exceeded 4.4 hours in containment.
- **Study Hypothesis is validated for breakage of large quantities of CFLs.**
 - There are health concerns associated with uncontrolled breakage of 30 CFLs or more (e.g., bulb crushing operations).



Implications

- *Work Practice and Job Safety Analysis (JSA) Guidance can now be used to respond to incidents involving 4 or fewer CFLs in the USPS*
- *Draft Report was Prepared November 2007*
- *Final Report is being reviewed by USPS Headquarters' Industrial Hygienist*
- *Union Briefings are Planned for Spring 2008*
- *Business Development has already been Briefed*
 - *Product Take Back Implications are Huge*
- *Strategy for Formal Release of Document is still Pending*

Recommendations



- Findings are applicable to both governmental and private workplace environments
- USPS Recommends Limiting Cleanup of 4 or fewer CFLs to avoid potentially exceeding ACGIH and NIOSH Ceiling Guidelines
 - Initial and refresher training is a prerequisite
- The actual upper limit of acceptable exposure may be greater than identified in this study.
 - However, out of an abundance caution, the concept of “incidental breakage” should be limited to 4 or fewer CFLs
 - Regulatory Agencies should re-evaluate their “incidental bulb breakage” cleanup guidelines.

