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June 13, 2003

Management Branch (HFA-305)  
Food and Drug Administration  
5630 Fishers Lane, Rm. 1061  
Rockville, MD 20852

RE: Docket Number 03D-0137, Draft Guidance for Industry and FDA;  
Surgical Masks – Premarket Notification Submissions

To Whom It May Concern:

Please accept my comments on the guidance described above,  
which was published on May 15, 2003 in the Federal Register  
(Volume 68, Number 94).

I am an industrial hygiene researcher with considerable experience  
and expertise with respiratory protection, particularly for aerosol  
exposures. I have conducted research evaluating the efficiency of  
both respirators and surgical masks, using both biological and non-  
biological aerosols. A copy of my CV is included for your information.

My comments address both the specifics of this guidance, as well as  
the much broader issue of surgical masks and their use in health care  
settings.

Surgical masks were originally designed to prevent contamination of  
the surgical field by infectious organisms emitted by surgeons and  
other personnel while talking, coughing, sneezing or similar activities.  
While numerous individuals and organizations (including CDC) have  
proposed that surgical masks can also be used to protect the wearer  
from external contaminants, this is incorrect and inappropriate. Only  
respirators certified by NIOSH can be used for this purpose in the  
United States.

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Surgical masks are not particularly different from respirators in their ultimate goal—that, is controlling the movement of contaminants. The only difference between them is the direction in which contaminants move. Thus, much that is known about the performance of respirators applies directly to surgical masks.

The protection offered by a respirator can be compromised in two ways—1) by failing to capture the contaminant in the cleaning device (filter, cartridge, etc.) and 2) by failing to prevent leakage around the facepiece. With the development of very efficient, low resistance filters, the most important factor determining a respirator's protection is the latter—the fit of the facepiece to the wearer's face.

These two aspects of respiratory protection are addressed in two different ways by the occupational health community. The efficiency of the cleaning device (e.g. filter) must be demonstrated by passing strict certification criteria and tests conducted by the National Institute for Occupational Safety and Health. These tests assess filter efficiency using “worst case” aerosols—neutralized and of relatively small size (0.3  $\mu\text{m}$  or less). These tests also assess the effects of temperature, relative humidity, loading and aerosol type (i.e. oil) on filter efficiency. Together, the NIOSH certification tests represent a worst-case challenge, which ensures that filters will provide adequate protection in any workplace setting.

The second important facet of respiratory protection, leakage around the facepiece, is addressed through OSHA regulations that govern the way in which respirators are selected and assigned to employees. The employer must ensure that the employee is medically-fit and can achieve an adequate fit when wearing the respirator.

Each class of respirators carries an assigned protection factor, which describes the protection offered by that respirator type to most individuals who have been properly fitted. Half-facepiece respirators, for example (which include the filtering facepieces used by most health care workers), carry a protection factor of 10. This means that they lower the concentration of contaminant outside the respirator by a factor of 10. Each respirator wearer must receive fit testing for their particular respirator and must perform a fit check each time they don the respirator.

The criteria used by FDA to evaluate surgical masks neglect entirely the issue of fit. In addition, the manner in which filter efficiency is addressed by FDA does not assist the user of such masks in selecting a mask that is appropriate for their particular situation.

The FDA guidance includes no protection factors or criteria for determining facepiece fit. Without such criteria, even a filter with high efficiency will provide little or no protection, because all of the exhaled air will follow the path of least resistance—through the gaps and leaks around the facepiece.

It is assumed that most particles emitted by a surgical mask wearer will be fairly large and easy to capture. However, it has been shown that a cough, for example, can generate a significant number of particles (up to 100,000), 70% of which are less than 1  $\mu\text{m}$  and 20% of which are between 1 and 2  $\mu\text{m}$ . Thus, the tests used by FDA to evaluate the filters of masks should demonstrate high efficiency (greater than 99.99%) for relatively small particles (less than 1  $\mu\text{m}$ ). The filter efficiency performance test with 0.1  $\mu\text{m}$  latex spheres should be the only test allowed.

FDA should state a minimum % collection efficiency expected of any surgical mask challenged in this test. The aerosol should be neutralized (not non-neutralized), because this represents a “worst-case” challenge. The specifications for this test should address the flow at which testing takes place (again, choose a flow that represents the “worst case”). I would suggest adding test criteria that address the degradation that might occur from exposure of the filter to high temperatures and relative humidity. Again, pick worst-case conditions.

The problem of facepiece fit is of even greater importance than filter efficiency. Respirator research studies have demonstrated that fit is the most important issue with respect to the protection offered by a respirator. A number of studies have shown that surgical masks do not offer the type of protection expected. Drawing from my experience with respirators, I believe surgical mask failures are largely or entirely due to their lack of fit.

I strongly recommend that the FDA include criteria for demonstrating that surgical masks can be fitted to the face. In developing such criteria, I suggest that the FDA work with the respirator certification testing program at the National Institute for Occupational Safety and Health in developing a rigorous set of filter efficiency and facepiece fit criteria. I also recommend they consult with the industrial hygiene community, and in particular, the Respiratory Protection Committee of the American Industrial Hygiene Association for input and expertise.

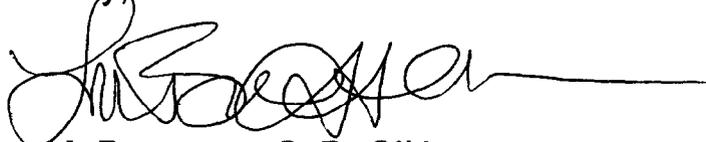
A couple of specific comments:

- There are a number of different certification classes (N, P and R) and efficiencies (95, 99 and 100) for respirator filters. The N95 is just one of 9 possibilities. Thus, it is inappropriate for the FDA to refer only to N95 respirators in its guidance. Rather, a more generic statement concerning NIOSH certification would be sufficient.
- Of perhaps greater concern in the FDA guidance is the discussion of how a manufacturer might label a combination respirator/surgical mask. The labeling of a respirator is under the regulation of NIOSH—not FDA. FDA should make no statements about respirator labeling or testing. It should not recommend any particular class of respirators for health care settings. I strongly suggest that FDA review the NIOSH certification regulations and consult directly with NIOSH about the language it uses to describe respirators in this guidance.

To summarize, surgical masks will continue to offer little or no protection to the surgical field if FDA ignores the important issue of facepiece fit and fails to recognize the importance of setting minimum performance standards for filter and fit.

Thank you for your consideration.

Sincerely,

A handwritten signature in black ink, appearing to read 'Lisa M. Brosseau', with a long horizontal line extending to the right.

Lisa M. Brosseau, ScD, CIH  
Associate Professor  
Director, Industrial Hygiene Program

## CURRICULUM VITAE

**Lisa M. Brosseau**

### Current Position

Associate Professor, Industrial Hygiene  
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### Education

<b>Institution</b>	<b>Degree</b>	<b>Date</b>	<b>Field</b>
Harvard University	Sc.D.	1989	Environmental Health Sciences Industrial Hygiene
Harvard University	M.S.	1983	Environmental Health Sciences Industrial Hygiene
Wellesley College	B.A.	1980	Environmental Sciences

### Dissertation

Measurement and Prediction of Aerosol Collection by Dust/Mist Respirators, Harvard University, School of Public Health, Boston, MA 02115, March 31, 1989.

### Professional Certification

Industrial Hygienist in Training, American Board of Industrial Hygiene, 1984  
Certified Industrial Hygienist, American Board of Industrial Hygiene, 1990, #4840

### Professional Experience

1998-present	Associate Professor; Division of Environmental and Occupational Health, University of Minnesota, School of Public Health; Minneapolis MN Director of Industrial Hygiene Program Director of Hazardous Substances Academic Training Program Member, Graduate School Faculty
1991-1998	Assistant Professor; Division of Environmental and Occupational Health, Industrial Hygiene Program, University of Minnesota; School of Public Health, Minneapolis MN
1989-1990	Postdoctoral Research Fellow; Department of Environmental Medicine, New York University Medical Center, Institute of Environmental Medicine; Tuxedo, NY

- 1985-1989            Research Assistant in Industrial Hygiene; Department of Environmental Science and Physiology, Harvard University, School of Public Health; Boston, MA
- 1984-1989            Teaching Fellow in Industrial Hygiene; Department of Environmental Science and Physiology, Harvard University, School of Public Health; Boston, MA
- Spring, 1986            Visiting Lecturer; Department of Civil Engineering, Tufts University; Medford, MA
- 1984-1985            Industrial Hygiene Intern; Department of Environmental Health and Safety, Harvard University; Cambridge, MA
- 1982-1983            National Accounts Coordinator; Loss Control Department, American Mutual Insurance Companies; Wakefield, MA
- 1980-1982            Loss Control Consultant; Loss Control Department, American Mutual Insurance Companies; Wakefield, MA

### **Professional Activities**

Roundtable Arranger, "Aerosols in the Healthcare Industries," American Industrial Hygiene Conference, Salt Lake City, UT, May 1991

Editorial Review Board, *American Industrial Hygiene Association Journal*, 1992 to 1998

Peer Reviewer, National Library of Medicine, Hazardous Substances Databank, 1993 to 1995

Site Review Panel, National Institute for Occupational Safety and Health, Hazardous Substance Academic Training Grants, 1994, 1995, 1996

Site Review Chair, National Institute for Occupational Safety and Health, University of Utah Education and Research Center, 1997

Study Section Consultant, National Institute for Occupational Safety and Health, Intervention Effectiveness; Small Business Innovative Research, Occupational Health Research, 1998, 1999, 2000, 2001, 2002

Peer Reviewer for:

American Industrial Hygiene Association Journal  
Applied Occupational and Environmental Hygiene  
Journal of Aerosol Science  
Aerosol Science and Technology  
ASHRAE Transactions  
Annals of Occupational Hygiene

### **Professional Association Service Activities**

*American Industrial Hygiene Association*

Member - Respiratory Protection Committee, 1985-present  
Session Arranger, 1989

Vice-Chair, 1991-92  
Chair, 1992-93  
Past-Chair, 1993-94

Member - Aerosol Technology Committee, 1990-present  
Secretary, 1992-93  
Session Arranger, 1993-94  
Chair, 1994-95  
Past-Chair, 1995-96

Member - Editorial Committee, 1990-1993

Board Member - Upper Midwest Section, 1993-95

*American National Standards Institute*

Member, Z88.12 Committee, Respiratory Protection for Infectious Aerosols, 1992-1994.

*American Conference of Governmental Industrial Hygienists*

Ad Hoc Small Business Committee, 1993-1996  
Chemical Substances Threshold Limit Value Committee, 1996-present  
Chair, Dust and Inorganics Subcommittee, 1997-1998  
Chair, 1998-present

## Publications

### Journal Articles

- Brosseau, L.M., J.S. Evans, M.J. Ellenbecker, M.L. Feldstein, "Collection Efficiency of Respirator Filters Challenged with Monodisperse Latex Aerosols," *American Industrial Hygiene Association Journal*, 50(10):544-549 (1989).
- Brosseau, L.M., M.J. Ellenbecker, J.S. Evans, "Collection of Silica and Asbestos Aerosols by Dust/Mist Respirators at Steady and Cyclic Flow," *American Industrial Hygiene Association Journal* 51(8):420-426 (1990).
- Brosseau, L.M., Cohen, B.S., C.P. Fang, C. Snyder, "Particle Size Distribution of Automobile Paint Sprays," *Applied Occupational and Environmental Health*, 7(9):607-612 (1992).
- Cohen, B.S., L.M. Brosseau, C.P. Fang, C. Snyder, "Measurement of Air Concentrations of Volatile Aerosols in Paint Spray Applications," *Applied Occupational and Environmental Health*, 7(8):514-521 (1992).
- Gordon, T., K. Galdanes, L.M. Brosseau, "Comparison of Sampling Media for Endotoxin-Contaminated Aerosols," *Applied Occupational and Environmental Health* 7(7):472-477 (1992).
- Brosseau, L.M., J.S. Evans, M.J. Ellenbecker, "An Empirical Model for Estimating the Collection Efficiency of Dust-Mist Respirators," *Annals of Occupational Hygiene* 37(2):135-150 (1993).
- Chen, S.K., D. Vesley, L.M. Brosseau, J. H. Vincent, "Evaluation of Single-Use Masks and Respirators for Protection of Health Care Workers Against Mycobacterial Aerosols," *American Journal of Infection Control* 22(2):65-74 (1994).
- L.M. Brosseau, S.K. Chen, D. Vesley, J.H. Vincent, "System Design and Test Method for Measuring Respirator Filter Efficiency Using Mycobacterium Aerosols," *Journal of Aerosol Science* 25(8):1567-1577 (1994).
- L.M. Brosseau, D. Vesley, T.H. Kuehn, S.M. Goyal, S.K. Chen, C. Gabel, "Controlling Viruses in Indoor Air by Ventilation, Filtration or Source Removal," *ASHRAE Transactions: Research*, 100(2):368-379 (1994).
- L.M. Brosseau, "Results of a Survey to Assess Curriculum Needs for New Academic Training Programs in Hazardous Substances," *American Industrial Hygiene Association Journal* 56(9):905-910 (1995).

- J.W. Marshall, J.H. Vincent, T.H. Kuehn, L.M. Brosseau, "Studies of Ventilation Efficiency in a Protective Isolation Room by the Use of a Scale Model," *Infection Control and Hospital Epidemiology*, 17(1):5-10 (1996).
- P.H. Wilsey, J.H. Vincent, M.J. Bishop, L.M. Brosseau, I.A. Greaves, "Exposures to Inhalable and 'Total' Oil Mist Aerosol by Metal Machining Shop Workers," *American Industrial Hygiene Association Journal*, 57(12):1149-1153 (1996).
- P. Harber, S. Barnhart, B.A. Boehlecke, W.S. Beckett, L.M. Brosseau, T. Gerrity, M.A. McDiarmid, E. Nardell, L. Repsher, T.K. Hodous, M.J. Utell, "Respiratory Protection Statement," *American Journal of Respiratory and Critical Care Medicine*, 154(4):1153-65 (1996).
- L.M. Brosseau, K. Traubel, "An Evaluation of Respiratory Protection Program Maintenance Requirements," *American Industrial Hygiene Association Journal*, 58:116-120 (1997).
- L.M. Brosseau, N.V. McCullough, D. Vesley, J.H. Vincent, "Mycobacterial Aerosol Collection Efficiency of Respirator and Surgical Mask Filters under Varying Conditions of Flow and Humidity," *Applied Occupational and Environmental Hygiene*, 12(6):435-445 (1997).
- J.H. Vincent, L.M. Brosseau, G. Ramachandran, P.-J. Tsai, M.A. Werner, T.M. Spear, and M.V. McCullough, "Current Issues in Exposure Assessment for Workplace Aerosols," in: *Inhaled Particles VIII*, (ed: Ogden, TL) *Annals of Occupational Hygiene* 41(Suppl 1):607-614 (1997).
- N.V. McCullough, L.M. Brosseau, D. Vesley, "Collection of Three Bacterial Aerosols by Respirator and Surgical Mask Filters Under Varying Conditions of Flow and Relative Humidity," *Annals of Occupational Hygiene* 41(6): 677-690 (1997).
- P.H. Reinke, L.M. Brosseau, "Development of a Convective Mass Transfer Model to Predict Air Concentrations of Chemicals Spilled Indoors," *Annals of Occupational Hygiene*, 41(4):415-435 (1997).
- N.V. McCullough, L.M. Brosseau, D. Vesley, "Bacterial Survival on Respirator Filters and Surgical Masks" *Journal of the American Biological Safety Association*, 2(3):32-43 (1997).
- L.M. Brosseau, "Penetration of Aerosols Through Respirator Valves Under Cyclic Flow Conditions," *American Industrial Hygiene Association Journal*, 59(3):173-180 (1998).
- N.V. McCullough, L.M. Brosseau, D. Vesley, J.H. Vincent, "Improved Methods for Generation, Sampling and Recovery of Biological Aerosols in Filter Challenge Tests," *American Industrial Hygiene Association Journal*, 59(4):234-241 (1998).
- N.V. McCullough, L.M. Brosseau, "Selecting Respirators for Control of Worker Exposure to Infectious Aerosols," *Infection Control and Hospital Epidemiology*, 20:136-144 (1999).
- L.M. Brosseau, D. Vesley, T.H. Kuehn, J. Melson, H.S. Han, "Duct Cleaning: A Review of Associated Health Effects and Results of Company and Expert Surveys," *ASHRAE Transactions*, 4334 (RP-759): 180-187 (2000).
- L.M. Brosseau, D. Vesley, T.H. Kuehn, J. Melson, H.S. Han, "Methods and Criteria for Cleaning Contaminated Ducts," *ASHRAE Transactions*, 4334 (RP-759): 188-199 (2000).
- G. Betsinger, L.M. Brosseau, J. Golden "Occupational Health and Safety in Household Hazardous Waste Management Facilities," *American Industrial Hygiene Association Journal*, 61:575-583 (2000).
- L.M. Brosseau, D. Vesley, N. Rice, K. Goodell, M. Nellis, P. Hairston, "Differences in Detected Fluorescence Among Several Bacterial Species Measured with a Direct-Reading Particle Sizer and Fluorescence Detector," *Aerosol Science and Technology* 32:545-558 (2000.)
- L.M. Brosseau, D. Parker, D. Lazovich, S. Dugan, T. Milton, W. Pan "Inhalable Dust Exposures, Tasks, and Use of Ventilation in Small Woodworking Shops: A Pilot Study," *American Industrial Hygiene Association Journal*, 62:322-329 (2001).
- L.M. Brosseau, D.L. Parker, D. Lazovich, T. Milton, S. Dugan, "Designing Intervention Effectiveness Studies for Occupational Safety and Health: The Minnesota Wood Dust Study," *American Journal of Industrial Medicine*, 62:322-329 (2001).
- M.J. Kerr, L.M. Brosseau, C.S. Johnson, "Sound Pressure Levels of Selected Construction Tasks," *American Industrial Hygiene Association Journal*, 63(3) 334-339 (2002).
- D. Lazovich, DM Murray, LM Brosseau, DL Parker, FT Milton, SK Dugan, "Sample Size Considerations for Studies of Intervention Effectiveness in the Occupational Setting," *Annals of Occupational Hygiene*, 46(2):219-227 (2002).

- D. Lazovich, D.L. Parker, L.M. Brosseau, F.T. Milton, S.K. Dugan, W. Pan, L. Hock, "Effectiveness of a Worksite Intervention to Reduce an Occupational Exposure: The Minnesota Wood Dust Study," *American Public Health Association Journal*, 92(9):1498-1505 (2002).
- L.M. Brosseau, "Review of 'Implications of hormesis for industrial hygiene,'" *Human and Experimental Toxicology*, 21:395 (2002).
- L.M. Brosseau, "Review of 'Implications of hormesis for industrial hygiene'," *Biological Effects of Low Level Exposures Newsletter*, 10(3), 9-10 (2002).

### Books and Book Chapters

- C.E. Colton, L.R. Birkner, L.M. Brosseau (editors), Respiratory Protection: A Manual and Guideline, Second Edition, Akron OH: American Industrial Hygiene Association, 1991.
- L.M. Brosseau and M.G. May, "Program Surveillance and Evaluation" in Respiratory Protection. A Manual and Guideline, 2nd edition. C.E. Colton, L.R. Birkner, L.M. Brosseau, editors. Akron, OH: American Industrial Hygiene Association (1991).
- L.M. Brosseau, "Work Area Surveillance and Industrial Hygiene" in Respiratory Protection, A Manual and Guideline, 2nd edition. C.E. Colton, L.R. Birkner, L.M. Brosseau, editors. Akron, OH: American Industrial Hygiene Association (1991).
- J.M. Vincent and L.M. Brosseau, "The Nature and Behavior of Airborne Gases and Particles" in Occupational Hygiene, Second Edition, H.A. Waldron and J.M. Harrington (editors), Blackwell Scientific, 1996.
- L.M. Brosseau, Respiratory Protection in Modern Industrial Hygiene, Vol 2, J. L. Perkins (editor), American Conference of Governmental Industrial Hygienists, in preparation.
- C.E. Colton and L.M. Brosseau (editors), Respiratory Protection: A Manual and Guideline, Third Edition, Fairfax VA: American Industrial Hygiene Association, 2001.
- L.M. Brosseau and C. Lungu, "The Nature and Behavior of Airborne Gases and Particles" in Occupational Hygiene, Third Edition, H.A. Waldron and J.M. Harrington (editors), Blackwell Scientific, in preparation.

### Other Publications

- B.R. Conard and L.M. Brosseau, "Point/Counterpoint Commentary: Size-Selective TLVs," *American Industrial Hygiene Association Journal* 58(9):629-632 (1997). (Prepared response as member and representative of the ACGIH Threshold Limit Value Committee.)

### Presentations

- Brosseau, L.M., M.J. Ellenbecker, K.P. Martin, "Asbestos Fiber Collection by NIOSH-Approved Respirators," presented at the American Industrial Hygiene Conference, Montreal, 1987.
- Brosseau, L.M., J.S. Evans, M.J. Ellenbecker, "Collection of Aerosols by Electrostatic Respirator Filters," presented at the Annual Meeting of the American Association for Aerosol Research, North Carolina, 1988.
- Brosseau, L.M., M.J. Ellenbecker, J.S. Evans, "Collection of Silica and Asbestos Aerosols by Dust/Mist Respirators under Steady and Cyclic Flow Conditions," presented at the American Industrial Hygiene Conference, St. Louis, May, 1989.
- Brosseau, L.M., J.S. Evans, M.J. Ellenbecker, "Collection of Monodisperse Aerosols by Electrostatic Respirator Filters," presented at the American Industrial Hygiene Conference, St. Louis, May, 1989.
- Brosseau, L.M., M.J. Ellenbecker, J.S. Evans, "Measurement and Prediction of Aerosol Collection by Dust/Mist Respirators," presented at American Association for Aerosol Research, Reno, 1989.
- Brosseau, L.M., M.J. Ellenbecker, J.S. Evans, "Asbestos and Silica Collection by Dust/Mist Respirators," presented at the International Society for Respiratory Protection, San Francisco, 1989.
- Brosseau, L.M., C.P. Fang, B.S. Cohen, "Particle Size Distribution of Automobile Paint Spray," presented at the American Industrial Hygiene Conference, Orlando, May 1990.

- Fang, C.P., R.W. Wood, J.F. Graefe, B.S. Cohen, C.A. Snyder, E. Bell, L.M. Brosseau, "Characteristics of Cocaine Base ("Crack") Aerosol Generated With an Evaporation Condensation System," presented at the 1990 American Association for Aerosol Research Annual Meeting, Philadelphia, June 1990.
- Brosseau, L.M., T. Gordon, K. Galdanes, "Development of a Sampling Technique for Airborne Endotoxin," presented at the 1991 American Industrial Hygiene Conference, Salt Lake City, UT, May 1991.
- Bates, C., L.M. Brosseau, A. Streifel, S. Reynolds, "Comparison of Measurement Methods for Endotoxins Generated from Humidifiers," poster presented at the 1991 American Industrial Hygiene Conference, Salt Lake City, UT, May 1991.
- Colton, C., C. Bates, T. Smith, N. Carlson, L.M. Brosseau, "Carbon Monoxide Monitoring of Parking Lots," poster presented at the 1991 American Industrial Hygiene Conference, Salt Lake City, UT, May 1991.
- Pehrson, R.D., G. Madery-Wygonik, M. Pearce, A. Streifel, L.M. Brosseau, "Cleaning and Disinfection of Equipment for Gastrointestinal Flexible Endoscopy: A Study of the Temperature Dependence of Glutaraldehyde Exposure," poster presented at the 1991 American Industrial Hygiene Conference, Salt Lake City, UT, May 1991.
- L.M. Brosseau and D. Larson, "Particle Size Distribution of Fiberglass Boat Manufacturing Aerosols," poster presentation at the 1992 American Industrial Hygiene Conference, Boston, MA, June 1992.
- B.S. Cohen and L.M. Brosseau, "Measurement of Air Concentrations of Volatile Aerosols in Paint Spray Applications," presented at the 1992 American Industrial Hygiene Conference, Boston, MA, June 1992.
- L. Iverson, A. Streifel, S. Reynolds, L.M. Brosseau, "Measurement of Endotoxin in Environmentally-Controlled Tom Turkey Barns," poster presentation at the 1992 American Industrial Hygiene Conference, Boston, MA, June 1992.
- L.M. Brosseau, "Sampling for Endotoxin-Contaminated Aerosols," poster presentation at the 1992 American Association for Aerosol Research Conference, October 1992.
- L.M. Brosseau, D. Vesley, J. Vincent, S.K. Chen, "Collection of Mycobacterial Aerosols by Single-Use Surgical Masks and Respirators," presented at the 1994 American Industrial Hygiene Conference, Anaheim, CA, May 1994.
- N.V. McCullough, D. Vesley, N.M. Hritz, L.M. Brosseau, "Respirator Filter Efficiencies Using a 0.55  $\mu\text{m}$  Latex Sphere Aerosol Challenge," poster presentation at the 1994 American Industrial Hygiene Conference, Anaheim, CA, May 1994.
- P.H. Reinke, L.M. Brosseau, "Development and Verification of a Convective Mass Transfer Model to Predict Air Concentrations of Chemicals Spilled Indoors," poster presentation at the 1994 American Industrial Hygiene Conference, Anaheim, CA, May 1994.
- L.M. Brosseau, D. Vesley, J.H. Vincent, S.K. Chen, "Collection Efficiency of Single-Use Masks and Respirators Using a Mycobacterial Aerosol," presented at the 4th International Aerosol Conference, Los Angeles, CA, 1994.
- L.M. Brosseau, D. Vesley, J.H. Vincent, S.K. Chen, "Experimental Apparatus for Testing Respirator Filter Efficiency Using Mycobacterium Aerosols," presented at the 4th International Aerosol Conference, Los Angeles, CA, 1994.
- L.M. Brosseau, D. Vesley, J.H. Vincent, S.K. Chen, "Collection of Mycobacterial Aerosols by Single-Use Surgical Masks and Respirators," presented at the American Filtration Society Conference, Minneapolis, MN, 1994.
- N.V. McCullough, D. Vesley, L.M. Brosseau, "Designing a Biological Aerosol Challenge for Respirator Filters," presented at the American Biological Safety Association Conference, Williamsburg, VA, 1994.
- L.M. Brosseau, D. Vesley, "Can the Behavior of Inert Aerosols Represent the Filter Collection Efficiency of Biological Organisms?" presented at the Society for Occupational and Environmental Health Tuberculosis Conference, Rockville, MD, 1994.
- N.V. McCullough, L.M. Brosseau, D. Vesley, J.H. Vincent, C. Pilon, "Determining Representative Respirator Filters and Surgical Masks For Bioaerosol Filtration Testing" presented at the American Industrial Hygiene Conference and Exhibition, Kansas City, MO, 1995.
- J.W. Klancher, L.M. Brosseau, D. Vesley, J.H. Vincent, "Development of An Experimental Apparatus for the Generation of Mucoïd Bioaerosols" student poster presented at the American Industrial Hygiene Conference and Exhibition, Kansas City, MO, 1995.

- N.V. McCullough, L.M. Brosseau, J.H. Vincent, D. Vesley, C. Pilon, "An Improved Respirator Filter Efficiency Test Using Mycobacterium Aerosols" presented at the American Association of Aerosol Research Conference, Pittsburgh, PA, 1995.
- N.V. McCullough, L.M. Brosseau, J.H. Vincent, D. Vesley, C. Pilon, "Results of Challenging Pre-Conditioned Respirator Filters and Surgical Masks with Mycobacterium Aerosols" presented at the American Association of Aerosol Research Conference, Pittsburgh, PA, 1995.
- N.V. McCullough, L.M. Brosseau, D. Vesley, C. Pilon, "Loading and Recovery of Mycobacterium Aerosols from Respirator Filters and Surgical Masks," presented at American Industrial Hygiene Conference, Washington, DC, 1996.
- N.V. McCullough, L.M. Brosseau, D. Vesley, C. Pilon, "Improved Generation and Sampling Methods for Tests Using Mycobacterium Aerosols," presented at American Industrial Hygiene Conference, Washington, DC, 1996.
- N.V. McCullough, L.M. Brosseau, D. Vesley, C. Pilon, "Challenging Respirator Filters and Surgical masks with a Mycobacterium Aerosol," presented at American Industrial Hygiene Conference, Washington, DC, 1996.
- N.V. McCullough, L.M. Brosseau, D. Vesley, "Recovery and Survival of Three Bacteria on Respirator Filters and Surgical Masks," presented at the American Biological Safety Association Conference, Salt Lake City, UT, 1996.
- N.V. McCullough, L.M. Brosseau, D. Vesley, "Respirator and Surgical Mask Filter Efficiencies Using Three Airborne Bacteria," presented at the American Biological Safety Association Conference, Salt Lake City, UT, 1996.
- N.V. McCullough, L.M. Brosseau, "Selecting Respirators for Control of Infectious Aerosols," presented at the American Industrial Hygiene Conference & Exposition, Dallas, TX, 1997.
- L.M. Brosseau, N.V. McCullough, "Selecting Respirators for Exposures to Infectious Aerosols," presented at the American Public Health Association Annual Meeting, Indianapolis IN, November 1997.
- L.M. Brosseau, "Size-Selective Sampling," presented at the American Industrial Hygiene Association, Upper Midwest Section Meeting, January 1998
- S. Dugan, L.M. Brosseau, D. Lazovich, D. Parker, P. Schiermeier, "Designing Intervention Studies in Small Businesses," presented at the American Industrial Hygiene Conference, Atlanta GA, May 1998.
- L.M. Brosseau, S. Dugan, D. Lazovich, D. Parker, P. Schiermeier, "Dust Sampling and Task Observations in Five Small Woodworking Shops," presented at the American Industrial Hygiene Conference, Atlanta, GA, May 1998.
- L.M. Brosseau, D. Vesley, N. Rice, K. Goodell, M. Nellis, P. Hairston, "Differences In Detected Fluorescence Among Several Bacterial Species Measured With A Direct-Reading Fluorescence Particle Sizer," presented at the American Association for Aerosol Research Conference, Cincinnati, OH, June 1998.
- V. Chouinard, L. M. Brosseau, "The Changing Auto Body Repair Industry—Can Cooperative Training Interventions Work?" presented at the American Industrial Hygiene Conference and Exposition, Toronto Canada, June 1999.
- C.S. Johnson, M.J. Kerr, L.M. Brosseau, "Sound Pressure Levels of Selected Construction Tasks," presented at the American Industrial Hygiene Conference and Exposition, Toronto Canada, June 1999.
- D. Parker, D. Lazovich, L. M. Brosseau, S. Dugan, T. Milton, P. Schiermeier, "Overview of Health and Safety in Small Business," presented at the American Public Health Conference, Washington DC, November 1998.
- L. M. Brosseau, D. Lazovich, D. Parker, S. Dugan, T. Milton, P. Schiermeier, "Design of Small Business Health and Safety Interventions," presented at the American Public Health Conference, Washington DC, November 1998.
- D. Lazovich, L. M. Brosseau, D. Parker, D. Murray, M. Ireland, S. Dugan, "Assessing Health and Safety Intervention Effectiveness in Small Businesses," presented at the American Public Health Association in Washington DC, November 1998.
- S. Dugan, L. M. Brosseau, D. Lazovich, D. Parker, P. Schiermeier, "Baseline Health and Safety Knowledge, Attitudes and Behaviors among Woodworkers," presented at the American Public Health Association in Washington DC, November 1998.

- L. M. Brosseau, D. Lazovich, D. Parker, T. Milton, S. Dugan, P. Schiermeier, "Baseline Exposure and Ventilation Assessment Results," presented at the American Public Health Association in Washington DC, November 1998.
- N.V. McCullough, L.M. Brosseau, "Selecting Respirators for Exposures to Infectious Aerosols," presented at the International Society for Respiratory Protection, October 1999.
- D.K. Wolf, F. Thompson, L.M. Brosseau, "An Exposure Assessment for Lead in the Deconstruction Industry," presented at the American Industrial Hygiene Conference and Exposition in Toronto Canada, June 1999.
- C.S. Johnson, L.M. Brosseau, "Process Safety Management of an Ammonia Refrigeration System at a Very Old Brewery," presented at the American Industrial Hygiene Conference and Exposition in Toronto Canada, June 1999.
- C.S. Johnson, M.J. Kerr, L.M. Brosseau, "Sound Pressure Levels of Selected Construction Tasks," presented at the American Industrial Hygiene Conference and Exposition in Toronto Canada, June 1999.
- V. Chouinard, L.M. Brosseau, "The Changing Auto Body Repair Industry—Can Cooperative Training Interventions Work?" presented at the American Industrial Hygiene Conference and Exposition in Toronto Canada, June 1999.
- S. Dugan, L.M. Brosseau, D. Parker, D. Lazovich, P. Schiermeier, "Minnesota Wood Dust Study: Baseline Health and Safety Knowledge, Attitudes and Behaviors Among Owners, Supervisors and Woodworkers," presented at the American Industrial Hygiene Conference and Exposition in Toronto Canada, June 1999.
- P. Schiermeier, L.M. Brosseau, S. Dugan, "Minnesota Wood Dust Study: Summary of Baseline and Intervention Ventilation Assessment Results," presented at the American Industrial Hygiene Conference and Exposition in Toronto Canada, June 1999.
- L.M. Brosseau, "Small Business Owners' Attitudes and Intentions Toward Health and Safety," presented at the British Occupational Hygiene Society in York, England, March 2001.
- S.K. Dugan, L.M. Brosseau, D. Lazovich, D. Parker, T. Milton, "Developing Tailored Interventions for Small Businesses," presented at the American Industrial Hygiene Conference and Exposition in New Orleans, LA, June 2001.
- L.M. Brosseau, "Intervention Effectiveness Studies in Small Businesses," presented at the American Industrial Hygiene Conference and Exposition in New Orleans, LA, June 2001.
- L.M. Brosseau, "ACGIH Threshold Limit Values for Chemical Substances Committee: The Process for Decision-Making," presented at the American Industrial Hygiene Conference and Exposition, San Diego, CA, June 2002.

### **Awards Received**

Non-Tenured Faculty Award, 3M Company, St Paul, MN  
November 1993; October 1995; April 1996

Grant-in-Aid, 3M Company, St Paul, MN  
October 1999; April 2000; June 2001

Faculty Excellence Award in Environmental Health, Division of Environmental and Occupational Health,  
1996, 1997

Nominated for the Leonard M. Schuman Award for Excellence in Teaching, School of Public Health, 1996

ACGIH Meritorious Achievement Award, 2002

### **Invited Lectures and Talks**

- "Pursuing a Career in Industrial Hygiene," American Society of Safety Engineers Professional Development Conference, Minneapolis, MN, June 1992.
- "Aerosol Filtration," Harvard School of Public Health, Measurement Techniques for the Industrial Environment: Air Quality & Ventilation, Boston, MA, April and October 1990, June 1991.
- "Respiratory Protection Filter Media," Harvard School of Public Health, Continuing Education Program, Boston, MA, August 1988.
- "Respiratory Protection Devices," 3rd Annual Occupational Health and Safety Institute, Harvard School of Public Health, Boston, MA, June 1988.
- "Respirator Valves: Survey of Respirator Maintenance Practices and Testing Particle Penetration Under Realistic Use Conditions," 3M Company, September 1995.
- "Collection of Biological Aerosols by Respirator and Surgical Mask Filters," Upper Midwest Section of American Industrial Hygiene Association, September 1995.
- "Selecting Respirators for Infectious Aerosol Exposures," University of California Berkeley, School of Public Health, August 1997.
- "Selecting Respirators for Infectious Aerosol Exposures," University of California Davis, School of Medicine, August 1997.
- "Minnesota Wood Dust Study," University of British Columbia, Vancouver, Canada, December 1998.
- "Particle Size-Selective Sampling," Upper Midwest Section of American Industrial Hygiene Association, February 1998.
- "Threshold Limit Values – What Are They and How are They Developed?" Upper Midwest Section of American Industrial Hygiene Association, January 1999.
- "What is an Industrial Hygienist?" Society for Women Engineers, University of Minnesota, January 1999.
- "What is Meant by 'Nearly All Workers'?" Applied Workshop: Protecting Today's Workers, TLVs in Practice, American Conference of Governmental Industrial Hygienists, March 1999.
- "Particle Size Selective Sampling," Upper Wisconsin Section, American Industrial Hygiene Association, September 1999.
- "What Motivates Owners of Small Businesses to Improve Workplace Health and Safety?" University of Minnesota, March, 2000.
- "Standard Setting of Occupational Sensitizers: An Example of Flour Dust." British Occupational Hygiene Society, April 2000.
- "The Role of Risk Assessment in the Development of Health Criteria and Standards: A Panel Discussion." AIHA Risk Assessment Symposium, October 2000.
- Invited discussant, Institute of Medicine Committee on Regulating Occupational Exposure to Tuberculosis, National Academy of Sciences, August 2001
- "Threshold Limit Values," Health Effects and Worker Exposure to TDI, ACGIH Symposium, Cincinnati OH, April 2002.
- Plenary Speaker, "Threshold Limit Values: Scientific Guidelines," Australian Institute of Occupational Hygienists, December 2002.

### **Courses Taught**

- PUBH 5184 Measurement of Airborne Contaminants in Workplaces (co-instructor), 1991-1994
- PUBH 5212 Ventilation Control of Environmental Hazards (co-instructor), 1991, 1992
- PUBH 5210 Industrial Hygiene Engineering (sole instructor), 1991
- PUBH 5218 Field Problems in Occupational Health (co-instructor), 1991-1999
- PUBH 5211 Introduction to Industrial Hygiene (sole instructor), 1993-1995
- PUBH 5255 Hazardous Materials Management (sole instructor), 1995-1998
- PUBH 5150-2/3 Industrial Hygiene Applications (sole instructor), 1997-1998
- PUBH 5173 Hazard-Related Exposure to Physical Agents in the Environment (co-instructor), 1999
- PUBH 5170 Introduction to Occupational Health and Safety (lecturer), 1999-present
- PUBH 5150 Interdisciplinary Evaluation of Occupational Health and Safety Problems (co-instructor), 1999-present
- PUBH 5172 Industrial Hygiene Applications (sole instructor), 2000, 2002

PUBH 5176 Hazardous Materials and Wastes Management (sole instructor), 1999, 2001, 2003  
GRAD 8101 Teaching in Higher Education (co-instructor), 2003

### **Other Teaching**

Lecturer, Industrial Hygiene Survey, Midwest Center Summer Institute (1991-1998)  
Lecturer, Continuing Education Course, Review of Industrial Hygiene, Midwest Center (1992, 2002)  
Lead Instructor, Introduction to Respiratory Protection, Industrial Hygiene Conference (1992; 1994)  
Lecturer, Introduction to Industrial Hygiene Exposure Assessment and Control (1995-1997)  
Lecturer, Introduction to Industrial Hygiene, Minnesota Safety Council (1993-1995)  
Co-Instructor, Professional Development Course: Inhalable Sampling, American Industrial Hygiene Conference (2000)  
Co-Facilitator, Mid-Career Teaching Program, University of Minnesota Center for Teaching and Learning (2002)

### **Academic Service Activities**

Member, Advisory Boards, Midwest Center Continuing Education Program  
Hazardous Substances Training Education  
Industrial Hygiene Education

Member, Advisory Board, Regions Hospital  
Occupational Health Program

School of Public Health  
Research Committee (1996-1998) Chair (1997-1998)  
Recognition, Awards and Honors Committee (2000-2001)

School of Public Health Appointments, Promotion and Tenure Policy Committee (1993 and 1995)

University Faculty Senate (1998-2000)

Division of Environmental and Occupational Health  
Student Admissions Committee (1991-1994; 1998-2000)  
Faculty Advisory Committee (1995-1996)  
Teaching Committee (1996-1998); Chair (1997-1998)  
Laboratory Committee (1997-1998)  
Awards Committee (2000-2003): Chair (2000-2002)

### **Grants and Contracts Obtained**

"Aerosol Penetration Behavior of Respirator Valves," E.R.C., Inc/National Institute for Occupational Safety and Health (1990-1991). Principal Investigator, \$8992.

"Aerosol Penetration of Respirator Valves," Centers for Disease Control/National Institute for Occupational Safety and Health (1991-1993). Principal investigator, \$30,000.

"Improved Ventilation Indices and Methodology for Indoor Environments: A Pilot Study." University of Minnesota Biomedical Research Support Grant (1991-1992). Principal Investigator, \$14,000.

"Filter Efficiencies of Single Use Masks Against Mycobacterial Aerosols." 3M Health Care--Surgical Division (1992-1993) Co-Principal Investigator, \$26,704.

"Hazardous Substance Academic Training Program in Educational Resource Centers." NIOSH (1993-1997; 1997-2002; 2003-2007). Principal Investigator, \$1,300,000.

"Midwest Center for Occupational Safety and Health (Educational Resource Center)," NIOSH (7/1/97 to 6/30/02). Program Director and Co-Investigator, \$4,000,000.

"Investigate and Identify Means of Controlling Virus in Indoor Air by Ventilation, Filtration or Source Removal," American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (4-6/1993). Principal Investigator, \$35,000.

"Testing Air Purifying Respirator Filters Against Tuberculosis and Other Biological Aerosols," Centers for Disease Control and Prevention (1993-1995). Principal Investigator, \$300,000.

"Predicting Air Concentrations Following Indoor Spills," Environmental Protection Agency (9/12/95 to 9/15/97). Principal Investigator, \$35,000

Characterization and Mathematical Modeling of Chemical Spills", University of Minnesota Grant-in-Aid of Research, Artistry, and Scholarship (7/1/96 to 12/15/97). Principal Investigator, \$15,000

"Wood Dust Intervention Study for Small Business," NIOSH (1995-1999). Co-Principal Investigator, \$800,000

"Evaluating the TSI Fluorescent Aerodynamic Particle Sizer," TSI Inc. (1997-1998). Co-Investigator, \$60,000

"Identification and Effectiveness of Current Methods Applied and Criteria Applied in Non-Routine Cleaning and Decontaminating of Air Ducts and Other HVAC Components. ASHRAE (4/1/96 to 9/30/96). Co-Principal Investigator, \$80,000.

"Development of a Survey of Owner Health and Safety Behavior," NIOSH (1998-2001). Principal Investigator, \$210,000.

"Demonstration to Motivate Small Businesses to Adopt Appropriate Hazard Control Technology in a Single Small Business Sector," CDC/NIOSH (1997-2000), Principal Investigator, \$140,000.

"Intervention to Prevent Construction Worker Hearing Loss," CDC/NIOSH (1997-2000), Consultant, \$569,945

"Small Business Owners' Health and Safety Behavior," National Institute for Occupational Safety and Health (3/1/98 to 2/28/01). Principal Investigator, \$150,000

"Effectiveness of a Machine Guarding Intervention," National Institute for Occupational Safety and Health (10/1/02 to 9/30/07). Co-Principal Investigator, \$1,500,400

"Effectiveness of Intervention on Health," National Institute for Occupational Safety and Health (9/30/02 to 9/29/03). Principal Investigator, \$111,375.

"Public Health Preparedness," Centers for Disease Control and Prevention (9/30/02 to 10/1/05), Consultant, \$100,000,000.