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Summary Report of the U.S. EPA Technical Peer Review Meeting on the Draft Document Entitled: *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster*

U.S. Environmental Protection Agency
New York, NY
July 14 – 15, 2003

National Center for Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC

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This report was prepared by Versar, Inc., an EPA contractor (Contract No. 68-C-02-061), as a general record of discussion held during the technical peer review meeting on the draft document entitled *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster* (July 14 – 15, 2003). As requested by EPA, this report captures the main points and highlights of the meeting. It is not a complete record of all details discussed, nor does it embellish, interpret, or enlarge upon matters that were incomplete or unclear. Statements represent the individual view of each meeting participant; none of the statements represent analyses by or positions of EPA.

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CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS v

EXECUTIVE SUMMARY vii

1. INTRODUCTION 1
   1.1 Meeting Purpose 1
   1.2 Background on Peer Review Process 1
   1.3 Meeting Participants and Agenda 5
   1.4 Organization of Meeting Summary Report 6

2. SUMMARY OF OPENING REMARKS/PRESENTATIONS 7
   2.1 Welcome from Meeting Organizer/Facilitator 7
   2.2 Welcome from NCEA Director 8
   2.3 Chair's Introduction 8
   2.4 Background Presentation on World Trade Center Assessment 9
   2.5 Peer Reviewer Question and Answer on Background Presentation 9

3. DISCUSSION SESSIONS 11
   3.1 Purpose and Scope of Assessment 11
   3.2 Exposure Assessment and Risk Characterization Approach 13
   3.3 Monitoring Data 16
   3.4 Particulate Matter 18
   3.5 Metals 21
   3.6 Polychlorinated Biphenyls and Dioxins 23
      3.6.1 PCBs 23
      3.6.2 Dioxins and Related Compounds 25
   3.7 Asbestos 28
   3.8 Volatile Organic Compounds 30
   3.9 Comment on the First Several Days After September 11 32
   3.10 Occupational and Indoor Exposures 32
      3.10.1 Occupational Exposure Assessment 32
      3.10.2 Indoor Air Exposure Assessment 34
   3.11 Conclusions/Executive Summary 35

4. OBSERVER COMMENTS 36
   4.1 First Comment Period 36
   4.2 Second Comment Period 38
   4.3 Third Comment Period 40
   4.4 Fourth Comment Period 40

REFERENCES 43

CONTENTS (continued)

APPENDIX A	PEER REVIEWER BIOGRAPHICAL SKETCHES
APPENDIX B	LIST OF OBSERVERS
APPENDIX C	AGENDA
APPENDIX D	POWERPOINT PRESENTATIONS
APPENDIX E	FLIP CHARTS FROM MEETING
APPENDIX F	WRITTEN COMMENTS FROM REVIEWERS
APPENDIX G	COMMENTS AND WRITTEN MATERIALS FROM OBSERVERS

LIST OF ACRONYMS AND ABBREVIATIONS

AHERA	Asbestos Hazardous Emergency Response Act
AQI	Air Quality Index
ATSDR	Agency for Toxic Substances and Disease Registry
f/cc	fibers of asbestos per cubic centimeter
COPC	contaminants of potential concern
DOH	New York City Department of Health
EOHSI	Environmental and Occupational Health and Safety Institute
EPA	Environmental Protection Agency
HVAC	heating, ventilation, and air conditioning
IRIS	Integrated Risk Information System
µg	microgram
µm	micrometer
MIXTOX	Toxicologic Interaction Data Base
MOE	margin of exposure
MRL	Minimum Risk Level
MVA	Millette Vanderwood Associates, Inc.
NAAQS	National Ambient Air Quality Standard
NCEA	National Center for Environmental Assessment
NIEHS	National Institute of Environmental Health and Safety
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no-observed-adverse-effects-level
NYCDOHMH	New York City Department of Health and Mental Hygiene
NYSDEC	New York State Department of Environmental Conservation
NYU	New York University
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCM	phase contrast microscopy

PEL	Permissible Exposure Limit
PM, $PM_{2.5,}$ PM_{10}	particulate matter, and PM less than 2.5 μm and less than 10 μm diameter
PVC	polyvinyl chloride
RfC	Reference Concentration
REL	Recommended Exposure Level
STEL	Short Term Exposure Limit
TDI	Tolerable Daily Intake
TEM	transmission electron microscopy
TEQ	toxic equivalent
TERA	Toxicology Excellence for Risk Assessment
TSP	total suspended particle
UC-Davis	University of California-Davis
VOC	volatile organic compound
WHO	World Health Organizations
WTC	World Trade Center

EXECUTIVE SUMMARY

The United States Environmental Protection Agency (U.S. EPA) Technical Peer Review Meeting on the draft document entitled: *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster* was held July 14 - 15, 2003, in New York, NY. This two-day meeting was organized and hosted by Versar, Inc., for the U.S. EPA's Office of Research and Development/National Center for Environmental Assessment (NCEA). The purpose of the meeting was to provide a scientific peer review of the draft document *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster*.

Versar, Inc., assembled a group of seven experts in air monitoring and transport modeling, environmental chemistry, public and occupational health, exposure and risk assessment, toxicology, risk characterization, and risk communication. In addition, reviewers had demonstrated expertise with the contaminants that were evaluated in EPA's assessment (particulate matter [PM], dioxins, polychlorinated biphenyls [PCBs], asbestos, volatile organics, and metals). In addition to considerations of expertise and experience, selection was based on the reviewers' availability for the peer review meeting. Additionally, the reviewer selection process consisted of screening for conflict of interest. All seven reviewers were asked a series of questions concerning potential conflict of interest, and they signed forms certifying that they had no conflicts of interest related to EPA's assessment. About 50 observers attended the meeting, providing additional comments and input on issues related to EPA's document.

The peer review meeting consisted of introductory presentations to establish the scope and procedures for the review, observer comment periods during both days of the meeting, and extended discussion sessions among the reviewers on each major section of the assessment document. These comment periods addressed the document's scope, approach, and use of monitoring data, as well as on the chemical-specific assessments. Details on the discussion, comments, and recommendations can be found in this report.

Reviewers generally had positive responses to EPA's assessment; however, several major recommendations and suggestions were provided for revisions to the report. They include the following:

- The document should focus on ambient "outdoor air" exposures for the general population. Although the indoor air and occupational assessments (rescue/recovery workers) are important, they are not the focus of the text and could be presented in summary form in the appendix to this report. The introduction to this report could mention that it focuses on general public exposures to outdoor air, and it could provide links to existing or potential reports on the indoor air and occupational exposure assessment efforts. EPA was encouraged to complete this outdoor air assessment as quickly as possible and work with other organizations to enhance efforts on the indoor and occupational issues, possibly by convening an independent group (e.g., the National Academy of Sciences) to analyze the indoor air data.

- It was recommended that the monitoring data section (Section III) of the document be expanded to describe in more detail the monitoring program design and available data. This section should include information on the purpose, scope, time frame, and location/number of samples and other information related to the monitoring that was conducted. Providing more information and consolidating the presentation in one section of the document would give the reader a more complete picture of the monitoring data available for the exposure and health evaluation. The section should also mention those chemicals that were not monitored for (or for which data are insufficient for the assessment). It is important that EPA's document clearly present discussion on the utility and limitations of the available monitoring data, particularly in terms of their end use for evaluating exposures and potential health effects. This section of the report also could introduce lessons learned to provide a basis for better response to future events.

- Reviewers agreed that no conclusions can be made about concentrations and exposures in the days immediately following the disaster, prior to the initiation of monitoring.

- Discussion of risk-based benchmarks should be expanded in the approach section (Section II) to introduce the types of benchmarks that are available, their applicability to this assessment, and the human health endpoints of concern for each benchmark. Although some reviewers felt that occupational exposure limits should not be used to assess general population exposures, others felt that they could be used if appropriately adjusted for exposure duration and sensitive individuals. In addition, the report should describe the potential health impacts of exceedances, including toxicology and epidemiology information for the chemicals of concern.

- Issues related to chemical mixtures should be introduced, where exposures to multiple chemicals having the same toxic endpoints or modes of action might be of concern. Reviewers suggested that EPA include relevant information from the chemical mixtures guidelines, framework for cumulative risk assessment, historic MIXTOX data base interactions, and the Agency for Toxic Substances and Disease Registry (ATSDR) interaction profiles (notably those including lead and chromium, and benzene, toluene, ethylbenzene, and xylene) and other recent information on mixtures. It was recommended that the document acknowledge and discuss the mixtures issue qualitatively, because the data are probably not sufficient to do a quantitative analysis.

- Reviewers had extensive comments on the PM assessment, recommending that EPA examine PM_{10} data and applicable benchmarks. Basing the assessment on $PM_{2.5}$ values might not be health protective because of concerns over respiratory effects from the unique PM emitted from the World Trade Center collapse (larger particles, glass fibers, and particles that exhibited alkaline characteristics). Suggestions were made to examine monitoring data for larger PM and to determine an applicable health-protective benchmark. The panel also noted potential inconsistencies in some of the $PM_{2.5}$ data and offered to provide additional input following review of the raw data.

- Reviewers found that EPA's assessments for metals (lead, chromium, and nickel) were acceptable and agreed that, with the exception of small exceedances in the first few days, metals were not of concern. Although lead was found at elevated concentrations in outdoor air, the event contributed little exposure for the general population, especially relative to historic lead background exposures. Comments on the chromium and nickel assessments were favorable, generally agreeing with EPA's approach and conclusions that these metals are of low concern.

- The benchmarks for the noncancer PCB assessment should be reexamined. If occupational benchmarks are used, they should be adjusted for application to general population exposures, which would account for differences in exposure duration and sensitive populations as indicated (because depending on the benchmark, there may already be some accounting for sensitive subgroups). It was noted that if adjusted benchmarks are used, the conclusions might change because more exceedances would be expected. The reviewers found EPA's cancer assessment for PCBs to be acceptable, agreeing that cancer risks would be well below levels of concern.

- The dioxin assessment was generally acceptable, but reviewers did raise concerns about (1) dioxin detection limits and presentation of the available data, (2) the approaches used for the cancer and noncancer assessments, and (3) exposure factors used for inhalation rate and exposure duration for the occupational worker assessment (if retained in the final document). Reviewers requested that EPA improve the presentation to make this complicated assessment more transparent to the reader. It was also suggested that EPA describe in more detail the noncancer health assessment using margin of exposure, because it is different from approaches historically used for other chemicals. Revised exposure scenarios and exposure factors should be considered for the World Trade Center resident and rescue/recovery worker assessments (if retained in the report). Finally, reviewers strongly suggested that EPA state that dioxin air concentrations are unknown for the first days following 9/11, prior to the initiation of monitoring. The document could mention that modeling is currently being done to better estimate releases

and concentrations during the days immediately following the disaster, but that a quantitative assessment of potential health effects could not be conducted at this time.

- It was noted that the assessment does not address compounds that would be expected to be present in elevated concentrations, such as organic combustion byproducts, including polycyclic aromatic hydrocarbons (PAHs) and brominated compounds, as evidenced by the extremely high dioxin concentrations. It was suggested that EPA discuss PAH data availability, perhaps in the expanded monitoring section.

- Several criticisms were voiced on the asbestos assessment. It was recommended that EPA: use the Integrated Risk Information System (IRIS) toxicity values for a health-based assessment, instead of the Asbestos Hazardous Emergency Response Act (AHERA) approach; revisit raw asbestos transmission electron microscopy (TEM) monitoring data to convert them from structures per square millimeter (s/mm^2) to volumetric units (structures per cubic centimeter [s/cc]); conduct a risk assessment; and discuss uncertainties. A more appropriate and health-protective approach would be for EPA to revisit the raw TEM analyses data to obtain the concentrations of fibers longer than 5 µm and the air volume data from the sampling. These data can be used to convert the asbestos data to appropriate volumetric units (s/cc) that can be used in conjunction with the IRIS asbestos value to conduct the risk assessment. Several of the reviewers commented that they believed that the results of this assessment would likely result in slightly more conservative health risk estimates. Reviewers also agreed that there should be a qualitative discussion of the uncertainties in the risk assessment, due to the inherent uncertainties in the sampling and analysis of asbestos and the conservative assumptions used in the risk assessment.

- Reviewer discussion on the volatile organic compound (VOC) assessment raised several issues about the applicability of the VOC monitoring data to assess general population exposures because of the locations of the samples, type of samples collected (most data points are for grab samples), and issues related to detection limits. All of these issues

could impact the conclusions drawn from the assessment. Therefore, EPA should include appropriate caveats because of the data limitations. Reviewers also suggested that EPA consider using different benchmarks for the VOC assessment, such as ATSDR Intermediate Minimum Risk Levels (also considering the toxicity information on which they are based) with the 24-hour sample data to evaluate potential risks to the general public, and Short Term Exposure Limits, for site recovery workers (if retained in the final assessment). Overall, reviewers agreed that VOC concentrations in outdoor air posed minimal impacts to the general population, but they were concerned about the limitations of the monitoring data.

- The future studies section (Section VII) should add some suggested efforts, including conducting animal toxicity testing with archived dust samples (e.g., 14- and 90-day rat inhalation studies and a 2-year rat study to address chronic exposures). Other future studies should revisit the nonasbestos fibers, PAHs, and other combustion byproducts, incorporating information from other researchers as available (e.g., health studies at New York University and PAH analyses from University of North Carolina).

1. INTRODUCTION

1.1 Meeting Purpose

The United States Environmental Protection Agency (U.S. EPA) Technical Peer Review Meeting on the Draft Document Entitled: *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster* was held July 14 - 15, 2003, at the Sofitel Hotel in New York, NY. This two-day meeting was organized and hosted by Versar, Inc., for the U.S. EPA's Office of Research and Development/National Center for Environmental Assessment (NCEA). The purpose of the meeting was to provide a scientific peer review of the draft document *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster*.

1.2 Background on Peer Review Process

Versar was tasked by NCEA to convene an expert panel and conduct an external scientific peer review meeting on EPA's assessment document. This effort was conducted under EPA Contract No. 68-C-02-061, *Support for NCEA Peer Review and Risk Assessment Guideline Activities*. This contract provides for support to NCEA on peer review, exposure and risk assessment document preparation, meeting organization, and related activities. Under this contract, Versar conducts numerous peer reviews for NCEA of exposure and risk assessment documents. Many of these reviews are "letter" reviews where documents are sent to experts who provide individual reviews to evaluate the technical merits of an NCEA product. In some cases, peer review meetings are held to assemble reviewers to exchange ideas and discuss issues related to a document, particularly when the product being reviewed is complex or potentially controversial. Additionally, other reviews provide for reviewer interaction through conference calls. The peer review of *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster*, conducted under Task Order No. 27, was initiated in April 2003, with the goal of conducting a peer review meeting in New York during the summer of 2003.

Versar's responsibilities included identification and selection of the experts, organization of the meeting, and production of the peer review meeting report. These activities were conducted on the basis of the specifications in EPA's Statement of Work and in accordance with the policies and procedures established by EPA's *Peer Review Handbook* (U.S. EPA, 2000). EPA's Statement of Work called for assembly of a panel of experts with experience in air monitoring, environmental chemistry, air transport modeling, public and occupational health, exposure and risk assessment, toxicology, risk characterization, and risk communication. In addition, EPA specified that reviewers were to have demonstrated expertise with the contaminants that were evaluated in EPA's assessment (particulate matter [PM], dioxins, polychlorinated biphenyls [PCBs], asbestos, volatile organics, and metals).

On the basis of these specifications, Versar identified more than 50 candidate experts and selected a final group of seven who had the requisite expertise. A few of the selected reviewers had experience specific to monitoring and assessing exposures and human health effects of air emissions from the World Trade Center disaster. In addition to considerations of expertise and experience, selection was based on the reviewers' availability for the peer review meeting. Furthermore, the reviewer selection process consisted of screening for conflict of interest. All seven reviewers were asked a series of questions concerning potential conflict of interest, and they signed forms certifying that they had no conflicts of interest related to EPA's assessment. Following Versar's final selection of the reviewers, EPA provided consent that the group of experts met EPA's requirements.

The members of the seven-person panel assembled by Versar for this peer review were:

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Following selection of the panel members, Versar's attention turned to selecting a Chair for the group. As called for in EPA's Statement of Work, the function of the Chair would be to facilitate the meeting, ensure that the meeting proceeded in a timely and effective manner, and provide all panel members with an ample opportunity to raise issues and contribute to discussions during the two-day meeting. The Chair would also assist Versar in developing the meeting agenda and peer review report. Versar selected Dr. Michael Dourson to serve as the Chair because of his demonstrated abilities in leading scientific meetings.

Materials were mailed to the reviewers so they could begin their individual evaluations of EPA's assessment. Versar provided reviewers with EPA's document and instructions for preparing brief written premeeting comments and EPA provided a list of general questions to help guide

their reviews. The written premeeting comments were compiled by Versar and distributed to all reviewers in the week prior to the meeting so they could be aware of what issues had been raised by the other reviewers and prepare for meeting discussions. During this time, Versar began working with the Chair to craft a meeting agenda, which was organized according to the major sections of the assessment report. The agenda also provided for introductory presentations and question-and-answer sessions to help establish the scope and purpose of the document prior to moving into more detailed comments on the report. The agenda also set aside four observer comment periods during the two days to allow the public to provide input regarding EPA's assessment report.

Plans for the peer review proceeded with identification of a meeting site in New York City for July 14 - 15, 2003, based on the availability of the peer reviewers. Logistics information for the meeting was prepared and provided to EPA for inclusion in the Federal Register notice announcing the meeting. The Federal Register notice, published on June 18, 2003, informed the public of the meeting, listed logistics information (dates, times, and location), instructed the public on how to obtain a copy of EPA's assessment, and described procedures to preregister for the meeting. Versar developed observer preregistration procedures to facilitate members of the public in attending the meeting and making statements during the observer comment periods. A Web site was developed by Versar (http://www.versar.com/epa/wtcpeerreview.htm) to facilitate observer registration. Interested members of the public preregistered with Versar via telephone, fax, email, or using the web site. Approximately 50 people preregistered and approximately 10 people signed up to make statements during the observer comment periods. Prior to the meeting, observers were provided with the agenda and logistics fact sheet on the location of the peer review meeting.

Versar conducted observer registration and opened the peer review meeting with a statement of purpose and ground rules for conducting the review. Versar staff assisted in organizing observer comment sessions and collecting materials submitted by reviewers. The Chair had the lead responsibility for conducting the meeting and the observer comments periods. Versar documented the proceedings via note taking and tape recording, which were used in preparing

this peer review summary report. This report captures the main points and highlights of the meeting. It is not a complete record of all detailed discussion, nor does it embellish, interpret, or enlarge upon matters that were incomplete or unclear. The report summarizes the major recommendations and suggestions provided by the reviewers, documents reviewer discussion, and describes other aspects of the peer review meeting, including introductory presentations, question and answer sessions, and observer comment periods.

1.3 Meeting Participants and Agenda

Attendees at the peer review meeting included the seven peer reviewers (biographical sketches for the peer reviewers are presented in Appendix A) and about 50 observers (list of observers is presented in Appendix B). The agenda for the peer review meeting (Appendix C) was developed by Versar and the Chair to include introductory presentations to provide background and establish the scope for the peer review, discussion sessions among the reviewers on each major section of the assessment document, and observer comment periods during both days of the meeting. In general, the agenda for reviewer discussion followed the organization of the assessment document. Specifically, the meeting began with a welcome, introductions, and a presentation highlighting the assessment and major conclusions, which were followed by extended discussion among the reviewers on the scope, approach, and use of monitoring data in the assessment. The second day of the meeting continued with reviewer discussion on the assessment, addressing the major chapters of the report, which present the assessments for each chemical/contaminant of concern. Over the course of the two-day meeting, four observer comment periods were scheduled to allow the public to provide input on the document.

1.4 Organization of Meeting Summary Report

This report summarizes the meeting discussions, focusing on the recommendations and suggestions provided by the peer reviewers.

- The executive summary provides a summary of the peer review meeting, including a brief list of the major recommendations and suggestions from the peer reviewers.

- Section 2 of this report summarizes the opening presentations and discussion.

- Section 3 presents summaries of the major discussion, comments, and recommendations provided by the reviewers on the assessment document.

- Section 4 summarizes the observer comments and statements.

- Section 5 contains references cited in this meeting report.

- The appendices to this report present written and visual materials from the meeting, including biographical sketches for the reviewers, list of observers, the agenda, presentation materials, flip charts produced during the meeting summarizing major recommendations, and the reviewers' written comments (prepared before the meeting and, in some cases, revised after the meeting). In addition, statements and handouts provided by the observers at and following the peer review meeting are presented.

2. SUMMARY OF OPENING REMARKS/PRESENTATIONS

Opening remarks and presentations were provided by several of the people responsible for organizing and hosting the peer review meeting, including staff from Versar, Inc., and EPA's National Center for Environmental Assessment (NCEA), as well as the meeting Chair. Presentation materials used in these talks are included in Appendix D.

2.1 Welcome from Meeting Organizer/Facilitator

Mr. David Bottimore, Project Manager from Versar, Inc., opened the meeting by welcoming the peer reviewers and observers. He provided an overview of the meeting agenda, including a statement of the goals and intended outcome of the peer review. The objective of the meeting was to obtain technical input on EPA's document related to the assessment approaches used, data analysis, and interpretation of the results. Included in these opening remarks were ground rules and procedures for conducting the meeting. One issue that was emphasized was that consensus would not be sought; rather, the goal was to seek the individual comments and suggestions from the peer reviewers. He also clarified the roles of observers, including EPA staff, and highlighted the time periods set aside to obtain observer comments. These opening remarks concluded with an overview of the agenda and introductions of the seven peer reviewers. During the introductions, reviewers provided summaries of their pertinent experience and disclosed information related to conflict of interest. Following these introductions, Mr. Bottimore introduced the meeting Chair, Dr. Michael Dourson, Director of Toxicology Excellence for Risk Assessment (TERA). Dr. Dourson continued the conflict of interest discussion among the reviewers. None of the panel members had additional questions or concerns about conflict of interest for the reviewers.

2.2 Welcome from NCEA Director

Dr. Peter Preuss, Office Director of NCEA, welcomed the panel and observers to the peer review meeting. He voiced his enthusiasm for the peer review panel that was assembled to provide feedback on EPA's assessment because of their credentials and experience with the topic areas and chemicals addressed in the document. EPA increasingly relies on peer review to ensure that its documents use the best science. EPA was not involved with selection of the reviewers; that was Versar's role, so the process was as independent as possible. He also welcomed the observers and stated that he looked forward to hearing their thoughts on the document. During his introduction he noted that written public comments had been received earlier on the assessment, and he invited observers to provide additional comments and suggestions. The ultimate goal is for EPA to receive recommendations and suggestions from the peer reviewers and observers on how best to improve the scientific content of the assessment, which will be incorporated by EPA into the final report.

2.3 Chair's Introduction

Dr. Dourson was the Chair for the peer review meeting and served as facilitator. He began his introduction by describing the peer review process and setting the ground rules. He reiterated the goal of the meeting and emphasized that technical input was sought from each participant, noting that there would be no attempt to achieve consensus. Rather, the discussion should bring out the diverse perspectives of individual experts in the group. He also described the procedure for the observer comment periods and encouraged observers to provide technical information that might be of assistance to the panel and to EPA in revising the assessment; observers were further requested to answer clarifying questions from either panel members or authors at the time of their presentation. He also permitted reviewers to approach either authors or observers with technical questions during breaks, but not the reverse. Reviewers were asked to report significant information from such conversations back to the entire group during the discussion sessions. Authors were permitted to respond to reviewers' questions and were also permitted to

ask clarifying questions of panel members, but not to participate in the discussion. He concluded his opening remarks by reviewing the agenda for the meeting.

2.4 Background Presentation on World Trade Center Assessment

Mr. Matthew Lorber of NCEA provided a presentation summarizing the scope, approach, and findings of EPA's assessment. He began his presentation with background information on the development of the assessment, which was initiated at the request of EPA Region 2. The assessment focuses on outdoor measurements of exposure to the general population and evaluation of the potential human health effects. The contaminants evaluated include particulate matter (PM), metals, polychlorinated biphenyls (PCBs), asbestos, dioxin, and volatile organic compounds (VOCs), which were monitored by EPA and other organizations following the World Trade Center collapse. His presentation summarized the principal findings from EPA's assessment, including specific conclusions for each chemical/contaminant of concern. Included in this discussion were the available monitoring data and approach for evaluating potential health effects. This approach relied on the use of health-based screening benchmarks and traditional risk assessment procedures, according to available data for each chemical. Although some chemicals were found at elevated concentrations in the time period following September 11, most returned to background concentrations in the following months. He concluded his presentation by noting lessons learned with respect to monitoring and assessing exposures and health effects. He also reviewed some general charge questions for the peer review panel to consider during its deliberations.

2.5 Peer Reviewer Question and Answer on Background Presentation

The peer reviewers asked clarifying questions, which introduced many of the topics that would be discussed in further detail over the course of the two-day meeting. Some of these questions were raised prior to the meeting by reviewers in their individual comments (Appendix F). Most of these initial comments pertained to the scope, approach, and overall purpose of the assessment. Specifically, reviewers raised questions about the target audience for the document,

selection of the contaminants of concern, and breadth of issues that are addressed in the report. Several reviewers inquired about EPA's purpose for the document relative to the various issues that the report addresses. Consideration was given to the idea that the document might benefit if it were to focus on the outdoor ambient air exposures to the general public, leaving other issues to be assessed in separate documents. Reviewers questioned the assessment's focus on inhalation exposures, noting that there are concerns about dermal contact, ingestion, or secondary inhalation exposures from indoor dust. The Chair concluded this questions session by reminding reviewers that these issues would the topics for more in-depth discussion during the rest of the meeting.

3. DISCUSSION SESSIONS

This section presents reviewer discussion on EPA's assessment, organized according to the major sections of the document. Subsections include brief summaries of major recommendations and suggestions, followed by more detailed presentation of the discussion.

3.1 Purpose and Scope of Assessment

The reviewers began their discussion by addressing the overall purpose and scope of the assessment and report. Most reviewers suggested that the purpose and scope of the EPA study be clarified to explicitly state that this report emphasizes ambient (outdoor) air quality and inhalation exposures to the general population. It does not focus on occupational (e.g., rescue and recovery worker) risks or secondary indoor air exposures. It was recommended that the language be clarified so the reader would get the proper impression of the report's purpose and scope. Several reviewers noted that secondary exposure to indoor dust should be examined, but that might be the focus of another (or subsequent) report. Another reviewer pointed out that the report does a good job of identifying other issues and studies that might be of interest to readers but agreed that this report should be kept more focused on ambient (outdoor) concentrations to which the general population might have been exposed and the potential health effects.

One reviewer noted that the document does an adequate job of summarizing ambient concentrations of contaminants following the World Trade Center event and of indicating when levels had returned to background. It was pointed out that the document does have a short section on indoor and occupational exposures, but they are secondary to the ambient air assessment for the general population. Although a few reviewers felt that the indoor air section should be significantly expanded to provide the data and assessments that these topics warrant, other reviewers recognized that this report cannot be comprehensive. Another reviewer offered the opinion that indoor air issues are totally different because of the nature of the particles and should be addressed separately. As a result of this discussion, most reviewers felt that the document would be better served by keeping the focus on ambient exposures. The indoor air and

occupational exposures are important, but they should be addressed in a separate assessment, and with other organizations who have been involved in these issues. EPA was encouraged to complete this outdoor air assessment as quickly as possible while expanding associated efforts on the indoor and occupational issues and perhaps convening an independent group to analyze the indoor air data (e.g., the National Academy of Sciences). If there are plans to do such a separate assessment, then the current section in this report can be kept brief or even removed so that it does not confuse the reader or distract from the main purpose of this assessment. Following this discussion, it was suggested that the title of the report be changed to reflect the focus on ambient (outdoor) air monitoring, general population exposures, and the potential health effects (both short- and long-term endpoints). Another suggestion was that the executive summary be revised and expanded, such that it could be used as a stand-alone document, because many readers will not take the time to read the entire report.

Reviewer discussion raised the importance of completing and releasing this document as soon as possible, while referencing the other issues and on-going studies that are being performed. One idea proposed was that the document could be a "living text," updated with new information as it becomes available. The final report could be considered an interim report, which links this report to studies being conducted by other groups (e.g., EPA Regions, Occupational Safety and Health Administration [OSHA], National Institute for Occupational Safety and Health [NIOSH], Agency for Toxic Substances and Disease Registry [ATSDR], National Institute of Environmental Health Sciences [NIEHS], etc.) that will be published at later dates. The final report would include mention of the occupational studies, indoor air assessments, evaluations of other exposure routes, epidemiological assessments, and modeling efforts (used to "back calculate" concentrations and exposures immediately following the September 11 disaster, before monitoring was initiated) that are ongoing. Most reviewers agreed with these suggestions and encouraged EPA to continue associated efforts and issue other reports at later dates. Two reviewers agreed to provide lists of on-going health and epidemiological studies.

A suggestion was made that the document be restructured so as to explicitly lay out the subject matter in a more linear fashion, particularly with respect to the monitoring data. One reviewer

suggested that the document expand and reorganize the presentation of information on the monitoring that had been conducted. The document would be clearer if the monitoring section (Section III) included background on the purpose of different data collection efforts, including information on how decisions were made, why they were made, and the purpose for which the data were to be used. There is a lack of clarity on the process and how the monitoring efforts evolved over time. Readers would better understand the data and the challenges in trying to assess the data for exposure and risk assessment purposes if this discussion were to be reworked in this manner. The report should outline the process and highlight what can be learned (and what cannot be learned) from the data collected, recognizing that data are very limited.

It was also emphasized that ambient air data are not available for the first few days immediately following the disaster, with the exact delay until sampling varying by the contaminants monitored. Therefore, conclusions cannot be drawn about the potential impacts from exposures during that time period. Including this information would also help to explain the lessons learned with regard to the data collection process and planning to be more responsive in the future.

3.2 Exposure Assessment and Risk Characterization Approach

Reviewer discussion on the exposure and risk characterization approach focused on (1) identifying and selecting of public health protective benchmark values, (2) defining the populations addressed in the exposure assessment, and (3) describing the potential short- and long-term health effects that could result from concentrations that exceeded applicable benchmarks.

One reviewer encouraged EPA to describe the process used to select the screening benchmark values, such as a ranking system or hierarchy, to choose among available values. It was recognized that not all contaminants have benchmark values available, but when more than one is available, the reader should understand the basis for EPA's selection. This reviewer suggested noting which benchmark value was being used, and whether that was the preferred value or not

and explain why. Several reviewers agreed and suggested that the process be clearly delineated and the context for decisions be made clear. It was felt that the report should provide a basis for the benchmarks used; indicate whether acute, subchronic or chronic values were available; and explain how they are tied to the target population being assessed. The issue was particularly evident for the use of occupational screening values to evaluate potential impacts to the general population. Although some reviewers felt that occupational exposure limits should not be used to assess general population exposures, others felt that they could be used if adjusted for exposure duration and sensitive individuals. The report should describe when such values were used and how they were derived.

Although a few reviewers advocated derivation of new benchmarks when no applicable values are available for a chemical, others cautioned against generating new values that have not been peer reviewed. EPA could consider deriving new values or using benchmarks derived by EPA Region 2 for its study (WTC, 2003), but the preference is to use existing values. Reference concentrations (RfCs) are particularly applicable for assessing chronic effects for short-term exposures. Reviewers reiterated that it is important that the processes for identification, selection, and adjustment of screening benchmarks be transparent to the reader.

Discussion continued on the interpretation of potential health implications from benchmark exceedances (first paragraph on page 16), particularly on the level of conservatism of such a screening assessment. One reviewer suggested that the document provide more information to the reader on the meaning of such comparisons with respect to the magnitude of the exceedance, time frame (acute or chronic exposures), and also the endpoint (health effect) that would be of concern. Discussion should address the potential implications of exceedances for acute and chronic exposures and include an indication of the number of samples that exceed the benchmark. Such qualitative information (e.g., whether there is only one high data point and all others are well below the level of concern) would help to assess the magnitude of concern. One suggestion was to add a table showing the benchmark values, their source/how they were adjusted, and the health endpoints of concern. Similar discussion and guidance should be provided to the reader on the utility of comparisons to monitoring data collected previously or

from other areas that are intended to represent background. One reviewer cautioned that it is not necessarily true to say that if concentrations were below benchmarks that there are no health effects. Issues related to chemical mixtures could be discussed in this section, where exposures to multiple chemicals having the same endpoints might be of concern. Reviewers suggested that EPA look at their chemical mixtures guidelines, cumulative risk issues, and MIXTOX database on interactions, additivity, and antagonism among chemicals. It was recommended that EPA acknowledge and discuss the mixtures issue qualitatively but recognize that the data are probably not sufficient to do a quantitative analysis.

Reviewers also reiterated the need to clarify in the exposure and health assessment approach section (Section II) that the exposed population being evaluated is the general public and not the rescue/recovery workers inside the restricted zone and that secondary indoor exposures are not assessed. A suggestion was made to improve the clarity of the map depicting the restricted zones in Figure 1 and tie in the receptor/exposure scenario information presented later on page 78. Again, such a presentation at this point in the document would help the reader to gain a clearer picture of the specific populations being assessed with these datasets and to whom it applied (and to whom it does not). A question was brought up as to how the area was restricted and whether the general population could have gotten back into the restricted areas, such that they might have been exposed to elevated concentrations. There is a need to clearly state in the report what receptors are assessed (and not assessed, such as rescue workers) in this document so that this is clear to the reader.

During the discussion of the exposure and risk characterization approach, one of the reviewers pointed out that, for the asbestos assessment, the Asbestos Hazardous Emergency Response Act (AHERA) method should be removed and health-based values from Integrated Risk Information System (IRIS) be used. The AHERA level of concern value (70 s/mm^2) is not a health-based benchmark (it is a technology-based value), and it should not be used. The only drawback is that the IRIS value does not include short fibers, so the assessment would have to leave those out. Regardless, this reviewer suggested that using transmission electron microscopy (TEM) data and the IRIS approach would result in a more health-protective assessment. Another reviewer added

that the TEM method is inherently conservative, because it will likely identify more fibers than is generally possible using phase contrast microscopy (PCM). Several reviewers agreed that this approach would be preferred because of the additional protectiveness.

3.3 Monitoring Data

Suggestions were provided for reorganizing and expanding the monitoring discussion (Section III) of the document to better introduce the scope of the monitoring effort and the data available for the exposure and risk assessment. By expanding the section and providing additional information, this section could provide a better basis for the subsequent exposure and health effects evaluation in Section IV. Information should be included on the purpose of each sampling station, analytes monitored, start and end dates of sampling, frequency of sampling, and sampling periods with missing data. These descriptions should include qualitative information as well as details on analytical methods and quality assurance efforts. This reorganization would expand the section by approximately 10 pages by moving forward information from the evaluation discussion in Section IV. It should also include the table of monitoring locations and pollutants measured presented in Appendix B of EPA's assessment report. This table could be rearranged by contaminant to be more intuitive, which would help to set the stage for the subsequent use of the data to assess exposure and risks to specific populations. As a result of this proposal for reworking this section, a reviewer suggested that perhaps the section be re-named something like "Environmental Monitoring Program Design."

The reviewers agreed that by expanding this section to better describe the monitoring conducted, questions could be answered as to why certain chemicals or data were not included in the assessment. One reviewer noted that the document should point out whether some data were not included because they were not collected under similar conditions and using comparable protocols. Expanding this section with additional discussion would provide better context for including or excluding data in the assessment, such as data collected from locations that might not represent general population exposures, (e.g., grab samples taken close to Ground Zero in the restricted zone). Reviewers agreed that the changes suggested would improve this section by

providing a clearer presentation of the data used in evaluating exposures and risks. Providing more information and consolidating the presentation in one section of the document would give the reader a more complete picture of the monitoring data available for the exposure and health evaluation. The section should also mention those chemicals that were not monitored for (or for which data are insufficient for the assessment).

It is important that EPA's document clearly present discussion on the utility and limitations of the available monitoring data, particularly in terms of their end use for evaluating exposures and potential health effects. Reviewers reiterated that the section should be expanded and reorganized to present the rationale for the monitoring sites, identifying the purpose of each site/sample, and adding timelines and descriptions of how many and where data/samples were collected. One reviewer suggested that additional figures be added to the report, such as timelines and graphics showing in more detail the location of monitoring sites (denoted by alphabetized lettering in maps) for each contaminant, explaining how they were chosen and why. It was also suggested that a discussion of meteorological conditions be included in this section, to better explain the behavior and movement of the plume over the time periods corresponding to elevated concentrations at particular locations. The reader needs to understand whether elevated concentrations at monitoring sites could be attributed to increased emissions or whether they were due to meteorological conditions. Such information would help to provide more context for the spatial and temporal trends in concentrations and evaluation of the data from broader geographic scales.

3.4 Particulate Matter

Commentary from the reviewers on the PM assessment was extensive, questioning the applicability of the $PM_{2.5}$ monitoring data and $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) benchmark for evaluating the potential health effects of the PM. Several reviewers challenged the use of the $PM_{2.5}$ values because of concern for the health effects of larger particles

(including glass fibers) that exhibited alkaline characteristics. Suggestions were made to examine monitoring data for larger PM and to determine an applicable health-protective benchmark. Additional comments on this section called for examination of dusts for combustion byproducts such as polycyclic aromatic hydrocarbons (PAHs), which would be expected to be present in elevated concentrations.

One reviewer stated that this section overall was well written and was comprehensive but brought up two specific points during this initial discussion. The first point was that there is text that discusses estimating exposures from the results of tests conducted to resuspend particulates from settled dust. Although this is valuable information, it should be noted that it is difficult to recreate fine aerosol from resuspended dust, and resulting data will be biased toward particulate sizes that are larger than the original airborne PM. This needs to be stated as a caveat in the report.

The second point was that the PM assessment should be expanded to include coarse particles (>2.5 μm). There are some PM_{10} monitoring data, but they are not extensive, and there needs to be an explanation of what the potential health implications might be from all PM. There are respiratory health effects being identified, but the $PM_{2.5}$ numbers do not indicate a problem. This reviewer stated that this discrepancy could be attributed to the characteristics of the particulates released from the collapse of the World Trade Center buildings. Specifically, there was an unusually large proportion of larger particles composed of glass fibers and having high alkalinity that may pose acute and chronic respiratory effects. It was suggested that PM_{10} monitoring data be examined to determine whether they could be incorporated into the assessment. Several reviewers agreed with this suggestion, noting that some PM_{10} data are available. Another reviewer agreed with the statement about the high concentrations of the larger particle sizes found in the dust but noted that much of it is even larger than PM_{10} (ranging from 10 to 53 μm) from settled dust sampling by Lioy et al. (2002).

Several reviewers discussed the use of a more appropriate health protective benchmark than the $PM_{2.5}$ NAAQS standard or the Air Quality Index value. Reviewers noted that the PM_{10} NAAQS

standard is higher than the $PM_{2.5}$ benchmark, but because the concentrations of the larger particulates are believed to be significantly higher, the assessment might find more exceedances. Furthermore, because the respiratory irritation was caused by these particles, there is even more of a concern than what would be expected for "typical" PM, which might call for an even more protective benchmark than the $PM_{2.5}$ or PM_{10} values. Looking at total suspended particle (TSP) standards or occupational benchmarks might be worthwhile to determine an applicable screening value for this unique PM. Several reviewers noted that the particulate characteristics changed over time (after initial collapse, after resting, later from fires, etc.), so this assessment gets very complicated.

Several reviewers considered the utility of conducting toxicity tests on the dust (e.g., 14- or 90-day rat inhalation studies), which could be used to derive a site-specific benchmark, but such an effort would be costly and time consuming. The reviewers concluded this PM discussion by suggesting that EPA consider these comments and revisit the issue to determine whether a more health-protective screening benchmark (in addition to $PM_{2.5}$ and PM_{10} values) could be determined that could be used in conjunction with the available PM monitoring data, providing increased attention on the potential health effects of the larger particles.

Another reviewer voiced concern that the dust would be expected to contain elevated concentrations of organic combustion byproducts such as PAHs and brominated compounds, as evidenced by the extremely high dioxin concentrations. The reviewers questioned EPA as to whether there are data available on PAHs that could be used in a manner similar to the write-ups of other contaminants. It was stated that there are no concurrent PAH data but that it would be a separate data set. There were limited PAH data available during the preparation of this report, but since then, more have become available. EPA noted that there was no real ambient measurement of PAHs; there were only two sample days in November 2001 and then regular sampling from January 2002 through May 2002.

It was suggested by reviewers that a qualitative discussion of the new PAH data be included in the report. A reviewer suggested that EPA should discuss the availability of PAH data in the

methods section so that the audience is aware of what data were collected and were available for use in the assessment. Another suggestion was made by one reviewer that the dust be reexamined to determine the composition and concentration of PAHs and related organic combustion byproducts. Many organic compounds persist in the environment and PAHs would still be in the dust samples collected. It was recommended that the dust samples be analyzed for other organic combustion byproducts that could substantially increase estimated risks. Alternatively, if toxicity testing were to be conducted on the dusts, it might more accurately reflect the cumulative effects from contaminants that had not been characterized and for which no benchmarks are available. The reviewers felt that such tests might be worthwhile in the future but that other approaches could be used in the short term for this document.

In subsequent discussion, reviewers raised miscellaneous comments related to the PM section. One reviewer suggested that the 1976 New York University (NYU) Medical Center monitoring data (included in Table 2 on page 43) be moved to a different table, separate from the 2000 values, and be more clearly described as providing historical context on background levels. Another reviewer, reflecting back to previous discussion, suggested that pie charts be added to the presentation, showing information on particle size distribution and composition of PM. Other comments reflected on the difficulty in characterizing exposures, especially in the first few days following the disaster, before monitoring was initiated. Additionally, there were some regional episodes in the following weeks when concentrations were elevated in areas away from Ground Zero, which could have been due to transport of the plume. One such episode occurred in early October, but the data were suspect. To help assess the PM issue in more detail, one reviewer offered to examine in more detail the PM data from three perimeter monitoring sites (particularly an October 2, 2001 data point that appeared to be suspect). Another reviewer volunteered to do some research to see whether any health-based benchmark values exist for glass fibers. This reviewer reported later that NIOSH has an occupational exposure limit of 3 fibers/cm^2 for glass fiber.

Discussion concluded with the Chair asking the reviewers whether they agreed with the conclusions presented in EPA's report. It was agreed by the reviewers that EPA's conclusion

bullets, presented on page 2 of the assessment, would hold true for $PM_{2.5.}$ However, reviewers were concerned about larger particulates and the need to evaluate PM_{10} monitoring data against a site-specific PM_{10} benchmark that would account for the unique composition of the particles released from the World Trade Center collapse and fires. Reviewers generally agreed that the greatest risks were from exposures in the time period immediately following the collapse and that PM levels to which the general public would be exposed decreased after a few weeks. They agreed that it was tough to apply such broad conclusions to a particular contaminant and suggested that if contaminant-specific conclusions are presented in this manner, that more precision should be applied to the statement of the time frame before levels returned to background.

3.5 Metals

The reviewers discussed the assessments for those metals that were reported to be contaminants of concern: lead, chromium, and nickel. In general, reviewers found that EPA's assessments for metals were acceptable and agreed that, with the exception of small exceedances in the first few days, metals were generally not of concern.

The first metal addressed by the panel was lead. One reviewer suggested looking at the source of lead and indicated that the discussion on lead was good but there was a need for more fate and transport information. A question was raised as to the bioavailability of the airborne lead in comparison to the types of sources to which the NAAQS standard would typically be applied. The bioavailability would depend on the form present which would be a result of the type of source. If the bioavailability were lower, then the dose resulting from a similar concentration would be lower (making the assessment more conservative). Two reviewers discussed this issue and suggested that EPA look further into the relative bioavailability of lead in the ambient air samples collected. In discussing this issue in more detail, the question was raised as to whether the lead concentrations observed were a product of particulates or combustion. Several reviewers hypothesized that lead was likely combustion generated, because it was found predominantly in the 2.5 μm fraction, and concentrations decreased fairly quickly. Reviewers

generally agreed that, with the exception of small exceedances in the first few days, outdoor air exposures to lead was not of concern. Another reviewer agreed with this statement and pointed out that the event contributed little exposure relative to background exposures, especially relative to historic lead concentrations.

The next metals discussed were chromium and nickel. Several suggestions were made that are applicable to all the metals, such as presenting graphs with the tables that summarize the metals concentration data (such as Table 2). Such a visual presentation would help the reader to see that metals levels were generally not above background concentrations. Similarly, it was suggested that the graphs of chromium and nickel concentration data in Figure 18 include notations on where the benchmarks and background levels would be, much like what was done in the PM graphs. One reviewer suggested that EPA review data from the Speciation Trend site (operated by the New York State Department of Environmental Conservation, on Canal Street) to show background levels of metals from 2000 to the present. It was also suggested that trace metal data be included in the report even if they were below detection levels.

Comments on the chromium and nickel assessments were favorable, with reviewers generally agreeing with the approach and conclusions that these metals are of low concern. Questions were raised briefly on whether the benchmarks selected for chromium and nickel were the best available, and whether EPA has newer reference concentrations (RfCs) for these compounds that could be used instead of the OSHA Permissible Exposure Limit (PEL) and ATSDR Minimum Risk Level (MRL) values. It was later clarified that there is an RfC for hexavalent chromium, but that the one for nickel was only in draft form.

Several reviewers stated that the data do not seem to indicate elevations of chromium and nickel above background levels and therefore felt that EPA's conclusions were correct, though they did question what the source of nickel might be. Another reviewer pointed out that nickel is a fuel-related element that is commonly present whenever there is a fuel combustion source. One reviewer stated that the plots for chromium and nickel for the 2.5 μm fraction do not follow the other plots and suggested that the monitored concentrations might not be attributable to the

World Trade Center. Another reviewer pointed out that the third paragraph on page 33, which talks about all metals and elements, states that chromium, arsenic, antimony, potassium, and zinc all had ambient air concentration peaks in late November. The reviewer stated that these elevated concentrations might be associated with the World Trade Center but could also be due to other sources. Another reviewer stated that the graphs on page 55 show that concentrations of metals and halides track with the World Trade Center collapse and seem to be indicative of combustion sources. The reviewer felt that the report should also mention that there were significant sources of chlorine and bromine in the World Trade Center prior to the collapse (e.g., PVC wire coating and perhaps bromine flame-retardant material on the furniture). It was suggested that the report present data for other trace metals, even if the levels are low or below detection limits.

3.6 Polychlorinated Biphenyls (PCBs) and Dioxins

3.6.1 PCBs

Reviewer comments on the PCB assessment generally focused on the benchmarks used for the noncancer assessment and the suggestion that the occupational benchmarks used should be adjusted for application to general population exposures. The results for the assessment could change as there might be exceedances if adjusted benchmarks are used. The reviewers found EPA's cancer assessment for PCBs to be acceptable, agreeing that cancer risks would be well below levels of concern. Additional comments were made on the presentation of the PCB data and the need for more discussion of organic combustion byproducts such as PAHs and brominated compounds.

One reviewer observed that there are not a lot of benchmarks available for PCBs; there are no subchronic or acute MRLs and no subchronic or acute RfCs. The reviewer suggested considering deriving a new benchmark based on available no-observed-adverse-effect-levels (NOAELs). There is already good information on the bottom of page 68 that could be used in setting a safe margin of exposure (MOE) or dose. Alternatively, the assessment of noncancer effects could be based on the NIOSH Recommended Exposure Level (REL) and OSHA PEL

occupational benchmarks, but those values should be adjusted for exposure duration and susceptible populations if they are to be health protective for the general population. This reviewer estimated that comparison of ambient air concentrations with either of these adjusted benchmarks might result in some exceedances.

Another reviewer noted that the rationale and description for adjusting occupational benchmarks, to make them more appropriate for assessing general population exposures, should be introduced earlier in the document, in Section II, the exposure and health assessment approach. Another reviewer noted that some of the PCB samples were taken close to "the pile," which might provide concentration data that are more representative of rescue/recovery worker exposures; in this case, occupational benchmarks could be used, but with an adjustment for exposure duration (because recovery workers were present for much more than the typical 8 hrs/day and 5 days/wk used in deriving occupational benchmarks).

Other comments on the PCB section included identification of a missing value in Table 3 (PCB monitoring data from September 2001 to April 2002) for the November 2, 2001 sample at Barclay and West Broadway. Another comment provided on the location of PCB monitoring stations in Figure 21 questioned the sampling site numbering and whether it matches the official designations for the World Trade Center buildings (i.e., WTC Building #5). One reviewer noted that the report identifies the likely fact that PCBs were in the building and that levels found were in some cases higher than those in ambient air. This reviewer felt that the levels and extent of PCB contamination were well characterized in the report. It was reiterated that various types of organic compounds that were found to be present in the buildings can participate in the creation of a variety of combustion byproducts, such as brominated compounds, which have not been characterized and could contribute to elevated risks. Several reviewers agreed that this larger issue should be discussed in the expanded monitoring section to clearly state what data are available and which compounds that might be a concern have not been characterized. One of the reviewers emphasized the importance of introducing such issues early in the document, in the monitoring section, to reduce the complexity of the exposure and risk evaluation discussion.

Reviewer discussion on PCBs concluded by reiterating that EPA's cancer risk assessment appears to be accurate, finding risks to be well below levels of concern. The noncancer effects assessment should be revised by revisiting the benchmarks used, which might change the conclusions.

3.6.2 Dioxins and Related Compounds

Reviewer comments on the dioxin assessment addressed (1) issues related to the monitoring data, particularly with respect to detection limits and presentation of the available data, (2) the approaches used for the cancer and noncancer assessments, and (3) exposure factors used for inhalation rate and exposure duration, particularly for the occupational worker assessment. In general, the reviewers found this section to be well done and requested that EPA improve the presentation to make this complicated assessment more accessible to the reader.

Initial discussion on the dioxin section focused on monitoring methods and detection limit issues, which resulted from two types of sampling that were used. Several reviewers questioned the applicability of some of the monitoring data that had high detection limits, but they ultimately agreed that EPA used the available data in an appropriate manner. Although reviewers did have concerns about the data, they recognized that dioxin levels were extremely high during the first few months, so detection limit issues were not of major concern until later, as levels decreased. Reviewers suggested that the discussion be clarified, both in the Section III monitoring methods section as well as in this section (particularly Table 4, which summarizes dioxin toxicity equivalent [TEQ] concentrations at three monitoring locations). This should provide a better characterization of the limitations of the data and the impact of the high detection limits for select samples at WTC Building #5 and Church and Dey during the first few months. In addition, the Park Row data should also include detection limit information. Reviewers also asked that EPA reorganize Table 4 to make the dates comparable across the three dioxin sampling locations. Reviewers also commented that EPA should provide its rationale for using half the detection limit, which is commonly used, instead of other possible approaches for dealing with nondetects. These comments also pointed out certain data points (e.g. 10/11 at

WTC Building #5), where most of the dioxin TEQ was contributed by non detects.

Reviewers also questioned why the highest measurements that were observed on September 23 were used to extrapolate back to earlier time periods when no data were available. One reviewer felt that it would be better to state that concentrations are unknown from the time period before monitoring was conducted, as was considered for other chemicals. This discussion should be included up front in Section III and reiterated here. The reviewer added that the document should state that modeling is currently being done to better estimate dioxin releases and concentrations during the first 10 days but that no assessment of potential health effects should be conducted at this time. Reviewers concluded the discussion of the dioxin monitoring data by reiterating that the table and text should provide more clarification on these issues.

Comments on the dioxin cancer and noncancer health assessments were generally positive, with requests that EPA clarify the approaches used. One reviewer noted that the dioxin cancer assessments were straightforward for estimating risks from short-term exposures. It was noted that a short qualitative discussion should be added to differentiate between potential impacts to different populations, such as the difference between a short-term, high exposure to children versus to the elderly. For the noncancer assessments, one reviewer commented that EPA's approach using an MOE based on body burdens should be described in more detail because it is atypical from approaches used for other chemicals. This MOE (the ratio of body burden where effects are found divided by a body burden at a level of interest) discussion might also benefit from the addition of information on background body burdens, as well as levels at which effects would be of concern. Such a discussion would give context for the degree of concern one might have from a 10% increase in body burden. It might also be noted that uncertainties related to this analysis, including animal-to-human extrapolation, could add another 10-fold factor, which might start to approach body burdens where effects might be observed. One reviewer would have liked to have seen a comparison of dioxin levels with health-based benchmarks but recognized that EPA does not have noncancer reference values for dioxin. This reviewer asked that EPA consider examining the World Health Organization's tolerable daily intake for dioxin

to see if it might be appropriate if adjusted for this application.

Overall, reviewers found the dioxin health effect analyses to be acceptable, but a few reviewers suggested that EPA revisit a few exposure factors used in the occupational exposure assessment. Specifically, several reviewers suggested that a higher exposure frequency be used (12 hrs/day and 7 days/wk) because it has been well documented that recovery workers were on site for extended periods, with few days off. Similarly, because of the strenuous work performed, reviewers suggested that EPA consider using an inhalation rate higher than 1.3 m^3/hr, possibly as much as twice that value. One reviewer also added that the inhalation rate for the residential receptor, 0.55 m^3/hr, might be increased to 0.7 m^3/hr. Reviewers suggested that EPA revisit these inhalation rates by consulting *Exposure Factors Handbook.* It was acknowledged, however, that if these exposure factors were changed, the results would be only slightly impacted.

An issue was raised during discussion of the dioxin occupational assessment, and discussed in more detail during other portions of the meeting, was that the focus of this report should be on general population exposures. Occupational exposures should be the topic of another document, where a more extensive assessment can be undertaken; therefore, it might benefit this document to move some of these analyses to an appendix. Also during this session it was suggested that the document set aside a subsection on chemical mixtures and cumulative risk because of concerns about interactions among chemicals. Although quantitative analyses, such as calculating hazard indices across multiple contaminants, might not be conducted for this report, it should be mentioned for consideration in future studies. The assessment approach section (Section II) would be an appropriate place to introduce these concepts.

3.7 Asbestos

Several criticisms were voiced on the asbestos assessment. It was recommended that EPA use the IRIS toxicity values for a health-based assessment, instead of the AHERA approach; revisit

raw data to convert them from s/mm^2 to s/cc; conduct a risk assessment (similar to what was done for dioxin); and discuss uncertainties.

One reviewer expressed concern over EPA's use of the AHERA standard as the benchmark because it is not a health-based value, but rather is based on practicality of measurements in asbestos abatement. This reviewer reiterated that the overall approach should be changed to a more appropriate procedure for outdoor (ambient) air and risk assessment purposes. This would also call for converting the monitoring data presented in s/mm^2 (used for the AHERA approach) to volumetric units (s/cc or s/mL) for use in the risk assessment with the IRIS unit risk value. There were concerns about the use of PCM for measurement for ambient air samples, because it could frequently lead to misleading conclusions. The preferred method for ambient (outdoor) air would be TEM, which is more sensitive and provides more reliable results for outdoor samples that have high concentrations of other fibers. This reviewer acknowledged that the existing measurement data can be used for the assessment, possibly by considering calculating an average of concentrations for the PCM and TEM measurements. EPA should revisit the raw TEM analyses data to obtain the concentrations of fibers longer than 5 µm and the air volume data from the sampling. This information can be used to convert the asbestos data to appropriate units (s/cc).

Additional discussion among several reviewers supported using the IRIS value for the asbestos risk assessment. One reviewer provided an overview of the suggested approach, which would be to use the converted data (reported in s/cc) and the IRIS toxicity value ($4x10^{-5}$ fibers/mL at a target risk value of 1 in 100,000). The assessment should also take into account the less-than-lifetime exposure duration, distinguishing between the lifetime exposure duration used in deriving the IRIS value (similar to how an assessment would be done for children). This approach would be similar to what EPA used for the dioxin risk assessment. Several of the reviewers commented that they believed that the results of this assessment would likely result in slightly more conservative health risk estimates. Reviewers also agreed that there should be a qualitative discussion on the uncertainties in the risk assessment due to the inherent uncertainties

in the sampling and analysis of asbestos and the conservative assumptions used in the risk assessment.

One of the reviewers also revisited the issue of glass fiber and mineral wool raised earlier in the PM discussion, acknowledging that these are large-diameter fibers (unlike those of asbestos) that can pose respiratory impacts. This reviewer reported that NIOSH has an occupational exposure limit of 3 fibers/cm^2 for glass fiber, which could be adjusted for application for the general population. Concentration data for glass fiber could be obtained from the filters collected for asbestos measurement, and a qualitative assessment could be added to the discussion to address potential health effects. Another approach, which would require more work, would be to use the $PM_{2.5}$ teflon filters and do an indirect analysis. Such an indirect analysis would be more of a future effort rather than being useful for this assessment. Several reviewers attempted to characterize potential risks from the glass fibers, which may be responsible for some of the respiratory irritation effects. One reviewer commented that there could be some exceedances for glass fibers, especially for the recovery workers, but less so for the general population. Conclusions for asbestos could not be addressed because of the need for these additional analyses.

3.8 Volatile Organic Compounds

Reviewer discussion on the VOC assessment raised several concerns about the utility of the VOC monitoring data to assess general population exposures because of the locations of sample collection, type of samples collected (most data points are for grab samples), and issues related to detection limits. All of these issues could impact the conclusions drawn from the assessment; therefore, EPA should include appropriate caveats because of the data limitations. Reviewers also discussed the benchmarks that should be used to characterize risks to the general public and site recovery workers (if retained in this assessment). Overall, reviewers agreed that VOC concentrations in outdoor air posed minimal impacts to the general population, but they were concerned about the limitations of the monitoring data.

One reviewer stated that the discussion on VOCs was very clear and well laid out, but this reviewer did have some concerns with using the data sets provided to draw conclusions on exposures and risks to the general populations. This reviewer added that most of the VOC data are from grab samples, which were not collected to characterize exposures but were intended to inform recovery workers within the restricted zone of the location of hot spots. As a result, the locations for most of the sampling were near the sources and plumes of smoldering fires, so they are not well suited for characterizing exposures for the general population (or even for recovery workers). Although grab samples of VOCs can be valuable for indicating high levels at certain locations and give an indication of which chemicals are present, 24-hour samples would be much more appropriate for an exposure assessment. Several reviewers were concerned about the possibility of inaccurate representation of VOC exposure from grab sample data.

After discussing the extent of the VOC grab samples, some reviewers felt more comfortable that there was reasonable spatial and temporal coverage, such that the data could be used as an upper bound estimate, with the proper caveats. Several reviewers reiterated the importance of presenting this information in the revised "monitoring design" section of the document to help the reader to understand the limitations of the data sets before they are used for the exposure and risk assessment. The reviewers also inquired about the extent of the 24-hour samples, discovering that those data sets were limited to one day in late September 2001 and a few days in December 2001. Reviewers concluded that use of the available data, which are mostly grab samples, would be acceptable if the appropriate caveats are included in the discussion on the limitations of the data. This should acknowledge that there are few exceedances, even using the grab sample data, that would be expected to be higher than levels to which the general population would be exposed. For the health effects assessment, reviewers advocated the use of the ATSDR Intermediate MRLs (also considering the toxicity information on which they are based) with the 24-hour samples to evaluate potential risks to the general public. Another reviewer suggested that the grab samples would be useful for comparison to Short Term Exposure Limits (STELs) to assess risks for recovery workers (if retained in the assessment).

In general, reviewers found the conclusions to be acceptable, noting that only benzene would be of slight concern from the grab samples. When using the 24-hour samples, there were no exceedances, based on the ATSDR acute and intermediate MRLs. One reviewer identified a potential problem with detection limits for benzene, which raised additional concerns about the conclusions. Several reviewers suggested that the last sentences dealing with benzene on page 110 be revised or deleted, because the conclusion states that exposure to the general population within the restricted zone was minimal, but this conclusion is based on few samples. It was suggested that this last sentence could be included in the report if the proper caveats are clearly stated. Another reviewer suggested taking out the entire last paragraph because it depended too much on limited data. It was generally agreed to by all the reviewers that more information be provided on the VOC sampling (such as the total number of samples, number below detection limits, spatial and temporal distribution, etc.) so that the data are more transparent to the reader in understanding the limitations in using these data for assessing general population exposures.

3.9 Comment on the First Several Days After September 11

The reviewers felt that the discussion presented in this section could be moved up to the front of the document to be included in the monitoring section (Section III). The issues raised are similar to the discussion that should be expanded upon in that section, which would provide a better description of the data that are available, what time periods can be reliably evaluated, and what populations can be evaluated using the data collected. It was suggested earlier that information be added to the report on the monitoring program design, including information on what monitoring was done and not done. The discussion currently presented in this section would fit well in that expanded section.

3.10 Occupational and Indoor Exposures

In general, reviewers felt that the occupational and indoor air information presented in the document distracted the reader from the primary focus of the document, which is ambient (outdoor) exposures to the general population. Reviewers found these assessments to be of

variable quality, which would be expected because of limited data to characterize concentrations to which recovery workers in the restricted zone might be exposed. Some reviewers felt that these discussions should be removed from the document, and others suggested that they be moved to appendices. Most reviewers stated that these issues need to be addressed in a more comprehensive manner, which would call for separate stand-alone documents. Because such documents might not be developed (at least by EPA), some reviewers suggested that the assessments done to date be retained, but be de-emphasized by placing them in the appendix.

3.10.1 Occupational Exposure Assessment

Reviewer discussion began with one reviewer suggesting removing the section on occupational exposure because there were not a lot of onsite measurements, especially for PM. The reviewer claimed that the data collected do not reflect the exposures of on-site recovery workers within the restricted zone. Several reviewers agreed that the workers participating in the recovery effort were exposed to more extreme conditions than indicated by the data presented (mostly from perimeter monitoring locations). The exposure was outdoors, but it was an extremely unique and unknown exposure. In addition, the recovery workers were often on site 12 hrs/day for 7 days/wk and they didn't use respiratory protection. Another reviewer suggested leaving the section in, but removing the references to occupational exposures to PM, because of the data shortcomings. Similarly, another reviewer added that the asbestos measurements do not provide an adequate characterization of occupational exposures. Limitations in the asbestos data result from variability in the PCM analyses, the location of the monitors, and other complexities, which call for a more extensive assessment in a separate report. Alternatively, several reviewers commented that the dioxin occupational analysis was well developed and appropriate, somewhat because on-site measurements were available. This discussion brought up again the suggestion that the monitoring methods section be revised to better describe the sampling procedures, methods, time frames, etc., which would better illustrate the strengths and weaknesses of the various data sets for use in estimating exposures.

Several reviewers felt that the occupational exposure discussion should be removed; however, a question was raised asking whether other reviewers would suggest removing this section if another assessment were not done focusing on worker exposure. One reviewer noted that the downside to keeping this section in the report is that the data do not provide a clear picture of conditions for recovery workers and that it distracts the reader from the main focus on outdoor exposures of the general population. Several reviewers agreed that "someone needs to do this" and suggested that EPA work with NIOSH, OSHA, and other organizations to conduct a more extensive assessment. Reviewers did acknowledge, however, that unless there will be a separate report on occupational exposure, it would be better to include the available information, but possibly de-emphasize this section or put it into an appendix. Many reviewers agreed with this sentiment, commenting that such a suggestion would be an acceptable middle ground.

3.10.2 Indoor Air Exposure Assessment

Reviewers felt similarly about the indoor exposure discussion, suggesting that it would be best if it were taken out and prepared as a separate report. The issues are very complicated and warrant more extensive analysis and discussion. In addition, there are many other groups addressing aspects of the indoor air issue, including many health studies that might not be completed for some time. It was pointed out that the main data set included in this section was the ASTDR study, and this creates an uneven match when compared to the rest of the document. It was also not clear whether the ASTDR study had been peer reviewed. The indoor air issue is more complicated than the ambient air assessment due to the challenges in cleanup and confirmatory sampling, which deserves a more extensive treatment in a stand-alone document.

Many reviewers agreed that the indoor exposure section should be further developed as a separate document, or it could be added to what has already been prepared and peer reviewed (WTC, 2003). This document could introduce the issue and refer readers to other studies/organizations that are addressing ancillary studies. One reviewer cautioned against adding web sites for ongoing studies because they can become outdated very quickly. It was also suggested that EPA re-examine the indoor air sections in the current draft of the report (e.g.,

asbestos assessment) because of errors in the measurements and assessment. Reviewers concluded their discussion with a suggestion that EPA work with other organizations with responsibilities for the indoor air issue. It might even consider commissioning an independent group of experts to further address the indoor air issue, such as the National Academy of Sciences. Reviewers wrapped up the discussion and recommended that EPA should move forward quickly to determine the most appropriate future activities and mechanisms for completing an indoor air health assessment.

3.11 Conclusions/Executive Summary

In general, the reviewers' comments on previous sections addressed the contaminant-specific and overall conclusions presented in the executive summary. The executive summary will change after EPA revises the assessment, based on the panel's comments. One reviewer felt that the second paragraph of the executive summary, which indicated that the report covers the inhalation exposures of the general population residing and working in the area, which are indoor activities, does not fit with the outdoor assessments, which are the focus of the report. Also, the executive summary should be improved to make it suitable to be a stand-alone document. One reviewer commented that the executive summary should more clearly indicate the time frames when contaminant levels returned to background levels.

During this final discussion session of the meeting, the Chair facilitated preparation of flip charts summarizing the major recommendations from the reviewers (presented in Appendix E). The items placed on the flip charts included those issues where the reviewers felt strongly about corrections or improvements that should be made by EPA to the document. Following this discussion, reviewers made final concluding statements. Overall, the reviewers felt that EPA should be commended for its assessment. The document will be well received if time is taken to revise and incorporate the proposed recommendations and suggestions. The document needs to be refined, with a clearly stated purpose and scope, which should result in an excellent assessment. When completed, this document will be the definitive statement on outdoor air and the potential health effects from the airborne pollution created by the World Trade Center disaster. The document should be completed in a timely manner because of the public's need for information on potential health risks. It would also be desirable to make it the first of a series of documents focusing on ambient (outdoor) air exposures for the general population. EPA was encouraged to consider further enhancing its separate assessments on indoor air (WTC, 2003) and to work with other groups on the occupational exposure issues. In addition, other longer-term studies should be considered, such as conducting toxicity tests on the dusts and characterizing other contaminants of concern, to better assess potential health impacts.

4. OBSERVER COMMENTS

Several opportunities during the two-day meeting were provided for observers to make comments and provide feedback on EPA's document. This section summarizes the statements made by observers who spoke during the meeting. Written statements, handouts, and documents provided by observers during and following the meeting are presented in Appendix G.

4.1 First Comment Period

Mr. Joel Kupferman, of the New York Environmental Law and Justice Project, stated that he was an attorney with the firefighter's union. He commented that EPA did not provide the data that it had obtained in a prudent manner. The data that were collected were very revealing and exhibited exceedances. He stated that releasing this information after the fact is really only an academic exercise. Mr. Kupferman felt that EPA did not go out of its way to obtain data and that his organization did. He also commented that only 218 out of 1000 landowners responded to questions on why they either did or did not re-open their buildings. Mr. Kupferman felt that there was inaccuracy in the monitoring data and indicated that the statement had been made that personal monitoring data had been thrown out because it was too high; they were dismissed as a spiked sample. Mr. Kupferman noted that studies are still on-going on the plume moving towards Brooklyn and that, in addition, trucks were known to have taken things from Ground Zero to other areas. Scientists indicate they want lots of data, but none of the site workers were registered beforehand so as to keep track of them. Nurses who have come forward with respiratory problems have not been included in reports. Mr. Kupferman felt that people should have been warned that they could have been exposed to chemical hazards from the World Trade Center buildings (e.g., 6800 pounds of mercury) and also that there is a need to better understand where the chemicals are moving. Mr. Kupferman offered, upon request by the Chair, to provide a list of names of the people he had mentioned who have come forward with respiratory illnesses.

Ms. Diane Dreyfus commented that no testing had been done on workers. She also stated that Dr. Chatfield was not a good choice for the panel because of his past work for W.R. Grace in the Libby, Montana, case. Ms. Dreyfus suggested that another reviewer be added to the panel, Jim Millette from EPA Region 8 (who is actually not an EPA employee but is a principal of a private corporation, Millette Vanderwood Associates, Inc. [MVA, Inc.]).

Ms. Ann Warner Arlen stated that she was the Vice-Chair of Community Board #2 (which covers Canal Street to 14th and the Bowery to the Hudson River) and reviews projects and brings matter of urgency to city agencies. Ms. Arlen raised two points. The first point was that she felt that the line drawn at Canal Street was extremely arbitrary. Particles were still found in the air, and the smell of fires could be detected beyond this cut-off point. Apartments beyond this area were full of fumes, and some people reported coming down with chronic cases of bronchitis and sinusitis. High levels of particulates were found near NYU and Beekman as well as in areas in Brooklyn and New Jersey; however, these impacted places were left out of the monitoring that was performed. The second point was that lessons learned are important in this situation; she hoped that responses would be better and stated that there is also a need to commit to doing the right thing now. She stated that people were told that "there is nothing to worry about" and that she had the feeling that these issues did not matter to the government. Upon request, Ms. Arlen offered to provide copies of the NYU/Beekman and University of California, Davis, particulate studies (not received as of the finalization of this report).

Ms. Jo Polett noted that she "is the target audience" because she lives just six blocks north of the World Trade Center and returned to her apartment on September 18, 2001, but then had to leave in November and only returned again ten days ago. Ms. Polett requested that EPA investigate indoor air. She noted that the cleaning efforts in her apartment were not done properly. She had no history of respiratory problems but has had recurring problems since returning to her apartment. Her apartment had been cleaned in May 2002, but during the subsequent testing, she found that one of the fans was never turned on in her apartment and that the others were not oscillating, as is required in the testing protocol. She made the point that this makes the sampling data useless. Ms. Polett also noted that the ATSDR/NYCDOHMH study referenced in

the report only sampled two buildings and was not representative of what was actually in the building. She stated that assessments can not be based on the available indoor air data. Although the outdoor air might be acceptable, there are high levels of contaminants in the indoor air, so the exposures are ongoing.

Ms. Kimberly Flynn, of 9/11 Environmental Action, read aloud a letter that she had written on behalf of the 9/11 Environmental Action group to the Regional Administrator of EPA Region 2, Jane M. Kenny, dated July 14, 2003. The letter was written to formally object to the failure of EPA to comply with the "proper, legally mandated public process in its assessment and cleanup of hazardous substances released in the World Trade Center disaster." The letter requested implementation of a public process to include affected communities in the decisions being made that affect their health and environment. Ms. Flynn noted in the letter that EPA had promised to establish a citizen's advisory group in 2002, but this was never created. The letter also voiced objection to the failure of both EPA and Versar to conduct public outreach for the current peer review meeting. She noted that community-based organizations and advocacy groups were not given the opportunity to nominate qualified experts to serve on the panel nor was the public given ample time to review the chosen panelists' CVs. The letter also noted objections to certain panelists who were chosen, based on possible ties to either EPA or major polluting industries regulated by EPA. The letter requested (and stated that this request was made in two previous letters) that EPA initiate a "legitimate public process" and a comprehensive cleanup of all affected residences and workplaces.

4.2 Second Comment Period

Ms. Jenna Orkin, of 9/11 Environmental Action, requested that Dr. Thomas Cahill's PM data be included in the PM section of the report. These data were made public in February of last year. She pointed out that the $PM_{2.5}$ data for areas beyond the site have consistently been reported by EPA to be at levels that are fine, but she stated that this was not the case. At Stuyvesant High School, PM concentrations were much higher than at Ground Zero. Ms. Orkin noted that EPA has stated that it does not expect short- or long-term health effects, but she pointed out that there

already are illnesses. She commented that there has not been any effort to do a study on the students at the high school. Most of her knowledge on the situation is anecdotal, but she stated that students have had respiratory illnesses and that one teacher at the high school was reported to have been a lung cancer victim. Ms. Orkin requested that EPA acknowledge the potential health effects from the high levels of contaminants. At Stuyvesant High School, asbestos concentrations were found to be as high as 123 s/mm^2; however, the contractor hired to sample in the high school reported no problems. All of these data are suspect. Ms. Orkin requested that a doctor be added to the panel to examine health effects from the World Trade Center. In answer to a question from the panel, Ms. Orkin noted that the PM concentrations at the high school were provided by sampling overseen by the parent's association of the high school (ATC–inside sampling; ATC and EPA–outside sampling). A question was raised by the panel whether Cahill's data are readily available. It was noted by Ms. Orkin that they were available on the web site, http://www.nyenvirolaw.org .

Dr. Robert L. Jaffe, of Environmental Toxicology Laboratory, questioned whether in vitro tests were performed. He noted that pollutant mixtures should have been evaluated, as well as the toxicity of small particles and new types of pollutants not previously studied. He suggested that if samples are still available, his laboratory could do tests with them. His lab has developed a new toxicity test using protozoa. Dr. Jaffe provided information to Versar to pass on to the panel describing his lab and testing procedure.

Ms. Jo Polett spoke for Ms. Nina Lavin, noting that the EPA fact sheet on the report being discussed does not say "ambient" in the discussion of potential short- and long-term effects. She also suggested that the executive summary be rewritten to add uncertainties on the health effects. She provided the peer review panel with copies of a New York Times article from December 28, 2002, for review, adding that such articles, stating that there are no health effects, hinder cleanup of apartments. She provided the panel with the executive summary of the ATSDR/NYCDOHMH study as well as supporting data. She requested that the panel review the full ATSDR/NYCDOHMH study, which is available on the Internet, as well as the underlying data. Ms. Polett posed a question asking whether asbestos really is a good indicator

of World Trade Center contamination, because it is being used to determine the need to clean up apartments.

4.3 Third Comment Period

Dr. Catherine McVay Hughes, of NYU, has prepared community outreach materials on the World Trade Center, highlighting ongoing research projects. She also pointed out that local papers have reported on a survey of respiratory problems in residents. She commented that the public outreach to the communities needed to be better. Dr. Hughes stated that there needed to be a consideration of risks from ingestion of dusts inside homes. This also poses additional risks to residents who work in the area, so they are exposed 24 hrs/day. It should also be highlighted that the restricted zones were not always effective at keeping people out of the restricted area. She pointed out that there are still buildings available for collection of dust samples. One suggestion she made was that EPA include, along with meteorological data, temperature maps, which could be useful in discussing the fate and transport of pollutants. A panel member asked whether there was further information on the respiratory symptom survey, and Dr. Hughes directed the panel to the Community Board #1 Web site, http://www.cb1.org , which provides the contact information for the District Manager, Paul Goldstein.

4.4 Fourth Comment Period

Dr. Marjorie J. Clarke, of Lehman and Hunter Colleges, commented that she was glad to hear the panel recommending that more studies be done, particularly indoor air studies involving additional organizations. She criticized EPA for releasing conclusions prior to conducting peer review of its studies, which resulted in confusion in the public on the potential health effects from the World Trade Center. She suggested removing conclusion #3 from the report and argued that it was being used to silence the cleanup program advocates. Other concerns were for synergistic effects of the complex mixture of pollutants, such that conclusions should not be made before the interactions are better understood. Using the precautionary principle should be encouraged. In addition, EPA's premature statements led to bad decisions, including delegating

responsibilities to other authorities for cleanup and other activities, which have resulted in increased exposures.

Ms. Kimberly Flynn suggested a re-writing of the executive summary and conclusion #3 to better reflect the information from various doctors on the extent of disease resulting from the World Trade Center exposures, even though the available chemical exposure data are limited. Qualitative statements should be made on the limited knowledge on chemical mixtures and impacts to occupational environmental health. She mentioned a presentation by Steve Markowitz that had been given at the New York Academy of Sciences in February 2003 that supports that statement. EPA has the opportunity to provide accurate information on risks to help restore public confidence and increase public awareness. Ms. Flynn endorsed the panel's recommendation for a separate document on indoor exposures and chronic health effects as well as the use of an independent panel to address the indoor air issues related to the cleanup. She stated that she hoped the case would be made to re-open the cleanup effort and to re-examine the indoor air data.

Ms. Orkin suggested that the reviewers consult a white paper by Congressman Nadler and also the EPA Inspector General's report of January 27, 2003, which criticizes EPA on apartment cleanup. She noted that EPA cleaned very few HVAC systems and left most decisions to the residents, who had little information on which to make decisions. EPA's cleanup was also incomplete and insufficient. She commented that the outreach by EPA needs to be more extensive to educate the public. Ms. Orkin noted that at Stuyvesant High School, a barge waste transport site was located very close by. However, the ventilation system of the school was only cleaned after threats were made to sue over elevated lead levels. Ms. Orkin reiterated that, based on NIOSH respiratory studies of faculty and staff, as of last May, 60% of them still had respiratory symptoms attributed to the World Trade Center. She also encouraged EPA to look at shorter asbestos fibers.

Ms. Jo Polett suggested that the term "ambient" be replaced with "outdoor" to make it clearer to the reader what the report addresses. She also advocated that an independent panel address the

indoor air issue and that a community representative be included on the panel. She also provided information on the inadequacy of the cleanup and stated that EPA did not address dust inside air conditioning systems. Most buildings were not completely cleaned up. EPA's outreach also needed to be improved; the May 2002 mailing was not received by many people, and other materials were not helpful.

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APPENDIX A

Peer Reviewer Biographical Sketches

Compilation of Biographical Sketches for Peer Reviewers of
Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster

Peer Reviewers

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Eric J. Chatfield, B.A., M.A., Ph.D.

Dr. Chatfield received his B.A., M.A. and Ph.D. from Cambridge University in the United Kingdom. His B.A. and M.A. were in Natural Sciences and included mineralogy and crystallography; his Ph.D. thesis was in Colloid Science, and was based on studies of particulate hydrosols and aerosols. From 1958 to 1968, Dr. Chatfield was with the Nuclear Safety Section of the United Kingdom Atomic Energy Authority where his work involved studies of particle size distribution of aerosols, using electron microscopy and diffraction, and included design and execution of field studies of the dispersion of airborne particulate. From 1968 to 1985 he was Head of the Electron Optical Laboratory at the Ontario Research Foundation. Dr. Chatfield is currently President and Principal Analyst of Chatfield Technical Consulting Limited which he formed in 1986 to specialize in asbestos analysis and research.

Dr. Chatfield has been developing methods for determination of asbestos since 1970, including a method for determination of asbestos in resilient flooring materials to provide quantitative results and to overcome the problem of false-negative results often obtained by routine PLM, a gravimetric method which provides reliable quantification of low concentrations of asbestos in building materials such as plasters, cementitious and texture materials, a method using PLM and SEM for screening of vermiculite samples for the presence of amphiboles, and preparation of reference standard suspensions for quality assurance in TEM analysis of water samples.

For the U.S. EPA, Dr. Chatfield developed the analytical method for determination of asbestos in water, a standard operating procedure for collection and analysis of air samples for asbestos, an analytical methodology for sampling and analysis to provide results for airborne asbestos with sufficient sensitivity and precision to permit risk assessment determination, a quality assurance guideline for TEM asbestos laboratories, and an analytical method for determination of asbestos in vermiculite. Dr. Chatfield was a member of the Select Committee which drafted the U.S. EPA AHERA TEM Analytical Methodology for asbestos abatement site clearance.

Dr. Chatfield is Project Leader of the International Organization for Standardization (ISO) Working Groups which have developed 3 analytical methodologies for measurement of airborne asbestos in ambient atmospheres, and are currently developing a sampling strategy for measurement of asbestos in building atmospheres. He is also a member of the ASTM Committee which is developing reference analytical methods for measurement of asbestos in dust and in air. Dr. Chatfield was a member of the Der Verband der Chemischen Industrie e.V. Working Group which developed a standard procedure for measurement of asbestos in parenteral medicines.

Dr. Chatfield was a consultant to The Royal Commission on Matters of Health and Safety Arising from the Use of Asbestos in Ontario, and prepared advisory reports on both PCM and TEM measurements of asbestos in air. He was editor of "Asbestos Fibre Measurements in Building Atmospheres", prepared for Health and Welfare Canada. Dr. Chatfield was a member of the Literature Review Panel and the TEM Analysis Steering Committee of the Health Effects Institute - Asbestos Research. Dr. Chatfield is a Technical Advisor and Laboratory Assessor for

the Hong Kong Laboratory Accreditation Scheme (HOKLAS) asbestos analysis accreditation programs, has provided training courses in TEM analysis for asbestos, has been a consultant to a number of laboratories concerning set-up, equipment requirements and operation of a TEM analysis service for asbestos, and on behalf of the U.S. EPA, he has conducted audits of laboratories performing TEM analysis for asbestos for EPA programs. Dr. Chatfield has been an expert witness on asbestos measurement for a number of court cases. Dr. Chatfield is a Fellow of the Chemical Institute of Canada. He has over 60 publications relating specifically to asbestos measurement.

Michael L. Dourson, Ph.D., DABT

Dr. Dourson directs Toxicology Excellence for Risk Assessment (TERA), a nonprofit corporation dedicated to the best use of toxicity data for estimating risk assessment values. TERA's projects include the development of complex risk assessments, such as soluble nickel salts, research into improvements of risk methods, such as comparative dietary risk for fish consumption, and education and outreach on risk assessment values through lectures and data bases, such as the International Toxicity Estimates for Risk (ITER). TERA prizes the development of partnerships between government agencies and industry.

Dr. Dourson has a Ph.D. in Toxicology, University of Cincinnati (1980) and is a Diplomate of the American Board of Toxicology and served on its Board as President, Vice President and Treasurer. He has published more than 50 papers on risk assessment methods, co-authored over 100 government risk assessment documents, and made over 80 invited presentations.

For fifteen years, Dr. Dourson held leadership roles in the U.S. Environmental Protection Agency, as chair of EPA's Reference Dose (RfD) Work Group, charter member of the EPA's Risk Assessment Forum and chief of the group that helped create the Integrated Risk Information System (IRIS) in 1986. Dr. Dourson won 4 EPA Bronze medals during his tenure.

Professional affiliations include past presidents of the Dose-Response Specialty Group of the Society for Risk Analysis, of the Society of Toxicology's Specialty Section on Risk Assessment and of the Ohio Chapter of the Society for Risk Analysis. Current affiliations include membership on the editorial board of three journals. Dr. Dourson previously chaired a panel that peer reviewed EPA's *World Trade Center Indoor Air Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks*.

Alison S. Geyh, Ph.D.

Alison S. Geyh is an assistant professor at the Johns Hopkins Bloomberg School of Public Health (JHSPH), Department of Environmental Health Sciences in Baltimore MD. Her work related to the World Trade Center disaster has included area monitoring and exposure assessment of one group of workers at the disaster site, and a health assessment of approximately 8000 workers who were involved in the clean up and recovery effort. Other research interests include assessing the impact of vehicle-related air pollution on the health and environment of

inner city residents and an exploration into the specific chemical composition of metal species found in particulate matter. Before moving to JHSPH, she was a Staff Scientist at the Health Effects Institute where she was project officer for several studies focused on issues of exposure to particulate matter. She holds a doctorate in physical organic chemistry from Brandies University and conducted postdoctoral research at Department of Environmental Health of the Harvard School of Public Health in Boston, MA.

Gary Hunt, M.S.

Mr. Gary Hunt is a Vice President of Air Toxics Programs and Director of Air Toxics Monitoring within TRC in their Lowell, MA office. He works principally in the toxic air pollutant area and, in particular, the characterization, quantification and control of toxic air pollutant emissions from stationary and fugitive sources (esp. combustion) , as well as their distribution, occurrences, transport and fate in the atmosphere. Areas of particular interest and professional activity presently include the following:

Characterization, Quantification and Control of Toxic Air Pollutant Emissions
Environmental Monitoring (Multimedia) in the Vicinity of Combustion/Incineration Facilities (MSW, Hazardous Waste)
Waste Incineration – Emissions Testing Programs (Trial Burns, Performance Testing, Compliance Testing; RCRA/TSCA/MSW/BIF)
Toxics Monitoring – Indoor/Workplace Air (e.g., PCB Fires)
Ambient Monitoring for PCDDs/PCDFs, PAHs and other semivolatile organics
Odor Diagnostics and Abatement – Air Emissions From Industrial Facilities
Fugitive Dust Emissions (MSW Landfills, Quarries, Etc.)
PCDDs/PCDFs Emissions From Industrial Sources – Characterization, Diagnostics
Ambient Monitoring of Toxic Air Pollutants
Litigation Support/Expert Testimony
Title V/CAA Compliance Monitoring Programs (CAM, PM, MACT)
Air Permitting (Title V, BACT, RACT, etc.)
Analytical Methods Development

Mr. Hunt, who holds a B.S. in chemistry from Villanova University and an M.S. in Environmental Sciences from Rutgers University, has more than 25 years of experience in air quality consulting. He is an internationally recognized expert in the field of toxic air pollutants. Mr. Hunt is a Qualified Environmental Professional (QEP) and Fellow Member of the Air & Waste Management Association, as well as a faculty member of A&WMA's CAM workshop series. He is also a member of the American Chemical Society, Sigma XI, the Water Environment Federation, and the American Society of Mechanical Engineers. Mr. Hunt has authored more than 100 journal manuscripts and symposia presentations on environmental topics.

Patrick L. Kinney, Sc.D.

Dr. Kinney is an air pollution epidemiologist with a strong interest in exposure assessment. He has carried out numerous epidemiologic studies addressing the human health effects of air pollution, including studies of the effects of ozone and particulate matter on children's lung function, on pulmonary inflammation in adult joggers, and on daily mortality in large cities. His recent work has focused on characterizing levels and determinants of indoor, outdoor, and personal exposures to air pollution in the underprivileged neighborhoods of NYC, including studies of indoor allergens, diesel vehicle emissions, volatile organic compounds, PAHs, and other air toxins. He directed an NIEHS-funded intervention trial seeking ways to reduce exposures to indoor allergens among asthmatic children living in Northern Manhattan and the South Bronx. He also is the P.I. of a study entitled "Urban Air Toxics Exposures of High School Students," funded by the National Urban Air Toxics Research Center. The study characterized air toxin exposures among minority high school students living in New York City and Los Angeles. Dr. Kinney co-directs the Exposure Assessment Cores of the Columbia Center for Children's Environmental Health and the Center for Environmental Health in Northern Manhattan.

Margaret MacDonell, Ph.D.

Margaret MacDonell is manager of the environmental health risk section of the environmental assessment division at Argonne National Laboratory. She has a Ph.D. from Northwestern and an M.S. from Notre Dame in civil / environmental health engineering, and a B.S. from Notre Dame in biology (with honors). Her work at Argonne has focused on risk assessments for contaminated sites, primarily for federal cleanup programs with an emphasis on Department of Energy (DOE) facilities. In addition to interacting with regulators and the public in evaluating multi-pathway risks, she has also conducted risk training workshops for federal, state, and tribal risk program managers as well as risk workshops for the local community at a contaminated site. Margaret is an adjunct professor at Northwestern University (teaching risk analysis and environmental impact assessment in the Technological Institute) and president of the Chicago Regional Chapter of the Society for Risk Analysis. She serves on the editorial board of international environmental journal and is a participant in various cumulative risk initiatives, including the interagency Mixed Exposures Research Group, American Chemistry Council Risk Assessment Methods Technical Implementation Panel, and collaborative DOE-Environmental Protection Agency interagency agreement on screening guidance for cumulative risk assessment.

Clifford P. Weisel, Ph.D.

Clifford P. Weisel, Ph.D. is a Professor in Environmental and Community Medicine at the University of Medicine and Dentistry of New Jersey-Robert Wood Johnson Medical School and Deputy Director of the Exposure Measurement and Assessment Division of the Environmental and Occupation Health Sciences Institute. Dr. Weisel also holds appointments at the Graduate Faculty of Rutgers University and the School of Public Health of UMNDJ and directs the

Doctoral Graduate Study option in Exposure Assessment, jointly given by the Graduate School of Biomedical Sciences of UMNDJ and the Department of Environmental Sciences of Rutgers University. He was the treasurer of the International Society of Exposure Assessment and an associate editor of the Journal of Exposure Analysis and Environmental Epidemiology and the Journal of the Air Waste and Management Association.

Dr. Weisel has conducted research to evaluate multi-route exposures to volatile organic compounds and trace metals using direct exposure measurements and biomarkers of exposures. His broad areas of interest are analyzing the relationship among ambient, indoor and personal air pollutants; the effect of air pollutants on asthmatics; multi-route exposure to disinfection by-products in drinking water; how the body burden of contaminants and their metabolites vary to reduce uncertainty in extrapolating basic mechanistic data determined at high concentrations in animals to environmental exposures in humans; measuring biomarkers and variations in metabolic rates for use in pharmacokinetic models in humans at environmentally relevant levels; and application of genomics to understand gene-environmental interactions.

APPENDIX B

List of Observers

Technical Peer Review Meeting on the Draft Document Entitled: Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster

July 14-15, 2003

OBSERVERS	
Name	**Organization**
Sara Allen	Ecology & Environment, Inc.
Belina Anderson	New York City Law Department
Michael Brown	U.S. EPA - ORD
Nancy Clark	NYC DOHMH
Marjorie J. Clarke	Lehman and Hunter Colleges
Nathalie Cohen	New York City Law Department
Bernard Cooney	N.Y. Environm. Law and Justice Project
Avidan Cover	New York City Law Department
Diane Dreyfus	Little Italy Neighbors Association
George C.D. Duke	New York City Law Department
Aura Engel	N. Y. Environ.Law and Justice Project
Barbara A. Finazzo	U.S. EPA - Region 2
Kimberly Flynn	9/11 Environmental Action
Robin Forst	Council Member Gerson
Herman Gibb	U.S. EPA - NCEA
Paul Gingrass	Zelle Hofmann
Virali Gokaldas	Natural Resources Defense Council
Hiller Hammer	A.K.R.F.
Jenny Ho	Environmental Defense
Robert L. Jaffe	Environmental Toxicology Laboratory
Joel R. Kupferman	N.Y. Environ. Law & Justice Project

OBSERVERS	
Name	**Organization**
Diane Levy	Columbia University
Carrie Loewenherz	NYC DOHMH
Matthew Lorber	U.S. EPA - NCEA
Faye Lubinof	New York City Law Department
Amy Mahl	Ecology and Environment, Inc.
Shek Mark	U.S. EPA - OIG
Stephen Mazzalonga	New York City Law Department
Kelly R McKinney	New York City Department of Health
Catherine McVay Hughes	New York University
Mary Means	EPA
Yosef Moshe	NYELJP
Morton Orentlicher	Ecology & Environment, Inc.
Jenna Orkin	9/11 Environmental Action
La-Verne Parris	Environmental Defense
Joseph Pinto	U.S. EPA - NCEA
Jo Polett	Downtown Resident - 9/11 Environmental Action
Peter Preuss	U.S. EPA - NCEA
Hara Robrish	New York City Law Department
Jessica Rosenzweig	Council Member Gerson
Amy Rozenfeld	New York City Law Department
Alex Salvagno	AAR Environmental
Rudy Sanfilippo	Uniformed Firefighters Association
Susan Smollens	New York City Law Department

OBSERVERS	
Name	**Organization**
Steven Tishco	New York City Law Department
Diane Van Dyke	N. Y. Environ. Law and Justice Project
Ann Warner Arlen	Community Board #2 Manhattan
Josh Weinberg	N. Y. Environ. Law and Justice Project
Henry Willis	RAND

APPENDIX C

Agenda

United States
Environmental Protection Agency
Office of Research and Development

Technical Peer Review Meeting on the Draft Document Entitled *Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster*

Sofitel New York Hotel
45 West 44th St.
New York, NY 10036

Agenda

MONDAY, JULY 14, 2003

8:30AM	**Registration Begins**
9:00AM	**Welcome, Introductions, and Conflict of Interest Discussion** *David Bottimore, Versar, Inc.*
9:15AM	**Welcome** *Peter Preuss, Director, National Center for Environmental Assessment (NCEA), Office of Research and Development, U.S. Environmental Protection Agency*
9:20AM	**Chair's Introduction** *Michael Dourson, Workshop Chair*
9:30AM	**Background on WTC Assessment** *Matthew Lorber, U.S. EPA/NCEA*
10:00AM	**Peer Reviewer Q&A Session on Background Presentation**
10:30AM	Break
10:45AM	**Observer Comment Period**
11:15AM	**Discussion Session - Purpose and Scope of Assessment**
12:15PM	Lunch
1:15PM	**Discussion Session - Exposure Assessment and Risk Characterization Approach**
2:15PM	**Discussion Session - Monitoring Data**

3:15PM	Break
3:30PM	**Discussion Session - Particulate Matter**
4:30PM	**Observer Comment Period**
5:00PM	**Wrap-Up of First Day**

TUESDAY, JULY 15, 2003

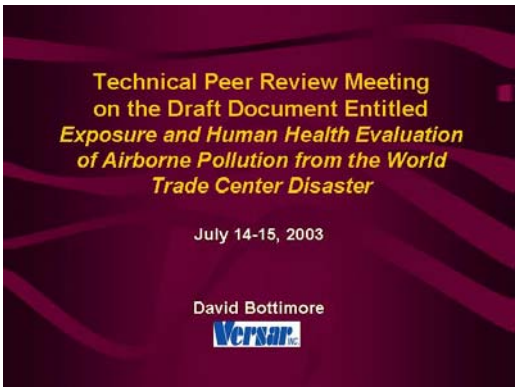
8:30AM	**EPA and/or Observer Comments**
9:00AM	**Discussion Session**[1] **– Metals**
	– PCBs and Dioxins
	– Asbestos
12:00PM	Lunch
1:00PM	**Discussion Session - VOCs**
1:45PM	**Discussion Session - Occupational and Indoor Exposures**
2:30PM	Break
2:45PM	**Discussion Session - Conclusions/Executive Summary**
3:30PM	**Observer Comment Period**
4:00PM	**Summary of Comments and Recommendations on WTC Document and Writing Assignments for Workshop Report**
5:00PM	Adjourn

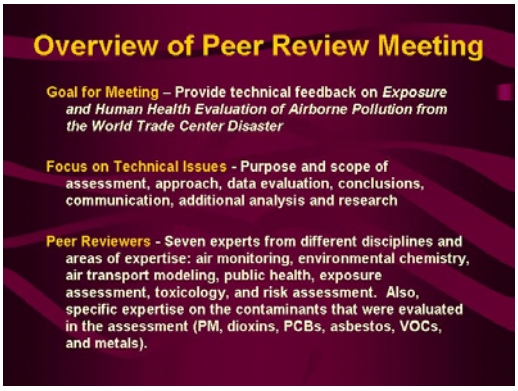
[1] The Chair will determine the appropriate time for the break during this discussion period.

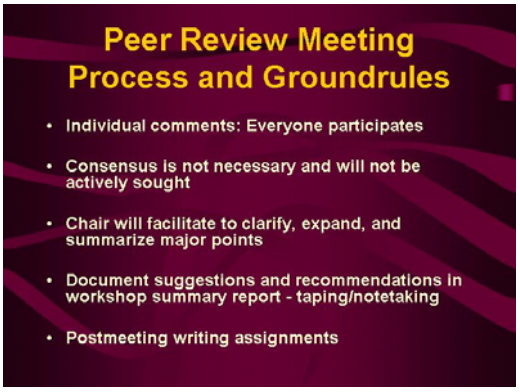
APPENDIX D

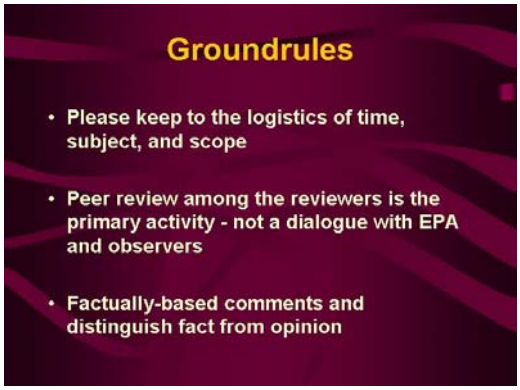
PowerPoint Presentations

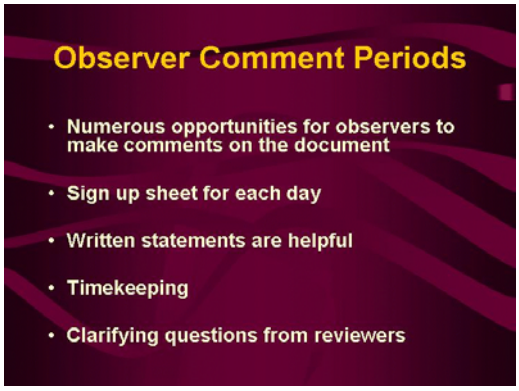
I. Introductory Talk by David Bottimore, Versar

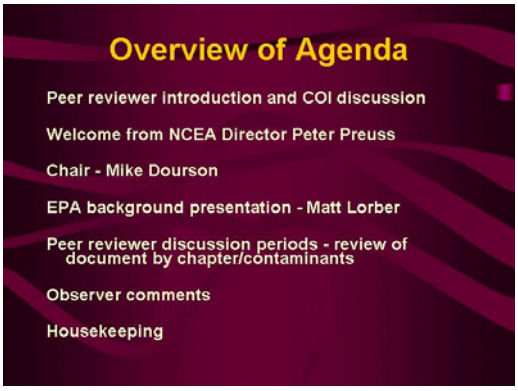


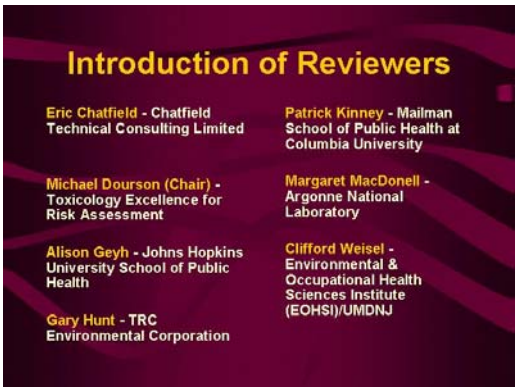




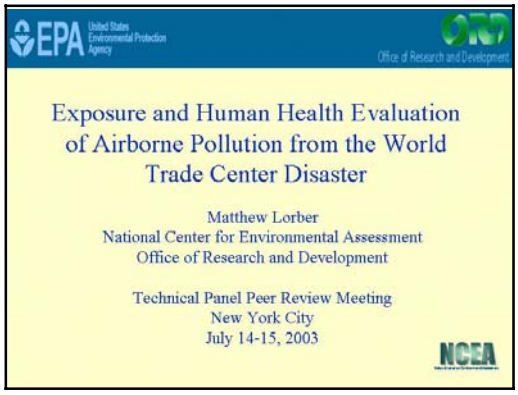


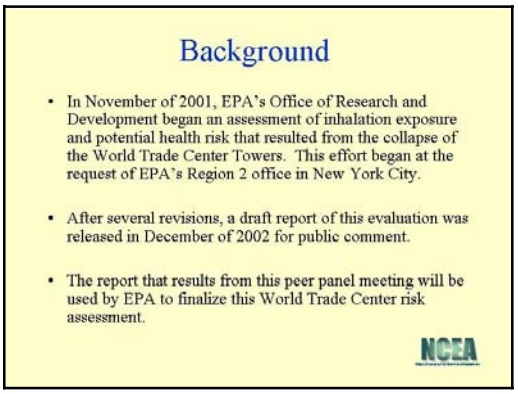


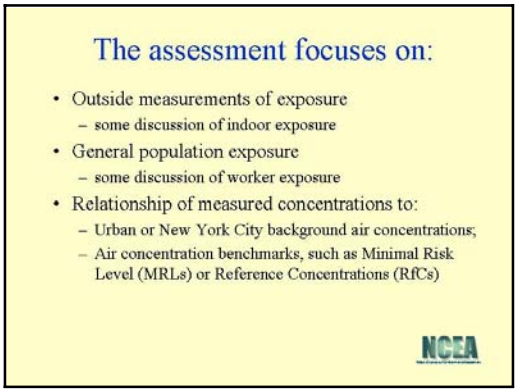


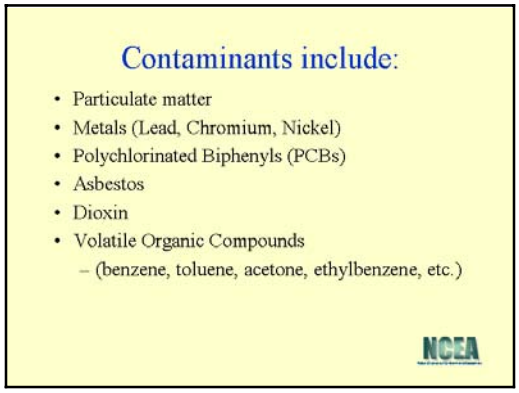

Introduction of Reviewers
Eric Chatfield - Chatfield Technical Consulting Limited
Michael Dourson (Chair) - Toxicology Excellence for Risk Assessment
Alison Geyh - Johns Hopkins University School of Public Health
Gary Hunt - TRC Environmental Corporation
Patrick Kinney - Mailman School of Public Health at Columbia University
Margaret MacDonell - Argonne National Laboratory
Clifford Weisel - Environmental & Occupational Health Sciences Institute (EOHSI)/UMDNJ

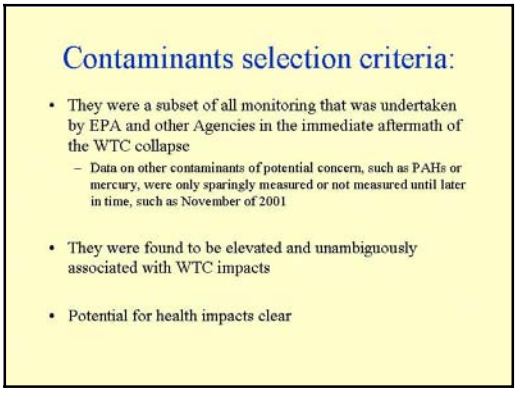
II. Overview Presentation of Document by Matthew Lorber, EPA

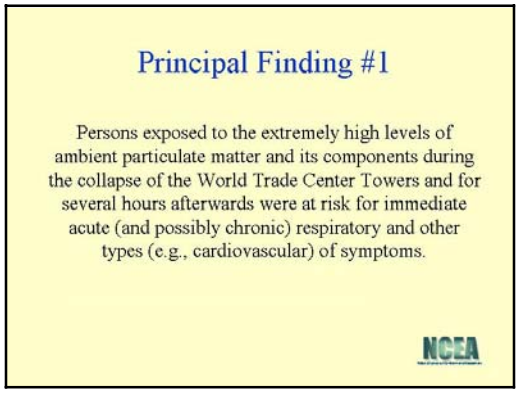












Spread of Dust/Smoke Over Lower Manhattan Immediately after Collapse of the WTC Towers

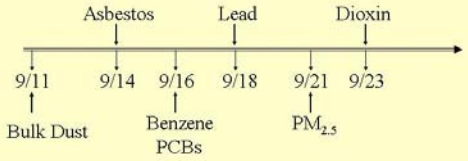
NCEA

Principal Finding #2

The first measurements of some of the contaminants were on September 14, while other contaminants were not measured until September 23. Available data suggests that the concentrations within and near Ground Zero were likely to be highest in the few days following September 11. Because there were only limited data on these critical few days, exposures and potential health impacts cannot be evaluated with certainty for this time period.

NCEA

Dates When Key Contaminants Were First Sampled in Air Within and Near Ground Zero



The Concentrations of These Contaminants Were the Highest in Their First Measurements

Satellite Photograph of the WTC Plume Lofting From Ground Zero at 11:43 a.m. on Sept 12, 2001

NCEA

World Trade Center Plume from Intense Fires (> 500° C) during Days Following September 11

NCEA

Principal Finding #3

Except for exposures on September 11 and possibly during the next few days, persons in the surrounding community were unlikely to suffer short-term or long-term adverse health effects caused by exposure to elevations in ambient air concentrations of the contaminants evaluated in this report. These elevated concentrations were measured mostly within and very near Ground Zero, and they lasted for 1 to 3 months after September 11.

NCEA

Figure Showing the Shrinkages of the Restricted Zones in the Vicinity of Ground Zero Over Time

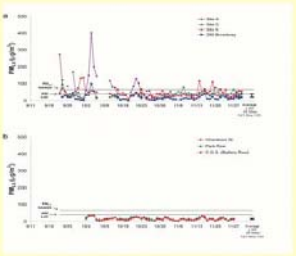
Definition of Restricted Zones:

All vehicular and pedestrian traffic prohibited within the boundaries defined for the given dates.

Particulate Matter

- For several days after the attack:
  - Levels of $PM_{2.5}$ exceeded EPA's 24-hour Air Quality Index (AQI) for susceptible subgroups at some lower Manhattan sites
  - Levels of $PM_{2.5}$ exceeded EPA's National Ambient Air Quality Standard at WTC perimeter
- Levels of $PM_{2.5}$ have exceeded the AQI on dates prior to 9/11/01 in lower Manhattan.
- By mid- to late October, PM values had largely returned to levels typical of New York City and other U.S. urban areas, with only a few sites occasionally approaching the AQI.

Panel A: Daily $PM_{2.5}$ concentrations at sites near Ground Zero and at 290 Broadway
Panel B: Daily $PM_{2.5}$ concentrations observed 3-10 blocks from WTC

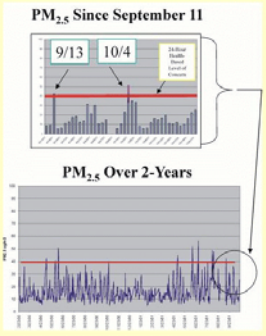


Notes:

Sites A,C, K were in the Restricted Zone through October. 290 Broadway was outside the restricted zone after 9/14.

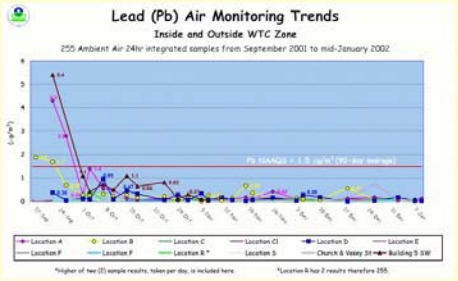
These sites (Chambers St., Park Row, Coast Guard Station) were not in the Restricted Zone in October.

Even though the WTC collapse resulted in elevated airborne particulate matter (PM) near the site, it is clear that the overall pattern of PM after 9/11 is not different from historical trends.



Lead

- The National Ambient Air Quality Standard for lead (90 day average of 1.5 µg/m³) was not exceeded at any sampling site.
- Five 24-hour air lead concentrations measured at three air samplers between September 17 and September 25 at WTC Ground Zero and at perimeter sites were between 1.7 and 5.4 µg/m³.
- After October 8, lead levels at all sampling sites were below 1.5 µg/m³.



Chromium, Nickel, PCBs

- None of the air samples exceeded any of the health benchmarks for these contaminants
- Air concentrations of PCBs presented minimal concern for cancer risk.

NCEA

VOCs

- Exposures to most VOCs were of minimal concern to the general population.
- Sustained benzene concentrations above the New York City background may have occurred for about a month after September 11 outside of Ground Zero but were of minimal health consequence.

NCEA

Asbestos

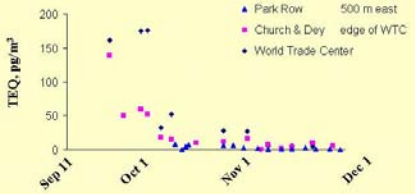
- High levels of airborne asbestos were found in two apartments sampled on September 18.
- A larger and more systematic study of residences conducted in November and December suggested indoor levels of asbestos in dust were slightly higher near the WTC.
- There were relatively few outside airborne measurements exceeding the EPA and OSHA benchmark values.
- Much discussion on the relevancy of both the measurement techniques and these benchmarks for evaluating human health impacts in this situation.

Dioxins
Exposure and Risk Assessment

- A more robust exposure and risk assessment was conducted for dioxin-like compounds because:
  - The 8-hour samples taken at Ground Zero and nearby, and the 72-hour samples taken a few blocks away allowed for a more representative sampling of ambient concentrations to which on-site workers, off-site office workers, and nearby residents were exposed.
  - Procedures to convert short-term dose to the potential for long-term cancer and non-cancer impacts have been developed, or are in development as part of EPA's Dioxin Reassessment.
  - Inhalation benchmarks for shorter-term exposures are still unavailable for dioxin-like compounds, as for other contaminants evaluated.

Dioxins - Concentrations

- Highest ambient concentrations ever measured
- Typical urban concentrations are 0.1 – 0.2 pg TEQ/m^3



Dioxins - Exposures

- Inhalation exposures assumed between Sep 11 and Nov 30
  - Site Worker: 9 pg TEQ/kg-day
  - Office Worker: 0.6 pg TEQ/kg-day
  - Nearby Resident: 0.7 pg TEQ/kg-day
- Background exposures:
  - 0.6 pg TEQ/kg-day from all sources
  - 0.02 pg TEQ/kg-day from inhalation

Dioxins – Health Risks

- Estimated lifetime cancer risk
  - Site Worker: $3 * 10^{-6}$
  - Office Worker, Resident $3 * 10^{-7}$
- Modeled increment to body burden
  - Site Worker: 1.8 pg TEQ/g lipid
  - Office Worker, Resident: 0.2 pg TEQ/g lipid
- Background risk
  - $1.4 * 10^{-4}$ lifetime from all sources
  - Average US adult body burden: 18 pg TEQ/g lipid

Lessons Learned - Assessing Exposure

- Sample as early as possible
  - Some contaminants not sampled for two weeks
  - Site access and power supplies became a problem
- Objectives for monitoring need to be clearly defined:
  - Sample to characterize plume (grab samples into the smoldering fires using probes)
  - Sample to characterize individual exposure (personal samplers)
  - Samples to characterize ambient air (stationary monitors)
- Measurement techniques need to be identified:
  - Methods for asbestos sampling
  - 72- versus 8-hr sampling for dioxin-like compounds

Lessons Learned - Assessing Health Effects

- Health guidance values for acute and subchronic exposures are needed
  - How relevant are standards developed for workers to outdoor exposures and to exposures faced by the general population?
  - "Acute Exposure Guideline Levels" program develops guidance levels for < 1 hr, 8-hour, and other time-frame exposures, but values for WTC contaminants were lacking
- Better understanding of:
  - short fiber toxicity and chemical mixtures especially as they relate to acute exposure
  - fibrous glass exposures
  - alkalinity of concrete dust

Charge for the Panel

- Have we considered all relevant and available data?
- Do you agree with our basic approach to evaluate air monitoring data with respect to background concentrations and to established air concentration benchmarks?

Charge for the Panel

- In addition to this basic approach, do you have any concerns with the manner in which we dealt with any of the specific contaminants?
- Does our analysis support the principal conclusions of this assessment?

Charge for the Panel

- With the exception of dioxin, we did not evaluate worker exposure. Also, we did not evaluate the indoor environment or the epidemiology studies being completed on worker impacts, although we reviewed some data on all three areas. Do you agree with our decisions to narrow the scope in this way, or do you think our target audience would be better served with a more expansive assessment document?

APPENDIX E

Flip Charts from Meeting

Major Recommendations from Reviewers at Close of Meeting

In the afternoon of the second day of the peer review meeting, the Chair led a brief session with the reviewers to recap some of the major recommendations and suggestions that were provided during the meeting.

- Replace AHERA asbestos standard with IRIS value; conduct analysis as for dioxin and PCB cancer evaluation
- Clarify dioxin monitoring and MOE discussion; revise exposure scenarios for WTC worker and resident
- Revise PCB noncancer benchmark
- Review data of potential inconsistencies of $PM_{2.5}$ data; incorporate data on PM_{10}
- State monitoring program design up front; state COPC not addressed (e.g., PAHs)
- Rank benchmarks for health; adjust OELs for duration and sensitivity; compare exceedances with tox or epi. data
- Define populations of concern (e.g., are “illegal” residents consider resident-worker scenarios)
- Keep text focused on out-door air; state text as interim subject to change; link to other efforts
- Enhance VOC discussion with LOD, then caveat conclusions as appropriate; revise tables; give “n” for samples
- Enhance ongoing effort on indoor environment; consider independent group analysis (e.g., NAS)

APPENDIX F

Written Comments from Reviewers

Review by
Eric J. Chatfield, Ph.D.

Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster. Report NCEA-W-1395, EPA/600/P-2/002A

Initial Comments by Eric J. Chatfield, 2003 June 29

I would suggest that the title of the report be changed to:

"Measurements of Ambient Airborne Pollution and Evaluation of the Potential Health Impacts from the World Trade Center Disaster".

This title would emphasize that the measurements under consideration are for ambient air, and introduction of the word "potential" conveys the acknowledged fact that there is a great deal of uncertainty in the interpretation, particularly for September 11 and the early days afterwards.

Overall, the draft report effectively summarizes a great deal of data collected from diverse sources, and the general conclusions reached appear to be consistent with the available data. However, I believe the report could be improved by re-organizing the sections into the following topics:

1. Executive Summary
2. Purpose
3. Rationale for Selection or Rejection of Pollutants to be measured
4. Measurements of Pollutants
5. Discussion
6. Conclusions and Recommendations

In a report such as this, the Executive Summary is particularly important, in view of the wide audience who may read this report. Many readers will read only the Executive Summary, and will not read the more detailed discussions later in the report. It is therefore most important that this section be as free-standing as possible. The Executive Summary should carefully discriminate between firm conclusions and other areas about which there is uncertainty or insufficient knowledge. It should also be clear that the general conclusions of the report refer only to exposures from ambient (outdoor) atmospheres, and not to the indoor atmospheres of buildings in which deposited pollutants were unchanged by weathering. I believe that the Executive Summary should also include reference to the limitations of some of the measurement methods.

Early in the document, there should be a detailed discussion of the contaminants considered to be of concern, the rationale for selection of those to be measured, and the rationale for those excluded. For example, glass fiber and mineral wool are known to have been major

components of the dust cloud from the collapse of the World Trade Center towers, but the only consideration given to them seems to be as a constituent of the particulate material (PM) measurements. These fibers do not normally contribute significantly to the airborne particulate material in urban environments, and it is therefore questionable whether the NAAQS screening benchmark for PM used in the report is a sufficiently protective value, given the irritating nature and composition of the dust that was generated by the collapse of the towers.

The use of screening benchmarks based on occupational PELs or TLVs should be re-examined. Given the unprecedented nature of the events and the need for some rational basis for interpretation of data, the PELs and TLVs provide a good starting point. For ionizing radiation, the practice is to adjust such benchmarks for application to the general public by taking account of the working week vs. the full year and the normal years worked vs. the normal life expectancy, and then reducing these modified PELs and TLVs by a further factor of 10.

The presentation and interpretation of the asbestos data needs to be re-examined. The practice of using phase contrast microscopy (PCM) as a screening measurement for ambient air samples could frequently lead to misleading conclusions. In general building atmospheres and in the outside atmosphere, there has usually been very little correlation between PCM results and transmission electron microscopy (TEM) results obtained from the same or parallel-collected samples. Accordingly, there is no reason to believe that samples showing elevated PCM fiber counts would necessarily coincide with those showing elevated TEM asbestos fiber counts. High PCM fiber counts could represent nothing more than an elevation in the number of paper fibers or naturally-occurring organic fibers, and elevations in asbestos fibers could have been overlooked. It has long been generally recognized that PCM is not a suitable means for measurement of asbestos in ambient atmospheres, however for some reason it was applied in this report.

All of the TEM data for asbestos are presented in terms of structures/mm^2 (s/mm^2) on the collection filters. There appears to be no reason to do this, and reporting the data in terms of structures/cc (s/cc) would be far more useful and scientific. The AHERA clearance value of 70 s/mm^2 is actually based on the average of 5 samples, and is itself only an initial screening test which substitutes for a statistical comparison of sets of 5 indoor and 5 outdoor samples. The value of 70 s/mm^2 is not a health-based standard, and it was derived solely from the asbestos contamination that existed on filter media available in 1987. The asbestos contamination on air sampling filters in current use is virtually undetectable, and as a consequence the continued use of the 70 s/mm^2 criterion amounts to an acceptance of a clean air standard of approximately 0.02 s/cc. Also, the AHERA protocol is intended to simulate the worst case situation indoors by use of aggressive air sampling after extensive cleaning of all surfaces. The outside results tabulated in this report would likely have been different if surfaces had been disturbed with leaf blowers close to and up-wind of the sampling location. Moreover, there appears to be variation in the analytical sensitivities of the analyses, which are dependent on the air volumes collected and on the area of the TEM specimens examined. I would recommend that all data expressed in terms of s/mm^2 be converted into air concentrations expressed as s/cc, with additional reporting of the concentrations of fibers longer than 5 μm. Assuming that all TEM analyses were performed in accordance with the AHERA method, the concentrations of fibers longer than 5 μm

should be available in the data, and these would provide a limited basis for risk estimation which cannot be performed using values in terms of s/mm^2.

Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster. Report NCEA-W-1395, EPA/600/P-2/002A

Supplementary Comments by Eric J. Chatfield, 2003 October 12

The following are supplementary comments on the EPA report. These additional comments were too detailed in nature to be included in my initial comments, and they were not discussed at the Peer Review Meeting because they did not fall under any of the general charges to the reviewers, but they may be helpful to EPA during the revision of the report.

1. In the List of Acronyms and Abbreviations, "f" should refer to "fibers", rather than to "fibers of asbestos", the letter "L" in "REL" and "STEL" I believe is "Limit", rather than "Level", "TEM" is "Transmission Electron Microscopy", and "XRF" is "x-ray fluorescence".

2. In the Executive Summary on Page 1, Paragraph 2, Line 3, it is stated that "It is an assessment of the inhalation exposure and potential human health risk incurred by the general population residing and working in the vicinity of the WTC." This statement requires some additional clarification, because most people residing and working near the WTC spend most of their time indoors, and indoor exposures are not the primary focus of this report.

3. On Page 2, in Line 8 of Paragraph 2, the sentence beginning "Dioxin and VOC's..." needs to be re-worded. As it stands, the sentence can be taken to mean that these pollutants are produced only from fuels. There were many other potential sources in the WTC buildings.

4. On Page 2, the final paragraph contains the expression "in the surrounding community". It would be good if this could be better defined.

5. On Page 9, Line 2, it is stated that PCM is used to identify structures greater than 5 μm in length. PCM does not have the ability to **identify** anything.

6. On Page 9, Line 3, the statement in parentheses is incorrect. TEM is used to detect and identify asbestos structures **greater than** 0.5 μm in length

7. On Page 9 in the final line of Paragraph 1, a reference for the value of 0.003 f/cc as typical of urban background should be given, particularly since it is used in the report as a definition of background. In fact, I remain uncomfortable with the concept of using PCM as a measurement method for asbestos in the general environment. I recognize that it may have been useful for rapid measurements in the early hours after the collapse, but the authors should be careful to not place too much reliance on the PCM measurements, either outdoors or indoors. In the measurements we made in the apartments, I never even contemplated the use of PCM.

8. On Page 9 of the report, in the 3rd Paragraph, it is stated that "One apartment was highly affected by the collapse of the WTC towers with completely shattered windows and dust piled throughout the apartment. The other was in a building that had little exterior damage.....". In fact, I was present at the sampling and only one small window had been broken in the first apartment, and the opening had been sealed with plastic sheet and adhesive tape. The other building had **no** exterior damage.

9. On Page 10 of the report in the first paragraph, some reference to the method of analysis of the bulk samples should be given, and a caution on the reliability of these data. It is well known that measurements by PLM in the range below about 5% are quite unreliable, and it is unlikely that the figures quoted to two significant digits are meaningful. Moreover, I think that asbestos was likely present in all of the bulk samples collected, and that the failure to detect asbestos in many of the settled indoor dust samples or the outdoor samples was a question of deficiencies in either the analytical method, or the conduct of the method.

10. On Page 11, Paragraph 2, Line 9, the method of analysis should be stated..

11. On Page 17, the last entry in Table 1 is incorrect. The AHERA clearance standard is not "a level of concern". Abatement activities were not undertaken to reduce air concentrations, because abatement decisions were not made on the basis of measured air concentrations. It is incorrect to say that school children were not allowed back in until several consecutive readings were less than the AHERA standard. In fact, the clearance decision is based on the average of 5 simultaneously collected samples in the work area being lower than 70 s/mm^2. Even that value is considered to be an "initial screening test".

12. On Page 70, there is a blank cell for the Barclay & West Broadway location on 9/27 in the final column.

13. On Page 86 at the beginning of the 2nd paragraph, the word "classified" would be more appropriate than "characterized".

14. On Page 86 in the 3rd Paragraph, it is stated that "Both asbestosis and benign pleural plaques result in reduced breathing capacity and mortality". I suggest that this be re-phrased, since it currently means that asbestosis and pleural plaques result in reduced mortality, which I do not believe is the case.

15. On Page 87 in Section IV.e.1, it is stated with respect to PCM: "It counts all fibrous structures with a minimum diameter of 0.3 μm and has a magnification range of 100 - 400X". The minimum diameter is usually taken to be 0.25 μm in the U.S., and counts are made at a fixed magnification of between 400 and 450. Later in the same paragraph, it is stated that "PCM results are reported on a mass-per-volume basis, ...". This is not correct - PCM results are never reported in that manner.

16. On Page 88 in the first paragraph, there needs to be some mention of the fact that the AHERA method specifies the use of aggressive sampling to create the worst case situation.

17. On Page 88 in the 3rd line of the first paragraph, it is stated: "The AHERA Final Rule establishing a 70 s/mm^2 standard for asbestos in schools.....". The AHERA Final Rule actually established an indoor-outdoor comparison as the clearance criterion. The 70 s/mm^2 criterion is an "initial screening test". In this paragraph, it should also be mentioned that the air sampling is to be conducted under aggressive conditions.

18. On Page 88 in the final three sentences of Paragraph 2, it is an over-simplification to state that there is not a good correlation between PCM and TEM measurements. When the direct-transfer TEM method is used, and the PCM size fraction of fibers is measured using TEM, the correlation can be very close. It is true to say that, in the general environment, there is generally little correlation between PCM measurements and TEM measurements of all fiber sizes. There are two reasons for this: the PCM measurements include fibers other than asbestos, and the TEM measurement includes asbestos fibers outside of the visible range for PCM. In fact, there is no reason to expect a correlation. Although it is not the responsibility of the authors of this report, I believe that the ATSDR procedure to obtain what are termed "TEM units" by multiplying PCM data by 60 is totally invalid. It needs to be clarified as to what these "TEM units" are - are they for all fiber sizes greater than 0.5 μm in length, or are they all fibers longer than 5 μm?

19. On Page 88 in the 3rd paragraph, it is stated that ".... structures meeting a minimum diameter of >0.3 μm with length >5 μm are counted as PCM equivalent ("PCME") fibers". NIOSH 7402 defines "PCME" fibers as those longer than 5 μm and thicker than 0.25 μm, and ISO 10312 defines them as longer than 5 μm and thicker than 0.2 μm.

20. On Page 89 in the first paragraph, on line 4, the AHERA clearance criterion is actually based on the average of a single set of 5 samples. There is no requirement for such TEM readings to be "consistently" below 70 s/mm^2, just that the average of the clearance set be below this value.

21. On Page 89, Paragraph 4, Line 5, it should be stated that the mass concentration of 30,000 ng/m^3 was derived **only for chrysotile**, and the data on which this value is based have a very large range. I have already commented in Item 18 about the multiplier used to convert PCM to TEM data.

22. On Page 91 in the first paragraph, reference is made to sampling stations set up **in** public schools. It is not clear whether these were external samples or actually inside the buildings. If they were inside, was the sampling aggressive or passive? The sampling conditions should be stated, since the AHERA protocol specifically requires aggressive sampling.

23. On Page 128 in the 2nd paragraph of Section VI.b.1, the description of how PLM distinguishes between fiber types requires revision - it is not correct. I doubt that a simple, one sentence description is even possible, and a more detailed explanation would

be out of place. I suggest that the sentence be truncated to: "PLM can distinguish between fiber types in a bulk sample.". I also suggest that a caution be added regarding the inaccuracy and unreliability of routine PLM measurements in the vicinity of 1%. As stated in Item 9, it is my opinion that the failure to detect asbestos in 82% of the residential units, and in 8 of the outdoor samples was more a question of limitations of the analytical method and the conduct of the method.

24. On Page 128 in the final paragraph, it states that "All air filter samples were analyzed first using PCM to determine if fibrous materials were present. It seems highly questionable to use a method, already admitted to have little correlation with TEM data, as a screening method for selection of samples for subsequent TEM analysis. Under this protocol, the existence of a few cellulose fibers could trigger analysis by TEM, and a sample containing considerable numbers of thin chrysotile fibers could be overlooked. Again, the ATSDR work is simply being reviewed by the authors of this report.

25. On Page 133, on the 5th line the report states: "A small-scale monitoring study of two residential buildings was conducted by contract (Chatfield and Kominsky, 2001)." The statement is incorrect - the work was not done under contract; all individuals involved in the study donated their time and the analytical costs to conduct this study.

26. On Page 133 in the 2nd paragraph, it is stated that the TEM analyses were conducted using AHERA counting protocols. In fact, ISO 10312 was used. The end result, however, would be similar. Chrysotile is also spelled incorrectly at the beginning of the 3rd sentence.

27. On Page 133 in the final paragraph, it should be mentioned that amphibole asbestos (amosite and actinolite/richterite) at concentrations of approximately 0.02% was also detected in these outdoor dust samples.

28. On Page 134, it is not clear whether the air sampling referred to was aggressive or passive. This should be clarified, because it affects the interpretation of the data. In fact, whether the air sampling was aggressive or passive should be stated for all of the asbestos air sampling data.

29. On Page 135, various dates are quoted. It would be helpful if the year was added to each of these dates.

30. On Page 135, the first sentence of Paragraph 4 needs to be re-worded. One suggestion would be to insert the word "who" or "that" between "people" and "may" on Line 2 of this paragraph.

Review by
Michael Dourson, Ph.D.

Pre Meeting Comments

General comments

The report is a nice description of likely risks to exposures during and after the time of the WTC collapse. It strikes the appropriate balance between readability and more extensive information. The overall findings shown on page 2 seem appropriate in general, although they should be revisited, perhaps, for each specific chemical. Since the report focuses on the "outdoor" environment, this should be part of the report's title.

I was not sure of the reason why only these chemicals were selected. From a previous EPA report on the WTC disaster chemicals such as Be, Hg, PAH were also considered. In addidtion, what is the comparison, if any, between the health benchmarks of region 2 (Appendix A) and those used here? What was the logic for not using the Region 2 values directly? Moreover, I was surprised that a mixtures risk assessment was not attempted, nor was the dermal pathway seemingly a concern.

Specific comments

(Page 5)
I agree with the conclusion on lead, especially since adverse effect is due more to continuous exposure.

(Page 6)
How did these air samples for nickel compare to EPA's developing RfC? (Presumably ATSDR did not have an intermediate MRL.) Should not EPA normalize the nickel OSHA PEL of 1 mg/m^3 for continuous exposure and divide by 10_H for sensitive individuals?

(Page 7)
The comparisons of safe dose for PCBs do not make me happy. How were PELs adjusted for continuous exposure and sensitive individuals, if at all? See Appendix A (A-4) for alternative values.

(Page 13)
It seems appropriate to limit this text to outdoor air as EPA has done, especially since EPA already has a text on indoor environment. However, this would be a good place to link to other related work and consider the dermal route and a mixtures risk assessment. This might also be the place to incorporate or acknowledge health information in workers, nurses and others qualitatively assessed after the first several days of the disaster.

(Page 17)
The choice of safe doses such as the RfC automatically accounts for the protection of sensitive populations. However, this is not necessarily true with other choices, such as with ACGIH's TLVs. How does EPA account for this difference? Please make this distinction. See for example the following chart where I have marked whether or not the sensitive individual has been protected (marked with a *).

Short-Term Exposures

No.	OSHA	Permissible Exposure Limit PEL
No.	OSHA	Short Term Exposure Limit (STEL)
Yes*	ATSDR	Acute inhalation Minimal Risk Level (MRL)
Yes*	ATSDR	Immediate inhalation Minimal Risk Level (MRL)
Yes*	EPA-STSC	Provisional Subchronic Reference Concentration (RfC) Give RfC Definition from IRIS.
No	ACGIH	Threshold limit value (TLV)
No	NIOSH	Recommended Exposure Level (REL)
Yes*	EPA	Asbestos Hazard Emergency Response Act (AHERA) level of concern
Yes	EPA	Air Quality Index (AQI)
Yes	EPA	National Ambient Air Quality Standard (NAAQSA)
		Long-Term Exposures
Yes	EPA	Reference Concentration (RFC) Please give RfC definition.
Yes	EPA	Cancer Slope Factor (SF)
Yes	EPA	Unit Risk (UR)
Yes	EPA	Maximum Contaminant Level (MCL)

(Page 23)
EPA states that screening benchmarks vary among chemicals on line 2. Have health guidelines been normalized among chemicals? For example, the OSHA PEL ≠ an acute ATSDR MRL? I would encourage EPA to develop a ranking among health values, and reasons why of course, similar to what EPA Region 2 and others did for indoor air.

(Page 23)
I suggest that EPA state its logic for choice among safe doses here. Specific changes to this text would be in the 3rd paragraph: 6th line: reference level by a small amount for a …… In the 7th line: standards, which are more applicable to the exposures experienced in this disaster. In the fourth 4th paragraph: last line: …criteria, or has adapted these criteria to fit the given situation and population.

(Page 24)
Please summarize your position on particulate matter at the start of this section.

(Page 40)
Please add to the end of line 11: but not for all chemicals. In the 2nd paragraph please show me this comparison.

(Page 41)
2nd paragraph, lines 8-10: please note that this is for acute exposure to PM 2.5 only.
Last paragraph, Line 7: How was dose equalized among humans and mice?
Last Paragraph, Last sentence: any interspecies adjustment used here?

(Page 64)
IV.b.2. Why not use the chromium and nickel RfCs?

(Page 68)
3rd paragraph, last sentence: please change six orders of magnitude to four.
An alternate RfC for PCBs might be:
RfC = NOAEL 9,000 mg/m^3 divided by (10_H X 10_A)= 90 ng/ m^3
This value is slightly less than 153 ng/m^3 that EPA chose.

(Page 75)
Please clarify Table 4 on page 83 by showing what values are ND and which are measured.

(Page 80)
This definition of MOE is not as per EPA (see background document 1 on IRIS). Furthermore, this definition only works for body burdens if it is directly proportional to dose. Is this expected?

(Page 81)
3rd paragraph: I would be more interested in exceedence of an RfD or RfC from an ingested or inhaled dose, than what is happening with body burdens.

(Page 95)
What would be the exceedence based on the IRIS value of 4 x 10^{-5} f/ml at 1 x 10^{-5} excess cancer risk? Why not estimate the incremental excess lifetime risk as for dioxin?

(Page 105)
3nd full paragraph: EPA states that the analytical method can not detect benzene concentrations below 0.02 ppm, but then gives concentrations less than 0.02 ppm (see p. 115). Hmm…

(Page 106)
2nd full paragraph: EPA concludes that the exceedences of benzene are not a public health risk. What is risk at 6-fold higher than short-term MRL? (See p. 115)

(Page 107)
Last paragraph: so what is the provisional subchronic RfC for chloromethane?

(Page 110)
Last sentence: EPA's conclusion on VOCs can be further supported by an analysis of excess cancer risk.

Review by
Alison Geyh, Ph.D.

Comments on "Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster"
NCEA-W-1395
EPA/600/P-2/002A
Date: 28 June 03
Reviewer: A.S. Geyh

The report, on "Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster" is the first summary of air contaminant data collected in response to the events of September 11, 2001. What follows are general comments about the report with some specific suggestions about the presentation of the data and results. A more detailed set of comments about this report from this reviewer will be offered at the meeting in NYC set for July 14 and 15.

General comments:

The report appears to the best of my understanding to have considered all the available data collected post 9/11 as well as historical data collected in and around the NYC area.

The use of available standards and benchmarks was appropriate overall. However, for some of the contaminants, such as the VOCs, it may be best to not try to put the results into a health context because of the sampling method and the original purpose for that sampling.

1. From my overall reading of this report there appears to be 3 key objectives
    1. To describe the data collection effort in response to the disaster
    2. To put the post 9/11 airborne contaminant data into historical perspective
    3. To assess to the extent possible the health implications from exposure to these airborne contaminants at the levels measured for the **general population.**

The third objective is clearly stated in the first paragraph of section I. The other 2 objectives are implied. I believe it is important to state them explicitly. In addition, I believe the data will speak for themselves in terms of their limitations and so the first paragraph could be condensed to listing these objectives along with the last sentence of paragraph 1 starting with " Accordingly, this report attempts to take a practical….."

If it is true that this assessment is focused on the general population, it would be best to leave out any discussion of exposure of the on site rescue/recover/cleanup workers. As we are learning there was a very steep concentration gradient from the center of the pile toward the perimeter, and the perimeter sites as well, as the 290 Broadway site, do no well reflect concentrations in the middle of the site and thus exposure on the site. As stated in the Lorber and Gibbs memo of 3 June 2003 good data on the worker population are limited and other agencies such as OSHA and NIOHS have conducted analyses of worker exposure at the WTC that may be more complete.

The brief review of the OSHA and NIOHS data in section VI should be left out as it is too brief to give a good picture of what these agencies did and how there results could be integrated with the EPA data. In addition, if the focus of this report is the general population in Lower Manhattan these sections may not be relevant.

The presentation of data on the indoor environments would be better served by a separate report that is solely devoted to all the issues related to EPA becoming involved with indoor air quality and apartment clean up.

Under section IV " Evaluation" subsections IVb(metals) – IVf(VOCs) were extremely well presented starting with a brief, but complete description of the health concerns related to the particular contaminant, background levels measured in and around the NYC area and also in other parts of the US, a description of the monitoring methods at the site, the number of samples collected, how the values measured compare with historical data and available benchmarks.

However, section IVa, the section describing the PM results is not as well organized and as a result is confusing. Some significant restructuring along the lines of the other sections would help the reader understand this very complicated data set and the implication of the concentrations actually measured. For example, in this section, the initiation of sampling for PM started some time after 9/11 but it is not stated when each site was set up and when actual data collection commenced by site. It is also not stated what PM were sampled for (PM2.5, PM10, both, TSP??) at any of the site except the 290 Broadway site. No end dates for sample collection are given (this information is also not offered in Appendix B). Sampling frequency is not given. Was sampling only done by TEOM or were filter based samples collected as well? It would also be helpful to have a summary of results before the discussion of the implication of exposure to PM by the community is started. Although this would probably entail a length table it would be helpful to the reader in terms of understanding what concentrations were measured.

Specific comments for section IVa

This section of the report spends a fair amount of space on estimating exposure during the first day and 2-3 days after the event. The numbers offered from this exercise are very approximate and represent only a very first cut at understanding people's exposures during this time period. As a result the subsequent health assessment is couched in the conditional (exposures may have been, potential health effects could be, it is possible, etc). As stated in the report, a significant amount of modelling work is currently being conducted to estimate concentrations on the day of and 2-3 days after from satellite data and other data sources. The results of these models will like give more robust estimates of exposure than are presented here and it might be best to wait for those result before embarking on a discussion of exposure and health effects during that time period.

The use of the Lioy et al. analysis of the settled dust samples to describe the composition of the airborne PM needs to be considered more carefully. By definition, settling is as size selective process for PM and so the smaller particles will naturally be under represented in a settled dust sample. In addition, on a mass basis the smaller particles contribute very little to the over all

mass and so the size distribution evaluation of a settled dust will find a small contribution of the mass due to small PM. Therefore, care must be taken in the extrapolation these results of this analysis of what was in the air during that time period.

Finally, the section entitled " High Temporal Resolution Analysis" states that it may be important for the health assessment to understand PM concentrations on a more highly resolved time scale, however the section does not discuss what temporal resolution is being considered that is different from 24 hr integrated measurements. In addition, the time period of Oct 3-5 is cited as a period of importance for understanding what was going on on a time scale less than 24hrs. Data collected by Cahill et al. are offered as evidence of the usefulness of having more resolved data but those data are not described in terms of time (or size) resolution.

Review by
Gary Hunt, M.S.

Preliminary Review
Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster (EPA/600/P-2/002A; October 2002)

Prepared by Gary T Hunt/TRC Corporation

The text to follow was based upon review of the External Review Draft of the EPA document as titled above (EPA/600/P-2/002A; October 2002) as well as, public review comments received by EPA contained in a Supplemental Document (June 2003).

The EPA document provides a significant amount of information in support of the primary stated objective of the project, which was an assessment of potential human health impacts associated with exposure to emissions from the collapse of the World Trade Center on September 11, 2003 (pg 13). It should be noted that the assessment focuses deliberately on exposure associated with direct inhalation of air emissions from the WTC site commencing on September 18 2001. This reviewer finds this report to be a very comprehensive document addressing large quantities of data collected by a number of agencies engaged in the monitoring effort. The report does a good job of identifying the point in time when air quality in the vicinity of the WTC site had returned to normal or background levels. Unfortunately, due to the emergency nature of the event itself and logistics issues there are little or no data available representing inhalation exposure during the critical hours and days immediately following the 9/11 disaster.

Perhaps the most critical question that needs to be asked in any study of this nature is what is the ultimate end use of the data? Based upon my review of the data in the EPA report as well as the attendant public review comments it is obvious that there is much disagreement over the end use of the data collected and ultimately the purpose and objectives of the program itself. As a result, data currently do not exist to satisfy a " wish list" of program objectives. Accordingly, it is this reviewer's recommendation that one of the charges of the forthcoming Workshop (July 14 and 15 2003) should be to reexamine the purpose and objectives of the EPA study and redefine these if warranted. These goals and objectives when clearly defined will dictate data needs. More specifically, do we have the data needed to satisfy program objectives and if not what course of action should be taken to gather the necessary data. For example, the October 2002 report does not adequately characterize current and future human exposure associated with inhalation of dusts present in the environment around the WTC site and the NYC Metropolitan area. These dusts likely represent a significant source of secondary exposure long after air emissions from the primary WTC Site had ceased in 2002.

Other recommendations for discussion on the agenda of the forthcoming Workshop including some justification for each are as follows:

- The target compound list of parameters monitored while quite comprehensive did not consider a number of critical compounds and compound classes of toxicological significance from a human health perspective that might also be contained in WTC air emissions. Mercury was not included nor were brominated POPs. The latter class of compounds includes PBDEs and other bromine substituted organics likely formed from

combustion of materials impregnated with bromine containing flame retardants. Data presented in the report do identify significant levels of elemental bromine in selected particulate samples collected in ambient air and dusts in and around the WTC Site.

- No data on PAHs are contained in the report. These perhaps represent the class of semivolatile organic compounds most likely present in the highest concentrations in air emissions from the WTC particularly during fires and combustion conditions.

- Due to the dynamic nature of the disaster and the lack of steady state combustion conditions in the days and months following 9/11 additional products of combustion analyses are warranted. These analyses if deemed warranted could likely be conducted on samples or sample extracts maintained in archival storage at the participating laboratories. The necessary data for products of incomplete combustion and in particular organics could be developed using existing GC/MS electronic data files.

- The data contained in the report are still too preliminary to support reliable quantitative predictions of potential human health risks (pg 24 EPA Report). The reviewer agrees with this statement. That stated the report should be viewed as a work in progress. Conclusions and recommendations based upon the available data should be limited to the quality of ambient air in and around the WTC site. As a result, broader conclusions about the effects of long-term exposure to entrained dusts and human health effects over time associated with the initial acute exposure to WTC air emissions cannot be supported by the data presented. The Workshop should consider addressing this charge as well in its deliberations on July 14 and 15 2003.

- It is well known that the calendar period of September 11-18 2001 was poorly represented in the available data-base. Due to the emergency nature of the event and logistics problems likely hampered the response times to deploy sampling equipment to the site. A lesson learned from the WTC disaster is to put the necessary planning and systems in place in the very near future so as to be ready for emergency monitoring on an as needed basis. This should include availability of portable instrumentation (e.g. battery powered) and " real time" monitors that can be readily deployed to respond to any national emergency.

November 18 2003
Peer Review Addendum
Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster (EPA/600/P-2/002A; October 2002)

Prepared by Gary T Hunt/TRC Corporation

Information Sources

The review to follow herein was based upon information provided to this reviewer from a number of sources. These sources include:

- Review of the External Review Draft of the EPA document as titled above (EPA/600/P-2/002A; October 2002).
- Public review comments received by EPA contained in a Supplemental Document (June 2003).
- Participation in Peer Review Meeting , which took place in New York City on July 14-15 2003.
- Review of Summary Report of the USEPA Technical Peer Review Meeting; September 11 2003 Draft Version.
- Review of Executive Summary of the USEPA Technical Peer Review Meeting, October 28 2003 Draft.
- Observers Comments offered during the Peer Review Meeting and subsequent to the July 14-15 2003 meeting.
- Journal article provided by Dr Clifford Weisel which appeared in Environmental Health Perspectives Volume 110 Number 7 July 2002.
- Short papers and oral presentations which appeared on the agenda of the Dioxin 2003 conference in Boston Ma during the period August 24-29 2003.
- Package of materials provided by Versar on August 11 2003.

Summary Comments and Findings

1. Purpose and Objectives of Program- Data End Uses

- The EPA document , which was the focus of the Peer Review Meeting provides a significant amount of information in support of the primary stated objective of the project, which was an assessment of potential human health impacts associated with exposure to emissions from the collapse of the World Trade Center on September 11, 2003 (pg 13). It should be noted that the assessment focuses deliberately on exposure associated with direct inhalation of air emissions from the WTC site commencing on September 18 2001. This reviewer finds this report to be a very comprehensive document addressing large quantities of data collected by a number of agencies engaged in the monitoring effort. The report does a good job of identifying the point in time when air quality in the vicinity of

the WTC site had returned to normal or background levels. Unfortunately, due to the emergency nature of the event itself and logistics issues there are little or no data available representing inhalation exposure during the critical hours and days immediately following the 9/11 disaster.

- Based upon my review of the information sources cited above it is obvious that there is much disagreement over the end use of the data collected and ultimately the purpose and objectives of the program itself. As a result, data currently do not exist to satisfy a " wish list" of program objectives. Accordingly, I would recommend that the Peer Review Summary Report and perhaps Executive Summary contain a section regarding the end use of the data and what it can and cannot be used for. This is particularly relevant in light of what the former EPA Administrator, Ms Whitman, said about the health impacts associated with WTC air emissions based upon the data contained in the EPA Report that was the subject of the Peer Review. She drew more global conclusions about the significance of the data than the data could justifiably support. These same sentiments were echoed in the Observers Presentations and comments rendered during the July 14-15 Peer Review Proceedings.

- The October 2002 EPA report does not adequately characterize current and future human exposure associated with inhalation of dusts present in the environment around the WTC site and the NYC Metropolitan area. These dusts likely represent a significant source of secondary exposure long after air emissions from the primary WTC Site had ceased in 2002.

- That being said I would recommend that the section to be added to the EPA Final Report regarding suggested end uses of the data include the following: *The data contained in this report are recommended for use in examining human health effects associated with direct inhalation of regulated air pollutants present in the ambient air in the aftermath of the WTC disaster. These data which focus on atmospheric concentrations of primarily regulated air pollutants cannot be used for inhalation exposure in the hours and in some cases days immediately following the WTC disaster nor can they be used in assessing exposures not related to direct inhalation of air emissions from the WTC* site. *For example, these data cannot provide a reliable benchmark for secondary exposure associated with inhalation of dusts deposited in indoor environments after their initial release during the WTC disaster.*

- The October 2002 EPA report should be viewed as a work in progress. Conclusions and recommendations based upon the available data should be limited to the quality of ambient air in and around the WTC site. As a result, broader conclusions about the effects of long-term exposure to entrained dusts and human health effects over time associated with the initial acute exposure to WTC air emissions cannot be supported by the data presented.

2. Target Parameters- Compounds of Interest Monitoring Program

- No rationale has been provided in the information sources cited regarding the basis for the selection of target parameters. In the opinion of this peer reviewer it appears that the target parameters were limited to primarily regulated air pollutants monitored using traditional or readily available sample collection and analyses procedures. The Peer Review Committee has directed EPA to address the rationale for the selection of target parameters in further editions of the Final Report.

- Combustion by products formed during the WTC initial collapse and more so in the numerous fires which took place in the ensuing months following 9/11 were not adequately addressed at any time during the monitoring program. Measurements were limited to PCDDs and PCDFs and even these were hampered by abnormally high detection limits and the unavailability of data for several weeks following the initial collapse.

- The WTC collapse and ensuing numerous fires , which persisted until December 19, 2001 constitutes a unique environmental disaster unprecedented in history. It is highly likely that significant quantities of combustion by products currently regulated and many new compounds at present unknown were introduced into the environment vicinal to the WTC site and the New York City Metropolitan area. These by products include but are not limited to the following types of semivolatile organic compounds: PAHs, PCBs, PBDEs, PCNs.

- In addition, it is likely that the WTC fires introduced many combustion by products into the environment whose toxicity to humans as individual compounds or as a composite mixture of compounds is unknown at the present time. Recent publications cited in the above information sources have provided the chemical characterization of a wide variety of these classes of compounds. These compounds were identified in both films deposited on Lower Manhattan windows as well as dusts and smoke aerosols deposited in weather protected locations east of the WTC site.

- The latter publication included analysis of both indoor and outdoor dusts representative of materials that settled immediately following the explosion and fire and concurrent collapse of the WTC. (Lioy et al Environmental Health Perspectives Volume 110/Number 7 July 2002). The results of these analyses, while limited to three samples, illustrate the chemical complexity of the mixtures released and provide some indication of the types of acute exposures experienced by residents, commuters and rescue workers in the minutes and hours immediately following the WTC collapse. Further these data should help us better appreciate the risks associated with longer term exposures to the dusts generated by the WTC disaster, and in particular exposure to dusts in work areas and residential properties downwind of the WTC site. These types of data are

currently unavailable through the EPA data base that was the subject of the Peer Review Meeting.

- The data from these studies further support the need to have the interiors of buildings affected by these dusts and associated HVAC systems cleaned so as to minimize the longer-term risks for building occupants.

- The target compound list of parameters monitored while quite comprehensive did not consider a number of critical compounds and compound classes of toxicological significance from a human health perspective that might also be contained in WTC air emissions. Mercury was not included nor were brominated POPs. The latter class of compounds includes PBDEs and other bromine substituted organics likely formed from combustion of materials impregnated with bromine containing flame retardants. Data presented in the report do identify significant levels of elemental bromine in selected particulate samples collected in ambient air and dusts in and around the WTC Site.

- No data on PAHs are contained in the report. These perhaps represent the class of semivolatile organic compounds most likely present in the highest concentrations in air emissions from the WTC particularly during fires and combustion conditions.

- Due to the dynamic nature of the disaster and the lack of steady state combustion conditions in the days and months following 9/11 additional products of combustion analyses are warranted. These analyses if deemed warranted could likely be conducted on samples or sample extracts maintained in archival storage at the participating laboratories. The necessary data for products of incomplete combustion and in particular organics could be developed using existing GC/MS electronic data files.

- The window films data (Dioxin 2003) can be used to back calculate gas-phase concentrations for a variety of semivolatile organics found in these samples. These include PBDEs, PCBs, PAHs, and PCNs. The window films serve as a convenient passive sampler representative of atmospheric concentrations on an historical basis. These samples accordingly may provide a means to establish human inhalation exposure over time for gas phase concentrations of a variety of semivolatile organic compounds present in the atmosphere.

- The results of the window film analyses suggest that a large quantity of combustion products were released by the WTC disaster and that the deposition of these contaminants occurred primarily within a 1 kilometer radius of the WTC site.

6. Lessons Learned and Implications for the Future

It is well known that the calendar period of September 11-18 2001 was poorly represented in the available data-base. Due to the emergency nature of the event and logistics problems likely hampered the response times to deploy sampling equipment to the site. A lesson learned from the WTC disaster is to put the necessary planning and systems in place in the very near future so as to be ready for emergency monitoring on an as needed basis. This should include availability of portable instrumentation (e.g. battery powered) and " real time" monitors that can be readily deployed to respond to any national emergency.

Review by
Patrick L. Kinney, Sc.D.

Initial Comments on

Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster
EPA/600/P-2/002A External Review Draft

Patrick L. Kinney, Sc.D.
July 6, 2003

This document summarizes results of EPA's comprehensive evaluation of potential health effects associated with air pollution emissions from the World Trade Canter collapse. Extensive air monitoring data collected by EPA and other agencies are reviewed and analyzed to examine trends over time and space, and to determine whether and to what extent health benchmark concentrations were exceeded. The report focuses on a subset of pollutants that are thought to be of greatest health concern: particulate matter (PM), metals (including lead, chromium, and nickel), polychlorinated biphenyls (PCBs), dioxin-like compounds, asbestos, and volatile organic compounds (VOCs).

Critique:

EPA's effort to carry out a comprehensive evaluation of air pollution health risks associated with the 9/11 disaster is commendable. The document will be of tremendous value to a variety of stakeholders, including the general public, policy makers, scientists and the news media. The overall quality of the report is high. The choice of pollutants to focus on makes sense. In general, the data are chosen, analyzed and interpreted appropriately; judgments as to health risks are well reasoned. I believe that the overall conclusions of the evaluation are reasonable given the available data, i.e., (paraphrasing) that 1) persons caught in the initial dust cloud associated with the collapse were probably exposed to very high concentrations of a wide range of pollutants, and that acute and possibly chronic health problems may be associated with these exposures; 2) after this initial phase, concentrations of air pollutants in off-site residential zones were often elevated compared to upwind sites but that these exceedences gradually diminished after 1-3 months following 9/11 and that the risks of adverse health effects from the elevated levels of exposure were generally low. The report is careful to point out that these are preliminary conclusions based on available data and that conclusions could change when new information becomes available.

Specific comments:

p. 6, 1st paragraph, last full line: eliminate 'month'

p. 6, 2nd paragraph, second line: the fact that the OSHA PEL of 1 mg/m3 was never exceeded seems fairly irrelevant, given that we know that generic PM2.5 can cause adverse health effects at levels at or below the NAAQS. This brings up a more general point, which is that somewhere early in the executive summary there needs to be a short paragraph explaining why occupational

standards may not be directly relevant to general population health risk assessment, including issues of voluntary and compensated risks vs. involuntary risks, healthy workers vs. widely varying susceptibilities in general population. This very important point will not be obvious to the general reader. It's discussed later in the report, but not mentioned in the E.S. It might be useful to give some examples of acute air standards for which both occupational and ambient standards exist, such as PM2.5 or SO2, to illustrate how different the numbers can be.

p. 6 last line: again for the general reader, it would be best to present concentrations in simple and consistent units. Instead of $1*10^3$ ng/m3, why not say 1000 ng/m3 or, better yet, 1 ug/m3.

p. 7 first line: same issue for 50 ug/m3.

p. 7, last paragraph: state the dioxin LODs

p. 9, lines 3 and 4: 'used to identify structures less than 0.5 um in length' is confusing. It implies that TEM ignores anything longer than 0.5, which I don't think is the case. In fact, I thought that the AHERA protocol involved counting structures as small as 0.5 but not less than that size.

p. 10, first paragraph, last line: It would be good to append a concluding sentence to the effect that these data support the conclusion that the WTC collapse resulted in increased indoor asbestos levels in lower manhattan.

p. 11. first paragraph, 8 lines from bottom: the September date is missing.

p. 12, third paragraph, line 1: include 'visitors' as another at risk population.

p. 16, line 1: the use of a health benchmark in a screening exercise is only valid if the health benchmark is appropriate for the population at risk, which I think is somewhat problematic here where occupational benchmarks are being used to screen risks in the general population. Need to include a few lines justifying this approach and discussing whether it's likely to be conservative or not.

p. 32, conclusion bullet (3), line 2: in addition to quoting the distance in blocks, I think it would be helpful to include distance in meters or km.

p. 32, last paragraph: Need to mention the problem that it's difficult or impossible reproduce the original PM airborne size distribution based on resuspension of settled dust, since the smallest particles have a tendency to stick very persistently to larger particles. Thus, these kind of data will tend to overestimate the fraction of PM in the larger size ranges and underestimate the PM in the smaller size ranges.

p. 35, third paragraph: There needs to be references to specific figures in this lengthy paragraph.

Review by
Clifford P. Weisel, Ph.D.

Critique of EPA Draft Report: "Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster"
Clifford P. Weisel, Ph.D.
August 21, 2003

The draft report describes the US EPA health assessment of published and publically available ambient air concentration data collected in and near lower Manhattan following the World Trade Center (WTC) disaster. A large amount of data was reviewed for selected toxic substances predicted to be most likely to have possible adverse health impacts on individuals who entered ground zero or lived in the nearby community. Exposure to ambient pollutants to both residents and workers (such as clean up workers) were considered and compared to standards or "typical" urban ambient levels. A limited examination of exposure to ground zero workers and indoor air concentrations was done as part of this report, but a full evaluation of workers and indoor environments was beyond the scope of the report and are expected to be presented elsewhere.
Recommendation: Since the report is predominantly focused on ambient air concentrations, it is suggested that the title be changed to more clearly reflect this.
Recommendation: More details should be provided on the selection of which toxic substances were analyzed and included in the report. A listing in the appendix of all the toxic substances data have been collected, time periods, numbers and locations for the outdoor air would be useful.

The report notes that there is a lack of air monitoring data in the days immediately following September 11, and for some contaminants for more than a week. A more detailed analysis and justification should be provided for the concentration used to evaluate the health impacts for the time period between September 11 and the first available measurement. As is indicated on Page 11, "air concentrations within and very near Ground Zero would have been at least at these high levels (Measured on September 23 for dioxin) and probably higher during the first several days after September 11." However, on page 78, the dioxin air concentrations between September 12 and 23 were assumed to be equal to the September 23 measurement. The assumption that the first measured concentration is representative of concentration for the entire time interval may not be correct, if the emission source strengths declined during that time period or the meteorology varied. This should be discussed in more detail for each of the pollutants examined and upper bound estimates of what air concentrations could exist and whether they may be of concern presented.
Recommendation: The ambient air concentrations should not be predicted for time periods prior to the start of sampling as there is current way to properly estimate those concentration. Under prediction could result in erroneously suggesting that the exposure was non-problematic when this was not the case.

The choice of comparison data and health based standard to be used for comparison to the air measurements is important in establishing a risk estimate and when discussing results in publically available reports. For the particulate matter, one of the comparison data set chosen was collected at the NYU Medical Center in August 1976. These data may not be appropriate for comparison as some of the concentrations measured were at levels that have health concerns

and the substances were subsequently listed as air toxics or Hazardous Air Pollutants in the 1990 Clean Air Act Amendments. Thus, saying exposure to similar levels in the past is not reassuring.
Recommendation: Do not use the 1976 data for comparison.

The report also correctly cautions about using occupational standards as a basis for environmental health criteria on page 23. However, that caution is less clear in other places in the report, such as on page 68 where the last paragraph begins "Occupational exposure limits provide an additional perspective by which to evaluate potential non-cancer health effects ... " Further, even using the TWA for the cleanup workers may be problematic since there were reports of their activities exceeding the 10 hour day - 5 day maximum that the standards are based on. Rescue workers reported working double shifts, working more than 5 days per week and staying in the area between shifts. These exposures would not provide the body the recuperation time that is assumed in the standards.
Recommendation: Care should be taken in applying the TWA for occupational to the environmental settings, even when using safety factors. Whenever these comparisons are done the appropriate caveats should be restated to minimize the chance that the statements will be taken out of context.

The conclusions on page 33 about the WTC emissions changing because of the changes in the metal content of the particulate matter during the Fall needs clearer justification and support.
Recommendation: Include the auxiliary data and discussions about the spatial distribution that were presented at the meeting to justify the text discussion of source emissions from on site. Include at least a paragraph about all of the metals that were measured, even if figures and/or tables of them are not included.

The description of the dioxin measurements on the EPA samplers, which collected 7 cu.m. of air, is technically correct. However, due to the low volume the results need more careful discussion. The samples with very high concentrations should be highlighted and the implications of these values, greater than measured in just about any other ambient air sample needs to be presented clearly, along with a reconsideration of whether they may present a health risk.
Recommendation: Reorganize the discussion and tables to clarify which samples were below detection because of the low volume collected and how the difference in detection limits between the two types of samples that were collected need to be considered in the comparison. Align the dates in Table 4 for the three sites so they can be more readily compared.

In the section on Potential Human Health for Dioxin the exposure scenarios and ventilation rates need to be reviewed.

The limited discussion of the indoor air and occupational exposures while commendable may be problematic.
Recommendation Occupational: For the occupational exposures, see if a more comprehensive report is being planned in deciding what should or should not be included here. It is probably

best to exclude or at least place in even stronger context the VOC measurements made for source emission evaluation as they are not applicable for exposure estimates without extensive modeling. Similarly, the measurements made for worker exposure determination need to be separated from the environmental exposures that occurred off-site more clearly. It may pay to discuss exposures to individuals who returned to their residences on-site or in the restricted zone prior to complete authorization using the worker exposure measurements.
Recommendation Indoor: A separate indoor exposure and risk report should be prepared that at the minimum has an oversight board with, if not prepared by, non-EPA scientists and community representatives to expand the breadth of the report to address community concerns and facilitate an atmosphere of trust between the community and EPA scientists. The section on indoor air should be carefully reviewed so as not to provide more emphasis to draft reports that have not been peer-reviewed. Having them included here provides an appearance of a peer-reviewed status possibly providing them with undue legitimacy.

A review of the PM conclusions needs to be done after the data has been evaluated. Several members of the audience mentioned samples collected at Stuyvesant HS, which was apparently done by DEP with coordination by the NYC Board of Education. (see http://www.nyc.gov/html/dep/html/airmonit.html for example and at some EPA web sites). These should be mentioned for completeness.

The following are supplementary comments on the EPA report. These additional comments were too detailed in nature to be included in my initial comments, and they were not discussed at the Peer Review Meeting because they did not fall under any of the general charges to the reviewers, but they may be helpful to EPA during the revision of the report.

1. In the List of Acronyms and Abbreviations, "f" should refer to "fibers", rather than to "fibers of asbestos", the letter "L" in "REL" and "STEL" I believe is "Limit", rather than "Level", "TEM" is "Transmission Electron Microscopy", and "XRF" is "x-ray fluorescence".

2. In the Executive Summary on Page 1, Paragraph 2, Line 3, it is stated that "It is an assessment of the inhalation exposure and potential human health risk incurred by the general population residing and working in the vicinity of the WTC." This statement requires some additional clarification, because most people residing and working near the WTC spend most of their time indoors, and indoor exposures are not the primary focus of this report.

3. On Page 2, in Line 8 of Paragraph 2, the sentence beginning "Dioxin and VOC's..." needs to be re-worded. As it stands, the sentence can be taken to mean that these pollutants are produced only from fuels. There were many other potential sources in the WTC buildings.

4. On Page 2, the final paragraph contains the expression "in the surrounding community". It would be good if this could be better defined.

5. On Page 9, Line 2, it is stated that PCM is used to identify structures greater than 5 μm in length. PCM does not have the ability to **identify** anything.

6. On Page 9, Line 3, the statement in parentheses is incorrect. TEM is used to detect and identify asbestos structures **greater than** 0.5 μm in length

7. On Page 9 in the final line of Paragraph 1, a reference for the value of 0.003 f/cc as typical of urban background should be given, particularly since it is used in the report as a definition of background. In fact, I remain uncomfortable with the concept of using PCM as a measurement method for asbestos in the general environment. I recognize that it may have been useful for rapid measurements in the early hours after the collapse, but the authors should be careful to not place too much reliance on the PCM measurements, either outdoors or indoors. In the measurements we made in the apartments, I never even contemplated the use of PCM.

8. On Page 9 of the report, in the 3rd Paragraph, it is stated that "One apartment was highly affected by the collapse of the WTC towers with completely shattered windows and dust piled throughout the apartment. The other was in a building that had little exterior damage.....". In fact, I was present at the sampling and only one small window had been

broken in the first apartment, and the opening had been sealed with plastic sheet and adhesive tape. The other building had **no** exterior damage.

9. On Page 10 of the report in the first paragraph, some reference to the method of analysis of the bulk samples should be given, and a caution on the reliability of these data. It is well known that measurements by PLM in the range below about 5% are quite unreliable, and it is unlikely that the figures quoted to two significant digits are meaningful. Moreover, I think that asbestos was likely present in all of the bulk samples collected, and that the failure to detect asbestos in many of the settled indoor dust samples or the outdoor samples was a question of deficiencies in either the analytical method, or the conduct of the method.

10. On Page 11, Paragraph 2, Line 9, the method of analysis should be stated..

11. On Page 17, the last entry in Table 1 is incorrect. The AHERA clearance standard is not "a level of concern". Abatement activities were not undertaken to reduce air concentrations, because abatement decisions were not made on the basis of measured air concentrations. It is incorrect to say that school children were not allowed back in until several consecutive readings were less than the AHERA standard. In fact, the clearance decision is based on the average of 5 simultaneously collected samples in the work area being lower than 70 s/mm^2. Even that value is considered to be an "initial screening test".

12. On Page 70, there is a blank cell for the Barclay & West Broadway location on 9/27 in the final column.

13. On Page 86 at the beginning of the 2nd paragraph, the word "classified" would be more appropriate than "characterized".

14. On Page 86 in the 3rd Paragraph, it is stated that "Both asbestosis and benign pleural plaques result in reduced breathing capacity and mortality". I suggest that this be re-phrased, since it currently means that asbestosis and pleural plaques result in reduced mortality, which I do not believe is the case.

15. On Page 87 in Section IV.e.1, it is stated with respect to PCM: "It counts all fibrous structures with a minimum diameter of 0.3 μm and has a magnification range of 100 - 400X". The minimum diameter is usually taken to be 0.25 μm in the U.S., and counts are made at a fixed magnification of between 400 and 450. Later in the same paragraph, it is stated that "PCM results are reported on a mass-per-volume basis, ...". This is not correct - PCM results are never reported in that manner.

16. On Page 88 in the first paragraph, there needs to be some mention of the fact that the AHERA method specifies the use of aggressive sampling to create the worst case situation.

17. On Page 88 in the 3rd line of the first paragraph, it is stated: "The AHERA Final Rule establishing a 70 s/mm^2 standard for asbestos in schools.....". The AHERA Final Rule actually established an indoor-outdoor comparison as the clearance criterion. The 70 s/mm^2 criterion is an "initial screening test". In this paragraph, it should also be mentioned that the air sampling is to be conducted under aggressive conditions.

18. On Page 88 in the final three sentences of Paragraph 2, it is an over-simplification to state that there is not a good correlation between PCM and TEM measurements. When the direct-transfer TEM method is used, and the PCM size fraction of fibers is measured using TEM, the correlation can be very close. It is true to say that, in the general environment, there is generally little correlation between PCM measurements and TEM measurements of all fiber sizes. There are two reasons for this: the PCM measurements include fibers other than asbestos, and the TEM measurement includes asbestos fibers outside of the visible range for PCM. In fact, there is no reason to expect a correlation. Although it is not the responsibility of the authors of this report, I believe that the ATSDR procedure to obtain what are termed "TEM units" by multiplying PCM data by 60 is totally invalid. It needs to be clarified as to what these "TEM units" are - are they for all fiber sizes greater than 0.5 μm in length, or are they all fibers longer than 5 μm?

19. On Page 88 in the 3rd paragraph, it is stated that ".... structures meeting a minimum diameter of >0.3 μm with length >5 μm are counted as PCM equivalent ("PCME") fibers". NIOSH 7402 defines "PCME" fibers as those longer than 5 μm and thicker than 0.25 μm, and ISO 10312 defines them as longer than 5 μm and thicker than 0.2 μm.

20. On Page 89 in the first paragraph, on line 4, the AHERA clearance criterion is actually based on the average of a single set of 5 samples. There is no requirement for such TEM readings to be "consistently" below 70 s/mm^2, just that the average of the clearance set be below this value.

21. On Page 89, Paragraph 4, Line 5, it should be stated that the mass concentration of 30,000 ng/m^3 was derived **only for chrysotile**, and the data on which this value is based have a very large range. I have already commented in Item 18 about the multiplier used to convert PCM to TEM data.

22. On Page 91 in the first paragraph, reference is made to sampling stations set up **in** public schools. It is not clear whether these were external samples or actually inside the buildings. If they were inside, was the sampling aggressive or passive? The sampling conditions should be stated, since the AHERA protocol specifically requires aggressive sampling.

23. On Page 128 in the 2nd paragraph of Section VI.b.1, the description of how PLM distinguishes between fiber types requires revision - it is not correct. I doubt that a simple, one sentence description is even possible, and a more detailed explanation would be out of place. I suggest that the sentence be truncated to: "PLM can distinguish between fiber types in a bulk sample.". I also suggest that a caution be added regarding

the inaccuracy and unreliability of routine PLM measurements in the vicinity of 1%. As stated in Item 9, it is my opinion that the failure to detect asbestos in 82% of the residential units, and in 8 of the outdoor samples was more a question of limitations of the analytical method and the conduct of the method.

24. On Page 128 in the final paragraph, it states that "All air filter samples were analyzed first using PCM to determine if fibrous materials were present. It seems highly questionable to use a method, already admitted to have little correlation with TEM data, as a screening method for selection of samples for subsequent TEM analysis. Under this protocol, the existence of a few cellulose fibers could trigger analysis by TEM, and a sample containing considerable numbers of thin chrysotile fibers could be overlooked. Again, the ATSDR work is simply being reviewed by the authors of this report.

25. On Page 133, on the 5th line the report states: "A small-scale monitoring study of two residential buildings was conducted by contract (Chatfield and Kominsky, 2001)." The statement is incorrect - the work was not done under contract; all individuals involved in the study donated their time and the analytical costs to conduct this study.

26. On Page 133 in the 2nd paragraph, it is stated that the TEM analyses were conducted using AHERA counting protocols. In fact, ISO 10312 was used. The end result, however, would be similar. Chrysotile is also spelled incorrectly at the beginning of the 3rd sentence.

27. On Page 133 in the final paragraph, it should be mentioned that amphibole asbestos (amosite and actinolite/richterite) at concentrations of approximately 0.02% was also detected in these outdoor dust samples.

28. On Page 134, it is not clear whether the air sampling referred to was aggressive or passive. This should be clarified, because it affects the interpretation of the data. In fact, whether the air sampling was aggressive or passive should be stated for all of the asbestos air sampling data.

29. On Page 135, various dates are quoted. It would be helpful if the year was added to each of these dates.

30. On Page 135, the first sentence of Paragraph 4 needs to be re-worded. One suggestion would be to insert the word "who" or "that" between "people" and "may" on Line 2 of this paragraph.

APPENDIX G

Comments and Written Materials from Observers

List of Comments and Materials Submitted by Public Observers

Comments and Materials Submitted Prior to and at Peer Review Meeting
7/14/03 Letter re: EPA/Versar Peer Review, from 9/11 Environmental Action. Statement by Kimberly Flynn, on behalf of 9/11 Environmental Action, July 14, 2003.
Statement by Jenna Orkin, 9/11 Environmental Action, at EPA Peer Review Meeting. July 14, 2003.
Materials provided by Jo Polett on July 14, 2003, at Peer Review Meeting: (1) Executive Summary to ATSDR report on WTC, (2) Letter to DOH from Nina Lavin (on residence 1), (3) Results of air and settled dust sampling at residence 1, (4) Indoor air quality survey of residence 1, (5) Indoor air quality survey of residence 1.
Sediment and Tetramitus Toxicity in NYC Drinking Water, Appendices I, II, IV. Fact Sheets by Robert L. Jaffe, Ph.D., Environmental Toxicology Laboratory, LLC
Flagellate Swimming Patterns as an Early Warning Signal for Terrorist Poisoning of Air and Drinking Water. Phase II White Paper. Paper by Robert L. Jaffe, Ph.D., Environmental Toxicology Laboratory, LLC
Environmental Health Effects of WTC. EOHSI Website, University Research. Provided by Catherine McVay Hughes, NYU, on July 15,2003.
World Trade Center Environmental Impact Research Community Update. Brochure, Fall 2002. http://niem.med.nyu.edu/wtc.pdf. Provided by Catherine McVay Hughes, NYU, on July 15, 2003.
Further Comments on EPA document for peer review :*Exposure and Human Health Evaluation of Airborne Pollution from the WTC Disaster*. Statement by Marjorie J. Clarke, Ph.D. July 15, 2003.
No Serious Health Risk for Public from Ground Zero, EPA Reports. New York Times, December 28, 2002.
Status of EPA Office of Inspector General Investigation of EPA's Handling of WTC Fallout. January 27, 2003. EPA/OIG.
Occupational and Environmental Health Impact of the World Trade Center Collapse, February 2003. Abstract to presentation by Steven Markowitz, N.Y. Academy of Sciences. February 3, 2003.
Do Lower Manhattan Cleanup Right. NYCOSH. William Henry. Fact Sheet. August, 2002.
We Protect More Than the Environment. . . EPA Flyer

Downtown Favors West St. Tunnel, Poll says . .. Downtown Express Online. May 2003
Predicting Health Impacts of the World Trade Center Disaster, January 2002. Article. Produced by R. Wallace and DW Wallace. N.Y. State Psychiatric Institute and School of Public Health, Columbia University. Provided by Joel Kupferman, Esq. July 14, 2003.
Comments on the EPA Office of Inspector General's 1/27/03 interim report titled: "EPA's Response to the World Trade Center Towers Collapse" A DOCUMENTARY BASIS FOR LITIGATION. July 4, 2003. Prepared by Cate Jenkins, Ph.D., US Environmental Protection Agency.
Comments and Materials Submitted Following Peer Review Meeting
NYC Council Hearing on Post-9/11 Remediation of WTC: Problems with EPA's Scopes of Work; EPA's Outreach. December 19, 2002. Statement by Marjorie J. Clarke, Ph.D.
NYS Assembly's second hearing on Air Quality issues surrounding the World Trade Center collapses and fires, April 12, 2002. Statement by Marjorie J. Clarke, Ph.D.
Additional comments concerning the document: Exposure and Human Health Evaluation of Airborne Pollution from the World Trade Center Disaster. Post meeting comment submitted by Jenna Orkin, 9/11 Environmental Action. July 24, 2003.
EPA Public Comment /WTC Health Consequences. Post meeting comment submitted by Carla Breeze & Wayne Decker, Neighborhood Environmental Watch. July 18, 2003.
Post Meeting Comments by Diane Dreyfus. July 16, 2003.
Respiratory Problems for Downtown Residents. From Downtown Dispatch - Summer 2003, by Community Board #1. Submitted by Diane Dreyfus. July 31, 2003.
Independence Plaza Tenants' Association's Report on Cleaning/Testing for Review by the NCEA Peer Review Panel. Letter from Patricia Dillon, for the IPNTA Environmental Committee, to David Bottimore, Versar Inc. July 22, 2003. With 2 attachments (1) Letter to Ms. Christine Todd Whitman, Administrator, U.S. Environmental Protection Agency. June 6, 2003. From Ms. Deborah Dolan, Duane Street Associates, and Diane Lapson, IPNTA Environmental Committee. (2) Letter to EPA Region 2 on cleaning/testing reports on 80 N. Moore and 310 Greenwich St. buildings. From Deborah Dolan, Hudson River Management LLC.
Meeting Follow up - WTC Public Comments to EPA. Submitted by Rachel Lindov. July 22, 2003.

Asbestos Fiber Length as Related to Potential Pathogenicity: A Critical Review. By Ronald F. Dodson, Ph.D., FCCP, FAHA; Mark A.L. Atkinson, M.A., D.Phil.; and Jeffrey L. Levin, M.D., M.S.P.H. Pre-publication copy, American Journal of Industrial Medicine. Submitted by Marjorie Clarke, July 24, 2003.
Public comments regarding the July 2003 Peer Review of the EPA study entitled: EXPOSURE AND HUMAN HEALTH EVALUATION OF AIRBORNE POLLUTION FROM THE WORLD TRADE CENTER DISASTER. Submitted by Bob Van Dyke, From the Ground Up. August 1, 2003.
Question on Use of Ambient Monitoring Network Data, submitted by Henry H. Willis, Ph.D., RAND, July 14, 2003.
Reply to Question on Use of Ambient Monitoring Network Data by Matthew Lorber, U.S. EPA, to Henry H. Willis, Ph.D., RAND. July 18, 2003.
LATEST EPA "All Clear"& Safe to Live Downtown NOT TRUE. Comments submitted by Ari Porter, July 15, 2003.
NCEA peer review comment; PCBs, PCDD/Fs, PBBs, PBDD/fs; background levels. Submitted by Paul Bartlett, CBNS, Queens College. July 25, 2003. With attached journal article *POLYCHLORINATED BIPHENYL (PCB) CONCENTRATIONS IN ATMOSPHERICALLY DERIVED ORGANIC FILMS FROM LOWER MANHATTAN AFTER SEPTEMBER 11, 2001*, Craig M. Butt, Jennifer Truong, Miriam L. Diamond, and Gary A. Stern. ORGANOHALOGEN COMPOUNDS Vol. 59, Pages 219-222 (2002).

Submission of public comment: 2002. EXPOSURE AND HUMAN HEALTH EVALUATION OF AIRBORNE POLLUTION FROM THE WORLD TRADE CENTER DISASTER (EXTERNAL REVIEW DRAFT). 01 Oct 2002. Comments submitted by Joel Kupferman, Esq., New York Environmental Law & Justice Project. August 1, 2003. With 23 attachments.
A - Toxics Targeting for WTC Complex
B - PortAuthorityVSallied
C - Kupferman9-19-01-nearWTC
D - Gonzales-Fallout-Chapter3
D1 - EPA-Daily-Summary-Oct2-2001
E - NIEHS Report-on WTC-Workers
E1 - CCRworkersafetyCritique
F - HealthStudyFreshKills
G - 92802Bulksample333RectorStreet
G1 - Amex testing & cleanup
H - DEP demand
I - Ladder25results73102
J - CONTAMINTED HOUSES AND RIG
K - TheAsbestosNightmare
L - WINDBORNE POLLUTANTS TRAVEL
M - 150FranklinStreetTestResults
N - 105DuaneStreetResults
O - asbestosdustsamplingEwing
P - WallaceHealthImpacts
Q - DailyNewsFireMaySmolder
R - PREZANTLETTERFIREFIGHTERHEALTH
S - PublicHealthFalloutfromSeptember11

NY COSH. Technical Peer Review of *Exposure and Human Health Evaluation of Airborne Pollution from the WTC Disaster*. Letter with 17 articles and reports attached.

1. Four HHE reports by NIOSH, one each for Borough of Manhattan Community college, Stuyvesant High, Office of Attorney General of State of NY, and offices of NYC clerical workers.

2. *Assessing Health of Immigrant Workers Near Ground Zero: Preliminary Results of the WTC Day Laborer Medical Monitoring Project,* 2002. Amer. J. Ind. Med, 00:1-2.

3. Levin, Herbert. *WTC Worker and Volunteer Medical Screening Program-Report of Initial Findings to Nat'l Inst. For Occup. Safety and Hlth of the Centers for Disease Control and Prevention,* January 2003.

4. Chatfield, Kominsky. *Summary Report: Characterization of Particulate Found in apartments After Destruction of the World Trade Center,* October, 2001.

5.	Ewing. *Asbestos in Settled Dust Concentrations in NYC Before September, 11, 2001*. Abstract. Conference Paper July, 2002 by ASTM Committee D22 on Sampling and Analysis of Atmospheres.
6.	*Phase 2 Sampling and Quality Assurance Project Plan, Rev. 0, for Libby, Montana-Environ. Mon. For Asbestos, Evaluation of Exp. To Airborne Asbestos Fibers During Routine and Special Activities*, March 2001.
7.	*Amphibole Mineral Fibers in Source Materials in Residential and Commercial Areas of Libby Pose an Imminent and Substantial Endangerment to Public Health*, December, 2001.
8.	*Asbestos Rules and Regulations*, city of NY, Dept. Environ. Protection.
9.	*Documents (Partial) Obtained from Freedom of Information Law Request from NYC Dept. Of Environmental Protection*, February 2003. NY Law and Environmental Justice Project.
10.	*Report of Findings: Building Air Quality Assessment*, November 2001, August 2002. Excerpts of 2 reports for high-rise commercial bldg. In Lower Manhattan.
11.	*Summary Data ASTM D5755-95 Standard Method for Microvacuum Sampling and Indirect Analysis of Asbestos in Settled Dust by TEM*, February 2003.
12.	Letter dated January 2002 describing results of air monitoring for asbestos in a World Financial Center Bldg.
13.	Letter dated December 2002 describing results of 3 rounds of sampling for lead dust in a large institutional building four blocks from Ground Zero.
14.	*Re: Environmental dust and Debris Sampling and Evaluation*, Letter dated November 2001.
15.	Two environmental sampling reports for apartments on Harrison Street, dated November 2002 and January 2003.
16.	Letter and environmental sampling results from ETNY Consulting and Monitoring, to Ms. Ilona Kloupte, a resident at 300 Albany Street
17.	*Summary of TEM Results for Asbestos (ASTM D5755 Dust Microvac)* for 2 apartments on Duane Street.