ISRP 2002 abstract

Presenter/author	Title	Abstract
Berryann, Roland **Zhuang**, Ziqing *National Personal Protective Technology Laboratory, NIOSH, Pittsburgh, Pennsylvania, USA*	**Recent NIOSH Research on Fit-test**	

Fit testing is an art as well as science. Such a dichotomy leads to imperfection in fit-test results. The art part helps fill in gap left by science. The aim of respirator research is to eliminate, reduce or define the uncertainty in testing results. The focus of NIOSH research is to reduce the art and increase the science in three primary areas: validation of fit-test methods, characterization of worker faces to validate fit-test panels representative of the US workforce, and investigation of the use of new test protocols and procedures to increase fit-test accuracy.

NIOSH effort in the first area has demonstrated the correlations of quantitative fit-tests to measured exposure dose of Freon-113 or protection factors under actual workplace environments for half-facepiece respirators. Similar studies are being conducted or planned for full-facepiece and loose-fitting respirators. In the second area, we found that the respirator fit-test panels based on military data were not representative of civilian workers. A study is underway to develop an anthropometric database of 4000 workers to redefine fit-test panels. In the third area, we found that a multi-donning approach had potentials to reduce fit-test errors. Fit testing is an invaluable tool in assessing the fit of half-facepiece respirators and increasing worker protection.

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Berryann, Roland **Zhuang**, Ziqing *National Personal Protective Technology Laboratory, NIOSH, Pittsburgh, Pennsylvania, USA*	**Recent NIOSH Research on Fit-test**	Fit testing is an art as well as science. Such a dichotomy leads to imperfection in fit-test results. The art part helps fill in gap left by science. The aim of respirator research is to eliminate, reduce or define the uncertainty in testing results. The focus of NIOSH research is to reduce the art and increase the science in three primary areas: validation of fit-test methods, characterization of worker faces to validate fit-test panels representative of the US workforce, and investigation of the use of new test protocols and procedures to increase fit-test accuracy. NIOSH effort in the first area has demonstrated the correlations of quantitative fit-tests to measured exposure dose of Freon-113 or protection factors under actual workplace environments for half-facepiece respirators. Similar studies are being conducted or planned for full-facepiece and loose-fitting respirators. In the second area, we found that the respirator fit-test panels based on military data were not representative of civilian workers. A study is underway to develop an anthropometric database of 4000 workers to redefine fit-test panels. In the third area, we found that a multi-donning approach had potentials to reduce fit-test errors. Fit testing is an invaluable tool in assessing the fit of half-facepiece respirators and increasing worker protection.

Art or Science?
- It's an Art as well as Science

- Terminology
  - Testing, checking, APF's
- Application of fit test methods
  - Quantitative fit-tests
  - Qualitative fit-tests
- Laboratory vs. workplace protection factors
- Safety margins

Why Fit Testing?
- One Size Does <u>Not</u> Fit All

- Appearances are deceiving
  - Filter penetration and face seal leakage

- Consequences of poor-fit can be significant
  - Illness and death

Why Fit Testing?
- Best Way to Assess Fit

- Quantitative and qualitative methods

- Correlation to actual exposures

- Improved worker protection

What Contributes to the Art?
- Imperfection in the Science

- Variations in results
  - With the same person
  - Among different people
  - Among respirator models
  - Among test methods
- Exercise regimes
- Fit test panel

What Is the Focus of NIOSH Research?
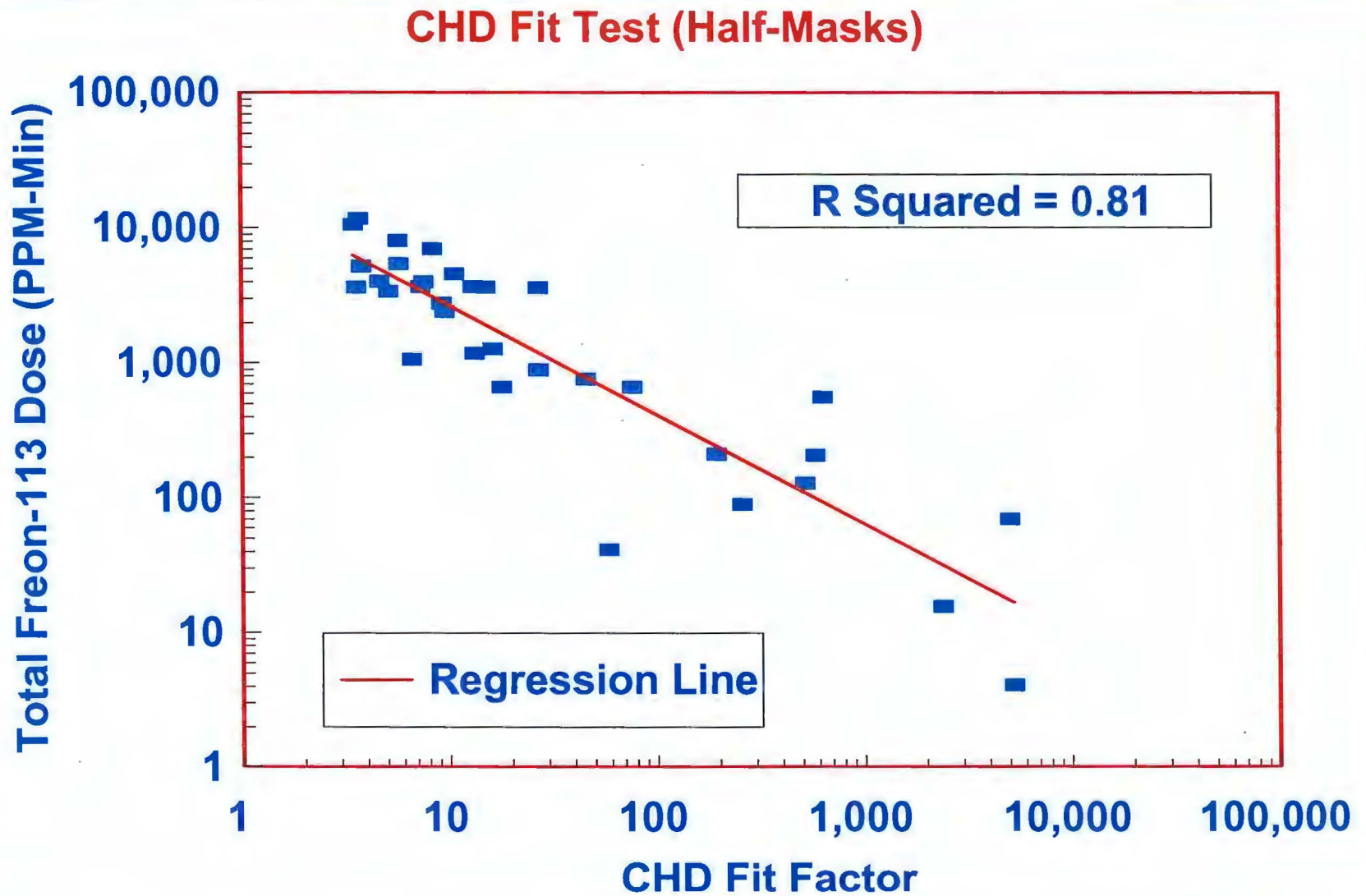## – Reduce the Art and Increase the Science

- Validate fit test methods

- Characterize worker faces

- Define new procedures

CDC Workplace Safety and Health

NIOSH

What is the focus? – Validate Fit-Test Methods

- Qualitative and quantitative fit test methods
  - Half-facepiece respirators
  - Full-facepiece respirators
  - Loose-fitting respirators
- Correlation to exposure
  - Actual
  - Simulated

CDC Workplace Safety and Health

NIOSH

Correlation between Freon-113 Exposure Dose and Fit Factors for *Half-Facepiece* Respirators

| Fit-Test Methods	R^2
Continuous high flow deep probe (CHD)	0.81
Ambient aerosol, 6-exercise (AA1) TSI PortaCount	0.78
Ambient aerosol, 17-exercise (AA2) TSI PortaCount	0.70
Continuous low flow flush probe (CLF)	0.41
Controlled negative pressure (CNP)	0.36
Exhalation valve discharge (EVD)	0.20

CDC Workplace Safety and Health

NIOSH

Comparison of the Accuracy of Fit-test Methods for Filtering-Facepiece Respirators

Fit-Test Method	Alpha Error	Beta Error
Accuracy Goal	≤ **50%**	≤ **5%**
Bitrex	51%	11%
Saccharin	56%	9%
N95-Companion	57%	9%
Ambient Aerosol	75%	4%
Generated Aerosol	84%	3%

Correlation between Fit Factors and Protection Factors Measured at a Steel Foundry (Half-Masks)
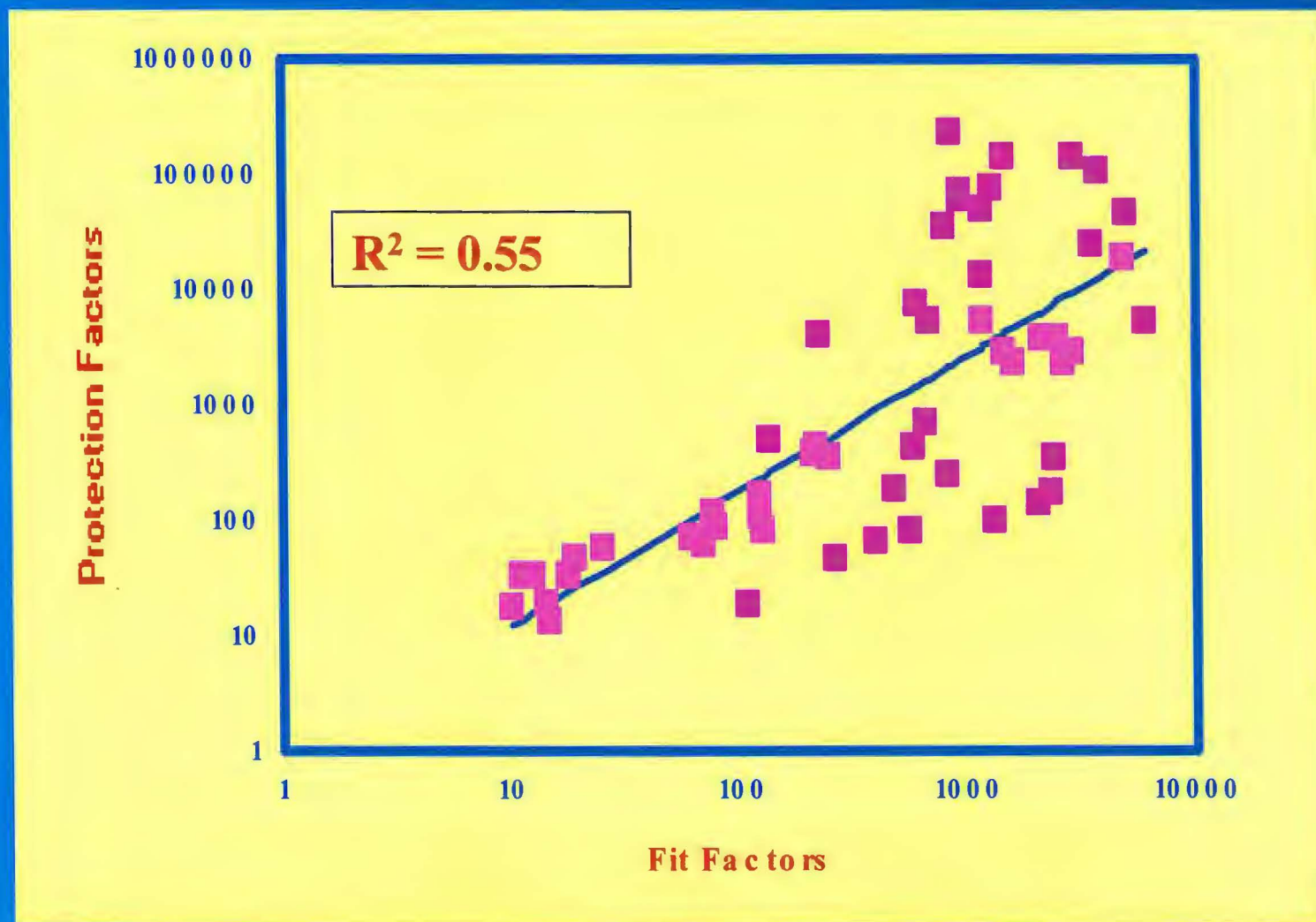
Correlation between Freon-113 Exposure Dose and Fit Factors for Full-Facepiece Respirators (R^2=0.26)
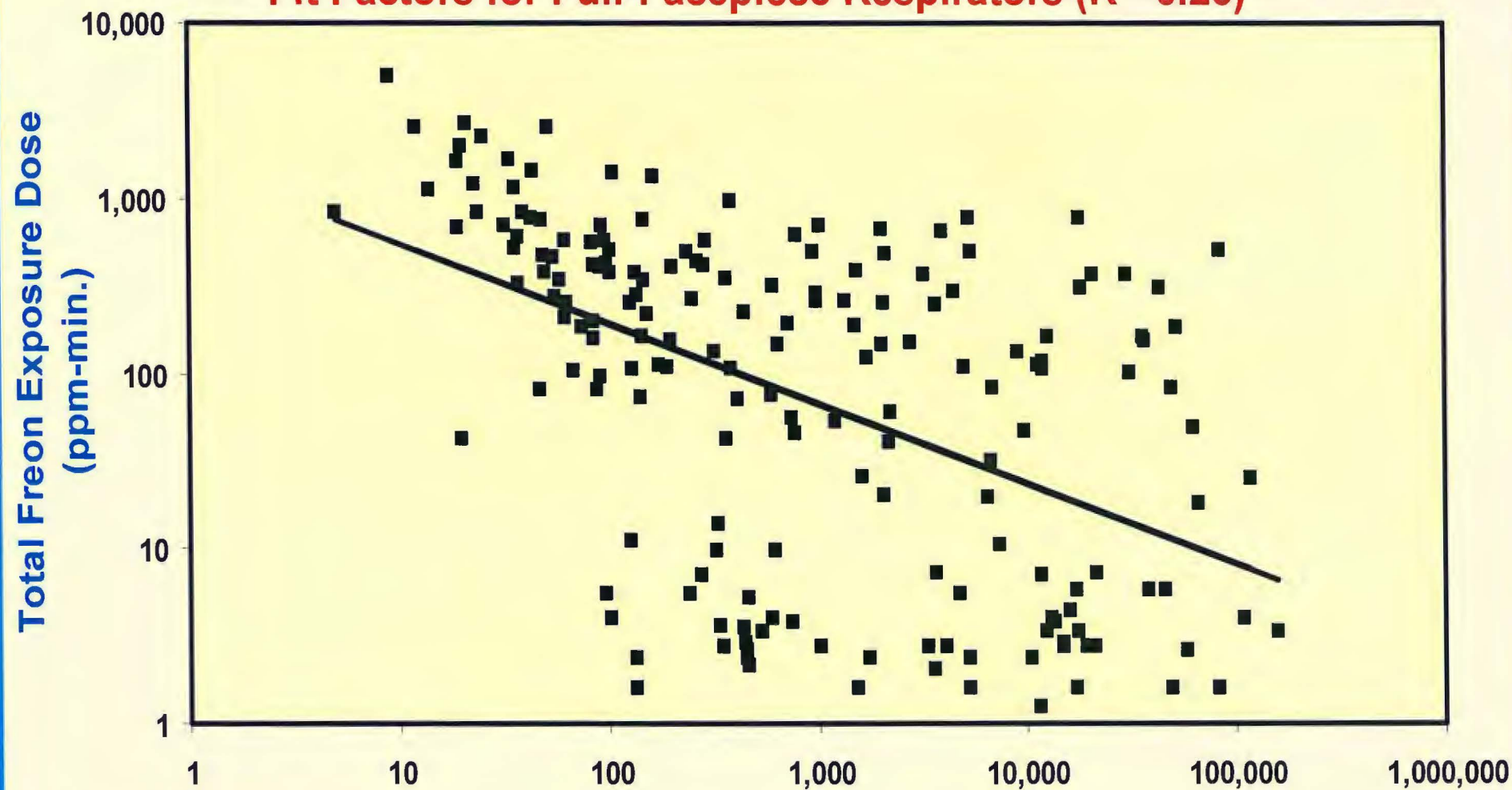
What is the focus?
- Characterize Worker Faces

- Develop an anthropometric database of respirator users
- Redefine and update important facial dimensions
- Redefine fit-test panels
- Develop new sizing systems

Race Distribution of 1967-1968 Air Force Survey Subjects and 2000 U.S. Population

Race	Air Force		2000 Census	
	Male	Female	Male	Female
White	98%	91%	71.6%	71.4%
Black	1%	8%	11.8%	12.5%
Hispanic	1%	1%	12.1%	11.5%
Asian/Pacific	-	-	3.7%	3.9%
American Indian	-	-	0.8%	0.7%

Distribution of the <u>CAESAR</u> Subjects by the Face Size Specifications of the LANL Full-Facepiece Panel

What is the focus?
– Define New Procedures

- Multiple donnings
- Exercise regimes
  - Number of exercises
  - Order of exercises
  - Duration of exercises
  - Type of exercises

A Multi-Donning Approach

- The respirator is donned five times
- Each donning only lasts 10 seconds
- Subjects conduct an integrated exercise
- A fit factor is recorded for each donning
- Each of the five fit factors exceeds a pass/fail value
- This approach has many advantages