ISRP 2002 abstract

Presenter/author	Title	Abstract
Zhuang, Ziqing *National Personal Protection Laboratory, NIOSH, Pittsburgh, Pennsylvania, USA*	**Correlation between Quantitative Fit Factors and Protection Factors Measured under Actual Workplace Environments at a Steel Foundry**	Past studies have found little to no correlation between workplace protection factors and quantitative fit factors (FFs). The purpose of this new study was to investigate the correlation between FFs and protection factors (PF) for half-facepiece, air-purifying respirators under actual workplace environments at a steel foundry. Fifteen burners, welders, and chippers wore two respirator models. Each worker donned a respirator twice per day for two days. Quantitative FFs were first obtained for each donning using the PortaCount Plus in a separate room. Without redonning the respirators, workers performed normal work for one to two hours, and protection factors were measured by collecting ambient and in-facepiece samples simultaneously. A second fit-test was conducted without redonning the respirator. Fit factors were obtained by averaging the results from the first and second fit-tests. The resulting FFs had a geometric mean (GM) of 400 (range=10-6010) and a geometric standard deviation (GSD) of 6.1. The protection factors had a GM of 920 (range=13-230000) and a GSD of 17.8. The protection factors were found to be significantly correlated with the FFs (R2=0.55 and p-value=0.0001). This field study has, therefore, shown fit factor to be a meaningful indicator of respirator performance under actual workplace environments.

Correlation between Quantitative Fit Factors and Protection Factors Measured under Actual Workplace Environments at a Steel Foundry

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Background

- **Quantitative fit test results were assumed to be indicative of the performance of respirators in the workplace**

- **NIOSH and other previous studies found no correlation**

New Approach

- **Compared quantitative fit factors (FF) with exposure dose of Freon-113**
  - Eliminate particle size effect
  - Increase test rigor
  - Eliminate in-mask sampling problems
- **Freon versus controlled negative pressure**
- **Freon versus corn oil and ambient aerosols**

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Objective

- **To evaluate the correlation between quantitative fit factors and protection factors**

Materials and Methods

- **Facility selection**
  - Ambient concentration (Co) for some jobs < PEL
  - Company had a respirator program
  - Half-masks were used

Materials and Methods

- **Worker selection**
  - Wore a respirator
  - Ambient concentrations < PEL (if not, FF >=100)
  - Met OSHA criteria
  - Had medical clearance

Burners on the Roughing Floor

Chippers on the Chipping Line
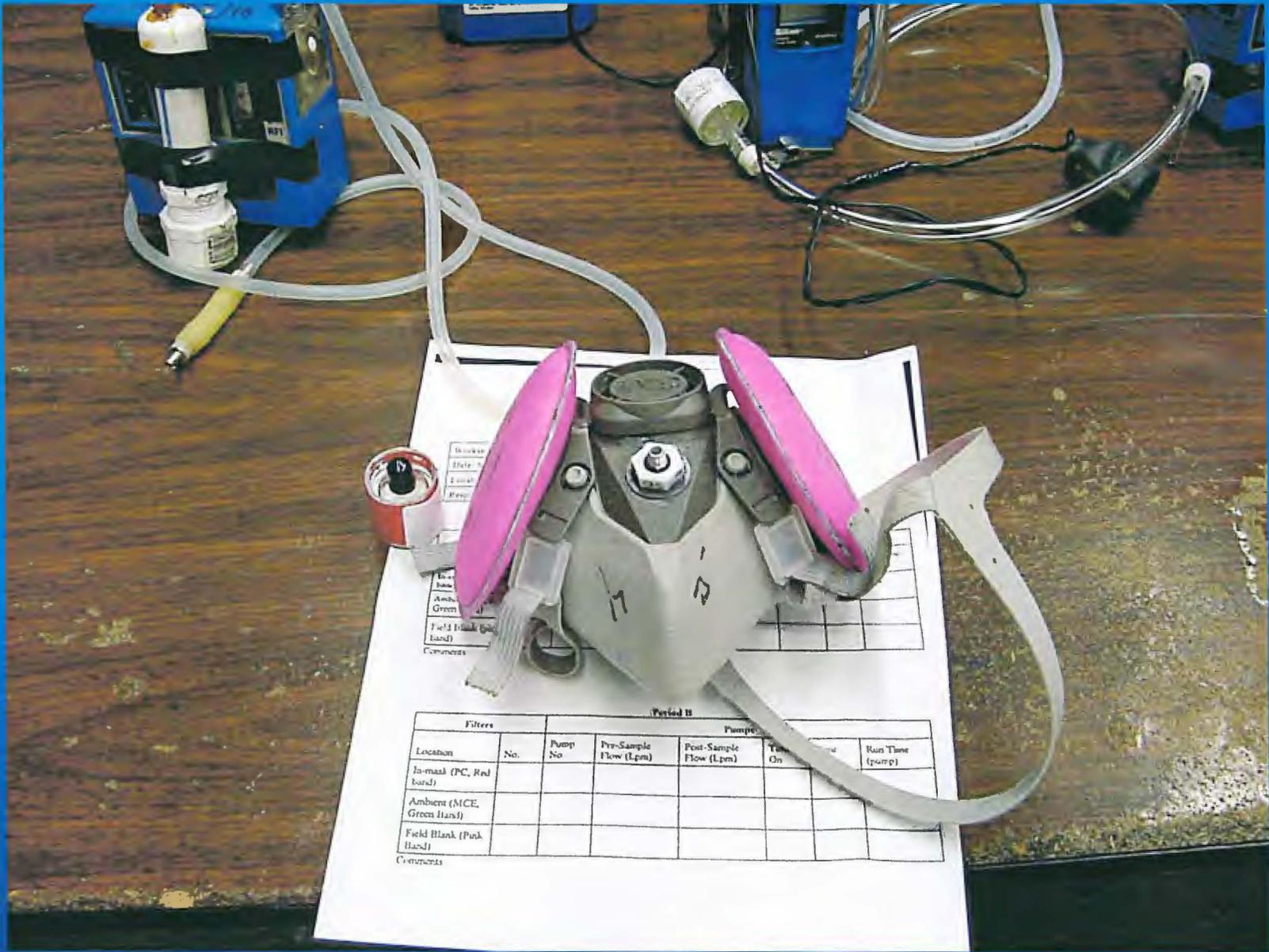
Materials and Methods (continued)

- **Respirator selection**
  - 3M 6000
  - MSA Comfo II

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	Period B						
Filters				Pumps			
Location	No.	Pump No	Pre-Sample Flow (Lpm)	Post-Sample Flow (Lpm)	Time On		Run Time (pump)
In-mask (PC, Red band)							
Ambient (MCE, Green band)							
Field Blank (Pink band)							

Comments

Materials and Methods (continued)

- **Fit test procedures**
  - A fit-test before and after
  - Standard fit-test exercises (8)
  - Overall fit factor = $7 / (1/ff1 + \ldots + 1/ff7)$
  - Average of the two tests

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Materials and Methods (continued)

- **Protection factor (PF) data collection**
  - Two PF samples per day for each worker
  - Two days
- **Ambient sampling**
  - Lapel sample
  - Total dust sample
  - 25 mm cassettes with 0.8 um MCE filters
  - 2 L/min

Materials and Methods (continued)

- **In-facepiece sampling**
  - A probe, ¼ inch in front of wearer's mouth
  - Total dust sample
  - 25 mm cassettes with 0.8 um polycarbonate filters
  - 2 L/min
  - Heating bonnet

- **Field blanks (FB) and lab blanks (LB)**

Materials and Methods (continued)

- **Sampling procedures**
  - Don the respirator
  - First fit-test
  - Attach sampling trains and cassettes
  - Normal work and monitoring
  - Second fit-test
- **Protection factor**
  - C_o / C_i
  - Fe

Materials and Methods (continued)

- **Particle size sample collection**

- **Sample analyses**
  - **In-facepiece, field blank, lab blank samples by proton induced X-ray emission (PIXE)**
  - **Ambient samples by inductively coupled plasma (ICP)**

- **Statistical analyses**

Results

Worker Face Size and Respirator Size Assigned

Worker	Face Size	Respirator Size
1	8	M
2	7	M
3	8	S
4	5	M
5	10	M
6	5	M
7	8	M
8	10	L
9	10	L
10	5	M
11	9	L
12	8	S
13	10	L
14	8	M
15	8	S

Field Blank (FB) and Lab Blank (LB) Data

	Iron Mass (µg)		
	LB PC Filters (PIXE)	FB PC Filters (PIXE)	LB MCE Filte (ICP)
N	5	15	10
Mean	0.058	0.063	1.59
Standard Deviation	0.012	0.021	0.85

Effect of Poor- and Good-Fitting on PF

	Good-Fitting FF ≥ 100	Poor-Fitting FF < 100
N	43	12
GM PF	2210	40
GSD	14	2

Correlation between PF and FF

Protection Factors vs Fit Factors scatter plot with $R^2 = 0.55$. X-axis: Fit Factors (logarithmic, 1 to 10000). Y-axis: Protection Factors (logarithmic, 1 to 1000000).

Correlation between PF and Ci_Fe

$R^2 = 0.90$

Protection Factors

In-facepiece Iron Concentration (ug/m3)
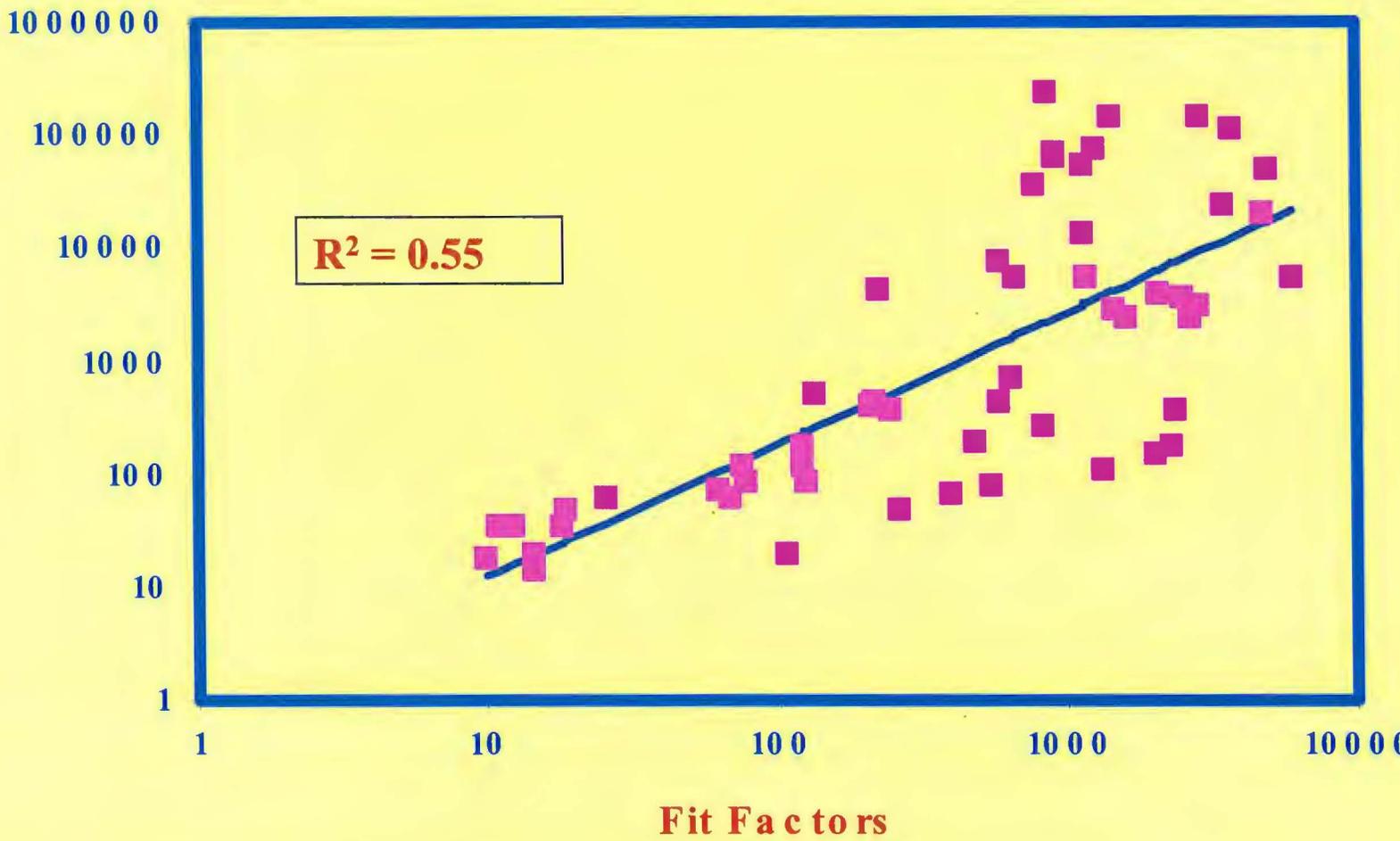
Correlation between PF and Co_Fe
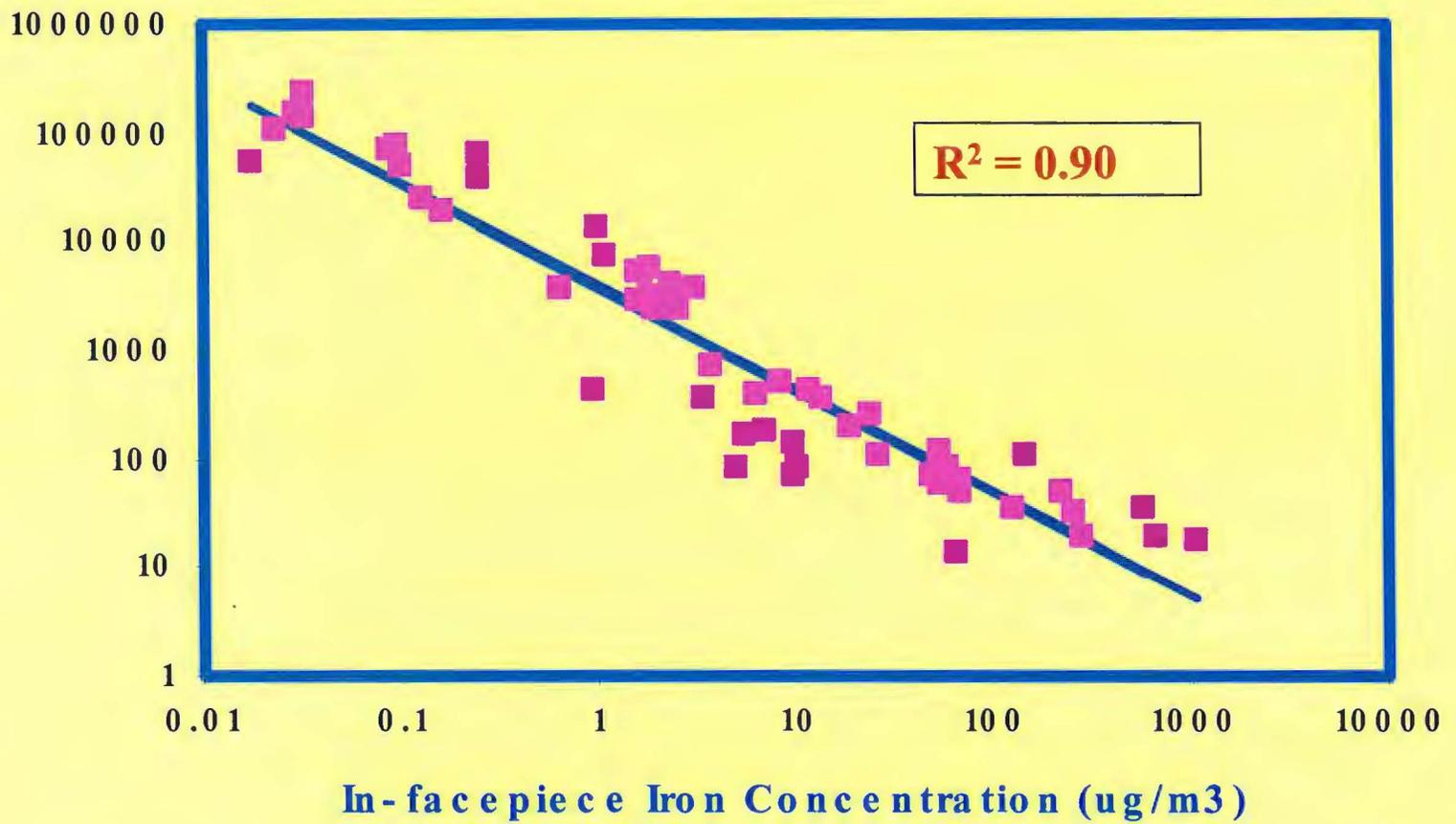
Discussion

- **Why no significant correlation was found between WPF and FF previously**

- **Why it was found in this study**
  - FFs < 100 were included
  - No redonning
  - Ambient aerosols in the fit-test rooms

Conclusions

- **Significant correlation was found between PF and FF**

- **This study has shown fit factor to be a meaningful indicator of respirator performance under actual workplace environments**

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Questions ?

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