Report on the External Peer Review of EPA's Draft Document "Exposure Factors Handbook"

Arlington, VA
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Notice

This report was prepared by Eastern Research Group, Inc. (ERG), an EPA contractor, as a general record of discussion during the External Peer Review Workshop of EPA's Draft Document *Exposure Factors Handbook*, held March 3–4, 2010, in Arlington, Virginia. 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 expand on matters that were incomplete or unclear. Statements represent the individual views of meeting participants.

Contents

1. Introduction

The *Exposure Factors Handbook* (EFH) was prepared by the National Center for Environmental Assessment (NCEA), within EPA's Office of Research and Development (ORD). The EFH was last revised in 1997. Since then, the *Child-Specific Exposure Factors Handbook* was updated and published in 2008. The updated version of the EFH incorporates the revisions made to the *Child-Specific Exposure Factors Handbook* and information from the published literature up to June 2009. The EFH serves as a resource for exposure assessors for calculating exposures and provides a summary of statistical data on various exposure factors used in assessing human exposures. These factors include:

- Drinking water consumption
- Soil ingestion and mouthing behavior
- Inhalation rates
- Dermal factors, including skin surface area and soil adherence factors
- Consumption of retail and homegrown foods
- Human milk intake
- Body weight
- Consumer product use
- Activity pattern data
- Life expectancy
- Residential characteristics

In March 2010, ERG, an EPA contractor, organized an independent peer review of the EFH. The overall goal of external peer review is to enhance the quality and credibility of Agency decisions by ensuring that the scientific and technical work products underlying these decisions are based on sound science and reflect recent peer-reviewed literature. The review was conducted by 15 nationally recognized experts (Appendix A):

- Henry Anderson, Wisconsin Division of Public Health
- Paloma Beamer, University of Arizona, Environmental Health Sciences
- Deborah Bennett, University of California, Davis, Department of Public Health Sciences
- Robert Blaisdell, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment
- Alesia Ferguson, University of Arkansas Medical Sciences, College of Public Health
- Brent Finley, ChemRisk
- David Gaylor, Gaylor and Associates
- Panos Georgopoulos, University of Medicine and Dentistry of New Jersey, Robert Wood Johnson Medical School, Department of Environmental and Occupational Medicine
- Annette Guiseppi-Elie, DuPont Engineering, Corporate Remediation Group
- Michael Lebowitz, College of Medicine
- Agnes Lobscheid, Lawrence Berkeley National Laboratory (LBNL), Environmental Energy Technologies Division
  *Dr. Lobscheid conducted this review as an independent consultant and not as a representative of LBNL.

- P. Barry Ryan (Chair), Emory University, Rollins School of Public Health
- Alan Stern, Independent Consultant
- Nga Tran, Exponent, Center for Chemical Regulation and Food Safety
- Rosemary Zaleski, ExxonMobil Biomedical Sciences, Inc.

The reviewers were provided with a charge (Appendix B), which asked for their comments on the general organization of the document, the necessity of the factors included, the completeness of the data sources, the discussion of “key” and “relevant studies,” the discussion of confidence ratings, the characterization of data variability, and the usefulness of current data presentation, as well as several chapter-specific questions. The charge also asked several questions about future products from EPA’s Exposure Factors Program. Peer reviewers were provided with and asked to consider the review document and copies of all comments submitted during the public comment period.

In the first stage of the review, the experts worked individually to prepare written pre-meeting comments (Appendix C), which were provided to all reviewers and EPA. In the second stage, ERG convened a two-day peer review workshop on March 3–4, 2010, at the Sheraton Crystal City Hotel in Arlington, Virginia. The workshop was open to observers (Appendix D). Appendix E provides the peer review agenda, which was organized by chapter and charge question. Written comments submitted by reviewers following the peer review are included in Appendix F.

This report summarizes the peer review discussions:

- Section 2 presents the reviewers’ final conclusions and recommendations.
- Section 3 presents the opening remarks.
- Sections 4 through 8 summarize the reviewers’ discussions on general questions.
- Sections 9 through 25 summarize the reviewers’ discussions on each chapter.
- Section 26 summarizes the reviewers’ discussions regarding future products.
- Section 27 summarizes other issues discussed during the peer review.
- The appendices provide the following: peer reviewers (Appendix A), charge to peer reviewers (Appendix B), reviewer pre-meeting comments (Appendix C), observers (Appendix D), agenda (Appendix E), and reviewer post-meeting comments (Appendix F).

2. Conclusions and Recommendations

After discussing all of the charge questions and chapters, the reviewers developed the following conclusions and recommendations, on which they generally agreed:

- Include a roadmap/flow chart.
- Better describe the changes between the 1997 version and the current EFH.
- Be more transparent in the methods (e.g., literature search) used to identify studies. One reviewer recommended adding this to a new section titled “Background.”
- Better explain the choice of key and relevant studies. Be sure to correct the erroneous use of certain key studies (as identified by reviewers).
- Be more transparent in how the recommended values were selected.
- Coordinate factors with the *Child-Specific Exposure Factors Handbook.*

- Re-work the Dermal Exposure Factors chapter (Chapter 7), but do not delay the release of the EFH to do so.
- Re-work the Lifetime chapter (Chapter 18).
- Release the EFH as a Web-based database.
- Heavily edit the Introduction (Chapter 1).
- Heavily edit the Executive Summary.
- Update some of the terminology and definitions to ensure they are used consistently, particularly in Chapters 1 and 2.
- Include physiological factors in the Inhalation Rates chapter (Chapter 6).
- Include enough information in the tables for them to be able to stand alone.

The reviewers generally agreed that the Residential Building Characteristics chapter (Chapter 19) needs extensive work. They all felt that re-working the chapter should not delay the release of the EFH. However, they disagreed on how EPA should proceed and offered several options during their discussion of the chapter (see Section 25).

The reviewers generally agreed that the National Health and Nutrition Examination Survey (NHANES) data should periodically be incorporated into the EFH. They did not agree, however, on the level of peer review that would need to take place. See the discussion under Other Issues (Section 27) for more details.

The reviewers generally agreed that the confidence ratings in each chapter needed more transparency. Some reviewers suggested replacing the more rigid categories with narratives. Others suggested using a more consistent numeric system. Still others suggested including narratives in addition to the confidence ratings. See the discussion under General Question 5 (Section 7) for more details.

The reviewers disagreed on the degree of context or background about exposure assessment that should be included in the EFH. They offered their opinions and suggestions (see Section 9) and said that EPA will have to decide on the audience.

3. Opening Remarks

Jenny Helmick (ERG) opened the peer review by welcoming the reviewers (Appendix A) and observers (Appendix D). She stated that none of the reviewers have any conflict of interest (COI) that would preclude them from participating in this peer review.

The panel chair, Barry Ryan, asked the reviewers and observers to briefly introduce themselves. Peer reviewers provided background on their areas of expertise. Peer reviewer biographies can be found in the pre-meeting comments (Appendix C).

Helmick reviewed the general approach of the peer review process. She noted that the pre-meeting comments (Appendix C) were developed by reviewers working individually prior to the peer review. They are considered preliminary comments and can be changed or refined during the peer review. Helmick explained that all discussions would be conducted only by the peer reviewers. EPA may offer clarification, if asked by the chair. In addition, she stated that reviewers should not hold discussions outside of the meeting, to ensure that observers could hear all discussions. She noted that an ERG technical writer was taking detailed notes and would be preparing a summary report of the peer review. This report would capture details of the discussions, including individual opinions, as well as any conclusions and recommendations that reviewers developed. There is no requirement for the reviewers to reach consensus. ERG would send a draft of this report to all reviewers to check for accuracy and completeness. After incorporating reviewer comments, ERG would finalize the summary report and send it to EPA, who would make it available to the public via the Internet.

3.1. Observer Comment Session

Helmick asked if there were any observer comments. No observers (Appendix D) chose to comment during the peer review.

3.2. Reviewer Discussion

Helmick turned the peer review over to Ryan, who reviewed the charge (Appendix B) and tightly packed agenda (Appendix E). He noted that a primary task of the peer review is to offer a public review of the draft EFH. Several of the charge questions were general and referred to the whole document. All reviewers were asked to comment on these general questions. There were also specific questions related to particular chapters. For these questions, reviewers were assigned specific chapters to review based on their areas of expertise. However, any reviewer could comment on any chapter or question, even if it was not assigned to that particular reviewer. Ryan reiterated that the pre-meeting comments are preliminary and will be included as an appendix to the peer review report (Appendix C). There is no need to reach consensus; however, where consensus is reached, it will be noted in the report. He also stressed the importance of speaking in this public forum only.

4. General Question 1

1) *Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?*

Ryan began the discussion by summarizing the reviewers' pre-meeting comments. He said that there was general agreement praising the overall organization of the EFH. However, there were numerous comments regarding specific tabular presentation throughout the document. Generally, the reviewers suggested a more readable and accessible presentation for the tables and provided many ideas on how that could be accomplished.

A reviewer commented that he thought the organization was generally good, but that he would like to see more work done on Chapter 1 and the Executive Summary, as they will be the most read chapters. He said that Chapter 1 should help guide people's appropriate use of the document. It would be useful to include more information on how the data were selected, why these factors are appropriate, and why these specific studies were selected. Two reviewers agreed with this point.

Another reviewer said that the definitions, explanations, and comments appear to be incomplete in various chapters, but especially in Chapter 1. It is important to expand on the explanations. This reviewer also noted that EPA should provide additional references to a variety of work that explain how the EFH can be used and how exposure assessment relates to risk assessment. A reviewer said that there are inconsistencies in the definitions used.

Another reviewer said that he would like to see more detail provided about the changes between this updated EFH and the 1997 EFH. He said that it would be helpful to know what studies and recommended values have changed. A reviewer noted that there was only a single paragraph describing the differences, and that EPA could develop that section more. Another reviewer agreed.

One reviewer said that having the recommended values up front was a structural improvement. However, he thought that it was difficult to determine the justification and source of these recommendations because sometimes the rationale was not provided. He also thought that the tables should have enough detail to be "stand alone" and that they should be closer to their respective studies. Another reviewer agreed that tables should stand alone (i.e., contain all important information). One reviewer suggested providing more summary statistics in the tables.

One reviewer commented that she liked the overall structure of the document; however, she noted that the Introduction (Chapter 1) could be improved by describing the interdependence between exposure factors. For example, dermal surface areas are related to body weight. A reviewer agreed that the correlation between factors should be more apparent. Another reviewer agreed and said that there should be better explanations in the beginning about how the linkages relate. For example, the body weight data are more current. One reviewer said a better placement of chapters would be useful (re-organizing to group those more closely related).

A reviewer noted that the updated EFH is a very large document and suggested including a road map in the first chapter to help navigate through the document. She also commented that even though the EFH is not a treatise on exposure science, more background needs to be provided in the Introduction (Chapter 1). She also suggested updating and incorporating Appendix A1 from the 1997 EFH into the updated EFH. Another reviewer said that EPA should incorporate key figures and links from the 1997 EFH into the updated EFH.

One reviewer said that more examples or better explanations on how to make an exposure calculation should be given. Chapter 1 contains some of these details, but the introductions for each chapter could be improved.

Two reviewers commented that the terms “exposure” and “dose” were inconsistently and incorrectly used. Another reviewer thought it was egregious that dose was not correctly defined. Three additional reviewers agreed that these kinds of mistakes should be corrected. The glossary should contain standard definitions for reference.

One reviewer commented that most users of the EFH will not read the original publication. Therefore, the EFH has to be clear about the data being presented. Several reviewers felt that the EFH was not clear about how certain studies were chosen and why other studies were not included—were they reviewed and deemed inadequate, or were they not reviewed?

One reviewer said that a future version of the EFH could be reorganized into three types of factors—environmental, biological, and behavioral.

5. General Question 2

2) *Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?*

Ryan began the discussion by summarizing the reviewers' pre-meeting comments. He said there was general agreement among the reviewers that all the factors presented are important. Several reviewers provided specific suggestions for additional factors in their pre-meeting comments. One reviewer commented that some factors were not considered and others were improperly considered. Based on the pre-meeting comments and discussions during the peer review, he felt that important factors are missing. Ryan asked whether it was clear in the pre-meeting comments which factors are critical to include. The reviewers generally agreed that their comments were explicit.

One reviewer said that there are additional factors that could be included in Chapter 19 (Residential Building Characteristics) and Chapter 7 (Dermal Exposure Factors). Another reviewer agreed, specifically noting that factors associated with microenvironments are missing. Three other reviewers agreed, mentioning the need for surface area exposure during contact. One reviewer commented that it would be useful to include information on residue transfer and solid adherence per contact event in Chapter 7.

One reviewer commented that additional factors (e.g., surface area) are needed to determine non-dietary ingestion exposure (Chapter 4).

Two reviewers said that it is important to include physiological data such as tidal volume in Chapter 6 (Inhalation Rates). Another reviewer agreed.

6. General Question 3

3) *For the factors included in the EFH, are you aware of other data sources that have not been identified?*

Ryan noted that according to the pre-meeting comments, the answer is yes. Almost all the reviewers offered additional sources for the various chapters. The reviewers did not discuss this question specifically, but referred to the pre-meeting comments (Appendix C) for the lists of studies provided.

7. General Question 5

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

Ryan began the discussion by summarizing the reviewers' pre-meeting comments. He said that generally the reviewers liked the concept of confidence ratings, but few thought that the factors were described adequately, used consistently, or seemed particularly useful. Few alternatives were offered, and the problem was deemed difficult to assess.

One reviewer commented that sometimes it wasn't clear how the categorizations were made. He said it was hard to reconcile why, if all parts of the rating are deemed high, the overall rating may be low. One reviewer agreed that the descriptions were not very satisfying. Another reviewer said that additional discussion is needed on why certain key studies were chosen over others.

One reviewer said that there was very little consideration of physiology and anatomy for the inhalation rates that are already provided by reputable bodies in this scientific area (Chapter 6). He considers this a serious problem and believes that the exposure factors for inhalation rates need to be reexamined utilizing significant published information in this area.

One reviewer noted that the confidence ratings never influence his selection of a value. He is unclear how the confidence ratings are supposed to be incorporated into an assessment. Another reviewer said that confidence ratings are needed, especially for the selection of key studies. Even though it would be a tremendous task, it would also be useful to have confidence ratings for the relevant studies. Another reviewer agreed and said that she really likes having the confidence ratings and finds it useful knowing that someone has already looked at and rated the data. It gives her an idea of how confident she can be in the analysis.

One reviewer noted that the confidence ratings were not consistently applied across studies. She suggested that a more consistent numeric system be developed and applied. In contrast, another reviewer said that while a uniform confidence rating system is well intentioned, he would prefer a narrative describing the strengths and limitations of the data. He said that a narrative discussing how the key studies address the intended use of the data would be more appropriate. Another reviewer agreed that there should be consistency among chapters but acknowledged that not all exposure factors are the same. One reviewer suggested adding narratives to the ratings.

Two reviewers commented that the confidence ratings were subjective (i.e., another person might apply a different rating). Additionally, another reviewer said there should be some discussion about the representativeness of the population. One of the reviewers thought that there may be circumstances where a sub-study may be more applicable. The other reviewer noted that EPA would have to anticipate the use of the EFH (which is not possible) to apply a confidence rating on every study, because each one might be more or less applicable in any given circumstance.

One reviewer commented that it is useful to have general confidence information. However, the confidence ratings should reflect how the data are being described and used (i.e., ratings for data being split into age groups should consider age group-specific sample size). The reviewer suggested providing confidence ratings both for the study and the data as used.

One reviewer suggested that the rationale for the overall confidence rating be provided in a footnote below each confidence table.

One reviewer commented that regardless of the confidence rating, if a value is presented in the EFH, someone may use it. If there is no confidence in a study, it should not be included.

8. General Question 7

7) *Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web-based, other)?*

Ryan began the discussion by summarizing the reviewers' pre-meeting comments. He said that opinions were divergent. Some reviewers felt that a paper copy was necessary. Nearly all wanted electronic access to the EFH, preferably in a searchable PDF format. Several reviewers mentioned establishing a searchable database.

One reviewer said that it was innovative and useful to have links to the actual papers in the 1997 EFH and that it would be very useful to continue this practice and expand it to include all studies that are referenced. Another reviewer noted that while EPA can provide links to its own documents, the Agency would run into copyright issues if it provided links to all journal articles. Another reviewer agreed that it would be useful to have links to upload the information. He suggested an interactive online resource that has access to publications and databases.

This same reviewer suggested creating an electronic, searchable version of the EFH, along the lines of the FactorFinder computer program. He said that most students and assessors would prefer an interactive online version. Three reviewers agreed that a searchable database would be useful. One reviewer noted that the European Union has an online exposure factors database (ExpoFacts). Two reviewers said that the database would be a good complement to the PDF version, not a replacement. One reviewer commented that an online searchable database might be easier to update.

One reviewer said that while it is fine to have electronic versions of the EFH on CD and on the Internet, he would hate for the paper copy to not also be available. Ryan asked the reviewers to comment on the need for a paper copy or whether a downloadable PDF would be sufficient. One reviewer said that a downloadable PDF is fine. Another reviewer agreed that a PDF is fine and suggested that perhaps EPA could charge a fee to those who want to order a paper copy. One reviewer suggested having it be available by chapter so that people would order the sought-after volume(s). Another reviewer noted that paper copies of the longer tables are especially useful.

9. Chapter 1: Introduction

8) *The Introduction contains a summary of the latest guidance and developments in exposure assessment. Please comment on whether we have captured the most important and relevant guidance and developments in exposure assessment.*

One reviewer commented that Chapter 1 (Introduction) and the Executive Summary will be the most read chapters. He said that both could use a lot of editing and formatting to make them what they should be—the most well-written chapters in the document.

One reviewer thought that Chapter 1 should explain the concept of using micro, meso, and macro activity patterns when calculating exposure. This would determine the type of algorithm and exposure factor needed. Another reviewer said that new developments in exposure assessment, such as using biomarkers, should be explained better. A road map with links to existing and ongoing efforts in Chapter 1 might be a useful way to show new concepts and approaches to characterizing exposure. Another reviewer agreed that an interactive road map would be very beneficial.

Two reviewers suggested adding a section that references other resources, databases (e.g., databases from the U.S. Geological Survey, the U.S. Food and Drug Administration [FDA], the U.S. Census Bureau), models, modeling frameworks, and tools that are standard in exposure assessment. One reviewer suggested that perhaps a table could be used to list the additional references and denote the applicable exposure routes. An asterisk could be used for those that are in draft form or under development.

Because exposure is part of a multidisciplinary approach, one reviewer suggested adding a road map to Chapter 1, similar to the one in the 1997 EFH, which shows the connections among chapters. Three reviewers agreed that a diagram would be beneficial. One reviewer said that there needs to be an explanation on how Chapter 19 (Residential Building Characteristics) and Chapter 17 (Consumer Products), specifically, fit into the exposure assessment. Two reviewers suggested adding a couple of paragraphs to describe each subsequent chapter.

One reviewer felt strongly that Chapter 1 should contain caveats to explain the strengths and limitations of the EFH. He specifically mentioned that the following should be added to the end of Section 1.2:

> "It does not supersede any standards or guidance provided by professional scientific societies involved more with exposure and/or risk assessments, statistics, or with specific organ systems (including the anatomy, physiology, immunology, biochemistry, etc. involved and the target organ exposure-dose-response relationships). The opinions of those bodies, NRC, WHO, UNEP, and other agencies should be respected as well."

He said that Section 1.9 should also contain caveats, particularly when evaluating exposure–dose-response relationships.

The following are several other specific suggestions made by the reviewers:

- Because the analysis for some of the exposure factors are done on a different life-stage basis, Chapter 1 should explicitly state which chapters have the data presented in EPA's recommended age groups and which do not.
- It would be useful to explain why some chapters do not have key and recommended studies.
- EPA should develop a separate document or appendix to the EFH to describe each of the handbooks listed in Chapter 1.
- It is important to describe in Chapter 1 the changes (especially involving key studies) between the 1997 EFH and this version (mentioned by three reviewers).

- To increase confidence in the studies presented, the methods used to search for and identify key and relevant studies need to be better explained (mentioned by two reviewers).
- ,The appendix to Chapter 1 in the 1997 EFH explaining dose calculations and providing examples should be updated and included in this version.
- To supplement the narrative, EPA should add a decision tree to guide the user toward selecting the most appropriate data for the assessment.
- Chapter 1 should discuss where exposure factors fit into the overall risk assessment.
- EPA should add a diagram of an exposure pathway.
- In Chapter 1, clarify how the EFH fits into the hierarchy of other exposure factor documents, particularly EPA’s *Child-Specific Exposure Factors Handbook*.

Ryan summarized the reviewers’ comments. He said that while the majority of the reviewers felt that Chapter 1 makes an important contribution, most thought that substantial modifications are necessary. Problems to be addressed run the gamut from readability to improper relative emphasis to definitions that are not current. Most believe that Chapter 1 needs at least some work, and many believe an extensive rewrite is needed. The reviewers nodded in agreement.

The reviewers then had a discussion about the intended audience of the EFH. Several reviewers had the suggestion to provide additional explanation/background information on conducting an exposure assessment. One reviewer felt strongly that the EFH is a handbook for looking up factors, not a guide for conducting exposure assessment. He thought that users of the EFH should have at least a minimum level of expertise and that the EFH was not the appropriate venue for learning about exposure assessment. While agreeing that the EFH should not be a textbook on exposure, many felt that it is and should continue to be a useful resource of information for the educated lay person.

10. Chapter 2: Variability and Uncertainty

6) *Please comment on whether data variability has been adequately characterized and described.*

9) *We acknowledge that there have been significant developments in the area of uncertainty analysis. Several new references have been added to the chapter on uncertainty and variability. Please comment on whether the information provided is useful as an overview of uncertainty and variability.*

Ryan began the discussion by summarizing the reviewers’ pre-meeting comments. He said that the reviewers’ comments with regard to the adequacy of the variability presentation were diverse. Several thought the presentation was good for populations but not for individual groups. Others felt that the presentation of variability was inadequate, uneven, and sometimes non-existent.

Several reviewers commented on the confusion between variability and uncertainty. One reviewer said that Chapter 2 does not adequately define variability, nor does it explain the measures needed to describe variability. Because there are differences in quantitatively estimating and practically applying the results of variability and uncertainty, one reviewer suggested discussing each separately.

One reviewer commented that the EFH provides good basic information, but he would like to see some additional topics, concepts, and methods referenced (specifics included in his pre-meeting comments). He does not expect to see a tutorial on variability and uncertainty but recommends adding a paragraph that tells the user where to go for further information. Acknowledging that the EFH should not be a statistics handbook, another reviewer suggested adding a brief discussion on sample size and estimates of central tendency. He thought it would also be beneficial to discuss how variability and uncertainty affect the final risk assessment. For example, bias is likely to be introduced if the population is not representative of the one about which you are concerned. One reviewer said that EPA's uncertainty and variability tool should be referenced in Chapter 2. Another reviewer agreed that there needs to be some discussion referring users to where they can get more information. One reviewer said that a good description will be helpful for those who need it.

One reviewer thought it was better to present variability and have less confidence than to not present the data at all. Another reviewer agreed it was important to present the data with appropriate caveats and let the health assessor decide whether the data are applicable. One reviewer said she liked it when multiple studies were combined to obtain a better distribution.

Several reviewers said providing the following statistics would be helpful to the exposure assessor:

- 25^{th} percentile
- 75^{th} percentile
- 95^{th} percentile
- Mean
- Median
- Standard deviation
- Confidence intervals
- Type of distribution

The following are other specific suggestions made by the reviewers:

- EPA should determine best-fit parametric models for the NHANES data so that if sufficient sample sizes are available, the distribution can be characterized.
- It would be useful to know instrumentation precision (e.g., when measuring dermal concentration and absorption).
- The other chapters should refer back to Chapter 2.

11. Chapter 3: Ingestion of Water and Other Select Liquids

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

One reviewer said that there should be an introductory paragraph alerting the user to issues that might have an effect on the type of water people are drinking (e.g., the type of water people are drinking has changed in the last decade, as evidenced by the increase in bottled water consumption). He also wondered whether there are data on the use of home filtration devices. One reviewer thought that a question about filtration use is on the NHANES survey. He also noted that there may be regional differences that impact people's ingestion of water. Another reviewer agreed that a risk assessor must be aware of the caveats.

One reviewer noted that smaller, more focused studies may provide more data. Their existence should at least be discussed, as the random sampling of the population does not apply to specific subpopulations (e.g., a roofer in Arizona who consumes more water than the average person). Another reviewer said that climactic variations have a big influence on water intake, and it would be useful to collect regional data to look at subpopulations. Another reviewer agreed that if the data are too broad, they may have limited use in a more specific risk assessment.

One reviewer noted that some of the studies list fairly recent publication dates; however, the newer publication is actually just a re-analysis of older survey data. This is particularly important because, as noted above, the type of water people are drinking has changed. Another reviewer noted the same thing and commented that newer data will be released soon.

One reviewer said that per capita and consumer-only intake rates are not well defined and are confusing. More explanation should be given as to how the risk assessor is supposed to use the two separate recommended rates.

One reviewer noted that from a contaminant perspective, bottled water may be even more contaminated than tap water, depending on the source of the bottled water. Also, if filters are not changed in the filtration devices, they become a source of contamination.

To enhance the usability of this chapter, one reviewer said that a simple decision tree or road map may improve the overall application of these factors in the exposure assessment. This chapter is an example of where issues of variability are not easily represented in the tables. A diagram can help guide the user to the most appropriate factors. One reviewer commented that this idea of a decision tree could be applicable to all the factors.

12. Chapter 4: Non-Dietary Ingestion Factors

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the*

studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

6) *Please comment on whether data variability has been adequately characterized and described.*

Two reviewers noted that it was not clear why certain studies were deemed relevant rather than key, especially for mouthing duration. To help clarify, one reviewer suggested organizing the chapter differently—by presenting a study once with sections underneath for each of the four factors, noting whether it was considered key or relevant for each factor. Another reviewer commented that the question of key vs. relevant was an issue throughout all the chapters.

The following are some additional comments made by the reviewers:

- One reference for adult mouthing frequency should be included.
- There seems to be a discrepancy among chapters in terms of when recommendations are made with caveats and when not enough information exists to make recommendations. Recommendations should not be made when inappropriate because of small sample size.
- The confidence ratings in Chapter 4 are necessary and relevant.
- Two reviewers commented on the use of age bins and how that affects the confidence for ages with smaller sample sizes.
- On the question of data variability, not much data exist for different socioeconomic groups. In addition, most of the data are concentrated on children.
- The items included in the "object" category must be defined in any text or tables reporting data on mouthing behavior for objects. The actual items included in an object category often differ across studies, and this lack of consistency contributes significantly to the variability.

13. Chapter 5: Soil and Dust Ingestion

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

10) *Data on soil/dust ingestion are limited. Has NCEA done an adequate job in reviewing, presenting, and summarizing the available data? Is the differentiation between soil and dust ingestion clear?*

One reviewer said that his main issue with Chapter 5 is the distinction between outdoor soil and indoor dust ingestion. The overlap of outdoor soil- and indoor soil-derived dust is not addressed. Soil can be tracked or blown into a house and mixed with dust of indoor origin. Therefore, ingestion of indoor dust may also result in soil ingestion.

Two reviewers commented that soil and dust ingestion data are sparse. One reviewer commented that it seems unlikely that adults ingest absolutely no dust at all. However, this reviewer mistakenly thought that a “dash” in a table represented zero rather than a lack of data. Therefore, a reviewer suggested explaining what the dash represents in the table.

One reviewer suggested providing more guidance on what percentage of the population exhibits pica behavior vs. geophagy. It should be made clear that geophagy is an extreme behavior and very rare. Another reviewer agreed that there should be a general discussion of both behaviors and a data set with distributions. One reviewer noted that, given the cloudy nature of the data, it is understandable that percentiles are not given. He also noted that from a policy standpoint, EPA has taken pica out of consideration for inadvertent soil ingestion, so to describe an upper percentile as a pica child would be inconsistent with how EPA uses the data.

One reviewer said that there needs to be more explanation about why the key studies were chosen, especially because EPA is proposing a new approach and moving away from the well-known Calabrese studies. He said that he does not disagree with the new approach, but that EPA should provide more detail about the uncertainties and the choice of key studies. Another reviewer would also like additional information about how the Hogan et al. model was developed and validated. She was also curious about how the outcome would change if the default values for dust ingestion were changed to 70 mg/day or higher. Another reviewer said he was impressed with the approach using the integrated exposure uptake biokinetic (IEUBK) model for lead. However, he noted that the uncertainties and variabilities associated with this model were not well described and that when factored in, the estimate derived using this approach was likely to have considerable overall uncertainty associated with it. He thought the approach should be presented as a secondary method, though, and commented that gold would be a good tracer to use for such an analysis, as it has almost no background and is nontoxic.

One reviewer commented that Chapter 5 is the only one in the Handbook that combines environmental and biomarker data. He thought this approach could be introduced in other chapters as well, especially because using biomarker data in exposure assessments is an up-and-coming approach.

14. Chapter 6: Inhalation Rates

4) *NCEA has grouped available studies in each chapter into “key” and “relevant studies.” “Key studies” were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as “key.”*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the*

studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

6) *Please comment on whether data variability has been adequately characterized and described.*

One reviewer suggested using a different study (Brochu et al. 2006) for breathing rates for the 0–2 age group. This study uses a doubly labeled water method that gives a better estimation of breathing rates. The strengths of the study are that breathing rates were repeatedly measured, and it was a fairly large data set (n=76). The weakness is that the subjects are not representative of the general population. However, there is less variability in this age group, and it would be difficult to come up with subjects not more or less representative. He commented that it is important that the upper percentiles not be overestimated, particularly for this age range because of the greater potency of carcinogens for early-in-life exposure. One reviewer did not think indirect measures of inhalation rates (e.g., the water study) were appropriate, as direct measurements have been made.

One reviewer said that there must be a better understanding of the anatomy and physiology to properly evaluate exposure-dose-response. This reviewer felt strongly that it was inappropriate to relate inhalation rates to body weight when inhalation is very strongly related to height, gender, race, and age. There are also developmental differences in children that should be considered, such as the fact that children have fewer air sacks, their total lung size is smaller, and their chest walls are compressible. The reviewer said that the only time that weight is important for inhalation rates is in obese people, because their weight affects how their diaphragm and intercostals work. Another factor that affects inhalation is activity level, which is extremely well studied. He thinks that the data provided are so general that they are not useful for conducting an appropriate risk assessment. He said that, because inhalation is important to many exposures, a lot more work needs to be done for Chapter 6 to be useful. Another reviewer suggested referencing existing software packages, studies, and models that take physiology into account.

One reviewer agreed that the recommended inhalation rates should be presented by gender, especially because they were previously. She also agreed that more information on physiology should be provided and noted that there was a small physiology section in the 1997 EFH. She also felt that because the inhalation rate distributions are estimated from doubly labeled water, time-activity, or food ingestion, actual data on lung physiology could ground-truth the calculated inhalation rates.

One reviewer said he was skeptical of the inhalation rates presented by age groups in Table 6.1, as the data in the table suggest a discontinuity in breathing rates, with individuals in their 20s seeming anomalous. He suggested using data-smoothing techniques to make the data seem more believable. He would have more faith in the numbers if they were plausible. Another reviewer suggested that perhaps one of the reasons a person in their 20s breathes less is because they have better lungs, and as you get older you have to breathe more rapidly to compensate for the decreasing lung function. He said this is a good justification for including an upfront discussion about physiology and activity patterns.

Two reviewers said that a few caveats should be presented in the chapter. For example, not all adults have the same lung capacity, and if you are looking at a specific subpopulation, you should be aware of its possible decreased lung function. Also, there are regional differences, because altitude, barometric pressure, and temperature are factors in inhalation rates.

The following are some additional comments made by the reviewers:

- It would be useful to convert the unit risk factors into inhalation cancer potency factors [1/(mg/kg body weight)].
- Known limitations with a specific approach should be acknowledged in the EFH. This reviewer specifically mentioned an EPA 2009 report with limitations that can lead to an upward bias of inhalation rates.
- As noted, some of the 95th percentiles might not be representative of the average person. This is particularly true for 95th percentiles based on the EPA 2009 report. Perhaps using a lower percentile could result in a more realistic value.
- Using activity patterns and dietary intakes to estimate inhalation rates will overestimate the upper percentiles.
- The overall usability of the information could be enhanced by adding graphical representations of the information contained in the tables. This would provide an understanding of the spread of the values, and smoothing would be implicit.
- There is an inconsistency in the use of the term “rate” in some of the table titles.

15. Chapter 7: Dermal Exposure Factors

4) NCEA has grouped available studies in each chapter into “key” and “relevant studies.” “Key studies” were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as “key.”

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

6) Please comment on whether data variability has been adequately characterized and described.

Four reviewers noted that Chapter 7 is limited to two exposure factors—surface area and soil-skin adherence. They noted that many other factors (some from other chapters) are needed for the calculation of dermal exposure. They specifically mentioned the following:

- Soil loading per contact event (note the chapter does give soil loading on the skin mainly through activity events), residue transfer, immersion data, deposition, and removal rates (e.g., handwashing events, wipe events, rub events)
- Soil properties and how long the different types of soil will adhere to the skin
- Factors in Chapter 4 (Non-Dietary Ingestion Factors) and Chapter 16 (Activity Factors)

- Activities contributing to dermal exposure to liquids and gases (e.g., while bathing, swimming)
- Changing skin surface thickness for different body areas

One reviewer felt that Chapter 7 does not provide enough information for the user. Another reviewer suggested that, unless additional exposure factors are added, the title of the chapter be changed to "Soil Adherence Factors" to more accurately represent the data presented.

Two reviewers suggested adding an explanation about the complexity of dermal exposure, noting that a diagram may help. It might also be useful to include references for where the user can get more data.

One reviewer commented that more explanation is needed for why certain studies were classified as key. She also noted that determining which studies are key and which are relevant is subjective, depending on what model approach is used to estimate exposure. The macro activity approach seems to be the main approach in the chapter. There is no explanation of micro activity data and how they can be used in a model to calculate dermal exposure to chemicals in soils.

One reviewer said that Chapter 7 needs to clarify which equations should be used to calculate dermal exposure. She specifically mentioned that because surface area is in the denominator, it might be preferable to use a 5^{th} percentile instead of a 95^{th} percentile for calculating the upper bound of dermal exposure. The reference to EPA's1992 *Dermal Exposure Assessment* is a bit dated.

It was noted by one reviewer that the distinction between exposure and dose was particularly confusing in Chapter 7. Another reviewer said that the EFH should provide the necessary information to go from exposure to dose.

16. Chapter 8: Body Weight Studies

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

One reviewer said that EPA should be commended for including the latest NHANES body weight data in the EFH. However, the reference for the body mass index is older and should be replaced with the newer data. She recommended that EPA be more explicit about the purpose for presenting the older body weight information.

Several reviewers commented on the fact that the body weights are linked with several other exposure factors. They specifically mentioned that dietary habits (fish vs. high calorie foods) and activity factors are related to body weight. Many felt that an interactive diagram (with active links) would be useful to show the interconnectedness of each chapter. It could be broken into routes of exposure and detail what is covered, what is not covered, and where to find the information in each chapter. Figure 1.2 in the 1997 EFH would be a good place to start.

The following are some additional comments made by the reviewers:

- This was one of the more straightforward and simpler chapters.
- The increase in obesity is quite marked, and using older studies, might not be appropriate. Two reviewers debated whether the rise in obesity is nutritional (diet and habit) or hormonal.
- It is important to provide data specifically for pregnant women, not just women of child-bearing age, as such parameters are critical for addressing fetal exposures.
- In theory, heavier people are more protected from exposure. The one exception noted is obese people who may have higher inhalation rates and whose overall health is compromised.

17. Chapter 10: Intake of Fish and Shellfish

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

11) *Recreational marine fish intake rate data were only available for individuals >18 years of age. Recommended recreational marine fish intake rate values for children have been estimated based on the age-specific ratios of general population children's marine fish intake to general population adult marine fish intake, multiplied by the adult marine recreational fish intake rates. Please comment on this approach and, if relevant, provide suggestions for alternatives, using the available data.*

13) *Recommended values for fish intake are not provided for recreational freshwater or Native American populations because the available data are limited to certain geographic areas and cannot be readily generalized to the U.S. population of freshwater recreational anglers or Native Americans as a whole. Instead, data from several relevant studies are provided in the chapter to give assessors the flexibility to choose data that are more appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.*

One reviewer said that he disagreed with using the U.S. Department of Agriculture (USDA) Continuing Survey of Food Intakes by Individuals (CSFII) data as the basis for the recommended values for the general population. The data are 12 years old, over-represent the consumption patterns of frequent consumers, and under-represent the patterns of infrequent consumers. One reviewer noted that USDA does have more recent data on fish consumption for the general population that should be incorporated. Another reviewer said that the NHANES fish intake data could be incorporated into the EFH.

Regarding recreational marine fish intake rate data for children (charge question 11), two reviewers commented that the approach was reasonable. Children in the family are likely to eat whatever fish their parents are eating and may consume it less often. There should be some recognition of the ratios explained in the introductory text.

One reviewer commented that the approach was not unreasonable, but it was not documented. To validate the assumption, he suggested investigating whether adult recreational fish consumers who are high consumers of non-recreational fish are also high consumers of recreational fish.

Another reviewer said that, while the approach seems reasonable and useful, it should not be used to develop a recommendation. She made some calculations that showed that the ratios for mean intake were different than those for 95th percentiles. She recommended using percentile-specific ratios instead of the overall mean ratio.

A fourth reviewer also agreed that the ratio approach makes sense conceptually. However, he could not reproduce the values presented. He suggested being more transparent about the methods used.

Regarding freshwater recreational anglers and Native American populations (charge question 13), three reviewers agreed that it was important to have population-specific information and liked the flexibility given to the assessor. They made the following comments:

- Given the studied habits of recreational fishers (e.g., they consume more total fish than non-anglers and are likely to target a set of local species), local recreational fish consumption rates are of much higher value to the assessor.
- Site-specific assessments should focus on site-specific information.
- It would be useful to include some additional general statistics from the available data sets in Table 10-5. This would help the assessor better understand the magnitude of interpopulation variability and enable a more informed choice as to a representative population.
- There should be some upfront discussion that alerts the user about the importance of searching for more specific information.

Because contaminants and consumption preferences vary according to species, two reviewers thought that intake rates should be available for the various species of fish and shellfish. Specifically, crabbing is very different than fishing—it should not be assumed that crabbing rates are the same as recreational fishing rates.

It is also important to know what proportion of the population is consuming the various types of fish and shellfish.

One reviewer said that the EFH should pay more attention to regional differences in fish consumption. He noted two additional studies (Stern et al. 1996 and Mahaffey et al. 2009) that would provide regional-level data. Another reviewer said that there are also regional differences among subpopulations (Native Americans and Hispanics). They should not be treated as homogeneous populations.

One reviewer noted that one of the public comments said that there was a concern about one of the subsistence data sets not being representative, specifically noting that the public comment indicated that a referenced survey (ChemRisk 1992) was conducted when there was a limit on fish consumption.

One reviewer asked whether a discussion on intake rates for angling and non-angling pregnant women should be added.

Two reviewers commented on the inconsistent/confusing use of the term "per capita." One reviewer suggested relabeling the data as "consumer only," as per capita should only be used when referencing values that apply to the entire population.

One reviewer wondered whether overall marine fish consumption rates were used for anything other than chemical risk assessments. One reviewer replied that there were other uses, including looking at nutritional factors such as omega 3 fatty acids and selenium. He also noted that 80 percent of overall marine fish consumption is tuna and shrimp and therefore, not likely to be very different among states.

18. Chapter 9: Intake of Fruits and Vegetables
Chapter 11: Intake of Meats, Dairy Products and Fats
Chapter 12: Intake of Grain Products

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

14) *We are aware that food consumption data from the National Health and Nutrition Examination Survey (NHANES) "What We Eat in America" are available and NCEA is partnering with the U.S. EPA's Office of Pesticide Programs to get these data analyzed and incorporated into the final Handbook. This analysis is expected to be available in May 2010. Are you aware of other published data concerning food consumption that should also be considered?*

Most reviewers agreed that it was important to incorporate the NHANES data into the EFH. As a point of clarification, David Miller (EPA) explained that the NHANES data would be incorporated in the exact same format as the data currently included. A reviewer noted that a reference to the FDA's Total Diet Study (TDS) should also be added to the EFH.

One reviewer commented that the introductory text for Chapters 9, 11, and 12 is redundant. She suggested introducing the exposure metric and database in one area and then discussing the different factors. Another reviewer agreed that it would be useful to reduce the repetitiveness.

One reviewer suggested the following ways to incorporate the NHANES data into the EFH on a more regular basis.

- Release a newer version of the EFH more frequently.
- Break the EFH into two parts—a section of factors that are updated on a regular basis (e.g., dietary factors) and a section of factors that are not updated regularly (e.g., dermal factors). Another reviewer supported this approach.
- A Web-based database may help with more frequent updates. Two reviewers supported this approach, especially because a great deal of data are available.

One reviewer wondered whether the updates would include fish intake. It might be useful to include the commercial sources of fish consumption in with the rest of the intake rates in Chapters 9, 11, and 12. One reviewer said that there could be better partitioning of the factors—maybe a chapter on "common" intakes and then separate chapters for sport fish and homegrown fruits and vegetables. These two reviewers talked about the benefit of conducting an exposure assessment on a probable composite diet, rather than combining all the 95^{th} percentiles. Another reviewer pointed out that the NHANES data are appropriate for intake of commercial fish; however, the recreational intakes are going to be highly variable by location and ethnic group. Another reviewer commented that NHANES is a national survey, and local or specific intakes would have to be compiled separately. One reviewer said that fish intake should be kept in a separate chapter because NHANES is only a small portion of all the fish data. One reviewer said a road map would help direct the user.

One reviewer said she that she would like to know what has changed in these chapters in particular. For example, in terms of obesity, it is important in exposure modeling to know that serving sizes have increased. One reviewer suggested including a table at the beginning of each chapter to convey what has changed. Another reviewer suggested using an asterisk in the tables to denote a change. However, two reviewers said they are looking for more than just the values; they would like a narrative that describes why some factors have changed. One reviewer said it might be worthwhile to include a simple trend analysis (e.g., a bar chart). One reviewer cautioned that some differences may be methodological and have nothing to do with trends.

One reviewer said that nutritionists look at the data differently than exposure assessors. He said that there should be an upfront discussion that talks about serving size and serving recommendations.

One reviewer noted the importance of being able to have access to regional data. Three reviewers discussed the logistics of disaggregating the NHANES data into regions. Mahaffey (2009) disaggregated the data into regional databases.

Several reviewers discussed the fact that different survey methods affect the results. They pointed to the following questions:

- Was the survey conducted on consecutive or nonconsecutive days?
- In what season was the survey was conducted (specifically related to homegrown produce)?
- Was the survey conducted on weekdays or weekends?

19. Chapter 13: Intake of Home-Produced Foods

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

Several reviewers noted the utility of these factors, but lamented the fact that surveys of homegrown food intake are sporadic. One reviewer said it might be helpful if EPA could fund a survey of homegrown food intake on a semiregular basis. One reviewer suggested obtaining additional information from an urban gardener association, seeing that urban gardening has increased dramatically both demographically and regionally. It would also be useful to include existing intake data on consumption of locally produced farmers market foods. Two reviewers noted that it is important to consider seasonal vs. year-long averages and that these data are usually collected based on recall. Hence, appropriate caveats are needed in the discussion, as well as recommendations for these parameters.

20. Chapter 14: Total Dietary Intake

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

Several reviewers said that Chapter 14 should also include nuts/legumes and beverage intakes.

One reviewer said that there is no information on variability within the general population on any factor besides age. It would be useful to reanalyze the data based on other factors—such as region, urbanization, and ethnicity—that may describe total food intake of specific food categories.

One reviewer wondered why the age bins in Chapter 14 are different than those in Chapters 9, 11, and 12. There are some age groups where the sample sizes are too small to accurately estimate upper percentiles. She recommends not presenting the upper percentiles in those cases.

Two reviewers commented on the currency of the data.

Two reviewers commented that the tables should stand on their own and include footnotes, even when carried through into the Executive Summary.

21. Chapter 15: Human Milk Intake

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

Two reviewers thought that human milk intake would be better in the *Child-Specific Exposure Factors Handbook*. EPA could remove it from this EFH and include a reference to the factor in the Handbook, perhaps in the Total Food Intake chapter (Chapter 14). Three other reviewers thought that the information should be provided in both places. All five felt that if presented in both places, the sections should be similar.

One reviewer commented that Chapter 15 was the "poster child" for exposure factors. The data are in good agreement and the methods for generating the data are straightforward. Two other reviewers also noted that the milk intake levels are pretty well established and fairly straightforward.

One reviewer noted that some of the referenced studies were more than 20 years old. The proportion of women who are breastfeeding has been increasing in recent years. She also wondered about the applicability of the studies from Australia. Another reviewer agreed that the extent of breastfeeding may have changed.

Two reviewers thought it would be useful to have more data on the breastfeeding population, such as ethnic, racial, and socioeconomic differences. Another reviewer noted that the studies included were on a relatively homogeneous population of breastfeeding women. Maternal age and parity are useful factors for determining contaminant intake.

Two reviewers talked about the impact on human milk intake when new foods are introduced into an infant's diet. The proportion of breastmilk to total diet intake is an important factor. People are encouraged to introduce solid foods later than they were 20 or 30 years ago. One reviewer suggested changing the focus of the chapter to be "Infant Intake" to encompass everything (e.g., breastmilk, formula) in an infant's diet.

Three reviewers discussed the physiologic mechanism behind breastmilk production.

22. Chapter 16: Activity Factors

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

Several reviewers noted that in this chapter, as with others, there needs to be a better distinction between key and relevant studies. Two reviewers specifically noted that additional discussion about the Consolidated Human Activity Database (CHAD) should be included in Chapter 16. Another reviewer said that there are a number of other EPA-funded activity pattern studies that should be referenced. One reviewer said that the American Time Use Survey (ATUS) should be used more.

Two reviewers said that Chapter 16 was not as readable as the other chapters and required more editing. One reviewer suggested adding information about activity pattern trends to the introductory text. A few reviewers commented on the numerous tables. One reviewer suggested that the tables might be easier to navigate if the EFH were Web based. Another said that EPA could spend some time reducing the number of tables to those that are really key, but then provide all the tables in an appendix or on a Web site. Several reviewers thought this was a good idea.

A few reviewers were surprised to see occupational mobility information included in Chapter 16, given that the EFH was concentrated on residential/public exposures. An explanation should be given for using this type of data in the Handbook. One reviewer said it was good to include these data, even critical for determining lifetime exposure risk. He said that more data could be provided on how each occupational category spends its time. Another reviewer said that assessors in California use the occupational data to evaluate people who are exposed as members of the public (i.e., not on the job). Providing such an example in Chapter 16 would be useful. One reviewer said that the EFH could provide guidance, but the occupational data should be provided in a document that specifically deals with worker exposures. One reviewer agreed on the need for worker-specified activity factors (because worker exposure scenarios are included in EPA-required risk evaluations). However, clarity was needed as to when these are required and when the Occupational Safety and Health Administration (OSHA) should take the lead. Two reviewers felt strongly that occupational exposures are an important part of total risk assessment. The risk assessor should be made aware of these exposures regardless of whether the data are included in the EFH or in a separate document.

The following are some additional comments made by the reviewers:

- Seeing that the studies used for activity patterns were based on memory recall, the confidence ratings should have been lower.
- The mean and 95th percentiles were presented as the recommended values. However, because the distributions are non-Gaussian, one reviewer suggested using median and 90th percentiles.
- EPA should compare relevant studies conducted previously with more recent data to determine if the data actually show a change in time-activity patterns in subsequent years/decades.
- Two reviewers recommended explaining the overlap in activity patterns to help avoid overestimating exposure. It would also be helpful to have more guidance about which studies are recommended.

23. Chapter 17: Consumer Products

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

One reviewer said that the information provided in Chapter 17 is too general. Additional detail on the specific product type being included in each category should be presented. Also, additional product usage information such as location (e.g., indoors or outdoors) is important to know when estimating potential consumer exposure. Finally, the data should be presented by gender and age to account for the differences in consumer product use patterns.

One reviewer suggested reorganizing the chapter into sections and data tables by types of consumer product categories—cosmetics/personal care, cleaning products, and pesticides. As currently presented, it is difficult for the user to go through all the tables to decide which factors to use.

One reviewer was uncomfortable with the personal care product data being estimated by the company rather than from a participant survey. This is only mentioned in a footnote to a table, and it should be discussed in the text. Another reviewer said that some data are collected and released by consortia or trade organizations, and the data are limited.

One reviewer said that the CTFA 1983 data are very old and unreliable. She questioned the rationale for even including the data in Chapter 17. Several reviewers then discussed the use of older data in retrospective exposure assessments and the need for access to the older data. One reviewer said that older data could be obtained from previous versions of the EFH. Another said that there are "really old" data collected under FDA contracts that could be used to conduct a retrospective exposure assessment.

The following are some additional comments made by the reviewers:

- The types of products are changing. An example is pesticide products for pets. There are no data on the top spot application.
- The addition of one pesticide study in Chapter 17 seems incomplete given the significant number of studies on pesticide use.
- A future research need would be to obtain cosmetic and personal care products information for children and teenagers.

24. Chapter 18: Lifetime

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

6) *Please comment on whether data variability has been adequately characterized and described.*

One reviewer said that it might be useful to describe population characteristics that impact an exposure evaluation, such as population mobility. He specifically mentioned incorporating information on immigration and military service. Another reviewer said that stage in life is another function of mobility. One reviewer said that if this kind of information is included in Chapter 18, the title should be changed.

One reviewer commented that Chapter 18 could be useful for assessing carcinogenic risk. He recommends adding the following information to the chapter:

- Information about lifetime radiation exposures (e.g., radon) and the methods used to obtain such estimates.
- Methods to incorporate long-term exposures using activity patterns, including specific occupational tenures and mobility found in Chapter 16.
- Methods for extending short-term to long-term exposures.

The following are some additional comments made by the reviewers:

- Provide an explanation for how EPA's Integrated Risk Information System (IRIS) calculates the cancer slope factor such that the relationship to lifetime can be established.
- Variance is not presented for Chapter 18. This should be explained.
- Because there is variability for races in this set of exposure factors, it would be useful to have data presented for Latinos, given the rapid growth of this group.
- Smoking or exposure to environmental tobacco smoke is a major factor that affects longevity. Should this information be provided in the EFH? At least provide a reference to where the user can obtain pertinent information.
- The insurance industry could be a good source for life expectancy data.
- Longevity varies between the northern and southern states.

25. Chapter 19: Residential Building Characteristics

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

6) Please comment on whether data variability has been adequately characterized and described.

15) Chapter 19 presents data on residential building characteristics that may be relevant for assessing human exposures in the residential setting. Please comment on whether there are any other data or factors, for which there are available data, that are important for inclusion in future revisions to this chapter?

Several reviewers thought that Chapter 19 needed a lot more updating. They suggested adding several additional parameters:

- The loss of outdoor particles as they move through the building shell or losses from infiltration should be added to the deposition and filtration section. This is critical for evaluating the impact of outdoor particles on indoor levels.
- Air exchange between different rooms or regions within a building should be discussed. For example, an attached garage will have different sources of air contamination.
- There should be some discussion of multi-unit dwellings and the fact that air can flow from one unit to another, thereby transferring pollutant sources from one unit to another. One reviewer replied that there is a residential appliance study conducted by the California

Energy Commission that would provide a lot of relevant information, such as year built, number of bedrooms, etc.

- The chapter also should present summary information on the distribution of house sizes, sample volumes, ages, and materials.
- The issue of embedded dust (i.e., dust not easily removed with a conventional vacuum cleaner) should be mentioned, as it provides a reservoir for organic compounds.
- A key pathway for consideration is vapor intrusion (i.e., factors on how soil gas enters buildings). There should be reference to other guidance being developed by EPA on this issue.
- The chapter presents a small subsection of possible indoor settings. There are many other areas where people spend time indoors (e.g., school, mall, movie theater).
- It would be useful to include information about ventilation (whether the windows are open or closed) in the tables with air exchange rates.

Two reviewers commented on the currency of the data. One found it striking that only eight of the references were published after 1996. The other said that even the newer references were updates to continuing studies. Several reviewers said that there are many more references that should be included in the chapter. One reviewer specifically mentioned including more recently collected data on air exchange rates and particle deposition. Another specifically mentioned studies that can be included in the resuspension section.

The following are additional comments made by the reviewers:

- It is not clear why air deposition is included in Chapter 19.
- The basis for the assumption of an 8-foot ceiling height should be discussed.
- Two reviewers mentioned including a diagram of building characteristics.
- Two reviewers commented that Chapter 19 has high variability in the housing volume data and high uncertainty in the air exchange rates due to methodological issues.
- The chapter identifies models that can be used to evaluate the microenvironment. However, there are many more approaches, formulations, and models that should at least be mentioned.
- Central air use varies regionally.
- The factors addressed in this chapter are essential components of risk assessment.

Several reviewers discussed options for this chapter. All felt that the draft was not ready for release but that the information was important and should be included in some form. They offered several different options for how EPA could proceed, but all felt that the re-working of Chapter 19 should not delay the release of the EFH.

- Present the data in a way that will allow the exposure assessor to relate the factors to a specific population, geographic area, or temperature.
- Release Chapter 19 as a general chapter that introduces the context for residential exposures. It could even reference where to find additional information. Then release a different document that goes into more detail on each of the parameters or release an update to this chapter at a later date. If a separate document is released, it might be useful to have it provide more contaminant-specific information.

- Seeing that the EFH is supposed to present values, if the chapter cannot supply useful, reasonable, accurate values, then it might be best to remove it altogether.
- Because many of the newer references are just updates to the continuing studies, perhaps the 1997 version of Chapter 19 should be included as a placeholder so that people are not misled into think that new information is being presented.
- A placeholder “glossary” could be included that describes what indoor factors need to be explored. This way, risk assessors would know what is important to consider without providing misleading values.
- Keep the chapter in draft form and replace it with a “General Building Characteristics” chapter years from now, after it has been peer reviewed.

One reviewer commented that any substantial revisions to the draft chapter should be peer reviewed by at least a small committee.

26. Future Products from EPA’s Exposure Factors Program

16) Are there any additional factors that need to be addressed in future revisions to the Handbook? Why are they of priority for EPA risk assessments? Are you aware of any sources of data for these new factors?

<u>Biomarkers</u>

One reviewer noted that individual biomarkers are specific to particular chemicals and therefore are outside the scope of the EFH. However, the role of biomarkers is and continues to be important in exposure assessment. He recommends including information on biomarker tools, most importantly the measurement of biomarkers in urine. Specifically, he thought that data (characterized by age, body mass index, exercise, and sex) on 24-hour urinary creatinine excretion would be very useful in future updates. One reviewer noted that there is a lot of controversy surrounding the use of creatinine values in children, and it could potentially be addressed by providing childhood-specific values in the EFH.

Another reviewer agreed that a future version of the EFH should have a chapter addressing biomarkers—not chemical-specific ones, but the general issue of interpreting biomarker data. Different methods in the literature need to be discussed, especially with respect to data needs and constraints. Another reviewer agreed that a generic, nonchemical-specific discussion would be useful.

Several reviewers discussed the appropriateness of including biomarkers in the EFH. One reviewer thought that including biomarkers would go beyond exposure assessment into the dose realm. Most others thought they should be included. One reviewer commented that biomarkers can be used to back-calculate exposure. A second reviewer said that biomarkers are being used as exposure markers. A third reviewer thought that because someone looking at exposure factors would ask about biomarkers, they should be included. A fourth reviewer said that future issues around exposure (such as biomarkers) should at least be mentioned.

One reviewer said that if a chapter on biomarkers is included in the future, a discussion on the pitfalls of biomarkers should be incorporated.

One reviewer suggested that a discussion on biomarkers could be included in the Lifetime chapter (Chapter 18). It could be a broader discussion to make people aware of the physiological changes that must be accounted for in an exposure assessment. Another reviewer suggested that biomarkers be included in a chapter on biological factors that are relevant to exposure assessment. These are especially useful data when conducting a risk assessment for a susceptible population.

Microenvironments

One reviewer said that indoor and outdoor microenvironments should be expanded on in a future version of the EFH.

Dietary Supplements

One reviewer said it would be useful to include data on dietary supplements in a future version of the EFH. Another reviewer commented that those data are very ingredient specific, and it would be a challenge. The frequency of supplement consumption might be available in NHANES.

Bottled Water

One reviewer said that including data on bottled water use is important for a future version.

Food Packaging

Three reviewers thought that information on the types of plastic containers being used for food products would be interesting. It would allow the assessor to determine an intake rate based on the types of food packaging. From food descriptors in NHANES, food packaging information (e.g., canned) can be derived. Then, intake of foods based on packaging types can be developed and added to the EFH.

Vapor Intrusion

One reviewer said that vapor intrusion into buildings should be addressed and should be applicable to both residential and non-residential buildings. If this cannot be done in this version of the EFH, users should at least be directed to where they can find additional information in other existing and upcoming EPA guidance (a more likely outcome).

Cleanliness Factors

One reviewer said that factors about the frequency of removal activities and cleanliness (e.g., number of times a person washes his/her hands or vacuums) would greatly benefit exposure calculations. Another reviewer said that removal efficiency factors from handwashing and mouthing should be included.

Commercial Building Characteristics

One reviewer said exposure factors on office buildings and/or commercial building characteristics need to be included, in addition to the information already provided on residential building characteristics.

17) Please comment on any areas where future research could be conducted to fill data gaps?

Soil and Dust Ingestion

One reviewer said that EPA should develop a rate for adult indoor dust ingestion.

One reviewer commented that the IEUBK approach needs to be supplemented with more information and research. Another reviewer agreed that the IEUBK method produces several layers of uncertainty. He suggested conducting a tracer study using gold to make the soil ingestion factors more precise.

Homegrown Food Intake

One reviewer said that more research is needed to update the data on homegrown food intake, especially in light of the data being more than 20 years old.

Fruit and Vegetable Intake

One reviewer said it would be helpful if future EFH revisions included a key study that provides intakes for raw and processed fruits and vegetables.

Cooking Activities

Two reviewers suggested including frequency and duration of specific cooking activities, such as gas vs. electric stove and microwave use.

Non-dietary Ingestion

Two reviewers agreed that there is a need to conduct research on mouthing and dermal contact activities of adults and older children. Similarly, analyses should be completed of the existing studies to determine if mouthing and dermal contact behaviors change as a function of the activities in Chapter 16.

Dermal Exposure

Two reviewers suggested that more research be conducted on residue transfer by class of compounds to enhance dermal exposure assessment (Chapter 7).

18) Please comment on how you would like the U.S. EPA/NCEA to release future updates to the Handbook.

The reviewers discussed this question under General Question 7 (see Section 8).

19) *What additional information might be added in the future that would help the exposure assessment community better interpret and apply the data from the Handbook?*

Spatial and Temporal Information

One reviewer suggested adding a chapter that describes how Geographic Information Systems (GIS) tools and databases can be incorporated into exposure assessments (i.e., GIS-based exposure factors). There are geographic data available (e.g., proximity to roadways) that can help differentiate exposures. Until a chapter is written and incorporated, it would be useful to add a brief discussion into the current version of the EFH that provides references to where the user can download relevant data.

Another reviewer said that there is not enough focus on spatial and temporal variability in the EFH. Within spatial variability, race and ethnicity form part of behavioral evaluation and need to be examined more closely.

Full Distributions

One reviewer commented that it is important to provide the full distribution of the data to facilitate conducting probabilistic analysis when appropriate. As appropriate (that is, where the data supports such), inclusion of key percentiles (25%, 50%, 75%, 90% and 95%) and central tendency statistics (e.g., median, mean) is needed.

Exposome

One reviewer said that the concept of Exposome should be introduced, as it is a key state-of-the-science concept currently being discussed in terms of exposure and health management. It is likely that it might be more fully realized by the time the next EFH is released.

20) *The Handbook addresses children as a susceptible population and includes data on older adults where available. So as to assist the Agency with planning for potential future projects, please comment on any other susceptible populations of interest that could be included in future updates to the Handbook, and suggest data sources for these populations.*

Pregnant Women

Three reviewers said that there should be separate exposure factors for pregnant women and developing fetuses. One reviewer noted this was especially needed for dietary ingestion of fish and produce. This should be a priority.

Others

The following additional susceptible populations were also mentioned:

- The “super” elderly (i.e., those older than 90 years)
- People with various chronic conditions, such as chronic obstructive pulmonary disease (COPD), heart disease, and metabolic diseases (e.g., diabetes)
- Obese individuals

- Immunocompromised individuals (e.g., people with AIDS, transplant patients)
- People with specific polymorphisms
- People with poor nutritional status/economically disadvantaged
- Latino groups
- Farm worker community

One reviewer said that from an exposure point of view, the key is to look for populations that have a greater exposure potential. The upper tails of the distributional data should be evaluated to help identify the populations contributing to the upper tails (i.e., those with the greater exposures).

Another reviewer responded that there are many biological and behavioral factors that affect different susceptible populations. For example, inhalation rates are different for asthmatics. Anyone taking steroids is immunosuppressed and would be more susceptible when exposed to environmental organisms such as fungi and microbacteria. A cardiac patient who takes medication has a different susceptibility. All of these different types of susceptible populations need to be protected, and the information needed to do so should be provided.

27. Other Issues

<u>Data Updates</u>

The reviewers discussed strategies for updating the water, dietary intake, and body weight data from NHANES on a more frequent basis. They offered the following suggestions:

- Release the EFH with a statement that directs users to a Web site where they can find more current data as they become available.
- Release new chapters as the data are incorporated.

To help their discussion, EPA was asked to clarify its process for releasing new documents. Jacqueline Moya (EPA) explained that EPA’s policy is to have everything peer reviewed before release. However, if the same methods and protocols are being used and they have been peer reviewed, there may be some leeway to add the new data without a full peer review. EPA management makes those decisions.

Several reviewers felt strongly that if a new chapter is released, there should be some level of peer review for that chapter (e.g., a Web-based review or teleconference). One reviewer said that a review is necessary to guide what data should be replaced, as well as what data should remain, (because the older data represent factors consistent with a time period and are needed to assess long-term exposures or exposure of elderly groups). Another reviewer said that EPA has varying levels of internal and external peer review for different products with different levels of imprimatur, and as long as it is clear that there was a review and it is clear where that review stands in the EPA review hierarchy, this may be a reasonable way to update the data.

One reviewer felt that it depends on the data being updated. For example, updating the NHANES data is a “straight from the database” kind of update. It is not necessary to peer review the update; it is more an issue of quality assurance. Another reviewer agreed that as long as the protocol has been formally approved and peer reviewed, she is amenable to this approach. Another reviewer said that there should be a higher level of review if a new result is seen in the data.

A couple of reviewers were concerned about what data was going to be updated without peer review. The reviewers discussed whether this kind of data update could be applicable to data other than that from NHANES. Most felt it was only applicable to NHANES at this time. Two reviewers commented that if there is another positively peer-reviewed protocol to update a data set in the future, the same approach should be used.

One reviewer cautioned that even though the NHANES data are released every two years, some of the factors require a four-year average. One reviewer cautioned that NHANES has changed its methodology for specific parameters. Another reviewer said to rely on EPA to use its best judgment to make the appropriate updates.

If EPA refers users to a Web site for the current data, there should be some explanation of how to use the new data and caution if the sample size is small.

<u>Executive Summary</u>

One reviewer commented that the Executive Summary will be the most read chapter, followed by Chapter 1. Another reviewer said that the Executive Summary should provide a sense of the EFH for the educated lay person. One reviewer commented that the Executive Summary needs to be heavily edited. The tables provided in the Executive Summary should be able to stand alone and therefore should include appropriate caveats and footnotes. These tables should be presented similarly to Figure 1.2 of the 1997 EFH to more easily access complete information.

Appendix A.
Peer Reviewers

United States
Environmental Protection Agency
National Center for Environmental Assessment

Peer Review Workshop of EPA's Draft Exposure Factors Handbook

Sheraton Crystal City Hotel
Arlington, VA
March 3-4, 2010

Peer Reviewers

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Appendix B.
Technical Charge to
External Peer Reviewers

Technical Charge to External Peer Reviewers

Contract No. EP-C-07-024
Task Order No. 4
January 12, 2010

External Review of the Exposure Factors Handbook: 2009 update

PRE-MEETING WRITTEN COMMENTS ARE DUE NO LATER THAN FRIDAY, FEBRUARY 19, 2010

BACKGROUND

The U.S. Environmental Protection Agency (EPA) is conducting an external peer review of the *Exposure Factors Handbook (EFH).* The overall goal of external peer review is to enhance the quality and credibility of Agency decisions by ensuring that the scientific and technical work products underlying these decisions are based upon sound science and reflect recent peer-reviewed literature.

The EFH was prepared by the National Center for Environmental Assessment (NCEA), within EPA's Office of Research and Development (ORD). The EFH serves as a resource for exposure assessors for calculating exposures and provides a summary of statistical data on various exposure factors used in assessing human exposures. These factors include: drinking water consumption; soil ingestion and mouthing behavior; inhalation rates; dermal factors including skin surface area and soil adherence factors; consumption of retail and home-grown foods, human milk intake, body weight, consumer product use, activity pattern data, life expectancy, and residential characteristics. The EFH was last revised in 1997. Since then the *Child-specific Exposure Factors Handbook* was updated and published in 2008. The updated version of the *Exposure Factors Handbook* incorporates the revisions made to the *Child-specific Exposure Factors Handbook* and information from the published literature up to June 2009.

<u>Organization of the Review</u>

All reviewers should comment on General Questions 1 through 7, Question 8 (Chapter 1), and Questions 16 through 20. There are specific charge questions for Chapters 2, 5, 9, 10, 11, 12 and 19 below. If you are assigned those chapters (or choose any of them as additional chapters you'd like to review), please comment on the appropriate charge questions below.

<u>Assigned Chapters</u>

Reviewers have been assigned to focus their review and comments on specific chapters, as listed below: After completing the assigned chapters, please review other chapters you feel qualified to review or are of interest to your research: Please try to get through as much of the document as time allows.

Reviewer	Assigned Chapters
Henry Anderson	1, 3, 6, 10, and 15
Paloma Beamer	1, 4, 5, 7, and 16
Deborah Bennett	1, 5, 17, 18 and 19
Robert Blaisdell	1, 2, 6, 8, 9, 10, and 11

Reviewer	Assigned Chapters
Alesia Ferguson	1, 4, 7, 16, and 18
Brent Finley	1, 3, 5, 7, and 10
David Gaylor	1, 2, 6, 8, and 18
Panos Georgopoulos	1, 2, 3, 6, 7, and 19
Annette Guiseppi-Elie	1, 3, 4, 11, 12, 13, 14, and 19
Michael Lebowitz	1, 2, 6, 16, and 18
Agnes Lobscheid	1, 9, 12, 13, 14, 15, and 19
P. Barry Ryan	1, 9, 11, 12, 13, and 14
Alan Stern	1, 4, 5, 10, 15, and 19
Nga Tran	1, 8, 9, 11, 12, 14, and 17
Rosemary Zaleski	1, 6, 10, and 17

CHARGE QUESTIONS

The following charge questions identify the scientific issues to be discussed and evaluated by the peer review panel. The review questions consist of seven broad questions that apply to the Handbook in its entirety, eight questions regarding specific chapters of the Handbook, and five questions pertaining to future products from EPA's Exposure Factors Program.

<u>General Questions (All Reviewers)</u>

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

6) Please comment on whether data variability has been adequately characterized and described.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

Chapter 1 (All Reviewers)

8) The Introduction contains a summary of the latest guidance and developments in exposure assessment. Please comment on whether we have captured the most important and relevant guidance and developments in exposure assessment.

Chapter 2 (Blaisdell, Gaylor, Georgopoulos, Lebowitz)

9) We acknowledge that there have been significant developments in the area of uncertainty analysis. Several new references have been added to the chapter on uncertainty and variability. Please comment on whether the information provided is useful as an overview of uncertainty and variability.

Chapter 5 (Beamer, Bennett, Finley, Stern)

10 Data on soil/dust ingestion are limited. Has NCEA done an adequate job in reviewing, presenting, and summarizing the available data? Is the differentiation between soil and dust ingestion clear?

Chapter 10 (Anderson, Blaisdell, Finley, Stern, Zaleski)

11) Recreational marine fish intake rate data were only available for individuals >18 years of age. Recommended recreational marine fish intake rate values for children have been estimated based on the age-specific ratios of general population children's marine fish intake to general population adult marine fish intake, multiplied by the adult marine recreational fish intake rates. Please comment on this approach and, if relevant, provide suggestions for alternatives, using the available data.

12) Relevant data on recreational marine fish intake presented in the chapter are limited to certain geographic areas and cannot be generalized to the U.S. population as a whole. Therefore, recommendations from these data could not be provided. Instead, the assessor has the flexibility to use data from these relevant studies that are more appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.

13) Recommended values for fish intake are not provided for recreational freshwater or Native American populations because the available data are limited to certain geographic areas and cannot be readily generalized to the U.S. population of freshwater recreational anglers or Native Americans as a whole. Instead, data from several relevant studies are provided in the chapter to give assessors the flexibility to choose data that are more appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.

Chapters 9, 11 and 12 (Blaisdell, Guiseppi-Eli, Lobscheid, Ryan, and Tran)

14) We are aware that food consumption data from the National Health and Nutrition Examination Survey (NHANES) "What We Eat in America" are available and NCEA is partnering with the U.S. EPA's Office of Pesticide Programs to get these data analyzed and incorporated into the final Handbook. This analysis is expected to be available in May 2010. Are you aware of other published data concerning food consumption that should also be considered?

Chapter 19 (Bennett, Georgopoulos, Guiseppi-Elie, Lobscheid, Stern)

15) Chapter 19 presents data on residential building characteristics that may be relevant for assessing human exposures in the residential setting. Please comment on whether there are any other data or factors, for which there are available data, that are important for inclusion in future revisions to this chapter?

Future Products from EPA's Exposure Factors Program (All Reviewers)

16) Are there any additional factors that need to be addressed in future revisions to the Handbook? Why are they of priority for EPA risk assessments? Are you aware of any sources of data for these new factors?

17) Please comment on any areas where future research could be conducted to fill data gaps?

18) Please comment on how you would like the U.S. EPA/NCEA to release future updates to the Handbook?

19) What additional information might be added in the future that would help the exposure assessment community better interpret and apply the data from the Handbook?

20) The Handbook addresses children as a susceptible population and includes data on older adults where available. So as to assist the Agency with planning for potential future projects, please comment on any other susceptible populations of interest that could be included in future updates to the Handbook, and suggest data sources for these populations.

Appendix C

Peer Review Workshop
for EPA's Draft Exposure Factors Handbook

Pre-Meeting Comments

February 23, 2010

Notice

Pre-meeting comments were prepared by each consultant individually prior to the meeting. They are preliminary comments only, and are used to help consultants become familiar with the document and charge questions, develop the agenda, and identify key issues for discussion. During the meeting, consultants may expand on or change opinions expressed in their pre-meeting remarks and may introduce additional issues. For these reasons, pre-meeting comments should be regarded as preliminary and do not reflect the final conclusions and recommendations of individual consultants. After the meeting, reviewers will prepare post-meeting comments that will reflect their final views. Post-meeting comments will be provided in the workshop report.

Contents

Biographies

Henry A. Anderson, M.D.

Chief Medical Officer for Occupational & Environmental Health
Wisconsin Division of Public Health, Madison

Henry Anderson received his BA degree from Stanford University and in 1972 a MD degree from the University of Wisconsin Medical School. He was certified in 1977 by the American Board of Preventive Medicine with a sub-specialty in occupational and environmental medicine and in 1983 became a fellow of the American College of Epidemiology. In 1980 he joined the Wisconsin Department of Health and Social Services as the Wisconsin State Environmental and Occupational Disease Epidemiologist. In 1991 he also assumed the duties of Chief Medical Officer. In July 2008 he was appointed Wisconsin State Health Officer and served in that capacity until January 2009. Since 1980 he has held adjunct Professorships at the University of Wisconsin - Madison, Department of Population Health Sciences and the UW Nelson Institute for Environmental Studies, Center for Human Studies. He has published over 230 scientific articles on a broad spectrum of environmental, occupational and public health topics. Current research interests include: disease and exposure surveillance, biomonitoring, risk assessment, childhood asthma, lead poisoning, health hazards of Great Lakes sport fish consumption, arsenic in drinking water, bioterrorism, asbestos disease, vermiculite exposure, occupational fatalities and occupational injuries to youth.

He has served on numerous national committees and currently serves on the NAS committee for "Assessment of Water Reuse as an Approach for Meeting Future Water Supply Needs" and on the USEPA National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances. He is the past chair of the National Institute of Occupational Safety and Health Board of Scientific Councilors. He is a fellow of the Collegium Ramazzini and an associate editor of the *American Journal of Industrial Medicine.*

Paloma Beamer, Ph.D.

Assistant Professor
Environmental Health Sciences
University of Arizona

Paloma Beamer, Ph.D., is an Assistant Professor in Environmental Health Sciences and Chemical and Environmental Engineering at the University of Arizona. She teaches graduate level courses in applied exposure assessment and control of occupational exposures. Her research focuses on developing databases of exposure factors for exposure modeling and risk assessment. She has published in Journal of Children's Health, Journal of Exposure Science and Environmental Epidemiology, Risk Analysis, Environmental Research, Environment International, and Environmental Science & Technology. She was elected to serve as Academic Councilor on the Board of the International Society of Exposure Science.

Deborah H. Bennett, Ph.D.
Associate Professor
Department of Public Health Sciences
University of California, Davis

Deborah Bennett is an associate professor in Environmental and Occupational Health in the Department of Public Health Sciences at the University of California, Davis. Dr. Bennett's research focuses on the fate, transport, and exposure of chemicals in both the indoor and multimedia environments within the context of both environmental risk assessment and environmental epidemiology. Her work utilizes both modeling and measurement techniques, bridging the gap between these two lines of inquiry. Current research interests include exposure to pesticides from indoor uses, relating environmental measures to biological measures for flame retardants, exposures and resulting risks from hazardous air pollutants, supporting exposure assessments in Autism studies, quantifying intake fraction and exposures to agricultural workers.

Dr. Bennett received her doctoral degree in mechanical engineering from UC Berkeley, worked as a scientist at the Lawrence Berkeley National Laboratory, and was a member of the faculty at the Harvard School of Public Health. Dr. Bennett received the Early Career Award from the International Society of Exposure Assessment and was an EPA STAR Fellow. She has served on an EPA Science Advisory Board committee as well as other EPA committees and was a US representative to OECD/UNEP Workshop on the use of Multimedia models. She serves as the treasurer for the International Society for Exposure Assessment.

Robert J. Blaisdell, Ph.D.
Chief, Exposure Modeling Section
Air Toxicology and Epidemiology Branch
Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

Dr. Robert Blaisdell is the Chief of the Exposure Modeling Section in the Air Toxicology and Epidemiology Branch of the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. His Section is responsible for development of the multipathway exposure assessment guidance for the Hot Spots Program. The Hot Spots Program addresses risk from airborne emissions from stationary facilities.

Dr. Blaisdell holds a doctorate in Pharmacology and Toxicology from the University of California, Davis. He has published papers on the subject of exposure assessment in Risk Analysis and Human and Ecological Risk Assessment.

Alesia C. Ferguson, Ph.D.
Assistant Professor
College of Public Health
University of Arkansas Medical Sciences

Dr. Alesia Ferguson is currently an Assistant Professor in the Department of Environmental and Occupational Health at the College of Public Health at the University of Arkansas Medical Sciences (UAMS). She is involved in teaching, research, and community service activities. Her teaching work focuses on exposure assessment, hazard control, workplace safety, and environmental policy. Her service activities focuses on student minority education, and community and environmental outreach. Her current research work predominantly involves the estimation of dermal exposure and dose to toxic chemicals using mathematical estimation models, observing and quantifying human health related behavior, and conducting lab controlled dermal exposure experiments with the human skin.

Previously as a member of the Stanford Exposure Research Group (ERG), Dr. Ferguson worked with a number of government agencies (e.g., Environmental Protection Agency (EPA), Research Triangle Institute (RTI)) and a number of private industries (SC Johnson Inc., Outdoor Residential Exposure Task Force (ORETF)) to quantify children micro-level activities patterns related to determining their exposure to potentially toxic compounds. The micro-level activity patterns are collected through video-taping and video-translation methodologies. Dr Ferguson is also now engaged in various lead activities in the state. Through EPA funding, Dr Ferguson and partners have been involved in lead parent education, contractor training, compliance and lead screening issues in the State of Arkansas. In general, her work is multidisciplinary in the human risk assessment field encompassing biology, toxicology, engineering, chemistry, and the behavioral sciences.

Brent L. Finley, Ph.D., D.A.B.T.

Principal Health Scientist
ChemRisk

Dr. Brent Finley is a board-certified toxicologist with 20 years of experience conducting and managing studies involving chemical exposures and human health risk assessment. He specializes in applied research, litigation support, regulatory negotiations, and riskbased site investigations. Dr. Finley has studied the health effects of exposure to a wide range of chemicals, including asbestos, petroleum-based products, chlorinated solvents, chromium, dioxins, and PCBs. He has provided expert witness testimony in lawsuits involving alleged health risks associated with exposures to asbestos in friction products, airborne chemicals from incinerator emissions, chlorinated solvents in groundwater, and chromium in tapwater. Dr. Finley has been involved in the preparation of more than 400 risk assessments, has published over 25 papers in the last five years, and has been an invited speaker at numerous technical seminars.

Before joining ChemRisk, Dr. Finley was the Director of Exponent's Human Health Risk Assessment practice (staff of 35) for six years. Prior to this, Dr. Finley was a staff toxicologist with Amoco Corporation. Dr. Finley's responsibilities at Amoco included the preparation of warning language for Amoco's fibers and resins product lines.

David W. Gaylor, Ph.D.

President
Gaylor and Associates, LLC

Dr. Gaylor received a B.S. and M.S. degree in Statistics from Iowa State University and a Ph.D. in Statistics from North Carolina State University. Dr. Gaylor, whose expertise is in the fields of biometry, statistics, and health risk assessment, currently is president of Gaylor and Associates, LLC. He retired from the National Center for Toxicological Research (NCTR), FDA, where he served as the principal advisor to the NCTR Director/FDA Associate Commissioner for Science on matters related to the planning, development, implementation and administration of health risk assessment policies reaching across a wide range of FDA's activities. In a prior position with the NCTR, he was Director of the Biometry and Risk Assessment Division where he was responsible for the administration and scientific direction of the Biometry and Risk Assessment program. In that position, he developed experimental protocols and provided statistical analyses of experiments in carcinogenesis, teratogenesis, mutagenesis, and neurotoxicity, and developed techniques to advance the science of quantitative health risk assessment.

Dr. Gaylor also serves as an Adjunct Professor of Statistics at the University of Arkansas for Medical Sciences and the University of Arkansas, Little Rock. He is a Fellow of the American Statistical Association, the Society for Risk Analysis, and the Academy of Toxicological Sciences and is a member of the Biometric Society, the Society for Regulatory Toxicology and Pharmacology, and the Society of Toxicology. Dr. Gaylor has served on more than 70 national and international work groups and committees on many aspects of biometry, toxicology, and risk assessment. He is currently a member of the editorial board of four professional journals: Risk Analysis, Human and Ecological Risk Assessment, Toxicology and Industrial Health, and Regulatory Toxicology and Pharmacology. Dr. Gaylor has also authored or coauthored more than 160 journal articles, 25 book chapters, and made over 100 presentations at scientific meetings on bio-statistics and a wide range of health risk assessment issues.

Panos G. Georgopoulos, Ph.D.
Professor, Department of Environmental and Occupational Medicine
Robert Wood Johnson Medical School
University of Medicine and Dentistry of New Jersey

Panos Georgopoulos, Ph.D. is a professor in the Department of Environmental and Occupational Medicine at UMDNJ-Robert Wood Johnson Medical School and Director of the Computational Chemodynamics Laboratory (CCL) at the Environmental and Occupational Health Sciences Institute (EOHSI), a joint project of UMDNJ-RWJMS and Rutgers University. Also, he is currently Co-Director of the Center for Exposure and Risk Modeling (CERM); Associate Director of the USEPA-funded environmental bioinformatics and Computational Toxicology Center (ebCTC); and Director of the Bioinformatics and Computational Toxicology Unit of the NIEHS-funded Center for Environmental Exposures and Disease (CEED) at UMDNJ. His research interests include computational chemodynamics and toxicodynamics, environmental and human exposure information systems methods, and risk and uncertainty analysis methods. He has served on numerous national and international committees for environmental exposure and health issues as well as on review panels such as the NIH Instrumentation and Systems Development Review Panel, the USEPA Science Advisory Board's Regulatory Environmental Modeling Guidance Review Panel, the National Aeronautics and Space Administration's Life Sciences Division Research Program, the USEPA Child Specific Exposure Factors Handbook Peer Review Committee, etc. He has published in numerous peer-reviewed journals, including the Journal of Exposure Science and Environmental Epidemiology, the Journal of Toxicology and Environmental Health, Environmental Science and Technology, Risk Analysis, and Environmental Fluid Mechanics.

Annette Guiseppi-Elie, Ph.D.
Principle Consultant, Risk Assessment
Dupont Engineering, Corporate Remediation Group

Dr. Guiseppi-Elie is a Principal Consultant on Exposure and Risk Assessment issues for the DuPont Company. Also, she is an Adjunct Associate Professor in Environmental Engineering and Earth Sciences at Clemson University. She has served on a number of scientific entities in her role as technical expert and advocate for the use of sound scientific principles and data in conducting environmental health risk assessments. These organizations include the USEPA Science Advisory Board, the Mickey Leland Center National Urban Air Toxics Research Center, the International Programme on Chemical Safety's Planning Committee on Harmonization of Exposure Assessment, and the American Chemistry Council's Human Health Exposure Assessment Technical Implementation Panel. She is past Chair of the American Industrial Heath Council's Environmental Health Risk Assessment Committee. Her expertise is in the areas of site and risk assessment, specifically, exposure assessments and includes environmental fate and transport processes. Dr. Guiseppi-Elie has conducted environmental site assessments and risk assessments both in the US and internationally. Her doctoral research focused on the fate and transport of dioxins in the environment. Her current research interests are in the areas of integrated/cumulative exposure and risk assessment and the relationship between indoor, outdoor and personal air exposures (e.g., the World Trade Center Indoor Air Assessment). Her work experience includes service on the faculty at Drexel University, service to Mobil Oil and the Exxon Corporation. Dr. Guiseppi-Elie received the B.Sc. degree in Chemistry and Zoology and the M.Sc. in Crop Production Entomology from the University of the West Indies (UWI), Trinidad in 1977 and 1979, respectively. She received a M.Sc. degree in Pollution and Environmental Control from the University of Manchester Institute of Science and Technology (UMIST), England in 1980 and her Ph.D. in Civil Engineering from the University of Maryland College Park (UMCP), USA in 1987.

Michael D. Lebowitz, Ph.C., Ph.D.,

Retired Professor of Medicine (Pulmonary) and Public Health (Epidemiology)
Research Professor of Medicine, University of Arizona, Tucson, AZ

Michael Lebowitz has a Ph.D. in Epidemiology & International Health, and Environmental Health Sciences (with minors in Biostatistics and Sociology), and a Ph.C. in Preventive Medicine (with a minor in Biomedical Sciences) from the University of Washington (Seattle). He also has an MA in Biostatistics (with a minor in Demography) and a BA in Psychology from the University of California (Berkeley). He completed his clinical training in cardio-pulmonary medicine at the University of London Postgraduate Cardio-thoracic Institute. He started in public health in 1962, and worked in both county and state health departments in Epidemiology and Biostatistics, was a faculty member at the University of Washington, and has been a professor at The University of Arizona (UA) since 1971.

Dr. Lebowitz‘ areas of expertise are environmental health sciences, occupational medicine, and chronic & infectious disease epidemiology. He chaired the Epidemiology-Biostatistics Division at UA and had been Associate Director of the Respiratory Sciences Center. He is currently serving on the EPA HSRB and the DHHS-NIH NCS Advisory Committee. He has served on the EPA Science Advisory Board, on National Academy of Sciences (NRC-NAS/IOM) committees, and has been a consultant and peer-reviewer for EPA, NIH, NIOSH and other agencies for over 40 years. He has also served as member/chair of committees for WHO, PAHO, and UNEP. He has been an expert consultant and witness for state and federal government agencies, various NGOs and CBOs. He has over 400 peer-reviewed publications.

He is a fellow of the American College of Chest Physicians, the American College of Epidemiology, and the Collegium Ramazzini. He is an elected member of the International Academy of Indoor Air Sciences, the American Epidemiological Society, the International Epidemiological Association, Delta Omega (the honorary public health society), and as an honorary member of the Hungarian Society of Hygiene. He is a founding member of the International Society of Exposure Analysis/Science (ISEA/ISES) and the International Society of Environmental Epidemiology, and a charter member the Society of Epidemiological Research. He has been a member of other medical and scientific societies. He is a past President of ISEA/ISES and recipient of its highest award (the Wesolowski Award), and is past Chair of the CDC National Prevention Research Centers Steering Committee. He has been received various honors and awards from The University of Arizona College of Public Health and Graduate College. He has been Principal Investigator (PI) of Arizona NHEXAS, other EPA & NIH grants and grants from other agencies.

Agnes B. Lobscheid, Ph.D.

Principal Scientific Engineering Associate
Environmental Energy Technologies Division
Indoor Air Department
Lawrence Berkeley National Laboratory

Dr. Lobscheid is a Principal Scientific Engineering Associate in the Environmental Energy Technologies Division at Lawrence Berkeley National Laboratory where she works on applying novel scientific and engineering methods to assess exposures to pollutants primarily released from combustion processes. Dr. Lobscheid received her PhD in Environmental Health Sciences from the University of California, Berkeley in 2004. The title of her dissertation was Methods to characterize ingestion and inhalation intake levels of airborne emitted polycyclic aromatic hydrocarbons (PAHs). She has published numerous technical reports and published in journals such as the Journal of Exposure Analysis and Environmental Epidemiology and Journal of Atmospheric Environment. She is a member of the International Society of Exposure Science and regularly presents at conferences. She also serves as an Alternate Member of Lawrence Berkeley National Laboratory Human Subjects Committee Internal Review Board and as a reviewer for the Journal of Atmospheric Environment, Journal of Hazardous Materials, Indoor Air, and Science of the Total Environment.

Dr. Lobscheid is currently working on exposure assessments to characterize conventional and liquefied natural-gas fueled cookstoves and ovens exposures in California residences, and to assess personal, ambient and indoor exposures to SVOCs. In addition, she is currently a co-investigator on studies intended to characterize the exposure and health impacts of energy technologies, including the health impacts of air toxic emissions resulting from the life-cycle stages of alternative transportation fuels, and a study researching the relationship between classroom ventilation rates and student illness-absence and student test-performance.

P. Barry Ryan, Ph.D.

Professor, Department of Environmental and Occupational Health
Rollins School of Public Health
Emory University

Dr. P. Barry Ryan is Professor of Exposure Science and Environmental Chemistry in the Department of Environmental and Occupational Health, Rollins School of Public Health, Emory University. He is jointly appointed in the Department of Chemistry at Emory University. Prior to joining the faculty at Emory in 1995, he was on the faculty at Harvard School of Public Health. He received a BS in Chemistry from the University of Massachusetts, an MS in Physical Chemistry from the University of Chicago, and doctorate in Computational Chemistry from Wesleyan University. He has been active in the exposure assessment field for over 25 years publishing in excess of 90 peer-reviewed manuscripts and book chapters and making over 170 presentations of his work to the scientific community. His work has included both cross-sectional and longitudinal studies of community-based exposure for multiple pollutants in multiple media. Dr. Ryan is currently Principal Investigator on an U.S. EPA-funded STAR Grant designed to assess the effectiveness of biological markers of exposure to organophosphate and pyrethroid pesticides. In addition, he is Principal Investigator studying the impact on the surrounding community of airport emissions of various airborne compounds, and of a retrospective study of exposure to perfluorooctanoic acid in a large area surrounding a manufacturing facility using this compound. Recently, he began work assessing exposure to pesticides experienced by individuals in a community in Northern Thailand. Dr. Ryan is a member of the Executive Committee of the Emory/Battelle/Morehouse consortium for the National Children's Study. In the recent past, he was Principal Investigator on the U.S. EPA funded longitudinal study of exposures to pollutants known as the National Human Exposure Assessment (NHEXAS) - Maryland study, and was Co-Principal Investigator of a study on health compromised individuals assessing the impact of particulate matter exposure on heart rate variability, and Co-Principal Investigator on a study of the impact of air pollution exposure on hiker lung-health in the Great Smoky Mountain National Park. Dr Ryan is a member of the Board of Scientific Counselors for U.S. EPA's Office of Research and Development. Dr. Ryan also completed a four-year term on the Federal Advisory Committee for the National Children's Study being undertaken by the National Institutes of Health. He has served on numerous advisory panels for the U.S. EPA, most recently as an ad hoc member of the FIFRA SAP on CCA-Treated Wood Products and the FIFRA SAP on Carbamate Pesticides. Dr. Ryan has also served on several National Academy of Science panels, most recently on the panel producing the monograph Managing Air Quality in the United States. Dr. Ryan is a trained chemist and maintains a large laboratory facility.

His wesbsite is http://www.sph.emory.edu/eoh/faculty/ryan.html

Alan H. Stern, Dr.P.H., D.A.B.T.

Independent Consultant

Alan Stern, Dr. P.H., D.A.B.T., is participating as an independent consultant. In another context, he is the lead scientist for toxicology and human health risk assessment in the Office of Science of the New Jersey Department of Environmental Protection. He has been involved with exposure assessment issues for mercury, chromium, lead, asbestos, wading pool exposures, fish consumption, and indoor dust measurement. Previously Dr. Stern worked as chief toxicologist for the New York City Department of Health, and as a life scientist for U.S. EPA Region 2. He served on EPA's Science Advisory Board for peer review of the All-Ages Lead Model and on the National Academy of Science's Committee on Toxicological Effects of Methylmercury. Dr. Stern has published articles in peer-reviewed journals such as Environmental Health Perspectives, Environmental Research, and Ambio.

Nga L. Tran, Dr.P.H.

Senior Managing Scientist
Health Sciences Center for Chemical Regulation and Food Safety
Exponent, Washington, DC

Dr. Tran is a Senior Managing Scientist at Exponent's Health Sciences Center for Chemical Regulation and Food Safety in Washington, DC. Dr. Tran has more than 20 years of experience in exposure and risk assessment. Dr. Tran has conducted numerous safety assessments for food ingredients, additives and contaminants, consumer care products, and environmental and occupational exposures. She has provided technical support and prepared a variety of reports and submissions to regulatory authorities including Generally Recognized as Safe (GRAS) affirmation petitions to the FDA and food additive submissions to Health Canada, JECFA and EFSA. Dr. Tran also has extensive experience in conducting scientific review for the substantiation of health claims.

Dr. Tran has extensive experience dietary exposure assessment and risk modeling. She has successfully applied risk apportionment models to evaluate contribution of dietary and lifestyle risk factors to diseases, such as dietary cholesterol and coronary heart diseases. Using the risk assessment toolbox, she has developed systematic methods of evaluating beneficial effects associated with food and food ingredients for substantiation of health claims and developed models to quantify health benefits of GM crops. Dr. Tran has also worked extensively on risk ranking methodologies for a wide range of risk management purposes. Her work in the risk ranking arena has included the development of tools to prioritize food risks (both chemical and microbial), environmental health risk ranking framework for military deployments, risk based site selection model to prioritize U.S pharmaceutical manufacturing sites for cGMP inspection, and exposure and risk screening methodologies for consumer personal care products. Complementary to her risk assessment work, Dr. Tran also led the development of the peer review procedures for food safety risk assessments for FDA's Center for Food Safety and Applied Nutrition (CFSAN).

Prior to joining Exponent Dr. Tran was a faculty member at the Johns Hopkins University, Bloomberg School of Public Health where she conducted research and taught exposure and risk assessment, risk prioritization, and risk harmonization. Dr. Tran remains an Adjunct Assistant Professor at the University.

Rosemary T. Zaleski, Ph.D.

Section Head of Epidemiology and Health Surveillance
Occupational and Public Health Division
ExxonMobil Biomedical Sciences, Inc.

Rosemary Zaleski is Section Head of Epidemiology and Health Surveillance in the Occupational and Public Health Division of ExxonMobil Biomedical Sciences, Inc. She has a Ph.D. in Environmental Sciences from Rutgers University. Her principal responsibilities lie in exposure assessment, including managing a program for development of exposure science tools and resources. She is currently involved in development of exposure tools and approaches in support of the EU Registration, Evaluation and Authorization of Chemicals (REACH) program.

Her experience includes multimedia and exposure modeling and environmental fate and effects assessment. She is currently chair of the International Life Sciences Institute (ILSI) Health and Environmental Sciences Institute (HESI) Risk Assessment Methodology Task Group on Chemical Mixtures Assessment. She is a Councilor of the International Society of Exposure Science and is a member of the Monitoring Work Group of the National Conversation on Public Health and Chemical Exposures and also EPA's Community of Practice for Exposure Science. She served on the Steering Committee of the ExpoFacts project that developed a public database of European exposure factors data and on the peer review panel of EPA's Child Specific Exposure Factors Handbook. She is a founding member and councilor of the first regional chapter of the International Society of Exposure Science (ISES). Rosemary is a 2007 recipient of the Central New Jersey YWCA Tribute to Women and Industry Award, and is active in ExxonMobil's Science Ambassador educational outreach program to local schools.

Responses to General Charge Questions

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

Anderson	The handbook is appropriately organized and generally presents the data in a logical sequence from general to specific. Having the summary table that includes all factors in the front is very useful and serves as a quick reference for the user. Generally the tables are described adequately in their titles so an assessor who is looking for a specific set of data can find it fairly easily. However it is likely that the user will need to work through a whole chapter rather than be able to go directly to what they need. The greatest difficultly is finding what you need. The layout of the tables is consistent across most of the factors and therefore once you find the needed table, where to look in the table is pretty self explanatory. The reason for expanding the child age categories in the tables is described, but in reality few exposure assessments will utilize this detailed level of data. It will simply need to be aggregated. While providing the breakout may be useful and consistent with the referenced EPA guidance, it would probably be of greater utility if the initial tables provided an integrated value for the factor for children. This would make the tables less cluttered and allow further distributions to be provided in the same table. The details could be provided in subsequent tables. In the introduction “Background”, it briefly indicates what areas have been updated or added to since the 1997 earlier handbook. While useful information, what the reader would like is to know what the changes are or if they are significant or not and in what direction. This section indicates that soil ingestion and fish consumption are updated but the user would like to know did the ingestion rates go up or down or not change, was a different “key” data set used. Does the user need to spend time working through the chapter or is it only that the references have changed but the values have not? Since many of these factors are used regularly by assessors, many remember what they have been using. If that needs to change, it would be helpful to say so up front and not make the user page through looking and trying to remember what it used to be and what it is now. In each chapter intro it would be useful to say whether the “key” study has changed or not and whether the main table values have changed. Highlighting the tables with changes would be helpful.
Beamer	For the most part the organization of the Handbook is very clear and easily understood. However some improvements could be made to the tables. In particular tables that are longer than one page. Although it is clear on the second page that this table continues on from the previous page by the title on the second page of the table, it is not clear in the current format used throughout when you are looking at the first page that this table continues onto the next page. For example, it is not clear that Table 7-2 continues onto the next page. Something should be added to bottom of tables that continue onto other pages that differentiates them from tables that are only page long. Also consider including the superscripts and reference citations on each page of the table. It is cumbersome and confusing to the reader to have to look through three pages of a table to figure what the reference or superscript refers to. Also consider breaking up Table ES-1 into different tables by chapter or factor. The current table is very confusing as some factors are cut in

two.

It is not clear how the data for Table 16-13 was determined. What are the criteria for proximity to gasoline fumes and gas oven fumes? Does this also include vapors or gases? More information would be helpful, as these are likely high exposure events and may be very important for assessments for specific contaminants.

Why were recreation activities assumed to be outdoors only in Table 16-14? Many of the activities described in Table 16-7, could also be conducted indoors.

There are also some tables with specific formatting errors that should be fixed.

- Table ES-1 under Chapter 4, "hr" should not be cut between to lines.

- Table ES-1, why is there a break in the Table between the end of Chapter 14 and the beginning of Chapter 15, but not between other chapters.

- Table ES-1, at the beginning of page xv there is a weird break along the top of the table.

- Table ES-1, after the first line on page xvi, there is a gap that appears out of place or inconsistent

- Table ES-1, although Chapter 17 is not being reported here, it would be helpful to have the Chapter title so one could know what factor the Chapter discusses.

- Does Table 5-7 provide estimates of soil or dust ingestion? Not clear just from table.

- Is there supposed to be a line under Home on Table 16-11?

- There seem to be some lines missing on Table 16-19, and Table 16-36.

- Do tables 16-34 and 16-35 represent DOERS only?

Other editorial comments:

- Why are the relevant studies for section 11.4.2 not separated out in the table of contents like other sections?

- Page 1-1, there seems to be extra space next to the 2nd and 3rd bullet points.

- Page 4-2, the sentence "Recommendations for duration of object-to-mouth contacts are based on data from Juberg et al. (2001) and Greene (2002)" is not congruent with what it says in Table 4-1.

- Page 4-5, Last paragraph, first two citations should be Zartarian et al., 1998, not Zartarian et al., 1997a

- Page 4-5, Last paragraph, Zartarian et al., 1998 reports an average object-to-mouth frequency of 11 and a median frequency of 9. Hopefully the correct values were used in

	developing the exposure factor. • Page 4-14, The second paragraph should cite Zartarian et al., 1998 not Zartarian et al., 1997a • Not clear why collection of excreta is mentioned twice in the first paragraph at the top of the second column on page 5-9. • Could equation formatting be improved? For example, eq. 5-1 looks like the text was just underlined rather than created through an equation editor. Same for eq. 5-2. The underlining is distracting in trying to interpret the equation. • Need a space after 5.3.4.10 on page 5-16. • For the introduction on dermal exposure, page 7-1, consider adding gases to vapor/fumes, and an additional bullet point for solids and residues. Similarly, on page 7-2 end of 2nd paragraph, consider "liquids and residues may soak through clothing" • Page 7-2, extra period before Insufficient in paragraph at top of column 2 • Could the final equation used for the US EPA Analysis of NHANES (Section 7.3.1.2) be reported directly in the text? So many equations are discussed in the text and in the appendix that it is not clear what the final equation was. • Table 7-16, "Summary of field studies" for what? • Consider adding a line above Rugby No.1 on page 7-31, that says Outdoors (Continued) • Is there a negative missing in eq. 7A-8? Natural log of 0.0239 would be negative. • Sometimes the abbreviation is eq. and sometimes it is Eqn. for equation, it would be nice to have consistent throughout. • The first sentence of the last paragraph of the first column on page 16-1, does not seem to be complete. Should something follow "various"? • In Section 16.2.2 on page 16-2, a period and space are needed after 16-4. • In Section 16.2.3 on page 16-2, the work "Bureau" is misspelled. • Near the top of page 16-19, is BLS, 2007 the same as USDL, 2007 and U.S. DL, 2007? This also occurs in the Tables referred to in this section.
Bennett	The information is presented clearly. I do not have any suggestions for the overall presentation of the data.
Blaisdell	**General Comments** The Exposure Factors Handbook generally presents the data in a clear, easily understood

	format (Question 1). I have no suggestions for improvement, except my suggestions for Chapter 2. The coverage of the literature is exhaustive and thorough. Some of it may be more of historical interest than of current value but it is difficult to develop criteria for excluding information, or to predict the varied uses for the data. Although, I do not think it is necessary to formally review exposure assessment guidance documents from the states, it might be useful to at least examine them for anything that might be useful. I would like to see a Recommendations for Future Research Section in each chapter. The factors that are addressed in the Draft Exposure Factors Handbook are the most needed for exposure assessment, although I did suggest that data on percent of total consumption for homegrown produce and meats be reviewed (Question 2). The selection of the key studies seems to appropriate for the chapters I reviewed (Question 3), except for the 0-2 age range for breathing rates. The NHANES data when USEPA finishes its analysis should probably replace the CSFII data in most cases. The confidence ratings for the Chapters that I reviewed seemed appropriate (Question 4). The only other source of data that I identified was for Chapter 10 (see below). The variability has been adequately described; however, you could determine best-fit parametric models for the NHANES data for Monte Carlo Analyses (Question 6). The Exposure Factors Handbook should be available in all the formats mentioned (Question 7). In response to Question 14, I commend your decision to analyze and incorporate the NHANES data for Chapters 9, 11 and 12. I would suggest analyzing general fish consumption for Chapter 10 from the same data. I would provide best-fit parametric models for Monte Carlo from the NHANES data.
Ferguson	In general the Handbook is organized in a reasonable and clear format. Most tables are easily understood and usable to those performing exposure assessments. I may have specific comments on individual tables in each chapter. Each chapter begins with a description of the exposure route and most needed/obvious exposure factors. Then each chapter presents the main exposure factors in one or two tables that appear early on in the chapter, where the data comes mainly from the key studies. Following this, the key studies are presented in more details following by detailed tables from key studies and most relevant studies and their related tables. In this manner EPA is making the data from the key studies easily accessible. However, EPA does make the user aware of the other data tables that can be used in detailed or more specialized exposure assessments. Some tables can be improved by highlighting difference in tables or areas of emphasis. I would put all references at the end of chapters, after all the tables. The details of calculating exposure assessments for each route are not typically given. There are some general ideas on required factors for the assessment. However, the user is referred to other EPA documents that present quantitative methods for exposure assessments for each route. There are occasions where more examples or better explanations can be given. These are detailed below for each chapter in my set of reviews. Chapter 1 contains the bulk or most details for making the exposure calculations and the reader should always review this chapter first. In fact each chapter should say “refer back to chapter one for guidelines on making exposure calculations”.

	The reader should note, the EFH is not organized by exposure route necessarily, or the activity patterns specific for each route would be found in the related chapter and the principles for making the route calculation would be found also in that chapter. In other words, I do not think each chapter fully stands alone with all the necessary factors for making the exposure assessment for that route of exposure.
Finley	With a few exceptions delineated in my comments below, I find the format to be very "user-friendly" and do not recommend any changes in presentation of the material.
Gaylor	The organization of the Handbook is appropriate. In general, the data presented in tables are clear and usable in the current format.
Georgopoulos	The 2009 Update to the USEPA Exposure Factors Handbook provides a most valuable resource that summarizes a wealth of information covering a diverse range of topics and improves substantially and effectively the previous version. The information, in both narrative and tabular form, is, in general, clearly presented, and one could state that the whole document is highly readable and usable (though, of course, some improvements are possible and some are suggested in the following). As long as the updated Handbook is used within the context for which it was prepared, and the user keeps in mind that it is neither a textbook (either introductory or advanced) nor an encyclopedia of the field of exposure analysis, it can be an excellent tool for supporting basic exposure assessments that indeed could help improve standard practices in the field. The multidisciplinary teams that developed, reviewed, and quality-assured this Update should definitely be commended for their effort and the overall quality of this effort's outcome. Though, as mentioned above, the 2009 Update of the EFH is a very readable document, it however lacks visual elements (it has very few figures, charts, etc.) and its usability could be further enhanced through: • The addition of more "text boxes," (such as those appearing, e.g., on pages 1-1 and 2-2) with concise definitions of basic terms, summaries of critical information, critical recommendations or caveats, etc. • The addition of a few flowcharts clarifying relationships among concepts discussed in the text as well as "decision tree type" diagrams that would supplement the narrative in guiding the user towards the selection of the most appropriate data for her/his assessment. • The addition of selected charts that present the information contained in some of the tables in graphical form (i.e. in addition to maintaining the table with the numerical values), as a means of facilitating the comprehension of this information. • The addition of a brief discussion of the general concept of microenvironments (indoor – residential and occupational, vehicular, outdoor) and of its critical significance in the proper assessment of exposures. • The addition of brief "Further Reading" recommendations at the end of each

	chapter, identifying standard literature sources (textbooks, handbooks, easily accessible reports, etc.) on the topic of the chapter, at "introductory," "intermediate," and "advanced" levels. • The expansion of the Glossary to include terms and concepts that are quite common in exposure analyses (even in cases where the Handbook does not focus particularly on them). For example, the Glossary does not currently contain terms such as "Aggregate Exposure," "Bayesian Analysis or Bayesian Statistics," "Geographic Information Systems (GIS)," "Microenvironment,"or "Physiologically Based Pharmacokinetic - or Toxicokinetic – Model," etc. (It should be noted that Bayesian methods are mentioned repeatedly in the narrative of Chapter 2 and PBPK models in the narrative of Chapter 6; however, GIS do not seem to me mentioned in the Handbook). It is realized, of course, that the Handbook is not a dictionary or encyclopedia of exposure analysis methods, but without doubt, it will be used by individuals new to this field, who would benefit by an expanded Glossary. Even basic concepts such as e.g. "Biomarker" deserve their own entry (currently they are only partially addressed in existing entries, such as "Biokinetic model comparison" and "Biomarker model comparison" that, however do not address in any way the possible range of available biomarkers of exposure - and, even more, their potential relationship to biomarkers of susceptibility and biomarkers of effect). • The "direct availability" of the information in the tables in electronic form (i.e. such as in spreadsheet or database form, in addition to the current pdf form) for direct input or linking with exposure models. Nevertheless, this probably relates to potential future versions of EFH with "enhanced interactivity and accessibility," that are discussed briefly in the answer to Questions 7 and 18.
Guiseppi-Elie	There are several positive improvements in the organization of the EFH. The most noteworthy are the addition of an Executive Summary (ES) with summary tables and recommendations, and likewise the inclusion of summary recommendations at the start of each chapter. While the organization is reasonable, there are several opportunities for improvement. . • There are some obvious formatting issues in the ES table that should be resolved during printing. Of greater concern with ES-1 is the fact that all the caveats noted in the individual chapters (e.g., for the lack of data to support upper percentile recommendations for drinking water for the very young age groups) are missing. Also, the overall confidence ratings, which are important in helping guide decision making, are missing from this recommendations. This table will be a key component of the EFH and will be where most users begin their assessment, in general and also to determine what has changed since the last version. It is critical that Table ES-1 be thoroughly reviewed and the appropriate information is included such that this very important summary is properly documented. • While a summary like documented in Table ES-1 is appropriate, the current version is too complicated and does not include the confidence rating. Instead, a version like the Roadmap Figure 1-2 of the 1997 version provides a much better presentation of this complicated information. While the need for a summary of percentiles is recognized, use of the roadmap format is much better suited to the

	range of information provided. It is likely more convenient to use this format for a PDF document with links than the paper version, in which case, the format (i.e., mean, upper percentile and confidence rating) of Table1-2 (of the 1997 version) is probably still relevant and sufficient for the ES. If current ES-1 format is retained, a lot more effort needs to be expended to make it correct, properly documented and easily understood. • Much has changed with the inclusion of the child-specific exposure factors. While this may be appropriate, there are now two "current" documents with similar but not exactly the same information. Section 1.7 and to some extent Section 1.8 address the issues with children exposure and risk calculations. However, it is not entirely clear which of these two handbooks takes precedence. Maybe this is appropriate and obvious, based on a given factor. However, the topic seems worthy of a section on its own. • If not in the ES, then in the Introduction, there needs to be a better (recognize that an attempt was made to do this) discussion of the interplay between the major (if not all) of the different guidance/tools (such as the EFH, Child-specific Exposure Factors Handbook (CSEFH), Highly Exposed Population (HEP), Exposure Scenarios) exposure assessment. A figure (roadmap style) might be useful to achieve this. For example, the discussion above on the use of the two current documents that contain child-specific exposure factors could be more easily facilitated using such a figure. • Appendix A1 of the 1997 version needs to be updated and included. This was a very useful primer on risk calculations and arguably is needed even more now with the inclusion of age bins which are not always consistently applied in this document with the CSEFH and are at odds with current RAGS "practice". • A section on what's changed and why would be useful in the Introduction as well as at the start of each chapter. The recommendations in this document have been used for well over 10 years. A "simple" summary table or description of the context for the change would be useful for practitioners to help with decisions on the use of the new information (or not) given EPA's overall caveat that these are not legally binding values • The use of the roadmap concept (and word search) in the downloadable current PDF version should be retained. This feature allows for ease of moving through an extensive document even for the most knowledgeable users.
Lebowitz	The format is satisfactory, but the information in summary tables could be considered incomplete (see my comments on Chapter 6). Further, the explanations (e.g., as discussed below re: chapter 1 and in my comments for the other chapters I reviewed) are incomplete.
Lobscheid	I think the Handbook contains much-needed data on exposure factors and is an extremely valuable resource to the exposure assessment community. The handbook includes exposure factors needed to assess inhalation, dermal, and direct and indirect ingestion exposures. Having used it in the past to assess inhalation and ingestion exposures, I can

	attest to its usefulness and am very glad to see that it is being considered for revision, with more recent data and analysis, where available. My suggestions for improving the clarity and usability of the EFH include the following: In each Chapter, consider placing all figures after the tables. For example, in Chapter 19 the mix of figures and tables at the end of the chapter is confusing. If this structure changes, make note of this change in Chapter 1, under Section 1.11 (Organization), i.e., "All Figures are placed following the Tables at the end of the Chapter". Consider placing the description of the Key recommended studies, following the Confidence Tables of each Chapter, in order of how each scored (The Key study with the highest Confidence Rating described first) based on the Confidence Criteria, i.e., General Assessment Factors (GAFs). This would be particularly useful for Chapter 15 (Human Milk Intake) and Chapter 19 (Residential Building Characteristics).
Ryan	The overall format is quite good with Introductory material followed by factor specific chapters. I find this to be the ideal method of presentation. I am concerned, however, that the data tables soon become overwhelming. I offer no solution for this at this time. The data must be presented and there are a lot of data. As Chair, however, I will solicit input from the general group on how best to make a presentation of the large amount of data. One possible solution is distribution of a database system that may allow queries to be done. One may, for example, perform a query for drinking water intake for a specific age group. The query would return the appropriate table. This may be necessary in light of the voluminous (now estimated at 3000 pages) report.
Stern	In general, the text of the EFH is clearly written – the introductory and summary parts more so than the review of the individual studies. One major deficiency, however, is that the recommended values are presented without a clear explanation of how, specifically, they were derived from the selected study/studies. I presume that there was a more or less formal approach that involved the weighting of the studies and the data within the key study/studies. However, this is not transparent. Furthermore, it is not clear how the studies designated as key studies relate to the studies used to derive the recommended values. For example, in chapter 4, the values given in Table 4-1 for hand-to-mouth frequency and object-to-mouth frequency are derived solely from Xue et al. 2007. However, there are 9 studies that are grouped in the text as key studies. The Introduction section to this chapter states that some of the key studies were included because they were used in the meta-analysis of Xue et al. What is the relationship of key studies to those used directly for the recommended values? What is the basis for the choice of the one recommended study in this case given the 8 other key studies? While the Xue et al. studies may be the most appropriate because they incorporate the best studies in their meta-analyses, this is not explicitly stated. Another deficiency is that, for the most part, the tables presenting the data from the individual studies are not self-explanatory, but generally require referring back to the details of the studies presented in the text in order to understand the nature of the data presented in the tables. This is also the case for some of the tables presented for the recommended values. For example, in chapter 4, the third section of the recommended values table (4-1) presents recommended values for "duration." Although this section is presented under the larger section entitled, "Object-to-mouth," reference to the description of the source studies indicates that some of those

	studies include only objects and not hands, while others include objects and hands. However, from table 4-1 alone, one cannot tell whether the frequency refers to objects-only or to objects and hands. This would be less of a problem if the tables were presented along with the text so that the reader could consult the table as the text is being read. However, presenting the tables in a separate section removes their context.
Tran	The presentation of intake rates for a) fruits and vegetables, b) grain products, c) meat, dairy products and fats, and d) total/broad food category intake in four separate chapters is easy to follow. However, the description of key study (CSFII 94-96, and 98), confidence in intake data from this study, and the conversion between wet and dry weight intake rates are repetitive throughout chapters 9, 11, 12 and 14. The overall introduction on food intake rates and method of calculation for each of these chapters are also redundant from chapter to chapter. It is suggested that an overall introductory chapter that discuss types of food intake data available (e.g. national survey at individual levels, e.g. CSFII or NHANES; food disappearance, production statistics, specific/targeted survey, etc…) and their relevance to exposure/risk assessment, intake terms (per capita, per user, per eating occasion, one-day, 2-day average, usual intake, etc…) and which metric is appropriate for what kind of exposure assessment, the key data source that is relied upon for all food intake rates (in this version the CSFII), and confidence rating for the intake rates derived from the key study to precede the individual food intake chapters.
Zaleski	Overall: I commend EPA for the level of work and resources directed to preparing this very important exposure assessment reference. This handbook is a much-consulted resource not only in the US but also internationally, speaking to the value of the information it holds. I also appreciate the privilege of being a member of the peer review panel. Substantial effort has been spent both in updating references and in providing, when available, distributional data to support probabilistic analyses. These efforts will be of great use to the exposure assessment community. In general, one point to make clearer within the handbook is that linkages between factors should be considered in their application. For example, skin surface area estimate have increased by about 10% from those in the current EFH, but these are calculated based upon body weight, which have increased by about 10%. So the updated skin surface area estimates are dependent upon and should be utilized with the updated body weight data. Brief discussion of the drivers for changes from the current EFH, such as this example, would be helpful to the exposure assessor applying these updated recommendations. The organization is very good. The up-front summary of all recommendations is very useful and easy to find. Starting each chapter also with the recommendations really helps with quickly locating the key information.

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

Anderson	The current factors included in the handbook are the ones most commonly used. I don't know the distribution of the types of exposure assessments that either the EPA, other federal agencies or the broader exposure assessment community do most frequently, but suspect they are more likely local or focused than national in scope. The focus of the handbook is to emphasize national population data and gives a premium to studies that are "general population" in scope. Whether that information is the most useful for more local or focused assessments is unclear. It would seem useful to do a survey and find out what the assessors like about the current handbook and what they would like added or changed rather than rely on a few reviewers' experience. In some instances new factors may have been considered, but there may not have been adequate data. Did the authors identify factors that they would like to have included but could not because of lack of data? Has EPA received any unsolicited recommendations or requests?
Beamer	The current draft EFH provides very useful data in a systematic manner for an enormous number of factors that are needed to conduct a wide variety of exposure assessments. These exposure factors are probably the ones that are needed most frequently, and are appropriate or inclusion in the handbook. Some additional ones for consideration are provided below.
Bennett	In terms of the topic areas selected, the Handbook includes the most important factors. Within the residential section, I do see some factors missing but I include those with my answers to question 15.
Ferguson	Please see comments for each chapter below.
Finley	I believe the EFH addresses all of the major exposure factors that must be considered in the conduct of a household or environmental risk assessment. In a few instances (described in detail below), I think the document could expand somewhat in terms of *how and when* different factors should be applied, although this may be beyond the scope of the EFH. This is particularly true for the fish ingestion exposure factors, where dozens of data summary tables are presented.
Gaylor	The factors addressed in the EFH are relevant and generally adequate to conduct exposure assessments for subsequent risk assessments.
Georgopoulos	The factors currently addressed in the 2009 Update of the EFH should be generally adequate in the context of most exposure analyses that this Handbook is intended to support, i.e. excluding "exposure assessments involving physiologically-based pharmacokinetic (PBPK) modeling" (as per statement on page 1-1) or, in general,

	analyses that would not attempt to incorporate other levels (i.e. beyond pharmacokinetic) of biological information in their methods. The one set of factors that is "missing" within the above-specified context should have to do with factors associated with microenvironments other than residential buildings. Of course, the EFH is not intended to support occupational exposure assessments; nevertheless, many "non-occupational" exposures (at least in the traditional sense of the term) take place indoors but in buildings that are not residential (e.g. schools and other public buildings, restaurants, movie theaters, stores and shopping malls, athletic facilities and clubs, hospitals, etc.) and these microenvironments need to be adequately characterized. In vehicle-exposures are also a major contributor to total exposure and the factors pertaining to relevant microenvironments (cars, buses, trains, etc.) also need to be properly characterized. Furthermore, local outdoor conditions (roadways, intersections, street canyons, etc.) can modify the environmental conditions relevant to an "ambient background" level (e.g. the airborne contaminant values measured at a "central" monitor location) and appropriate factors that will help to quantify this modification need to be developed.
Guiseppi-Elie	The document appears to strike a reasonable balance of exposure factors considered including both general and specific factors (e.g., food ingestion and activity patterns). While there may be several other specific "pathways" and, hence, factors that are worthy of review and recommendations, the current focus of the EFH appears appropriate. Notwithstanding the above comment, exposure factors associated with indoor air residential exposures and particularly the subsurface vapor to indoor air (or vapor intrusion) pathway are worthy of additional attention. Further, factors associated with residential characteristics are not well researched. Only two factors were "quantified" under Chapter 19 on residential characteristics and these could only be poorly addressed because of the lack of information. Commercial (/industrial) characteristics are not addressed at all, yet assessors are often required to evaluate these settings. In each of these instances, the EFH should clearly direct users to alternate sources of information. In most cases, separate guidance and associated factors (e.g., in industrial settings) is more appropriate but still needs to be addressed.
Lebowitz	The factors currently in the Handbook are useful but the approaches to actual exposure and risk assessment are either old or incomplete.
Lobscheid	Yes, I think that the EFH contains important information on what data and analysis is available on exposure factors to assess inhalation, ingestion, and dermal exposures.
Ryan	I believe the most important factors are presented in the document and, where appropriate are sub-divided by age group.
Stern	It appears that the appropriate general topics necessary for conducting exposure

	assessments have been addressed.
Tran	The dietary factors include in chapters 9, 11, 12 and 14 are useful food commodity factors for assessing exposure to environmental contaminants that may be present at the commodity levels (e.g. spinach, pork, etc…). However, if contaminants are present at the "food as consumed" level, e.g. in canned soup, the dietary factors in these chapters are of limited utility.
Zaleski	I agree that these are the most used factors. In future, wondering if there will be a companion handbook of physiological factors for PBPK modeling?

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

Anderson	For the chapters I reviewed in depth, I would have to say that I am aware of other data sources not mentioned or discussed. Unfortunately it is impossible to know what studies the authors reviewed and rejected using their criteria. Nowhere is it mentioned how studies were identified, how many reviewed and culled to get the few used as "key" or of sufficient import to summarize. All we know is that supposedly reviews included publications into 2009.
Beamer	Nicas and Best (2008) provides hand to mucus membrane frequencies in adults while working in office settings. While this may not exactly correspond with the other studies, it does provide some estimate for adults on mouthing frequency. (Nicas and Best. 2008. Applied Occupational and Environmental Hygiene, 5(6): 347-352.) For soil adherence also consider the studies by Choate et al. (2006) and Yamamoto et al., (2006). Choate et al. (2006). Dermally adhered soil: 1. Amount and particle-size distribution. Integr Environ Assess Manag, 2(4):375-384. Yamamoto et al. (2006). Size distributions of soil particles adhered to children's hands. Arch. Environ. Contam. Toxicol, 51(2): 157-63.
Bennett	The Agency has done a thorough job for most of the factors reported. I note a few missing data sources by chapter below. Chapter 5: Estimates of indoor dust based on number of hand to surface contacts and subsequent hand to mouth contacts. This work is being done within EPA through the SHEDS program. Chapter 17: There is considerable more literature available on pesticide application rates than was presented in the Chapter. While not all studies may be appropriate to be included, at least a broader list should be made available with a statement of why the data was not included if the Agency did not feel they were adequate studies. Below is a list of references that include information on pesticide application rates: Adgate J.L., Kukowski A., Stroebel C., Shubat P.J., Morrell S., Quackenboss J.J., Whitmore R.W., and Sexton K. Pesticide storage and use patterns in Minnesota households with children. *J Expo Anal Env Epid* 2000: 10(2): 159-167 Davis J.R., Brownson R.C., and Garcia R. Family Pesticide Use in the Home, Garden, Orchard, and Yard. *Arch Environ Con Tox* 1992: 22(3): 260-266. Flint M.L. Residential Pesticide Use in California: A Report of Surveys taken in the Sacramento (Arcade Creek), Stockton (Five-Mile Slough) and San Francisco Bay Areas with Comparisons to the San Diego Creek Watershed of Orange County, California. *University of California Statewide IPM Program* 2003: CA DPR contract

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Savage E.P., Keefe T.J., Wheeler H.W., Mounce L., Helwic L., Applehans F., Goes E., Goes T., Mihlan G., Rench J., and Taylor D.K. Household Pesticide Usage in the United-States. *Arch Environ Health* 1981: 36(6): 304-309.

Whitmore R.W., Immerman F.W., Camann D.E., Bond A.E., Lewis R.G., and Schaum J.L. Non-Occupational Exposures to Pesticides for Residents of 2 US Cities. *Arch Environ Con Tox* 1994: 26(1): 47-59.

It should be noted that there is also the potential for consumers to not follow label instructions when using pesticides. One study that notes this is: van der Jagt K.E. Residential exposure should be considered in appropriate terms - Summary of discussions. *Ann Occup Hyg* 2001: 45: S167-S170.

The list of studies appears to be complete for personal care and household care products.

There is a study coming out from California that includes additional information on all facets of this chapter but manuscripts are presently under preparation or review and thus do not fit the timeline for this version, but should be noted for the next version.

Chapter 18: I am not aware of any other data sources.

Chapter 19: There are a number of missing data sources with respect to particle deposition. However, there are also a number of factors missing that are also related to particle deposition and therefore I include these missing references in my answer to Question 15.

Air flow between rooms: A laboratory study was completed looking at air flow rates between rooms which may be of interest to readers.

Miller SL, Leiserson K, et al. 1997. Nonlinear least-squares minimization applied to tracer gas decay for determining airflow rates in a two-zone building. *Indoor Air* 7:64-75.

When discussing deposition onto floors, a small study was completed that looked at the distribution of the size fraction of particulate matter onto floors.

Edwards RD, Yurkow EJ, et al. 1998. Seasonal deposition of housedusts onto household surfaces. *Science of the Total Environment* 224(1-3):69-80.

Dust loading on floors: Data in this area is very limited. I note one study that was not properly peer reviewed, but my be of interest given the scarcity of data on this topic.

Leese KE, Hall RM, et al. 1993. *Use of a high-volume small surface sampler (HVS3) for the microbial evaluation of dust from carpeted and non-carpeted surfaces.* EPA and Waste Management Association's Intn'l Symposium: Measurement of Toxic and

	Related Air Pollutants, Durham, NC. Resuspension Rates: In addition to reporting calculated resuspension rates, it may be of interest to readers to know about studies that report on air concentrations following activities that are likely to resuspend particles. Long, et al. report the average fraction of particle mass in the air in the 0.7 – 2.5 μm and 2.5 – 10 μm size fractions following walking events (Long, et al. 2000). Ferro has reported the concentrations or $PM_{2.5}$, PM_5, and PM_{10} following a range of activities, including folding blankets, making a bed, dancing on a rug, dancing on hard flooring, vacuuming, and walking on hard floor (Ferro 2003), as well as other papers related to particle resuspension. Long CM, Suh HH, et al. 2000. Characterization of indoor particle sources using continuous mass and size monitors. *J. Air & Waste Manage. Assoc.* 50:1236-1250. Ferro AR, Kopperud, R.J., Hildemann, L.M. 2004. Elevated Personal Exposure to Particulate Matter from Human Activity in a Residence. *Journal of Exposure Analysis and Environmental Epidemiology*. 14(S34-S40). Qian, J; Ferro, AR; Fowler, KR. 2008. Estimating the resuspension rate and residence time of indoor particles. JOURNAL OF THE AIR & WASTE MANAGEMENT ASSOCIATION Volume: 58 Pages: 502-516. Ferro, AR; Kopperud, RJ; Hildemann, LM. 2004. Source strengths for indoor human activities that resuspend particulate matter. ENVIRONMENTAL SCIENCE & TECHNOLOGY 38(1759-1764) Qian, J; Ferro, AR (2008) Resuspension of dust particles in a chamber and associated environmental factors . AEROSOL SCIENCE AND TECHNOLOGY Volume: 42 Pages: 566-578
Ferguson	These are detailed for the chapters below.
Finley	With the exception of some creel/angler studies for the fish ingestion factors (described in detail below), it appears to me that the EFH has captured most or all of the critical studies for each exposure factor.
Gaylor	I am not aware of other usable data sources.
Georgopoulos	Most of the major data sources for the factors that are currently included in the EFH have been identified (or are in the process of being added, as per the material provided for performing the review). Of course there are various studies that provide some additional “supporting” or “related” information, that could potentially be mentioned in the handbook; though most of them should not be considered critical. Some specific suggestions regarding such studies are given in the responses for individual chapters.

Guiseppi-Elie	EPA self identified the National Health and Nutrition Examination Survey (NHANES) "What We Eat in America" study. It is critically important to include this dataset in the review and recommendations for the "food ingestion" pathways. The key study identified in the current recommendations for several food categories is from a dataset that is 12+ years old. Again, it is critical that EPA wait to get this dataset and not move forward with the current document without these. In addition, the Leland Center and the Health Effects Institute together funded research on the Relationship between Indoor, Outdoor and Personal Air (RIOPA). These studies included measurements of air exchange rates. The Health and Environmental Sciences Institute (HESI) Exposure Factors database (http://www.hesiglobal.org/NR/rdonlyres/EED82508-73D3-4405-A123-2E3BD5DCEB7A/0/HESIExposureData10Aug04.zip) provides ready access to mouthing data in a common downloadable format. Also, the ExpoFacts database (http://cem.jrc.it/expofacts) is another useful source.
Lebowitz	Yes, many, as I provided and inferred in my reviews of other chapters; also see response in the next paragraph.
Lobscheid	I would like to describe one publicly available data source that may be useful, i.e., the California Statewide Residential Appliance Saturation Study (RASS) (CEC, 2004) may be a useful. The RASS may be a Relevant study to include data in future revisions to the EFH. The RASS was initiated in 2002 and surveyed nearly 22,000 respondents/households. I would not recommend it as a Key study because it is not representative of the US population and the low survey response rate (19% vs the expected 47% to the initial mail-solicitation; a non-response follow-up study conducted by telephone had a response rate of roughly 45%). Additionally, the selection of households was weighted to the population represented by the sponsoring utilities. The RASS database includes linked data on the following residential and household characteristics that may be useful to describe and incorporate in Chap 16 (Activity factors), 17 (Consumer products), and 19 (Residential Building Characteristics) of future EFH revisions. **<u>For Chapter 16 (Activity Factors):</u>** Length of time household living at current residence Whether residence is "partial-year" or vacation home Cooking frequency of household during week (breakfast, lunch, and dinner, and other separately) Presence of swimming pool at residence

<u>For Chapter 17 (Consumer products):</u>

Presence of microwave oven

Presence of dishwasher and frequency of use

<u>For Chapter 19</u>:

Type of building (Single family detached home and number of stories, Townhouse/Duplex/row house, apartment or condominium (2-4 units), apartment or condominium (5+ units), mobile home, and other)

Year residence built

Bedrooms in home

Square feet of living space (including bathrooms, foyers, and hallways)

Whether exterior walls are insulated

Whether home's attic/ceiling insulated

Presence of Double and/or single pane windows

Household occupancy and age of household occupants

Whether natural gas line or hook-up to any part of home

Type of heating system used in home

Presence of pilot light if natural gas used for fuel,

Type of fuel used for cooking appliances (cooktops/stovetops/range, or oven, or outdoor barbeque) and age of appliance

Additionally, the following Household information is included for each household/residence in RASS, including:

- Highest level of education by any head of household
- Primary language spoken in home
- Any occupants that are permanently disabled
- Ethnic groups represented by head of household
- Household's total annual income

The Reference for the RASS is:

	CEC (2004). California Statewide Residential Appliance Saturation Study (RASS). Final Report, June 2004. Prepared by KEMA-XENERGY, Itron, and RoperASW under Contract No. 400-04-009 with the California Energy Commission (CEC). Report and data available for download at: http://www.energy.ca.gov/appliances/rass/. Additional Information on the RASS can be obtained by contacting Glen Sharp, the Project Manager at the California Energy Commission (CEC). His contact information is provided at the bottom of the RASS website (listed above)
Ryan	I have mentioned a few studies in my general comments on the specific chapters given below. I do have some concern that large-scale investigations such as NHANES, which gather at least some data on some factors, have not been a central focus. Further, I am concerned that some of the data used in developing the factors is now becoming a bit long in the tooth. Are intake factors, body-size factors, etc., that were developed based on data from the late 1980s and early 1990s still valid in today's society? The growth in obesity in the American populace has accelerated substantially since then and should be reflected in any new Exposure Factors Handbook. However, such data may not be readily available at this point. If that is the case, readers and users should be cautioned somehow, perhaps in the Introduction, about the validity of such factors.
Stern	I believe that there are relevant data sources available for Chapter 10 (Intake of Fish and Shellfish) that have not been cited and discussed: 1. Stern AH et al., (1996). Estimation of fish consumption and methylmercury intake in the New Jersey population. J Exposure Assessment Environ Epidemiol. 6:503-525. 2. Mahaffey KR et al. (2009). Adult women's blood mercury concentrations vary regionally in the United States: association with patterns of fish consumption (NHANES 1999-2004). Environ Health Perspect 117(1):47-53. Stern et al. (1996) provides data on frequency of fish consumption and portion size in the general population in New Jersey based on a telephone survey of 1,000 households. In addition to asking species-specific information on fish consumption over the previous 7 days, the survey also asked about the usual frequency of fish consumption. This allowed for the identification of infrequent (and frequent) consumers and thus, statistical re-weighting of the data to account for the under-representation of the consumption patterns of infrequent consumers. Mahaffey et al. (2009) provides data from the NHANES study of regional patterns of fish consumption. These data would be very useful to exposure assessors for refining the overall national estimates provided in the summary recommendations of the EFH.
Tran	See response to question 14
Zaleski	When aware of additional data sources, these are pointed out under chapter specific information.

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

Anderson	In my four focus chapters (3, 6, 10, 15) the key studies appear to probably be the best available data. What is missing in either the introduction or in the individual chapters is a description of how the authors searched for studies to review (did they use key words in Google, in Pub med or Medline etc?) It would be most useful to know how many studies they identified and reviewed and which were not included in the "relevant" listing and why. If there were thousands of papers reviewed, the reader needs to know that. Much time can be saved by Handbook users if they can be confident that the author team did an exhaustive review of the literature, systematically assessed and evaluated each study and what is in the Handbook are the best available and that the user would have little to gain by doing their own literature search. But as the Handbook currently stands, what or how the authors collected data is unclear. In all of these chapters, the confidence ratings are provided for the key study, but there are no ratings for the "relevant" studies described. These are not ranked in any way and it can not be determined if they would be higher rated than the key study, if only for a more targeted population. So while the summaries of the relevant studies are informative, and there is some discussion of some of the evaluation criteria, it is up to the reader to decide for themselves. The "relevant" studies are listed in chronological publication order with the oldest listed first. I would suggest that ordering them in the reverse order, with the most current first would make more sense. Or order them by recommended rank. In all the chapters the tables are focused upon age groups, which are dominated by narrow band child groups. It would be helpful in each chapter to mention what other characteristics significantly impact the values obtained, but are not included in the prime tables. Do males and females consume the same amount of water so gender does not need to be assessed or incorporated into the factors? The key study table would suggest that because gender is not included. In the water chapter it is not until table 29 that gender first appears and sporadically after that. If one wants gender information, it is quite a search effort. In the water ingestion chapter 3, three key studies are used independently for general water, pregnant and lactating women water ingestion, and swimming water ingestion. These three scenarios are sufficiently discrete that deriving factors separately makes sense. While the publication date of the general water key study (2008) makes it seem current, in reality it is a reanalysis of data from 1994-96 and 1998, well more than a decade old. While water consumption is driven mostly by physiological need, the availability and marketing of bottled water has increased significantly over that time. The Chapter 6, inhalation rate chapter combines the data from several studies into the primary one tables and indicates that means were obtained from a combination of the studies. It is not possible to reconstruct how the data were combined in the table and there is little discussion about how the studies were sufficiently similar to do a "meta analysis." As in chapter 3 males and females are combined. It is unclear if this is because the underlying data did not provide gender specific data or that it just couldn't be put in the table or the differences were unimportant. While it is understandable why the data in table 6-1 is in meter cubed per day rate and table 6-2 in meter cubed per minute, the different

	measures are a bit confusing. It would be helpful if in the text it could mention which tables can provide gender specific rates so someone desiring such information can go right to those tables. Although in general the table titles are very informative and helpful. Chapter 10, fish intake uses data from the 1994-96, 98 study, which is outdated. While there are many "relevant" studies mentioned and summarized, it does not appear that any current studies have been considered. I believe there have been some recent publications using the NHANES data that might be considered. There are also many studies that include fish consumption correlation with specific human chemical biomarker data. So much is known about contaminants in fish, that a general consumption rate is a poor indicator of many exposures, which are what the exposure assessor is using – combining consumption with contamination. While the early study is probably adequate for general information, much has changed, even though it does not appear that overall total fish and shellfish consumption changed over the years they reviewed. The species of fish consumed has changed especially since the rapid growth of farmed fish and shellfish. It would be helpful if the annual commercial sales of fish were provided so commercial distribution can be appreciated as well as the increasing amount. The general fish consumption tables provided are probably not very useful to the exposure assessor as combining wild caught fin fish with farmed fish, with shell fish and then implying specific contaminant or even nutrient exposure is pretty gross as shrimp and squid are quite different from swordfish, tuna or farmed catfish. Chapter 15, Human milk consumption combines several different studies into the table for breastfed infants. This chapter is a challenge because of the paucity of data. But it is valuable to include. I am not familiar with this literature, but it appears that nearly all the data used is quite old, some of it over 30 years. Since so many different studies are utilized, it is difficult to assess the confidence in each study. Was a minimum threshold needed to include a study in the composite? It would be very hard for a user to duplicate the data in the tables from the source documents. More method detail description is needed.
Beamer	In general the studies designated as key were appropriate, however it was difficult to determine sometimes why some studies were classified as relevant. It would be helpful at the end of each study to have a statement that qualifies their classification. For Chapter 4, the studies designated as key for mouthing frequencies are appropriate. They have already been included in formal meta-analyses that was used to develop the recommendations for this factor. It is not clear why certain studies were determined to be relevant and not key for mouthing duration. For example, Zartarian et al., 1998, AuYeung et al., 2004, and Beamer et al., 2008 all use the same methodologies with very high QA/QC methods although they are not mentioned, but yet only Beamer et al., 2008 was considered key. Although there is probably a very legitimate reason why those studies were determined to be relevant instead of key, this is not clarified in the current text. Chapter 5 represents a very complicated exposure factor: soil and dust ingestion. Key studies utilized several indirect methodologies to estimate this factor. This chapter provides a very nice section of limitations of methods not present in other chapters, that can really aid the reader to determine sources of error. The key studies presented here are

	the most appropriate as they provide the most complete mass balance approach. For Chapter 7, selection of the US EPA study on body surface area as the key study is appropriate. It provides a synthesis of many methods applied to a representative sample of the US population. Again it is not clear however, why certain studies were key and others relevant for Section 7.4. I could justify it, because the key studies were based on actual activities while the others were soil contact trials. However, this should be more explicit to the reader. For Chapter 16, the key studies provide the largest datasets representative of different age groups and the US population. They are supported by the relevant studies, but it is clear why they are selected as key.
Bennett	Chapter 5: I agree with the key studies. Chapter 17: This question is not applicable to Chapter 17 as key studies were not selected. Chapter 18: The selection of key studies is appropriate. Chapter 19: This question is not applicable to Chapter 17 as key studies were not selected.
Ferguson	A key study is defined as the 'most useful for deriving exposure factors' (definition by EPA in Chapter 1). There is some amount of subjectivity in that definition. Currently, it is mostly based on the identified attributes and confidence ratings used to select studies. However, one more attribute to judge a study is how often the data is used to make exposure calculations in the exposure field. Of course this might require tracking down a lot more data, and usage of data. However, this is something to consider in the future. In the glossary (G-7), you define a key study as ..“A study that is useful for deriving exposure factors”. That fits the definition of a relevant study also. Consider expanding the definition for key study as defined in the main document. Please see other specific comments below for each chapter.
Finley	**My comments here apply to Chapter 3, the “Water Ingestion” chapter** **Comment #1:** I was a little confused by the presentation of “per capita” vs. “consumer only” intake rates that appear separately in many of the tables, including the tables that contain the “recommended rates”. It appears the “per capita” data represent the results of surveyed individuals whether or not they consumed any “source water” during the survey, while the “consumer only” data presumably represent intake rates of only those individuals who consumed source water during the survey. Assuming this is true, I should note that neither of these “definitions” seems to appear in either the text (pages 3-1 and 3-2) or the tables (Tables 3-1 and 3-3) that describe the recommended ingestion rates for community water. The definition of these terms should appear in Section 3.2.

It is also unclear why these data (per capita vs. consumer) are presented separately as recommended rates. I didn't find any discussion as to the merits of one vs. the other. Since the "consumer only" rates are consistently higher than the "per capita" rates across all age groups, some discussion regarding this matter is warranted. It is unclear to me how a practicing risk assessor would/should make a distinction between these two rates, regardless of the site-specific conditions under evaluation. Since these are recall data, I would assume the "consumer only" rates are probably more accurate(?), yet the text in the "Recommendations" section (3.2) seems to emphasize the per capita rates.

Comment #2 In several of the data tables, it is noted that, for select data, "Sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States"*. The meaning and purpose of this notation, and how it is to be interpreted by the exposure assessor, is unclear to me.

Comment #3 I did not see any estimates of private well water consumption rates. Risk assessors often must evaluate actual (current) or potential (future) exposures via well water. In those regions where the well water is potable, should the assessor simply assume the direct and indirect consumption rates that the EFH recommends for community water? Is there any reason to believe that well water consumption rates would be significantly different from those estimated for community water?

Comment #4: I note that the EFH recommends consumption rates for water ingested while swimming. Does ingestion while showering occur to a degree that warrants consideration?

Comment #5: In the fish ingestion chapter, the EFH discusses the potential effects of cooking on contaminant loss/increase in fish tissue. In a situation where the tapwater contaminant is a volatile compound, should loss while cooking (and potential subsequent inhalation) be considered?

My comments here apply to Chapter 7, the "Dermal Exposure Factors" chapter.

Comment #1: There is relatively little discussion of soil properties and how they might influence the degree to which soil adheres to skin. Perhaps this is beyond the scope of the EFH. If not, then I think it would be helpful to discuss soil particle size and organic content to the extent that it relates (or doesn't) to dermal adherence rates and how these factors should be considered (quantitatively) by the risk assessor.

Comment #2-While it may be beyond the scope of the EFH, there is no discussion of what I will refer to as the "monolayer" question. Common sense dictates that more "mud" is likely to adhere to skin than "dry soil" (per unit area of skin), and this is indeed reflected in the results presented in Chapter 7. The question is how much of this solid matrix (in terms of thickness) is actually capable of delivering contaminants to the skin surface? For example, is it known whether any or all of the published adherence rates indicate total coverage of the skin? Are some of the higher adherence factors actually measuring soil that is in contact with an underlying film of more soil instead of skin? If so, would one expect the uppermost layer of soil particles to actually deliver contaminants to the skin surface?

Comment #3-I found the discussion of "advantages" vs. "disadvantages" for each of the

	key studies to be highly informative. **Comment #4:** Similar to a comment I have on indoor dust ingestion rates: assuming the primary purpose of assessing indoor dust exposure is to determine the risks posed by contaminated soils outdoors, isn't it critical to understand how much of the indoor dust is actually comprised of soil? And if so, should this be taken into account (via a modification factor, perhaps) when using the indoor dust adherence rates recommended in this chapter? **Comment #5-**On page 7-2, first full paragraph, it is noted that "soil can get under clothing" and that assessors should "consider this possibility for the scenario of concern and select skin areas that are judged appropriate". However, it is not clear whether any of the adherence rates presented in Chapter 7 reflect soil adherence measured on unexposed (clothed) skin. Presumably, less soil would adhere clothed skin (?). It is also unclear whether the effects of "occlusion" (possibly increased dermal penetration by contaminants) should be considered for clothed skin. Some clarification would be helpful. **Comment #6-**On page 7-2, second full paragraph, it is noted that "insufficient data were available to develop distributions of probability functions for these values". I'm not sure I agree, and it is not clear whether any actual decision-making criteria have been applied to reach this conclusion. At the least, it would seem that there is more than sufficient data to develop distributions for age-specific skin surface areas. As noted on page 7-12, distributions have been published by Murray and Burmaster (1992) and Phillips et al (1993). **Comment #7-** The first paragraph of Chapter 7 indicates that "this chapter focuses on adherence of solids to skin". Yet in a few places in this chapter reference is made to "liquids" in contact with the skin, such as the first full paragraph on page 7-2 ("Liquids may soak through clothing an contact covered areas of skin"). It is therefore unclear whether this chapter is intended to provide guidance on dermal contact with liquids or whether the critical information for doing so is presented elsewhere in the EFH.
Gaylor	The selection of key studies appears to be appropriate for assigned Chapters 6, 8, and 18.
Georgopoulos	Answers are given in responses for individual chapters; it can be stated, however, that the selection of "key" studies has been generally appropriate.
Guiseppi-Elie	The key study identified for the ingestion of water (Chapter 3) and food (Chapters 11, 12, 13, and 14) all have their basis in the 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII). While there have been more recent analyses of the data (e.g., water in 2008), the basis EPA self identified the National Health and Nutrition Examination Survey (NHANES) "What We Eat in America" study. It is critically important to include this dataset in the review and recommendations for the "food ingestion" pathways. EPA should wait for access/evaluation of this dataset and not move forward with the current document without

	these. In Chapter 3, the recommendations for water ingestion while swimming is based on one recent study. The confidence in the study is appropriately rated as low based on numerous uncertainties. Chapter 4 on Mouthing behaviors (frequency and duration), the key studies appeared to be appropriate, however, the confidence around the recommendations were low because current state of the science in this field is limited. Chapter 19 on Residential Characteristics did not identify key studies.
Lebowitz	I did comment, and found their selection rather strange. Their methods of selection are doubtful and their characterizations of uncertainty lack a clear understanding of the literature. Further, they ignored some of the really best data and sources of information in those I reviewed, including some of those used by other components of EPA using similar general criteria.
Lobscheid	The initial definition of "Key" studies in Section 1.4 (Selection of Studies for the Handbook) is unclear, i..e. "Certain studies described in this handbook are designated as "key", that is, the most useful for deriving exposure factors". Specifically, the term "most useful" is very unclear. Suggest providing the following sentence to define what makes a study "key": " Key studies have high confidence ratings based on the specific criteria that make up each of the five General Assessment Factors (described in Section 1.4.1)" Additionally, I suggest appending Section 1.4.1 (General Assessment Factors) to Section 1.4. That is, describe General Assessment Factors as the basis for selecting "key" studies in Section 1.4 and renumber the subsequent section, i.e., Section 1.4.2 (Selection Criteria) as Section 1.4.1) Chapter-specific comments (for Chapters 9, 12, 13, 14, and 15) on studies that have been identified as "Key" are provided below. **<u>Chapter 9: Intake of Fruits and Vegetables</u>** In Table 9-2, page 9-4, the Rating for **"Variability and Uncertainty"** GAF should be "low- for individual fruits and vegetables" and "High- for total fruits and vegetables". This is due to the fact that full distributions were provided for total fruits and vegetables, but it appears that only the means were given for individual fruits and vegetables. This doesn't change the "Overall rating" however, of the recommendation based on the EPA analysis of the CSFII 1994-96, 1998. It is not clear why the age-groups in Table 9-7 through 9-11, based on US EPA's analyses of the 1994-96 CSFII, differ from the age groups of Tables 9-3 to 9-6 (based on US EPA's analyses of the 1994-96, 1998 CSFII). An explanation for why the age groups

differ should be provided in Section 9.3.1.1.

In the future, I suggest that the total fruit and vegetable intake (Chapter 9) be revised to conform to the EPA's life-stages and assess the variability by the age distribution of the population.

<u>Chapter 12: Intake of Grain Products</u>

In Table 12-2: suggest that the confidence in the **"Variability and Uncertainty"** be listed as "High- for total grains", but "low- for individual grain products". This is due to the availability of the full distributions for total grains, but only means were documented for individual grain products. This doesn't change the "Overall rating" however, of the recommendation based on the EPA analysis of the CSFII 1994-96, 1998.

As with "Chapter 9- Intake of Fruits and Vegetables", it is not clear why the age-groups based on the 1994-1996 CSFII (in Tables 12-7 to 12-14) differ from the age groups in Tables 12-3 to 12-6 (all of these based on US EPA's analyses of the 1994-96, 1998 CSFII). An explanation for why the age groups differ should be provided in Section 12.3.1.1.

In the future, I suggest that the total grain intake (Chapter 12) be revised to conform to the EPA's life-stages and assess the variability by the age distribution of the population.

<u>Chapter 13: Intake of Home-Produced Foods.</u>

The US EPA's analysis of the NFCS 1987-1988 is the Key study provided for the intake of home-produced foods.

However, the data from the 1987-1988 National Food Consumption Survey (NFCS) are over 20 years old and are dated for assessing current intake of home-produced foods. In Section 13.3.1, page 13-7, the EFH states that "intake rates of home-produced foods are higher among populations in non-metropolitan and suburban areas and lowest in central city areas". However, this geographical trend in home-produced foods has likely shifted somewhat , or at least become more prevalent in central-city areas, since the 1987-1988 NFCS was conducted. The 2009 National Gardening Association Report on The Impact of home and Community Gardening states that "43 million US households plan to grow their own fruits, vegetables, berries and herbs in 2009- …up 19% from 36 million households in 2008."Althouth the National Gardening Association (2009) Survey, conducted in 2008, is much more recent, but unfortunately it does not contain any home-grown food intake values. It is useful as a Relevant study, however. I think that including additional characteristics (in addition to those listed in Table 13-70) of food gardeners would be helpful, including collecting data on the prevalence of food gardening by Urbanization, and ethnicity. Data is available on the prevalence of home-gardening by US Census Region in the 2009 National Gardening Association report, but the following information is not currently included in Table 13-70 of the EFH:

US Census Region	% of all home-grown gardening households
Northeast	22%
Midwest	26%
South	29%
West	23%

Chapter 14: Total Food Intake

There is only one Key study- the US EPA's analysis of the CSFII 1994-96, 1998. N relevant studies are provided for total food intake. Unfortunately, this data source is 11-15 years, and therefore the total food intake values may not represent the current trends in food intake (e.g., food intake patterns resulting in the prevalence of obesity).

Unfortunately, there is no information on variability within the general population on any factor besides age. Inclusion or re-analysis of the data based on other factors that may describe total food intake of specific food categories, would be useful (such as by the "region", "urbanization", and "ethnicity"factors that are provided in Chapter 9 Intake of Fruit and Vegetables and Chapter 12 Intake of grain products). Because the data source is the 1994-96, 1998 CSFII which was also used to estimate total fruit an vegetable intake (Chapter 9) and total grain intake (Chapter 12), the total per-capita food intake may also be re-analyzed and reported based on additional spatial and demographic variables.

In the future, I suggest that the analysis of total food intake (Chapter 14) be re-analyzed to conform to the US EPA's life-stages (i.e., new childhood age categories).

Chapter 15: Human Milk Intake

There is a lot of data and information provided in this chapter related to human milk intake, but most of the Key studies, with the exception of Arcus-Arth et al (2005) and Butte et al (2000), are nearly, or in most cases more than, 20 years old. Additionally, the fact that Arcus-Arth et al (2005) included populations from Sweden and Finland makes their data less representative of average daily milk and lipid intake by infants in the US population. I think that these two factors (not entirely representative of the US infant population and dated studies) makes the **"Applicability and Utility"** of the key studies closer to a "Low" rating than a "Medium" Rating.

Additionally, because the Mitoulas et al (2002) and Mitoulas et al (2003) data were collected in Australia, I think it is questionable in terms of representatives to the US population to include these data in Section 15.4.2 and 15.4.3, respectively. Consider placing these in Section 15.5..1- Relevant Studies on Lipid Intake from Human Milk", instead.

Consider including baby formula intake here too (in addition to Chapter 3- “Ingestion of Water and Other Select Liquids”) so that all infant food intake would be in one succinct chapter. If this is done in future revision, than I suggest changing the title of Chapter 15 from “Human Milk Intake” to “ “Infant Intake of Human Milk, Lipids, and Formula.” In any case the latter title is more descriptive of all the exposure factor information contained in this chapter currently, even without inclusion of the additional formula information from Chapter 3.

Lastly, I think it is worth considering placing Chapter 15 solely in the Child Specific EFH and not in the EFH and noting in Chapter 14 (Total Food Intake) that the infant diet in terms of human milk, lipids and formula is included as Chapter 15 of the EPA’s CSEFH (2008). If Chapter 15 remains in the EFH it is still worth noting that the infant diet, in terms of human milk, lipids and formula is presented in Chapter 15 (of the EFH)..

<u>Chapter 19 Residential Building Characteristics</u>

There are no explicitly “Key” studies, only four recommended studies for characterizing the volume of residence and four studies describing the air exchange rate. Are these “Key” Studies? If they are, then they should be referred to as such in future revisions of the EFH. The recommended value for House volume is provided by the 2005 RECS survey data (US DOE, 2005), and the recommended central estimate value for housing volume was based on the 2007 American Housing Survey (US BoC, 2008). But the PFT database (Versar, 1990) contains potentially outdated (1982-1987) measurements, and there has been an increase in housing volume since the data were collected, so the “currency” of the PFT database is questionable. Fortunately, the **“Applicability and Utility”** GAF takes this into account, and a “Medium” rating is provided. Also, please include under “Currency” that data from the 2007 American Housing Survey was used.

Additionally, in Table 19-2, associated with the **“Uncertainty”** GAF for “House Volume”, the Rationale states:

“Some measurement error may exist since surface areas were estimated using the assumption of 8 ft. ceiling height” but, this appears to contradict the Rationale under the **“Adequacy of Approach”** that states :

“For the RECS survey, volumes were estimated assuming an 8 ft ceiling height. The effect of this assumption has been tested by Murray (1996) and found to be insignificant.”

Therefore, I suggest changing the Rating for the **“Variability and Uncertainty”** GAF to High.

In Table 19-3: I believe that the confidence rating for the **“Soundness”** and **“Applicability and Utility”** GAFs on the Air Exchange Recommendations should be “Low”. The reasons for this are as follows:

1) The “Adequacy of the Approach” had major limitations (uniform mixing

	assumption) and the residences were not selected at random. 2) The residences in the PFT were not representative of residences in the US and included homes that were not randomly selected. 3) The measurement in the PFT database were taken over 20 years ago and only short term data were collected Additionally, in Table 19-3: The "Rationale" associated with the **"Variability in Population"** GAF should be moved to the "Rationale" associated with the **"Representativeness"** GAF, i.e., append "because some of the sample sizes for the subcategories were small and not representative of the US, the utility is limited" to "Representativeness" rationale, and restate the Rationale for **"Variability in the Population"** to: "Distributions are presented by US Census Regions, seasons, and climatic regions, but some of the sample sizes for the subcategories were small." Also, In Table 19-3, I suggest including the following as part of the "Rationale" for characterizing the **Uncertainty** GAF: "Some measurement error may exist. <u>Additionally, PFT has been found to underpredict seasonal average air exchange by 20 to 30 percent (Sherman, 1989)."</u> Lastly, in terms of presentation, I suggest moving Section 19.3.1.4 US Census Bureau, 2008- AHS for the US 2007 as Section 19.3.1.1 instead. The AHS is the most current study and the basis for the recommended volume of residences (in Table 19-1). Additionally, move Section 19.3.1.3US DOE, 2005- RECS description second (as Section 19.3.1.2) because it is the second most current study, and also because the Murray (1996) study (currently Section 19.3.1.2) reference the RECS study.
Ryan	This had been done below in the discussion relevant to each chapter for review. I will not repeat that discussion here. My comment on this focuses on the specific nature of several of the studies that are listed as "key." A study of one specific age group, a specific location, or exposures under a specific exposure profile, do not adequately represent population statistics. I was actually surprised to see certain studies listed as key based on this concern. While such a study would certainly be key if the population for which the factors are needed matches well with the study at hand, it may not be key for another. For example, several of the "key" or "relevant" studies focus on a large-scale investigation- some 3000+ individuals- which is good, but the study looked only at children, obviously giving little insight into adult consumption levels. The study selected is excellent, but it is not "key" for an individual exploring the EFH for information on an elderly population consuming garden-grown vegetables in the shadow of a power plant, or an urban population of adults in general. Proper caveats should be placed on the selection criteria for key studies reflecting the focus of such a study.
Stern	<u>Chap. 4</u> - The studies chosen for the recommended values for hand-to-mouth frequency, object-to-mouth frequency, and duration appear to be reasonable choices (although as noted in my response to question 1, the meaning of "duration" here in ambiguous).

	However, there is no explicit explanation of why some key studies were used for the recommended values and others were not. Chap. 5 - Table 5-1 does not indicate how the key studies were used to derive the recommended values. There is no citation for any of the individual values or of the recommendations a whole. Chap. 10 - The use of the CSFII data as the basis for the recommended values for general population fish intake is questionable. This is a 2-day survey and, as such, over-represents the consumption patterns of frequent consumers and under-represents the patterns of infrequent consumers. There are no data internal to that database that can be used to re-weight the data to compensate for this. Furthermore, the CSFII data are up to 15 years old. Although the text states, on the basis of comparison of the 1994-96 CSFII to CSFII data from the 1970's. that fish consumption did not appear to change significantly over that period, there is reason to believe that both fish consumption advisories and information on the beneficial effects of fish consumption may have significantly changed fish consumption patterns in the intervening 15 years. In addition (and as above) it should be pointed out that Table 10-1 (the recommended values for general population fish consumption) does not provide the source of the data for those recommendations. The reader has to consult Table 10-2 to get that information. Chap. 15 - The key studies are in good agreement with respect both to the mean and upper percentile estimates, The experimental method is direct and (as pointed out in the text) there is likely to be little variation by ethnicity or location in babies' breast milk intake. Thus, representativeness is less of an issue here than for other exposure parameters. Chap. 19 - Given the wide range of variability in both the effective volume of residences and their air exchange rates, it is not clear that a single recommended value for each of these parameters can be useful when dealing with specific exposures in specific populations. The residential volume studies appear to be based on clear and direct data. The studies of air exchange rates appear to carry significant uncertainty due to methodological uncertainties, geographic/climatic variability, and temporal variability in household activities that can affect the air exchange rate.
Tran	The CSFII 94-96, 98 is the key data source for the dietary factors in chapters 9, 11, 12 and 14. It is recognized that EPA is in the process of but has not completed updating its food commodity intake database (FCID) for the more recent NHANES data release (i.e. NHANES 03-06); therefore, it cannot yet analyze the more current NHANES data to develop food intake at the commodity level for purpose of updating the EFH. For this reason, the previous analysis of the older consumption dataset, mainly the CSFII 94-96, 98, is included in the current EFH update. However, it should be noted that not only there has been changes in food pattern/intake rates since the CSFII 94-96, 98, but there has also been significant changes in the types of food products available in the marketplace and consumed today than from a decade ago. This is evident by the fact that there are more than 700 new food codes in the NHANES 03-06 database that were not in the CSFII 94-96, 98. Hence relying on the more than 10 yr old consumption data has limitations. Further, it is noted in the charge to this peer review that the EPA FCID update will be

	available in May 2010. Thus, by the time the EFH update is peer-reviewed/finalized, the recommended dietary factors based on the CSFII 94-96, 98 as presented in the current revision of the EFH would be completely outdated.
Zaleski	Any comments on key studies are noted below by chapter.

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

Anderson	Considerable attention is given to the confidence rating methodology in the introduction and elsewhere. And it is hard to disagree with the selected variables. These are all valuable components of confidence in the data. But in reality applying the final construct is left to "expert opinion" and judgment of the authors. What was missing in the chapters that I reviewed in depth was a confidence rating for all the studies summarized. The only confidence rating provided was for the single "key" study. The confidence rating would be valuable if it can be used to compare multiple data sources, not simply describe the final selection. Were any of the other studies found to be stronger than the one study, but just not across the board? How many of the data sources were given ratings? Were the ratings used to select the "key" study and did that study stand out from the rest evaluated, or were there multiple studies with the same ratings and the one selected determined to be of broader applicability? Since most exposure assessments done are probably more local than "national" a regional or more local data set might have a higher overall confidence rating than the general population "key" study as long as the assessment is relevant to the area covered. Unfortunately, the confidence rating schema was not applied to all the "relevant" studies summarized. And there is no information on whether what is discussed as relevant includes all studies found or only those that met a certain threshold of confidence. What a handbook user wants to know is whether it is worthwhile doing their own literature search and review because the handbook only contains a small proportion of the available data sources or whether the authors did an exhaustive search and review and have included all the data that might be relevant for an assessor to use.
Beamer	They do seem to provide a clear rationale. However, they do not seem to be applied similarly across studies or chapters. A more clearly defined rubric or numeric system may need to be developed to provide more consistency across factors. For example, the rationale does not seem to be similarly applied between Table 4-2 and Table 7-5, in particular for the soundness and clarity sections. While both of these methods provide adequate values, they both are based on small sample sizes. Similarly the studies used for activity patterns (Table 16-2) were based on memory recall, which would be difficult to accept as having a "Soundness" of "High." Memory recall interviews have a high potential for bias, compared to diary entry. "Medium" would seem more in line with the other chapters. Also in Table 16-2 it not clear from the ratings on that table why we should have a "low" confidence in the upper percentiles as every section is rated "High" or "Medium".
Bennett	For the most part the confidence ratings are clear. In the introduction, it is noted that the EPA does not weight each topic area equally and uses best scientific judgment when determining the overall rating. It would be nice if in a footnote below each confidence

	table if a sentence could be included that outlined the rational for the overall confidence rating.
Ferguson	In general the confidence ratings to select studies and rate factors provide a clear rationale and reflect the disadvantages and/or limitations of the studies. Please see comments on each study below. I feel in some cases, if resources allowed, EPA could contact some of the study authors to determine some factors necessary for improving the confidence ratings, such as quality assurance and methodologies used.
Finley	The confidence ratings are fairly subjective but I find that the EFH does a very thorough job of delineating how and why the confidence ratings were assigned. While I find the explanations informative, I think it is unlikely that the confidence ratings will have much impact on the choice of exposure factors.
Gaylor	The confidence ratings used to select studies and exposure rate factors reflect the advantages and/or limitations of the choices. Some consideration should be given to the use of confidence intervals for estimates of central tendency in order to indicate their precision for various studies.
Georgopoulos	Given the general status of data specific to exposure factors, the current confidence ratings appear to be a reasonable approach. A quantitative characterization of confidence in specific exposure factors is not possible for the majority of currently available data sets. Incorporating recommendations for future collection of information that would allow calculation of specific quantitative confidence metrics, can enhance the design of new data collection studies.
Guiseppi-Elie	For the most part, the categories of factors used to are appropriate. There can be legitimate disagreement on the interpretation of the merit of a study in any of these regards. For the food ingestion chapters that I reviewed, my particular concern was the rating of medium to high in some with the use of 12+ year old data that could have changed more recently. Also, while this dataset had a large population, when broken into individual age bins, these numbers decrease sometimes dramatically to the extent that they did not meet minimum requirements but were still used. My suggestion is to refrain from using data beyond its limits (even with footnoted caveats as these can often be ignored). A combination of quantitative and qualitative narrative should be used as appropriate.
Lebowitz	No, they don't – see last comments.
Lobscheid	My comments are focused on the description of the Confidence Ratings in Section 1.4.2- Selection Criteria (page 1-3 to 1-4) and Section 1.5- Approach Used to Develop Recommendations for Exposure Factors (p 1-5 to 1-6). I offer these suggestions to make the confidence ratings more clear. I think that the Table at the beginning of each chapter Summarizing the Confidence in the Key studies, by GAF, is helpful and succinctly

summarizes the important criteria of all the key studies for assessing specific exposures to the population and sub-populations.

"Currency of information" on page 1-3 refers to studies that use the most recent practices or techniques to assess the exposure factor. Please consider rephrasing "currency of information" to "Temporal Representativess"

Additionally, in Table 1-2, on page 1-19 , under "Applicability and Utility", I suggest the following changes:

- "Representativeness" to "Population Representativness"
- "Currency" to "Temporal Representativeness"

On Page 1-4, in the section on "Variability in the Population", in addition to referring to Section 1.5.1, please refer to additional information on variability found in Chapter 2 of the EFH.

On Page 1-4: the section on "Uncertainty" is without a formal definition of Uncertainty. Consider including a definition and/or referring to Section 1.5 and Chapter 2 for further discussion on Uncertainty.

Section 1.5 is a description of the procedure used to assign recommendation for Key Studies. Therefore, "(2) Single versus Multiple Key Studies" should instead describe an action taken as part of the procedure, i.e., "(2) Selection of one or Multiple Studies". Likewise, instead of

"(3) Variability" consider replacing with "(3) Assess Variability"

"(4) Uncertainty" consider "(4) Assess Uncertainty"

"(5) Confidence Ratings" consider replacing with "(5) Assign Confidence Ratings".

In Table 1-1, it is misleading to state that this table characterizes variability in all the listed exposure factors, considering that some of the exposure factors, such as soil adherence, time indoors, time outdoors, and life expectancy, only have average values from key studies checked. This table provides information on the descriptive statistics available from the key studies for each exposure factor. Consider including a column for whether the standard error or standard deviation is also provided/available. Also, consider including another column for "Lower percentile (s)" because it is misleading to have volume of resident and air exchange rate "checked" for "upper percentile", when only the lower percentile is provided.

Consider renaming Table 1-2 from "Considerations used to rate confidence in recommended values" to "Criteria used to…." Additionally, associated with "Accessibility", consider rephrasing "The study data could be accessed." to "The study data is publicly available"

The column headers in "Table 1-2" could be more clearly stated. Instead of "Increasing Confidence", suggest ""Factors that Increase Confidence" and likewise, instead of

	“Decreasing Confidence” suggest “Factors that Decrease Confidence
Ryan	The confidence ratings are explained adequately in the Introduction. However, I find their implementation a bit odd. In particular, the explanation states that even if all parts of the rating are deemed, say, “High” the overall rating may be lower due to the lack of applicability. This really needs to be clarified. I would guess that such a rating would apply if the data collected were for a different population, a non-representative population, or some such and that is appropriate. However, would this not affect the assessment of, say, variability (see below) and thus call the data into at least some question.
Stern	I did not find the categories used to generate the confidence ratings particularly useful. They seemed more geared to generating a ranking than to explaining the strengths and limitations of the data. Some of the categories were not really relevant to the data at hand. For example, in the Confidence summary for chapter 10 (Fish and Shellfish Consumption), the response to the “Currency” category was “The most current CSFIII 1994-98 data were used.” The relevant fact here is not that the most recent CSFII data were used, but that the most recent data from the CSFII study is more than 12 years old. I think that a narrative discussing the how the key studies addressed the intended use of the data would be more appropriate.
Tran	The key study for the dietary factors in chapters 9, 11, 12, and 14 are the CSFII 94-96, 98. • It may be more appropriate to rate the “applicability and utility“ factor as low rather than medium due to the age of the data (1994-96) and per the above comment. • For the “variability an uncertainty” factor: in the discussion of the data from Smiciklas-Wright et al 2002, it was noted that recipes not provided by respondents of CSFII 94-96 for mixed foods and that standard recipes were used to determine the components of mixed foods and thus there is uncertainty associated with component food intake rates from this study. This source uncertainty (recipe uncertainty) is also true with the translation from 8-digit food codes to food commodity ingredient level (e.g. deriving the beef portion in a beef stew). This is a source of uncertainty that should be noted in the confidence/data quality summary table.
Zaleski	In general the parameters considered to develop confidence ratings are appropriate. However, for some factors confidence in a study is assessed, but that does not necessarily correlate with the confidence in the data as presented. For example, some studies may have an adequate overall sample size, but when data are broken into smaller subcategories by age and gender, sample size may be very limited. The current approach does not adequately address these cases. For example, in Table 3-2 the drinking water ingestion study is rated medium to high, but in Table 3-1 there is a footnote that indicates sample size may be insufficient for some age groups. A suggestion is to provide a confidence rating both for the study and then for the data as

	used (so, for example, there may be medium overall confidence in a certain study but low confidence when the data are stratified into multiple age bands due to lower sample size per age band). Further, a whole-picture approach is suggested for application of data. For example, where a "reality-check" suggests that the tails of a distribution may be biased, EPA should avoid recommendations based upon extremes of the tails and remain closer to 10th and 90th percentiles (as discussed under Chapter 6 comments).

6) **Please comment on whether data variability has been adequately characterized and described.**

Anderson	The approach to discussing and describing variability taken is appropriate and for the most part adequately provides the user with an understanding of variability and how to describe it. What to do about it is another issue all together. It would be helpful if the authors alerted the user to the factors or sub factors which display unusual variability. Otherwise it might easily be overlooked. It would be useful to define what is the typical range of variability seen in a given chapter topic area.
Beamer	For the most part variability of parameters has been adequately described. It may be appropriate to also present median values in the recommendations, particularly for factors that might be skewed. For certain factors it may be important to include 5th percentiles for calculation of high exposure. For example body surface area is typically in the denominator for calculation of dermal exposure. Therefore individuals with the smallest surface areas would have the highest exposures and perhaps be the most at risk groups for dermal exposure, rather than the 95th percentile body surface area where the exposure would be averaged over a larger area.
Bennett	Chapter 5: Rather than present variability for the general population, the authors include a central tendency of soil consumption for the general population and then include values for pica and geophagy. They state that these represent an unknown high percentile value. I think a bit more guidance could be given on how to use these values. From reading the chapter, I get the sense that geophagy is quite rare, while it appears based on the study results that pica is much more common. Chapter 17: Variance was not given in this chapter. Chapter 18: Variance was not presented for lifetime. The reason for this should be made clear. Chapter 19: A low end percentile for both home area and air exchange rate was presented and I think this is adequate given the quantity of available data.
Ferguson	Data variability is best described for age groups and sexes throughout the document where studies provide. Data variability is not well described for races or socioeconomic status for most factors (Activity factors have the most expression in variability in the chapters I was assigned). This is mostly due the lack of studies focused on these differences. However, on this issue I have specific comments below for the chapters reviewed.
Finley	For the most part, yes. The summary of means and upper bounds for most exposure factors is very helpful. However, as noted below I believe there are instances where sufficient data exist to develop probability distributions (e.g., soil ingestion and dermal adherence).

Gaylor	Values of the standard deviation provide a good measure of variability. For data that are approximately normally distributed, the estimate of the 95^{th} percentile is: (mean + 1.645 x standard deviation). Likewise, other percentiles can be estimated readily. For data that are approximately log-normally distributed, the standard deviation of the logarithms of the data provide a good measure of variability.
Georgopoulos	The discussion of the various issues of data variability in Chapter 2 captures the essential elementary concepts in an adequate manner (though the general discussion of "probabilistic" methods in Chapter 1 would probably require some clarification. Indeed, a potentially novice user should not assume that a basic "distributional" calculation that aims to capture the (often critical) range of actual exposure outcomes based on known estimates of the variability of key parameters is somehow a challenging problem that involves advanced probability concepts. Additional comments can be found in the responses to the questions for individual chapters.
Guiseppi-Elie	I did not review Chapter 2 on Variability, although the topics covered in the Table of Contents appeared to be the appropriate ones. I may add more after I review. In general, in the specific chapters that I did review, variability was addressed by using percentile information as far as possible, which seems reasonable from an overall perspective. Some factors may require more insight, e.g., specific recommendations were made on the CSEFH on variability that were intended to be reflected in any update of the EFH.
Lebowitz	Data variability has not been adequately characterized and described in the summary tables and information.
Lobscheid	As stated in Section 2 of the EFH, there are four types of variability that exposure assessors may be interested in characterizing: • Variability across locations (Spatial Variability); • Variability over time (Temporal Variability); • Variability within an individual (Intraindividual Variability; and • Variability among individuals (Interindividual Variability). The following Table summarizes my comments on whether data variability, based on these four types of variability, has been adequately characterized for the exposure factors of Chapter 9,12,13,14,15, and 19 (Yes := adequately characterized and No:= not

	adequately characterized).

Chapter	Spatial Variability	Temporal Variability	Intra-individual Variability	Inter-Individual Variability
9- Intake of Fruits and Vegetables	Yes- in the Key Study- by urbanization and region	Yes- in the Key study by season	No	Yes- in the Key study by age, race/ethnicity
12- Intake of Grain Products	Yes- in the Key Study by urbanization and region	Yes- in the Key Study by season	No	Yes- in the Key study by age, race/ethnicity
13- Intake of Home-grown foods	Yes- in the Key study by urbanization and region	Yes- in the Key study by season	No	Yes- in the Key study by age, race/ethnicity
14- Total Food Intake	No	No	No	Yes- by age
15- Human Milk Intake (*)	Yes- in Relevant Studies by region and urbanization	No	No	Yes- by age in the Key studies and by ethnicity in the Relevant studies (**)
19- Residential Building Characteristics	Yes-for house volume by state and region. Yes- for air exchange rate (AER), by state and census region	N/a for house volume. Yes-for AER by season	No	Yes- on house volume by housing type and year of construction. Yes- on AER by climate region and season.

(*) In Chapter 15, the variability in breast milk intake is well documented in the key studies. I think the SE, or standard deviation would be useful to include in Tables 15-3 to 15-6 (the recommended value tables).

(**) I think that inclusion of additional data on partially breast-fed infants would be also be useful to include to characterize the variability in the infant diet.

Ryan	Data variability, in most instances, is adequately presented in terms of population distributions of the parameters. However, the underlying data used to produce these distributional characteristics, is perhaps inadequate to support some of the parameter estimates. If, for example, only a small number of non-representative individuals were used to generate an estimate, is it useful to present the distributional characteristics? What about a study that is statistically representative of some group, but that group is

	unique in some set of characteristics that makes it less useful as a big picture item?
Stern	It would clearly be very useful if the relevant data were presented in terms of percentiles so as to make the descriptions of variability useful in probabilistic/Mont Carlo analyses. Although for some of the individual (but not specifically key) studies the data are presented in an adequate array of percentiles, for the key studies (at least for those I reviewed), only a central tendency and upper percentile estimate were presented (and sometimes only a central tendency estimate) when the recommendations were presented. In many cases this reflects that fact that the key studies do not present sufficient (or sufficiently characterized) data to allow a detailed description of percentiles. However, this is not explicitly explained in the text that discusses the key studies. And, in at least one caser, the CSFII data that serve as the key data for fish and shellfish consumption, percentiles are presented in the detailed discussion of the key study, but not in the recommendations. The rationale for this is not clear to me.
Tran	The percentile estimates were adequately tabulated and summarized in the dietary factor tables in C 9, 11, 12. However, care should be taken to note the small sample sizes when reporting upper percentile estimates for several fruits/vegetable intake for young age groups (<1yr) and it may be prudent to not report the upper percentiles when the sample size is to too small. NHANES has published statistical notes on adequate sample size for percentile reporting.
Zaleski	In general, data variability is addressed appropriately.

7) **Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?**

Anderson	Paper copy is probably easier and quicker to access than having to go on line to an EPA website to get a pdf version of the handbook. A searchable pdf version that can be downloaded to a user's computer so it is readily available is probably the easiest. The most useful format would be an on-line version that had an analytic engine behind it so the user could manipulate the data to get the value needed and not have to page through multiple tables to try and find the value. Such an interactive tool is probably well into the future, but such a goal for the program would be a good one and as research surveys are funded and completed, maintaining an eye for how the data could be made accessible for analysis would be important. Thus an on line "handbook" only improves on the paper copy if it takes advantage of what the internet and computer resources have to offer. Simply providing a pdf version on line, while useful does not advance utility very far. Being able to do word searches or key word searches would be very helpful and is not something that can be done with a paper copy.
Beamer	I love paper copy formats. It is very useful to have one on your bookshelf that you can refer to as needed. However, it is also nice to be able to access it via the web. That way it is always available when needed. On the web version it is useful to have both one complete document and one that breaks it up by sections to provide more flexibility for users needs.
Bennett	The paper format is a useful format. It should be made available on-line as well, with each chapter downloadable as a PDF.
Ferguson	Web based access from the EPA web-site is a must. I think this is the method most people will access such a large document. However CDROM and paper copy should be available to order for others to order at a reasonable cost.
Finley	I personally find it difficult to review the EFH in any format other than a hard copy paper version (due mainly to the volume of data summary tables). Others may prefer an electronic version (or some other format).
Gaylor	I prefer the paper copy.
Georgopoulos	USEPA should seriously consider an electronic, searchable version of EFH, along the lines of the FactorFinder computer program for the EFH. Indeed, in the past many users of EFH found FactorFinder extremely practical and, with advances in computer standards, a "modern multiplatorm version" (e.g. in coded in Java, as the original FactorFinder, but with "more visual" options) would be a great resource (and a great advancement in terms

	of usability of format). Both self-standing and web-based versions of such applications would be useful (and relatively straightforward to develop).
Guiseppi-Elie	While I recognize the need for a paper copy, it is my least favored format. Ideally, a web-based document that included hyperlinks to the various other guidance, tools, etc. as referenced in the document would be most useful. This can be accessed from anywhere at anytime. The current PDF version with roadmap concept works well. It is a good compromise to be able to navigate an extensive document efficiently.
Lebowitz	Paper copy is fine for many, but it should be available as well on CD-ROM and the EPA website.
Lobscheid	I prefer a paper-copy and CDROM for review. But, for research purposes, find it preferable to view the document online and download the individual chapter and/or the entire document, and then to print, at my discretion, particular sections of the handbook that I need for my research.
Ryan	A hardcopy of this document would be completely unwieldy. At thousands of pages, it would take up a significant portion of a bookshelf. A downloadable electronic version is certainly preferable. EPA has excellent experience in producing easily-downloadable pdf versions of various reports. This should be no exception. An even better solution would be a web-based query system such as that discussed above. Introductory material should be readily available in pdf format, but a better system for the useable data is needed. A searchable database with keyed elements offers a better approach. If I want to know the expected breathing rate of an exercising adult aged 40-60 years, I should be able to type such a query into the system and get the information out, including references to both primary and secondary data, estimates of the population distribution, etc. This would make the document (as a system) much more useful than thumbing through an enormous printed copy.
Stern	It is becoming less and less likely that a paper version of the EFH would be used in-lieu of a digital (e.g., CD) or web-based version. This is particularly the case given the searchability of the digital/web versions. In recent years, my references to the EFH have all been through the CD or web version. However, I suggest that for digital/web versions the pdf double column format not be used as it is extremely difficult to follow the text.
Tran	There is an inherent disconnect between the speed of food intake data that are being generated from the NHANES surveillance program and the long and extensive period between revision/update of the EFH. At the current rate, new NHANES food intake data are being released every two years, while the frequency of updating the EFH is once every 10-12 yrs (last update was 1997). Given the time current time-lag, it is a challenge to maintain the currency of the dietary factors in the EFH. It may be more expedient to provide updated dietary factors for the EFH electronically via a web-based program. Also given the large number of data tables covering the wide range of food commodities

	in the US diet and the various exposure estimates (per capita, per user, per eating occasion, one-day, two day average, etc..), a web-based data-query system would be the most effective and useful mean of delivering the data to user. The USDA nutrient data query system (see USDA website: http://www.nal.usda.gov/fnic/foodcomp/search/) is an example of such a system.
Zaleski	The current format is very useful. But I highly recommend a companion web-based format or even database type format (similar to that of ExpoFacts, the European Exposure Factors Database http://expofacts.jrc.ec.europa.eu/).

Responses to Chapter-Specific Charge Questions

Chapter 1 - Introduction

8) The Introduction contains a summary of the latest guidance and developments in exposure assessment. Please comment on whether we have captured the most important and relevant guidance and developments in exposure assessment.

Anderson	It is useful to reference all the relevant EPA guidance documents that relate to exposure assessment and risk assessment. The listing appears quite extensive, but I am not familiar with all the EPA guidance. Going beyond EPA to include other developments probably is unwarranted as it is then difficult to know how comprehensive the discussion is and whether all perspectives have been included. It would be helpful if there are some new guidance documents that are under development or some that are undergoing revision to mention them. I think the critical information that helps exposure assessors is the reference to the EPA documents and how they can be retrieved. If mention can be made if any of them are specific to some of the factors, those links should be mentioned. Trying to capture the whole field is expecting too much.
Beamer	Yes, the Chapter does a very nice job of laying out the latest guidance and developments in exposure assessment. Under section 1.6, I would consider adding: • US EPA (2005) Approaches for PBPK Models and Supporting Data in Risk Assessment • US EPA Standard Operating Procedures for Residential Exposure Assessments • Is there a manual for SHEDS or perhaps a list of EPA models that individuals may also like to consider using in conjunction with EFH to estimate exposure? Consider also a discussion of aggregate exposures to complement the discussion of cumulative exposures.
Bennett	Chapter 1 provides a good summary of exposure assessment. However, in the discussion of uncertainty, I think there should at least be some mention of the concept of joint uncertainty and variability.
Blaisdell	In response to Question 8, the most important latest guidance and developments in exposure assessment have been addressed. The issue of correlation between variates is briefly discussed on page 1-12. It is desirable to express intake values such as drinking water or food intake in terms of L/kg BW-day or g/kg-BW both because it both takes correlations between body weight and intake values into account and the intake of a toxic chemical can be expressed in the most common expression of dose (mg/kg-BW) . It might be better to state that long- term total caloric intake is correlated with BW but that individual food items such as strawberries may or may not be. You could mention that there is limited information at best on correlation between variates such as drinking water intake and breathing rates. Collecting longitutidinal data on multiple intake variates on the same individuals over time could

	help address this.
Ferguson	The main change seems to be these life-stages over subpopulations and the grouping of exposure factors where possible into these life stages for especially children. This is commendable given distinguishable changes in activity patterns and physiology. I think the field will as a result drift to calculating/measuring/observing exposure factors in this manner, and eventually toxicological data to match. It is good that the necessary guidance documents are listed. It can be overwhelming for the user to track down these documents and so it would have useful to highlight main recommendations from these guidance documents. I have already mentioned that the main updates (listed on Page 1-1) should be further explained with one of two sentences. The reader should be aware that some of these recommendations from guidance documents are later covered in Sections 1.9. *Page 1-4, Paragraph 1* Here it says that 'recent studies are more likely to use state of art methodologies that reflect advances in the field'. I am not sure if EPA used the latest papers in the field….see comments on Chapter 7 for dermal factors. *Page 1-6, Last Paragraph, Column 1.* This sections list the factors required for making an exposure assessment. Since the chapters do not give guidance on how to calculate exposure for a particular route (well, it is spotty and uneven), the beginning of each chapter sound point the reader back to this section and the various guidance documents. Also, for each chapter, the reader should be guided back to section 1.9 that talks about the fundamental principles of an exposure assessment. **Additional Comments:** 1) *Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?* Answer: Under the general comments, I have commented on the EFH overall. It is quite useful that EPA has created these life stages rather than subpopulations in terms of exposure factors. If we are calculating lifetime exposure, then we can sum exposures over life-stages. There are still occasions that we will make exposure calculations for subpopulations. There may be exposure only experienced by a subpopulation due to the nature of the chemical or the nature of activity patterns unique to a subpopulation. Through public comments and by EPA's own comments, we see that toxicological data is available or does not coincide with these new age groupings. Until this information catches up, or is collected in this manner, EPA should attempt to give some reasonable recommendations for overlapping the datasets. (For example, toxicological data for age

group 1 through 5 should be used for age group 2 through 12, until further data is available).

Page 1-1, Second Column

Under the background section, EPA talks about the main revisions to the EFH. However, it would be useful to say whether the change is minor or major and even briefly what the change is under this section. That may take only one added sentence for each of those 11 bulleted points, for easy reference.

Page 1-2, Paragraph 2:Column 1, Minor change to first sentence

Switch the position of behavioral and physiological. Right after this first sentence you explain the behavioral differences and then the physiological difference. Just for consistency and flow.

Page 1-2, Paragraph 2

I am not clear what the EPA document's (i.e., 'Guidance on selecting age groups….') children age groups are based on, just from this section. Briefly mention whether it is based on developmental stages or physiological difference or some combination.

Some readings on children and exposure (may be useful to read/quote):

1) Moya, J.; Bearer, C. F.; Etzel, R. A. Children's behavior and physiology and how it affects exposure to environmental contaminants. Pediatrics. 2004, 113(4).

2) Thompson, K. M. Changes in children's exposure as a function of age and the relevance of age definitions for exposure and health risk assessment. Medscape Gen Med. 2004, 6(3), 1-37.

Page 1.10, Section 1.9

This is an 'Exposure Factors Handbook', and the approach in this section is to explain exposure from a dose perspective. So exposure is called External Dose. This section should be dedicated to having 3 simple exposure equations for inhalation exposure, ingestion exposure (dietary and non-dietary) and dermal exposure, if possible. Then there should be a focus on how exposure becomes dose, and the calculation of average daily dose. The reader can get confused between the two. It might require a discussion of picking an exposure boundary and defining the exposure in that manner and the dose a continuation of that with added factors. I realize ultimately we are interested in that internal dose, but it is important here to makes these distinctions because we gather data according to exposure factors and dose factors and then wish to appropriately use them in physical representations.

Page 1.10, Section 1.9.1 Paragraph 3, Column 2.

In the sentence… "Factors presented in this handbook that affect dermal exposure are skin surface area and estimates of the amount of soil that adheres to skin". I hope the reader does not confuse this sentence to mean that these are the only factors. Maybe follow-up with…"Other factors not covered in this handbook are important in the calculation of dermal exposure." See comments for the dermal exposure chapter.

2) *Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?*

Answers

Page 1-7, Last Paragraph, Column 2

We keep saying that that there is no guidance for age groups for presenting adult data, but the reader should be aware how activity patterns (e.g., time spent at home, time spent at work), really begins to change for the elderly. At that advanced stage, the human body becomes compromised due to the development of illnesses, chronic disease and, therefore, more susceptible to lower chemical concentrations. This should be considered in exposure assessments. I think EPA does address this further along in the chapter. It is worth repeating here.

Page 1-8, Second paragraph, Column 1

We are using the terms age bins and life-stages interchangeably? Also, for this section, EPA mentions that there were recommendations for EPA to consults with experts, and conduct long term research in the various fields in order to address the toxicokinetic and behavioral changes for children. Is this something EPA plans to do in order to improve the age bins/life-stages for the next version of the EFH?

Page 1-10, paragraph 3

In the equation, is the reader aware of what ADAF means? I do not see this term in the Glossary, although I do see ADD (Average Daily Dose) and others.

Page 1-10, Paragraph 4, Column 1

"Once in the environment, the chemical…………soil, dust, and diet." You could follow this sentence up by saying these fate and transport mechanisms result in various chemical concentration that the individual is exposed to.

3) *For the factors included in the EFH, are you aware of other data sources that have not been identified?*

Answer:

See comments under individual chapters.

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection*

	of studies that have been classified as "key." Answer: See general comments, or comments for each chapter. 5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.* Answer: Page 1-3, Paragraph 4, Column 1 EPA talks about the selection criteria for judging a paper, one of which is whether the approaches to capture the exposure factor are direct or not. The nature of each exposure factor is unique. Sometimes, they cannot be judged by the same criteria. For example, a lifetime measure (i.e., how long people live, chapter 18) is an easier, more direct factor to obtain. Just follow past trends and gather death certificates on numerous people and there it is. But a factor such as soil loading on the skin, is by nature a more difficult factor to measure directly (and costly for substantial data-points). Sometimes we have to wait for the field to develop that more direct method of data collection. So, by nature it is going to receive a lower score under "soundness" or "adequacy". All is not even or fair in the world of exposure. This should be stated in the introduction chapter. 6) *Please comment on whether data variability has been adequately characterized and described.* Answer: See individual chapters, and general comments. 7) *Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?* Answer: See answer in general section above.
Finley	I believe the Introduction does a thorough job in this respect, particularly with respect to the recent emphasis on "life stages" in the exposure assessment.

Gaylor	The more important and relevant guidance and developments in exposure assessment have been included in the Exposure Factors Handbook (EFH). Specific comments follow. Page 1-4. Uncertainty. The statement --- inherent variability in environmental and exposure-related parameters or possible measurement error----refer to variability, not uncertainty. Page 1-5. Section 1.5.2. (Single versus Multiple Key Studies). The midpoint of the range of upper percentiles across studies may provide a poor estimate, as the lowest and/or highest value that provides the range may be the result of a small or deviant study. A weighted average of upper percentiles across studies generally would provide a better value. Page 1-5. Section 1.5.3. (Variability, last sentence in Column 1). The average and median are measures of central tendency, not measures of variability. The variance, standard deviation, and inter-quartile range are measures of variability. Page 1-5. Section 1.5.4. Uncertainty. Measurement error and sampling error that are quantifiable are measures of variance, not uncertainty. Page 1-10. First full paragraph. Should be qualified as for mutagenic carcinogens. Page 1-18. Table 1-1. The average and median are measures of central tendency. The average or median in combination with upper percentiles provide an indication of variability. Page 1-20. Table 1-3. Need to state that these age-dependent potency adjustment factors were developed for mutagenic carcinogens.
Georgopoulos	The Introduction to the 2009 Update of the EFH indeed captures many essential developments in exposure assessment, especially the importance of the lifestages issue, and provides sufficient historical context for the reader who might be new to the subject. However, in this reviewer's opinion, the improved treatment of the lifestages issue is basically one positive step towards accepting the fact that "exposure biology" needs to be further incorporated in the "everyday practice" of exposure analysis and assessment and it is hoped that future updates of the Handbook will indeed incorporate (actually in a manner consistent with the present discussion in Chapter 1) further information and exposure assessment relevant guidance related to issues such as the effects of aging, of genetic variability, of altered pathophysiological states, etc. Also, as mentioned in the answer to Question 6, the discussion of "probabilistic" methods in Chapter 1 requires some clarification, so as not to deter someone from performing basic"distributional" calculations that aim to capture not only a point estimate but a distribution/ range of actual exposure outcomes based on known estimates of the variability of key parameters.
Guiseppi-Elie	Chapter 1 could benefit from additional contextual setting. It is not that the appropriate reference are included but rather how these complement each other and inform the

	assessment process seems to be lacking. The discussion on how to perform exposure assessment would be better earlier in the Chapter. Then, the context of how this document and others fit into the assessment would provide for more informative user handbook. I re-iterate that the Roadmap concept for the different documents would facilitate this objective. The inclusion of the factors from the CSEFH can cause some confusion. Demonstrating the nexus of the two by example would be helpful. Inclusion of an appendix on calculating risk, particularly with all the changes, would be helpful. Some form of summary of what has changed and why would likewise be useful.
Lebowitz	<u>Specific Comments on Chapter 1:</u> 1.2 - It should be stated at the end of this section that "It does not supercede any standards or guidance provided by professional scientific societies involved more with exposure and/or risk assessments, statistics, or with specific organ systems (including the anatomy, physiology, immunology, biochemistry, etc. involved and the target organ exposure-dose-response relationships). The opinions of those bodies, NRC, WHO, UNEP, and other agencies should be respected as well." – these others should have been consulted more (see comments below). 1.5 (5) – It should be stated that these factors of interest are discussed in each chapter. 1.7 (bottom of first column on page 1-8) – One could not agree with this more – it is very obvious that this is needed. 1.8 – There are many good statements in this section and reinforce the need just mentioned. 1.9 – This section should be updated to reflect the advances in exposure assessment reflected in NRC/NAS documents, the Journal of Exposure Analysis/Science & EE, and the book "Exposure Assessment" edited by Ott, Steinemann & Wallace (Taylor & Francis, 2007). 9.1 – These equations are one approach only. At the end of the paragraph starting "The intake rate …" add after "soil" "and other media". The next paragraph starting with "The exposure duration …" is good policy/practice but is not followed well in other chapters (certainly not in Chapter 6 which I reviewed). Re: fourth complete paragraph on page1-11 (first column) – Do the authors really mean "potential dose" rather than calculated or estimated likely dose, and shouldn't it be in reference to specific end organs? Re: fifth complete paragraph on page 1-11 (first column) – This approach (or description) doesn't take into account the effect of acute massive exposures and doses on long-term responses, as known to occur (e.g., asbestos, beryllium, etc.). The next two paragraphs reflect/highlight some of the problems I have with this EA approach – the dependence on body weight and not estimated end-organ dose derived from the exposure and likely independent of body weight, at least for several of the organ systems. For example, the respiratory system volumes of exposed pollutants reaching the system are height and age determined, as well as specific for gender, race and patho-physiology. The first paragraph on page 1-12 doesn't reflect the more extensive statements and review in chapter 6. The last paragraph of sec. 1.9 indicates the simple generalized approach to RfDs – there aren't specific RfDs for children or for other susceptible and sensitive

	population groups. Yet, these populations are critical in setting standards (e.g., air quality standards). Thus, those actually evaluating exposure-dose-response relationships for standards use real data rather than models and focus on data collected on these susceptible and sensitive groups. 1.9.2 – first suggestion - The exposure assessor should not use average values for a population unless no other data are available and if non-linear models can't be determined. 1.10 – Cumulative and aggregate exposure assessment and risk assessment should be emphasized more and used more. In Summary and in response to Question 8, the introduction does not provide the latest guidance and development nor capture the most important guidance and development in exposure assessment.
Lobscheid	Because the analysis of some of the Exposure Factors were done on a different life-stage basis (e.g, Chapter 9- Intake of Fruits and Vegetables, Chapter 12- Intake of Grain Products, and Chapter 13- Intake of Home-Produced Foods), and Chapter 15- Human Milk Intake, I suggest stating explicitly stating in the introduction (in Section 1.7 at the end of the Section, following the list of "recommended age groups"), which chapter have the data the recommended exposure factors presented in the EPA's recommended age groups, and which chapter do not. Additionally, please mention that when data was not analyzed in the recommended age group categories, the analyses were matched as close as possible to the recommended age group categories. Also, stating whether or not the "References for Chapter 1" are in Draft or Final Form would be helpful. Some Final reports are cited as such , but are there any other "draft" reports besides the US EPA (1994a) Estimating exposures to dioxin-like compounds? Or, are all the others either "interim final" or "final" reports?
Ryan	In general, I believe that Chapter 1 has indeed covered the most important and relevant general guidance as well the primary developments in exposure science (note the preferred term exposure science rather than the more restrictive exposure assessment.) However, the organizational structure could be improved substantially. Let me offer the following suggestions. Sections 1.1 and 1.2 are appropriately placed in that it is necessary to state the Purpose and Intended Audience right up front. Section 1.3 Background should indeed come next but the content of this section is not what I would expect to be. One should commence, as has been done, with a history of the document's development, but this history is much too brief and focuses on changes from an undescribed document, namely, the earlier versions of the Exposure Factors Handbook (EFH). A paragraph describing the previous document would be useful here. While some material is included in the Section 1.1 Purpose, a better description could be placed in a section called Background. As it is, the Background section is hard to follow. The bulleted point highlighting the revisions in the document could be much better developed in a Table with some descriptive text supplementing it. I am not at all sure why the sub-section entitled *Variation Among Studies* (note I think the word "among" should not be capitalized) is included in a

Background section. It should receive its own discussion, and probably be a separate sub-section; it is not part of "Background." Further, the discussion of the selection of age-groupings is given under this heading, which seems inappropriate. My suggestion is a complete re-write of the Background section is warranted.

Section 1.4, Selection of Studies for the Handbook, is both necessary and, I think, well done. After an introductory section, it progresses from a discussion of General Factors influencing selection, and then details the Selection criteria. I am not a fan of the presentation of this section; the multiple indentation and set-offs, especially in light of the two-column presentation, makes reading difficult and individual indented sections with too few words per line. Yet the content is quite good. A simple re-formatting, without need for a re-write is in order here.

One concern is criterion (2) Applicability and Utility. This asks if the information is relevant for the Agency's intended use. I have two problems with this. First, the Agency's intended use is not made clear. And second, this is a general document that will be used by other not in the Agency. Its use is more general that might be suggested by the comment. In the same section, under Representativeness of the Population, the last sentence reads: "… Higher confidence ratings were given to exposure factors where the available data were representative of the population of interest. …" A fuller explanation is needed. For example, if the population of interest in the study used is not especially relevant, e.g., left handed mine workers in Kentucky, why should this have equal precedence with, for example, a much larger study descriptive of the population of New York City? Other criteria come into play here.

Section 1.5 is robust and well developed. Again, I think a reformatting would add to the presentation.

The first paragraph of Section 1.6 offers an excellent succinct summary of the steps needed to be performed in an exposure assessment. Why this little gem of a paragraph is tucked away six pages in is puzzling. Put it up front in the Background or Introductory section as it lays the framework for the entire document. This adds interest and a firm foundation for all that follows.

Section 1.6 is entitled "Suggested References for us in Conjunction with this Handbook." It is quite provincial to suggest only readings involving other EPA documents. Surely the authors have encountered an occasional piece not published by EPA that offers insight into exposure analysis. I offer a near-identical criticism of Section 1.12 References for Chapter 1 that lists a small number of non-EPA references, which one may argue are somewhat arbitrary in content. Of course these are discussed explicitly in the text, but the selection of these eight references to the exclusion of thousands of other peer-reviewed publications, book chapter, monographs, etc., on exposure science is just not warranted.

Sections 1.7 and 1.8 discuss age groupings. I do not think this belongs in an introductory chapter, but rather should be a separate chapter in itself. There is still a good deal of tension between age groupings suggested by behavioral specialists and those suggested by physiologists. Throwing exposure assessors into the mix would doubtless give rise to a different set of age groupings. This merits discussion. The reference to the 2000 meeting on this subjects may suggest to the reader that the matter is settled when in actuality these is still a substantial amount of disagreement on what appropriate age groupings are. The National Children's Study, for example, is likely to choose a different final scheme for

	age groupings. Users of the Exposure Factors Handbook need to be aware of this lack of consensus and include such considerations in their uncertainty analyses. In Section 1.9 confusion abounds. Dose and exposure are intertwined, sometimes considered the same thing, then substantially distinguished from one another. In fact, in Eqn. 1-2 we have the lead in clause: "… The exposure can be expressed as follows: " then the equation says "External Dose = …" What is it? External dose? Exposure? Potential Dose? Definitions are important and this must be cleaned up. Indeed this subsection, 1.9.1 Dose Equations starts off with the phrase "… Starting with a general integral equation for exposure…" followed by a reference, but no integral equation for exposure. What is a reader to think? But in a more fundamental sense, why is this in the Introduction anyway? Shouldn't there be a separate chapter laying all of these things out? Fundamentals of exposure, as the main section heading indicates, is an appropriate topic for the Introduction, but a detailed description of LADDs, ADDs, Dose, Exposure, etc., is better described elsewhere. Section 1.10 Cumulative Exposure is a weakly developed add-on. There needs to be more discussion. One should start with the precipitating legislation, the Food Quality Protection Act of 1996, define route-specific exposure, aggregate exposure, and cumulative exposure in a clear fashion. Just putting in this brief discussion of Cumulative Exposure is confusing, misplaced, and does not give any insight into how the exposure assessment should be carried out. Section 1.11 Organization offers little more than a Table of Contents, which is given elsewhere. Either more description is needed as to what is covered in each section- even a paragraph on each would help- or it should be left out as redundant with the Table of Contents. Other Comments on Chapter 1. Along with the Executive Summary, the Introduction will doubtless be the most-read component of the Exposure Factors Handbook. Given this assumption, this should be the most readable as well. The two-column presentation does not lend itself well to the readability so desired. This is especially evident on the Page 1-1 that contains bulleted items, as well as a text-box insert summarizing the purpose of the document. I found this to be distracting. New material added since the 1997 version could be better summarized in tabular form rather than in bullet form. Indeed bulleted forms and multiple levels of indenting are used extensively throughout the introductory chapter.
Stern	In general, chapter 1 is a good guide to the use of the EFH and to the general considerations involved in the recommendations in the individual sections. It is also a useful concise guide to exposure assessment However, with respect to general guidance for exposure assessment, it should be noted that equation 1-2 supposedly gives the external dose. However, in discussing the relationship between exposure and dose, it is important to understand that dose is defined as the mass of a substance in contact with an interface divided by the body-weight. Equation 1-2 does not, however, yield a dose (as per this definition), but a mass of contaminant. In such a document it is important that this common misnomer not be promulgated.

	Additional Comments <u>Chap. 1</u> Pg. 1-5, par. 4, line 4 – Change “base” to “based” Pg. 1-10, eq. 1-2 – As noted previously, this equation is labeled as predicted ”dose” but in fact it predicts a mass. Dose is defined as mass/body wt. This also applies to the text on pg. 1-11, par. 3. Pg. 1-11, par. 4 - The adjustment of the dose response parameter for differences between species in absorption across body barriers is carried out for inhalation exposures, but not generally for ingestion exposures. Ingestion is generally not specifically adjusted for species differences in absorption. Pg. 1-13, first bullet, line 13 - Change “itself” to “themselves” (data is a plural word).
Zaleski	A useful guidance document to add is: Dermal Exposure Assessment: A Summary of EPA Approaches. EPA 600/R-07/040F. Also, in this section, the Child-Specific Exposure Factors Handbook is cited as a resource. Throughout this draft EFH, child-specific exposure factors are provided, and in some cases are based upon data more current than in the Child-Specific Exposure Factors Handbook (CSEFH). There are cases where the recommendations in this draft EFH differ from those in the CSEFH. While the effort to update materials is well-intentioned, these differences will lead to great confusion in application. Clear reference to the CSEFH and how the values in this draft EFH compare to CSEFH recommendations should be made any place in this document where child-specific data are given. Future editions of the CSEFH should do the same in reference to child-specific data contained in the EFH.

Chapter 2 – Variability and Uncertainty

9) We acknowledge that there have been significant developments in the area of uncertainty analysis. Several new references have been added to the chapter on uncertainty and variability. Please comment on whether the information provided is useful as an overview of uncertainty and variability.

Anderson	This is a complex area and it is difficult to do it justice in a short chapter. The handbook is not a textbook or intended to be exhaustive. All that should be done is provide an overview and the conceptual framework. As elsewhere, the focus is upon EPA documents and perspective, which may not provide all the various perspectives seen in the literature. As a non-expert in this area, I found this chapter laid out what I would need to be aware of while doing an exposure assessment and what needs to be paid attention to. It points the reader to other references should it spark greater interest by the reader. For me the handbook is a reference source for exposure factor numbers that have been vetted by the EPA. It is not a how-to guide or text book on all exposure and risk assessment issues.
Blaisdell	The discussion of variability and uncertainty is an extensive and thoughtful academic discussion. Variability analysis is well integrated into risk assessment practice, either with use of average and high-end estimates or Monte Carlo Analysis. There is an extensive literature on various distributions for exposure parameters. When point estimate approaches are used, knowledge of the variability in exposure parameters can be used to inform the selection of point estimates (e.g. the 90th or 95th percentiles for a high-end estimate). The limitations in assessment variability in risk assessment are the lack of data on variability and the lack of longitudinal data that would properly characterize interindividual variability. There is a particular dearth of information on variability in fate and transport model variates. It is therefore usually only possible to estimate a portion of the variability in a risk assessment. The path to better and more complete characterization of variability would involve more investment in research. In contrast, uncertainty analysis seems to be usually confined to a qualitative discussion, such as in the Exposure Factors Handbook. Quantitative approaches to uncertainty in actual risk assessments such as two- dimensional Monte Carlo Analysis seem to be rare. I would like to see an extension of the discussion to include the practical aspects of quantification of uncertainty in typical risk assessment applications, particularly in regulatory environments. Actual examples, of how quantitative uncertainty analysis has been used in human risk assessment could be helpful. I would like to see a discussion of the relative uncertainty in exposure parameters, fate and transport, and dose response. The dose response values in most site-specific risk assessment are the often most uncertain, followed by fate and transport (if used) and then by exposure parameters. Quantifying the uncertainty in exposure parameters will do little to quantify the overall uncertainty in a risk assessment if the majority of the uncertainty lies in the dose response (e.g. cancer potency factors) part of the assessment. Although, there is a literature on estimating uncertainty in dose-response, there does not appear to be any consensus on appropriate methods. Uncertainty in many risk assessment applications is well understood and often could be

	addressed by allocation of more resources. Examples include soil sampling around a hazardous waste site instead of application of a fate and transport model, or collection of onsite meteorological data instead of meteorological data from the nearest airport to a facility. Risk assessment tools are often applied to situations as the least costly alternative and more as relative measure of risk between sites for the purpose of risk management resource allocation. The application of expert elicitation to attempt to quantify uncertainty in such situations would be costly and defeat the purpose of the using the risk assessment methods in the first place. I would suggest expanding the discussion to include such practical considerations. I would recommend separating the discussion of variability and uncertainty in Chapter 2. The methods used in quantitative estimation of uncertainty and variability are different. The integration of quantitative assessments of uncertainty and variability into the everyday practice of risk assessment is quite different. There is enough superficial resemblance (e.g. use of distributions) to cause confusion. The utility of quantitative information on variability to the risk manager seems straightforward. How quantitative uncertainty estimates fit into risk management decisions seems less clear.
Gaylor	Chapter 2 provides an overview of variability and uncertainty. Since the field of statistics is focused on the study of variability and to a lesser extent uncertainty, it is strange that there is little or no discussion of appropriate statistical techniques. A short discussion should be added of the role of sample size on the estimation of the precision of measures of central tendency. The standard deviation of the mean is the standard deviation of measurements divided by the square root of the sample size. The uncertainty of the mean due to the variability of the measurements is provided by the statistical confidence limits, which are a function of the standard deviation of the mean. In addition, it should be noted that statistical tolerance limits place confidence limits on estimates of percentiles. For a calculation that depends on the sum of two or more factors, e.g., cumulative exposures, or the multiplication of two or more factors, it was noted that an estimate of an extreme should not be calculated by assigning extreme values to all factors. Again, statistical techniques are available to estimate percentiles for the sum or multiplication of factors. It is surprising that there is no discussion of statistical sampling plans and the use of statistical analysis of variance techniques to estimate the size of the various components of variance (variability). Based on the items identified above, it is recommended that additional input should be solicited for statistical issues on variability and uncertainty. It should be indicated that estimates of variability based on the range depend upon the size of the sample. For example, with a sample size of 100 the smallest and largest values provide estimates of approximately the 1^{st} and 99^{th} percentiles; while the smallest and largest values from a sample size of 1000 provide estimates of approximately the 0.1^{st} and 99.9^{th} percentiles. Hence, the sample size should always be indicated for ranges.

	Special attention should be given to the public comments on Chapter 2 provided by Dr. Kenneth T. Bogen.
Georgopoulos	Te treatment of variability and uncertainty constitutes a critical topic for exposure analysis and the 2009 Update has substantially advanced the guidance that is provided in the EFH. However, at a minimum, it would be very useful to include some additional references to the topic; as the journal-based literature on the subject is not only enormous but is rapidly expanding, with many new and potentially useful methods evolving constantly. In addition to the included reference to Cullen & Frey, 1999; references could be selected from available comprehensive USEPA reports and a from a few recent monographs and textbooks (e.g., Bedford & Cooke, 2001; Isukapalli & Georgopoulos, 2001a; Ayyub & Klir, 2006). It is of course beyond the scope of the EFH to provide a self-contained introduction to uncertainty analysis concepts and methods. Nevertheless, some brief but more specific comments on the increasing usability (software availability etc.) and application of Bayesian methods (mostly through the implementation of computationally efficient Markov Chain Monte Carlo algorithms like Metropolis-Hastings etc.) for the characterization of uncertainty in exposure/dose systems, should be added to the text of Chapter 2. (e.g., Gelman et al., 2003; Gilks et al., 1995; Robert & Casella, 2004). Some suggestions for other potentially useful references follow: • [Isukapalli & Georgopoulos, 2001b] This is a USEPA report on computationally efficient uncertainty analysis methods and applications to environmental and biological models: - it also includes methods for different types of uncertainty characterization, uncertainty propagation, and uncertainty reduction. • [Isukapalli et al., 2010 - in press] An overview of recent developments in Uncertainty, Variability, and Sensitivity analyses • [Babendreier & Castleton, 2005] This a study that discusses uncertainty analyses in integrated multimedia environmental models • [USEPA, 2008] Discusses key issues and case studies concerning uncertainty and variability in Physiologically-Based Pharmacokinetic (PBPK) models:. • [Xue et al., 2006] Presents exposure modeling focusing on two-stage Monte Carlo techniques for characterizing uncertainty and variability • [Bois, 2009] It presents toolboxes for uncertainty reduction via Bayesian Markov Chain Monte Carlo (MCMC) method • [Saltelli, 2008] This is a good primer on global sensitivity analysis with practical toolboxes for global sensitivity analysis. It should be noted that performing combined sensitivity and uncertainty analysis is generally needed in complex exposure systems, since it is possible that a parameter with low uncertainty can contribute substantially to overall uncertainty in model outputs if they are sensitive to this parameter while, conversely, high uncertainty and low sensitivity

	for a given parameter may mitigate each other. • [Georgopoulos et al., 2009] This is a study that presents and compares methods for reducing uncertainty in exposure reconstruction and i interpretation through the use of exposure data at different levels of detail in combination with available biomonitoring data. • [Refsgaard et al., 2007] It includes reviews on multiple forms of uncertainty in integrated modeling.
Lebowitz	General Comments: There is some confusion in this chapter as to measures of variability and some distinct (not general) approaches to uncertainty. This uncertainty appears to include the usage of the standard deviation and non-parametric equivalents of statistical variation. (The use of averages, e.g., means *vs*. medians, and lesser discussion of non-linear models, appear to pervade this chapter and the Handbook.) The answer to question 8 is "no" as the information provided is only marginally useful as an overview of variability and uncertainty and the information lacks accuracy and precision. The chapter could use some editing and rewording. Real data examples would be useful – there certainly are plenty in the literature, even in just one journal (JESEE). **Specific Comments:** Introduction: First paragraph: I would suggest, after the 2nd sentence, to start with "Exposure and", and move the 4th sentence (without the beginning "Thus" to follow this start. That way one doesn't have to add "exposure assessment" to the NRC statement, even though it is very applicable and necessary for risk assessment. Second paragraph: There is too much denigration of exposure assessment herein, especially considering that most risk assessments, as described in Chapter 1, don't utilize all the detailed quality data collected in exposure assessments. Further, it needs to be reworded as well because it doesn't reflect what this handbook is all about nor what the EPA would like. Third paragraph, line 6: add "as well as variability" after "uncertainty". Fourth paragraph: it should state that these reasons may be primary, but it should end with the note that other reasons for addressing variability and uncertainty exist, as found in the literature on exposure and risk assessments, though not listed herein. 2.1: It would be very important for the definition of variability to include the statistical definition (discussed above) as such statistical measures are necessary to understand variability in a set of data, and since some referral to it (whether correct or not) occurs in

this chapter.

First paragraph, line 14: It may be inappropriate to state that variability cannot be reduced, as it can through sub-population analyses and through various statistical simulation methods. Actually, uncertainty in the form of biases are harder to reduce or correct. Further, one could state that even with such further analyses, "… variability may not be reduced in existing data sets, but could be with further data collection in the existing study population(s) or by replication of an exposure study with larger sample sizes, better statistical sampling techniques, and/or more precise measurements. One has ignored discussion of measurement variability herein, an important component of variability.

First paragraph, line 17: I would suggest adding, after "variability" the words "other than that due to sample size, inappropriate statistical sampling techniques or lack of precise measurements …". One could add a sentence as well that states "measurement variability could be due to the instrumentation and its precision, inter- and intra-observer/technician and subject variability, temporal and spatial variability in exposures not necessarily characterized well, and other factors discussed in the literature."

First paragraph, last line: I would suggest adding at the end "and enogenous (e.g., genetic) factors.

2.1, paragraph 4 (in second column of page 2-2), Re: uncertainty – there are many reasons for uncertainty about a distribution, but they shouldn't include statistical measures of variability (e.g., standard deviation or other statistical measure appropriate to the best fitting distribution of data). One is further confusing the two terms by discussing these statistical measures under uncertainty!

2.2:

Second line in first column on top of page 2-3, at end, I suggest adding "and variability due to measurements". I would also add two more bullets at the end of the next paragraph, i.e., "Variability in and between observers/technicians" and "Variability (precision) in measurements".

Paragraph on "Inter-individual variability", first paragraph, (1): after "age" add "gender, race, height," and after "body weight" add "(including any obesity), phenotypic genetic expression, and pathophysiological conditions".

2.3:

The last sentence starting on the bottom of page 2-3 (2nd column) is incorrect due to the increase in the proportion overweight, which also has a differential distribution by gender and race/ethnicity.

Page 2-4, 1st column, re third strategy. What "average" are they talking about here? It can't be the mean if the distribution is definitely non-Gaussian. Would they use a median? (see the "For example" in the paragraph on the top of the 2nd column.)

	2.4: Re: the classification of uncertainty, second paragraph. To (1) should be added “or biased” (not accurate). Somehow, the issues of biases are not incorporated well, including in Table 2-2, but they should be included. The discussion of uncertainty should be expanded to include this important area. 2.5 is relatively well done. 2.6 – Figure 1 is misleading, even when using log AF, since these distributions appear to be Gaussian. They could well be gamma or negative binomial or Pearson types of distributions not characterized but likely. This needs to be discussed here.

Chapter 3 – Ingestion of Water and Other Select Liquids

Anderson	See comments for General Question 4
Finley	See comments for General Question 4
Georgopoulos	Chapter 3 provides an excellent overview of studies on the ingestion of water and other select liquids. Overall the usability of the information provided could be enhanced through the addition of some graphical representations of the information contained in the tables. The list of the studies identified is quite exhaustive; some potential additions (especially useful in comparing US with foreign data) could be the following: • [Kim, 2008] Provides original data on water consumption rates for Korean housewives in the winter and summer seasons to measure their exposures to volatile disinfection by-products (DBPs) in chlorinated tap water. Data were collected from visits to 60 households • [Schijven & Husman, 2006] Provides original data derived from answers to questionaires given to occupational and sport divers in the Netherlands. Useful for exposure studies related to diving activity. Specifically, it lists the volume of water swallowed per dive) • [Riederer et al., 2006] Provides a distribution of (self-reported) water ingestion rates for 182 women aged between 15 and 49 from two communities in the Philippines. Some additional potentially useful reference suggestions would be [Caldwell et al., 2009], [Chowdhury et al., 2009], and [Davis & Janke, 2009].
Zaleski	This revised draft EFH provides upper values based upon 95th percentiles, whereas previously recommendations were based upon 90th percentiles. Within Chapter 1, it is clearly indicated that the upper percentile refers to 90th percentiles and greater throughout this book. When a change has been made in the reference percentile selected to represent an upper bound, the basis for this change should be transparent. It is unclear if the Dufour et al. study (p. 3-21) used to estimate ingestion during swimming considered tracer uptake from dermal exposure during swimming. This should be added to the discussion. Without this information, it can not be determined if the ingestion estimate represents ingestion alone.

Chapter 4 – Non-Dietary Ingestion Factors

Beamer	See comments for General Questions
Ferguson	1) *Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?* <u>Answer</u> One has to follow the data presentation and explanations carefully in this chapter. This chapter is divided into presenting data on mouthing frequency and mouthing duration. This data is separated also into data on mouthing objects and mouthing of the hands or bodyparts. Occasionally one study may have data on 2 of these factors or all of these factors. In that case the details of the study are repeated. I suggest a different format for this chapter. Present the general study once and then sections under that show whether a particular study has the 4 elements: frequency-objects, duration-objects, frequency-mouth/bodyparts, duration-mouth/bodyparts. Of course it should keep track of whether it was considered a key study or relevant study for each of those four exposure factors. *Page 4-1, Paragraph 3, Column 1* Some studies are quoted as examples of techniques for gathering non-dietary ingestion exposure factors. I would try and use some of the original or earliest studies. For example, Zartarian 1998, came well before Black (2005) for using videotaped methodologies to capture non-dietary activity patterns. *Page 4-1, Paragraph 3, Column 2* Although Ferguson et al., 2006 states that a child can be aware of the videographers, creating play acting and biases, I believe the paper also said children tend to ignore that camera after some time has passed. *Page 4-5, Paragraph 1, Column 1* Is there supposed to be a table for the Zartarian et al., 1997a study? Why present it without giving some data. Is it still a relevant study then. *Page 4-8, Paragraph 4, Column 1* One advantage of the Black et al. 2005 study was that it presented both survey responses and videotaped information of mouthing behavior. Can EPA mention whether these were in agreement or not? *Page 4-8, Paragraph 5, Column 1* For the Xue et al., 2007 study, 7 studies are mentioned. Can all be listed in this bracket? In general there are tables of data for the Xue et al. studies and they should list the

included studies (e.g., table 4-10 and 4-11).

Table 4-9

There are three numbers in the table. In the bracket it appears to be the mean and the standard deviation. What is the number outside the bracket? This is not clear to me.

Table 4-12

Make a vertical line between the data for mouth and both hands. Also what is the age group, or range for this table? Same comment for Table 4-20.

Table 4-13

What are non-dietary objects? Are paper and toys not also non-dietary objects. Is the non-dietary row the total for all the others? This is not clear.

Table 4-23 and Table 4-24.

Does the total non-dietary include the hands? If that is the case, the total non-dietary should be greater than the Hands column. In the description for non-dietary, hands are listed. Table 4-24 seems correct, but Table 4-23 does not seem correct.

2) *Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?*

<u>Answer:</u>

This chapter gives no guidance on how to use duration and frequency of mouthing in order to calculate non-dietary exposure. Can EPA point to some guidance documents or study where reasonable calculations can be found for non-dietary ingestion exposure. The first paragraph could more specifically say that when objects or the hands are mouthed, environmental contaminants on these objects or bodyparts are removed and enter the mouth. Sequence of events may be important, such as whether a handwashing event occurred after contact with soil and before the hand is placed in the mouth.

EPA mentions on Page 1, paragraph 5 (column2) that this handbook does not address contaminant transfer from bodyparts or objects. This is a factor that is needed to make an exposure assessment for non-dietary ingestion exposure. The amount that transfers or the area of the object or bodypart mouthed is needed.

It is possible that some of the videotaped studies presented could review existing videotapes to gather that data. EPA should consider funding such a study.

This paper contains some information and data:

1) AuYeung W, Canales RA, Leckie JO. “The fraction of total hand surface area involved in young children’s outdoor hand-to-object contact. Environ Res. 2008 Nov;108(3):294-9. Epub 2008 Aug 29.

Page 4-2, Paragraph 3, Column 1

The sentence reads.. " Recommendations for hand-to-mouth durations are not provided since those estimates may not be relevant to environmental exposure." It is unclear to me why these durations would not be relevant. Can EPA explain this further? It is because all the contaminant is assumed to be removed immediately and so frequency, not duration matters.

3) *For the factors included in the EFH, are you aware of other data sources that have not been identified?*

Answer: No

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

Answer:

It is troubling that Xue et. al., 2007, and 2009 is chosen at the main key study because it summarizes data from six other studies, yet it receives a low score for almost every confidence rating category.

If some of the larger studies included in Xue et.al., were evaluated separately, and considered key studies separately would confidence be even medium in some categories?

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

Answer:

Answered above under general comments.

6) *Please comment on whether data variability has been adequately characterized and described.*

Answer

I think for this chapter there could be a summary table of the studies and the study participants (so we can see variability across all these studies). We know that, for example, the Beamer et al., 2008 paper looks at 23 farmworker (Latino children).

	Although, no one has really compared the mouthing behavior of this group to any other group, it is worthwhile to mention this and even for someone to do that comparison. 7) *Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?* <u>Answer</u> Web based access from the EPA web-site is a must. I think this is the method most people will access such a large document. However CDROM and paper copy should be available by order.
Guiseppi-Elie	See comments for General Questions
Stern	Pg. 4-4, Clarity and completeness-Reproducibility - How can reproducibility be defined in terms of comparison to results using "alternate data collection techniques?" Pg. 4-7, par. 2 - I do not believe that the "randomized design" referred to here is described in the text.
Zaleski	Any text or tables reporting data on mouthing of objects should clearly specify what is considered in the object category. This context is needed to appropriately interpret object-related data, as Xu et al., 2009 have suggested that study differences in the definition of "object" may be contributing to the statistically significant different in object-to-mouth behavior with regard to study.

Chapter 5 – Soil and Dust Ingestion

10) Data on soil/dust ingestion are limited. Has NCEA done an adequate job in reviewing, presenting, and summarizing the available data? Is the differentiation between soil and dust ingestion clear?

Anderson	As with Chapter 2, this is not my area of expertise or research, but the chapter seems adequate and these factors, especially the dust ingestion, has been receiving considerable attention as the indoor exposure to fire retardants via dust ingestion and dust inhalation have been shown to be important routes of exposure. The differentiation between soil and dust seems clear, although there is a clear overlap between the two. Soil contributes to the "dust" to a different degree, but not the other way around.
Beamer	Estimation of soil/dust ingestion is difficult as there are no direct methods. Further clarification of the methods used would provide more transparency of the available data. The analogy give on page 5-4 to fractions of a teaspoon by volume is difficult to picture. Perhaps consider comparing to something else. For example, your average aspirin is around 325 mg, so your daily soil or dust ingestion would be approximately equivalent to a 6th of an aspirin and the combined about would approximate a 3rd of an aspirin. On page 5-7 perhaps consider addition an equation for the general algorithm described in the second paragraph of the second column? It may be appropriate to list the size fractions of soil and dust that were analyzed for each of the studies. Where the same size fraction of soil used as for dust when dust concentration values were substituted into the algorithms? Studies have demonstrated that particles of soil and dust adhered to hands are generally < 63 microns in size (Choate et al., 2006; Yamamoto et al., 2006). Using concentration values for size fractions soil and dust that are not representative of what might actually be on the hands or ingested might affect the results and contribute to some of the negative values observed. For example in the differences observed in Calabrese et al. 1989 (page 5-9) may be related to different size fractions of soil and dust. Calabrese et al., 1996 (page 5-20) did report differences for some elements in comparing size fractions of <250 microns with those of <2 mm. However these particle sizes are still large relative to what may actually adhere to hands. This was followed up by Stanek et al., 1999, on page 5-21, which indicates that the smaller size fraction of <100 microns had a lower concentration, which would result in increased soil ingestion rates according to their algorithm. Are there any reports for the particles in the 2 to <53 micron particle range for Stanek et al. 1999 on page 5-21? Studies that measured tracers in soil and dust with size fraction of <63 microns should be considered separately if possible. The statement on page 5-8, that only one study (Lásztity et al., 1989) has published using the simultaneous equation method, does not coincide with the description of Barnes (1990) using the simultaneous equation method on page 5-9. Have any studies been conducted to determine absorption rates of these tracer elements?

	This may help EFH users in selecting which tracer element to use. Based on the data from Calabrese et al. (1990), page 5-17, should EFH users rely more on Al, Si, Y and Zr measurements in the other studies? Is there an explanation for the 2 in equation 5-1? For the discussion of Hogan et al., 1998 on Page 5-13, how was the model developed? Or validated? Were parameters fitted independently? Was there a sensitivity analysis? How sensitive was the model to changes in soil and dust ingestion? As these are the value being proposed for EFH recommendations additional information here would be helpful. Does the outcome change significantly if the default value of dust ingestion is changed to 70 mg/day? How about 700 mg/day? Or at least over the range of values measured by the tracer studies? In Calabrese and Stanek (1995) on page 5-19, are any of the recovery rates mentioned for elements in soil or feces? For any of the other tracer studies? What digestion/extraction methods were used? Were the same used for soil and feces? Could the increased content of organic matter in feces influence the recovery rates? Depending upon what acid was used for soil digestion, different recovery rates could be obtained too. For example if a typical nitric acid digestion for soil was used that does not completely extract all elements, especially those within a silicon matrix, how does this compare to the treatment of the soil in the acidic environment of the stomach? Could the acids in the stomach mobilize more elements than the digestion methods used on the soil? It would important to assess the key studies based on these criteria too as this may also explain some of the negative values. Under the section for limitations of key studies: consider adding for tracer element studies that soil/dust size fractions, and digestion/extraction methods of sample analysis may be additional limitations. Limitations for the biokinetic model comparison methodology may be confidence in other model parameters and no discussion of a sensitivity analysis. Choate et al. (2006). Dermally adhered soil: 1. Amount and particle-size distribution. Integr Environ Assess Manag, 2(4):375-384. Yamamoto et al. (2006). Size distributions of soil particles adhered to children's hands. Arch. Environ. Contam. Toxicol, 51(2): 157-63
Bennett	For the most part, NCEA has done a good job summarizing the data. There in one inconsistency with the definition of indoor dust. If the definition of indoor dust includes resuspention, inhalation, and subsequent swallowing of indoor particulate matter, it seems contradictory to assume there is no exposure to indoor dust for adults. Also, is inhalation of particulate matter then clearly excluded from the inhalation pathway? There is very little data available on ingestion of dust. I think the assumptions are adequate in terms on children's ingestion of dust. However, while children clearly have more hand to mouth activity than adults, it also seems unlikely that adults ingest absolutely no dust at all. Also, it does seem odd that there is not an increase in exposure in the age ranges that have the highest amount of hand to mouth activity, however, given

the limited amount of data, it does not seem feasible to determine such differences.

The definition of pica and the assigned value seem to be contradictory. The definition states it is ingestion between 1000 and 5000 mg, yet the central tendency is assigned at 1000 mg.

In the section related to making the values more meaningful, it suggests that 50 mg it 7/1000 of a teaspoon. It might be more useful to reference something smaller, as it is hard to picture 7/1000 of a teaspoon. Additionally, it may make sense to reference the dimensions in terms of mm, rather than cm.

Finley

Comment #1-With a few exceptions (described in subsequent comments), I found that the key and relevant studies were adequately summarized. The format of the data presentations in Tables 5-1 through 5-20 is very helpful.

Comment #2-The distinction between "indoor dust" and "soil" is clear and I agree that both ingestion pathways should be evaluated separately if possible.

However, on page 5-1 it is stated that "it is not possible to distinguish between outdoor settled dust and soil because outdoor settled dust generally would be present on the uppermost surface layer of the soil". This seems to ignore the possibility of outdoor dust that has settled on non-soil surfaces where direct or indirect ingestion of the dust might occur (e.g., playground equipment, outdoor patio furniture, etc.). I am not aware of any studies that have attempted to distinguish "outdoor dust" vs. "outdoor soil" exposure pathways. Yet, one could envision an exposure scenario where contact with outdoor dust, but not soil, is a viable pathway (for example, a family living on a lawn-covered property that is near a contaminated site with exposed soils).

Comment #3- On page 5-3, the "recommended" adult value of 50 mg soil/day is proposed (based on data from Davis and Mirick (2006), yet it is indicated that there are no published data for dust or soil+dust ingestion for adults and therefore no recommendations for these values are offered in the draft EFH. I would prefer to see some attempt to develop values for these ingestion rates from the available data. The Davis and Mirick values are clearly a combination of soil and dust exposure, not just soil (because the adults spent time indoors). Perhaps the Davis and Mirick value should be considered a combination of both, with some percentage assigned to soil ingestion and the remainder to dust ingestion (for a total soil+dust ingestion rate of 50 mg/day). Alternatively, perhaps one could simply assume the same dust and soil+dust ingestion rates as those that have been assigned to the 6-<21 year age group (60 and 100 mg/day, respectively).

Comment #4-The second full paragraph on page 5-3 should be clarified. Specifically, the source study for the soil, dust, and soil+dust ingestion rates (presumably, Hogan et al 1998) should be cited here (as was done for the adult ingestion rates), as well as the fact that this is a biokinetic model study. This would make the reference to "blood lead levels" and other study details ("small number of study subjects") less confusing. Oddly, nowhere in Chapter 5 is the source study for the non-adult soil or dust ingestion rates clearly identified.

Comment #5-On a more general level, the bases of the non-adult soil and dust ingestion rates could be explained more clearly or in more detail. Essentially, the EPA has decided to not rely on any of the numerous tracer element studies, instead focusing on the single "key" study that employed IEUBK blood lead modeling.

At the very least, I think the EFH needs to explain how/why this study (Hogan et al 1998) is superior to all of the tracer element studies of children that have been published over the past 20 years (e.g., the numerous paper by Calabrese, Davis, and Stanek) and which form the basis of the recommended soil ingestion rates in the current EFH; many practicing exposure assessors are very familiar with these latter studies and have applied them in environmental risk assessments in the past. Pushing these studies aside to embrace Hogan will likely represent a "sea-change" to many. In the same vein, I believe it could be made more explicit that ALL of the non-adult values are ultimately derived in whole or in part from the data reported in the 1-6 year age group in Hogan et al (1998).

Comment #6: Regarding the EPA's interpretation of the Hogan et al (1998) study in more detail, I have a few observations.

First, Hogan et al (1998) employed the default IEUBK value of 30% bioavailability. If this estimate is off by a significant percentage for these lead smelting settings, the soil and dust ingestion rate assumptions would similarly be incorrect. How confident is EPA that the default IEUBK biovailability values represented the true soil and dust lead biovailabilities in these settings?

Second, the text on page 5-3 indicates that the soil and dust ingestion rates for the age group 6 months-1 year (both are 30 mg/day) are based in part on the assumption that the relative proportions of soil and dust ingested in this age group are the same as the default values assumed in the IEUBK model for the 1-6 year age group (45% and 55% respectively). This suggests that: 1) the IEUBK model does not have separate dust and soil ingestion rate default values for the 6 month-1 year age group (but does for the 1-6 year age group), and 2) that Hogan et al (1998) estimated a total soil + dust ingestion value of approximately 60 mg/day in the 6 month-1 year age group and chose to apportion 30 mg/day to each pathway. If this is true, then it would be helpful if this was explained more directly; as currently written the reader is required to invest quite a bit of time to "put the pieces of the puzzle together". This could probably be remedied with just a few more line of text.

Third, some commentary on the confidence (or lack thereof) in the 45%/55% assumption in the IEUBK model (for the 1-6 year age group) is warranted, since this directly affects the soil and dust ingestion rates recommended for the 6 month-1 year age group. More specifically, are these default percentages based on actual measurements in 1-6 year olds or are they simply "guesstimates"?

Comment #7: On page 5-3 of the document, the EPA indicates that there are insufficient data to support the development of a distribution for use in probabilistic risk assessment. I'm not sure I agree. Over 30 different analyses of soil/dust ingestion rates, mostly in children, are described in the EFH. There are published probability distributions of soil ingestion rates that are likely outdated (e.g., Finley et al 1994) but which could provide a "road map" for developing a child soil ingestion rate distribution with or without the pica behavior included.

Comment #8: There is no discussion of soil particle size or organic content and the

	possible influence these factors might have on soil or dust ingestion rates. Since dermal contact with soil/dust has a direct influence on soil/dust ingestion rates, and because dermal adherence is governed in part by soil properties, such a discussion might be worthwhile. Perhaps this is beyond the scope of the EFH. **Comment #9:** Presumably, the dust ingestion pathway is evaluated in order to ultimately understand the risks posed by outdoor soils. Exposures and risks associated with the soil + dust ingestion pathway often "drive" the risk at a contaminated property. In some instances, the dust ingestion pathway poses the highest risk because, although the dust and soil ingestion rates are similar, the indoor dust concentrations are much higher than those found in soil. But what if the indoor dust is comprised primarily of non-soil components? For example, consider a home where little soil is tracked into the house (because of little to no exposed soil around the home) but the home contains a fireplace that is used frequently and perhaps a significant degree of cigarette smoking occurs in the house. The indoor dusts might contain a relatively high concentration of polycyclic aromatic hydrocarbons and/or dioxins that are completely unrelated to soil contamination. How does one estimate or otherwise account for the levels of soil in indoor dust, which are certain to be very site-specific? **Comment #10**: The nature of the soil and dust exposures that occurred in Hogan et al (1998) should be discussed briefly. For example, were these settings where the children were consistently in contact with exposed soil? Or did relatively little direct contact occur? And does this need to be considered when using the EFH soil ingestion factors in a risk assessment? **Comment #11:** As described in Davis and Mirick (2006), consumption of unwashed garden produce (from a backyard garden) is a potential source of soil ingestion. Although Davis and Mirick (2006) indicated that there was no association between vegetable/ fruit consumption and soil ingestion rate, they also acknowledge that the study design would not have detected an increase in soil ingestion via this pathway (because any soil on unwashed fruits/vegetables would have been analyzed and recorded as a food source). So, my question is whether this is a potential pathway that warrants consideration and if so, are there any soil ingestion rates that should be recommended? **Comment #12:** Swallowing of inhaled soil particles is accounted for in the "key studies" used to derive the recommended ingestion rates. I believe the EFH should make it clear that this pathway does not need to be considered separately in exposure assessments.
Stern	Given the limited data and the often confusing multiple re-analyses of the limited data, the EFH does a good job in presenting and summarizing the available data. However, with respect to soil and dust ingestion and the distinction between them, the discussion is confusing. This is particularly the case because the existence of indoor soil-derived dust is not directly addressed. Indoor soil ingestion is discussed, but it appears that this term is applied only to ingestion of soil deliberately brought indoors (e.g., potting soil for indoor plants). However, soil material can be transported into the house where it can mix with dust of indoor origin to produce a heterogeneous dust material. Ingestion of indoor dust, therefore, also results in soil ingestion. Also, the transport of soil indoors appears to be dealt with only with respect to material that is "tracked in." However, small size soil-derived particulates can also be transported indoors by air, particularly with open

windows.

Additional Comments

General – A clear description of how the recommended soil ingestion values were extracted from the various studies and analyses is lacking. Also, the relationship of soil and indoor dust and the overlap with respect to soil-derived indoor dust is not clearly defined.

Pg. 5-3, par. 3 - The nature of the recommendation for "soil only" for outdoor or indoor sources or both needs clarification. As written, it seems to include exposure to outdoor soil while indoors (i.e., indoor soil-derived dust). In actuality, it probably refers to indoor soil (e.g., potting soil). The question of ingestion of indoor soil-derived dust needs to be addressed. Is this implicitly included in the 30 mg/day recommendation?

Par. 5 - "*…due to the significant number of observations in the U.S. tracer element studies that are at or exceed that quantity, the recommended soil pica ingestion rate is 1,000 mg/day*" This would seem to imply that 1,000 mg/day is an underestimate of the central tendency value for pica soil ingestion. Given that, I don't understand the basis for selecting 1,000 mg/day as the recommended value for this parameter.

Pg. 5-11, 5.3.2.5 - This needs more discussion as the values are largely unclear.

Pg. 5-13, par. 4 - What does it mean that "exposures… had been collected?"

Par. 7 - While the relatively close matches are consistent with the 50 mg/day estimate, the accuracy of the estimate depends on the slope of the relationship between soil Pb and blood Pb. If the slope is very shallow, then there may be a large uncertainty in the estimate.

Pg. 5-20, par. 5 – More explanation is required to explain how the estimate of 31.3 percent of the weight of indoor dust comes from outdoor soil is derived from the parameters described in this paragraph. Also, the last two sentences in this paragraph are confusing and difficult to follow.

Pg. 5-24, par. 3 - This explanation is not clear.

Pg. 5-25, par. 2 - *"The second source of potential bias…"* This explanation appears to fall under the general rubric of multiple compensating errors. It might be easier to describe it in those terms.

Pg. 5-26, par. 6 - *"…or outdoor soil tracked inside buildings by human or animal building occupants."* Here and elsewhere in this chapter, soil-derived indoor dust is associated with tracking of soil into dwelling. There is no reason to discount the transport of soil derived particulates into dwellings as ambient airborne particulates.

Pg. 5-27, par. 3 - *"The 64 children in the Calabrese et al. (1997a) study apparently were a stratified random sample…"* This statement is not meaningful unless we are told on what basis the stratification was done. Also, for section 5.4.4 as a whole a summary synthesis section is needed to evaluate the quality and applicability of the overall database. Section 5.4x is only concerned with the *limitations* of the database. Given that values are derived and suggested for use a summary statement that is either overall positive or negative is warranted.

Pg. 5-33, table 5-5 - This table is not self-explanatory.

Chapter 6 – Inhalation Rates

Anderson	See comments for General Questions
Blaisdell	The increased appreciation of the differential sensitivity of children has led USEPA to use different age categories useful for estimating risk of appropriate age ranges of children. As the Handbook points out children have greater exposure than adults on a per kg body weight basis for inhalation. In order to properly assess the dose (mg/kg BW—day) for various age group the unit risk factor needs to be expressed an inhalation cancer potency factor in IRIS. The Office of Environmental Health Hazard Assessment (OEHHA), California Environmental Protection Agency used a simple assumption of 20 m3 per day and a 70 kg body weight in order to convert unit risk factors to an inhalation cancer potency factor. A more sophisticated approach might be possible. The recommended breathing rates in Table 6.1 also need to be expressed in L/kg-BW—day. The information is available for the studies you recommend. OEHHA is in the process of updating our Exposure Assessment and Stochastic Analysis Document. We have recently reviewed the available literature on breathing rates. We would suggest that Brochu et al. 2006 (really Butte et al. 2000) be used for breathing rate for 0-2 years rather than including Arcus-Arth and Blaisdell 2007 with Brochu et al. 2006. There may not be enough data from Brochu et al. 2006 to determine the age ranges birth to 1 month, 1<3 months, 3<6 months, 6<12 and 0<2years. The doubly labeled water method measures breathing rates over a two-week period and gives a better estimation of typical breathing rates than 2-day caloric intake method in Arcus-Arth and Blaisdell 2007, particularly for the upper percentiles. Since the early in life potency of carcinogens in the 0-2 age range contributes a large fraction of overall lifetime risk, it is important that the upper percentiles or high-end estimates are not overestimated. One of the general weaknesses of the doubly labeled water studies compiled by Brochu et al. 2006 is that subjects are not representative of the general population. However, it seems intuitively obvious that the range of inter-individual variability is lower in the 0-2 age range and therefore there should be less concern that a particular group would be non-representative, particularly in light of fairly large N of 76. The study also offers the rare advantage of repeated measures on the same individuals. This means that 95th percentile is more likely to represent interindividual variability. The method of Layton 1993 used by Arcus-Arth and Blaisdell 2007 has a greater likelihood of an overestimated 95th percentile because the two days of intake data for each individual do not capture typical intake. In addition, caloric intake is not tightly coupled to breathing rate on any given day, only on the average. We agree with the approach that you have suggested for other ranges. The upper percentiles of Arcus-Arth 2007 and USEPA, 2009 probably represent overestimates of the upper percentiles and the Brochu et al 2006 data suffer from not being representative but all three data sets are close.
Gaylor	Tables 6-1 and 6-2 provide adequate inhalation exposure rate factors for most risk

	assessment situations. Table 6-1. Since means increased up to 16.3 m^3/day up to 21 years, it does not appear biologically credible that the mean for the 21 to < 31 years group would drop to 15.7 m^3/day and then the mean for the 31 to < 41 years group would again increase. Statistical smoothing techniques should be employed to provide recommendations that are biologically credible across age groups. Similarly, data smoothing should be employed for ages 21 to < 61 for the 95th percentiles. Table 6-2. Similarly, statistical data smoothing techniques on means and 95th percentiles across age groups should be employed to obtain biologically credible recommended inhalation rates. Special attention should be given to the comments on Chapter 6 submitted by the Tri-Service Environmental Risk Assessment Risk Assessment Work Group and from the American Chemistry Council, dated November 30, 2009.
Georgopoulos	As in the case of Chapter 3, Chapter 6 provides a rather thorough overview of studies on inhalation rates; again, the overall usability of the information provided could be enhanced through the addition of some graphical representations of the information contained in the tables. The list of the studies identified is again quite exhaustive; some potential additions could be the following: • [Allan *et al.*, 2008] It provides an update to previous work that creates probability density functions (PDFs) for daily inhalation rates (IR) using time-activity-ventilation (TAV) approach (activity associated with MET values); results compared to approaches using metabolic energy conversion (MEC) and doubly-labeled water (DLW) and suggest that lower IR in younger age groups and higher IR for adults and elderly • [Bennett & Zeman, 2004] Examines variation of breathing pattern in children, shows that increased BMI affects a child's inhalation rate, an important point as childhood obesity becomes a greater issue; new data collected for this study and analysis • [Bennett *et al.*, 2008] Identifies the nasal contribution to breathing at rest and during exercise for both children and adults; important consideration for exposure assessment because oral breathing means that nasal filtration has been bypassed; new data collected and analyzed for this study and compared to other available data • [Phalen, 2009] This is standard textbook in the field; it provides basic information on the “mechanics” of inhalation studies; could be a “suggestion for further reading” for those who want to understand better the potential and limitations of available methods. • [Ridley *et al.*, 2008] Presents a method for estimation of energy expenditure levels in children/adolescents for different levels of activity in different

	settings; examines data from previous studies • [Ridley & Olds, 2008] Presents a comparison of methods for assigning energy expenditures in children (i.e., analysis of existing data) • [Speakman & Selman, 2003] Effects of physical activity on Resting Metabolic Rate (RMR) which is a large component of daily energy expenditure; contains information on existing animal and human studies which address short-term responses to a single bout of exercise and the effects of long-term training • [Thompson *et al.*, 2009] In fact Chapters 6, 7 and 8 (inhalation rates, dermal factors, body weight) could all benefit from the database of physiological values relevant to elderly subpopulations that is discussed in this article. • [Westerterp, 2003] Presents measurements of energy expenditure: effects of body size, age, and effects of exercise (including high-intensity exercise, long-term training, etc.); examines and analyzes existing data with new criteria
Lebowitz	<u>General Comments:</u> It appears that major attributes of the respiratory system need to be reconsidered to properly evaluate exposure-dose-response & risk assessments, especially the system's anatomy, physiology, and immunology, in relation to age, gender, race, size, and activity level in order to properly address exposure factors for inhalation. Anatomically, major parts of this Chapter ignore the nasal-pharyngeal & oral-buccal, tracheal-bronchial, and bronchiole regions and focus only on the alveoli in the parenchyma of the lung. Given that much of the impact, including particle deposition, of pollutants is in these regions, and that they influence the physiology and immunology of the lung as well, there should be more consideration of them. Also, the chapter basically ignores muco-ciliary clearance, etc. Further, these are major regions in the development and deterioration of the system that influence inhalation rates at different ages. Specifically, the newborn, infant's and child's lungs are smaller with fewer alveoli for gas exchange, they have different pressure-volume and –flow characteristics, and therefore will require greater inhalation rates for gas exchange earlier in life. (Newborns especially, and to varying extents, infants and children, compared to adults have low pleural pressure at resting volume, low functional residual capacity as a ratio to total lung capacity (FRC/TLC) and high specific compliance of the chest wall, thus having different volume-pressure curves.) Also, the intercostals muscles are less well-developed requiring further work of breathing and, thus, affect inhalation rates and exposure-response characteristics. Given the immature status of the tissues and cells therein, the effects/responses will likely be greater and have impact on further growth and development. There are major, mostly exponential, changes in the anatomy and physiology of the lung during the newborn-infant-child period up to the age of 9-12, and then somewhat of a

plateau in lung function, then a decline in function starting somewhere between ages 20-35 (depending on population characteristics and patho-physiological changes during growth, including the possible effects of prior exposures).

Deterioration with age due to anatomical and physiological factors, exposure-dose-response effects and patho-physiological changes that have occurred are very important as well when considering inhalation rates in older ages; they have different pressure-volume and –flow characteristics. (It is debated whether the decrease in these measurements with age is linear or exponential.)

Inhalation rates are a function of weight only when dealing with obese individuals with fat depositions that interfere with the breathing muscles (diaphragm & intercostals). However, all volumes, including tidal volumes (actual inhalation under normal conditions) are a function of height, as well as age and usually vary as well by gender and race. Volumes will be different for individuals of different height but of the same age, gender, and race. Standard volume and flow (e.g. FEV_1 equations are height and volume corrected within race and gender groups. (APS Handbook of Physiology – Respiration Vo1. I, Table 1 (p.388) provides vital capacity (VC) divided by height cubed (VC/H^3 in L/m^3) for over 3000 healthy men from ages 18-64, and shows that it increases from 0.990 at ages 18-19 to 1.025 at ages 20-29, then declines to 0.930 at ages 60-64.)

Inhalation rate can be equated with the physiological measurements “respiratory rate” (RR), “minute ventilation”, “expired volume” (V_E), and “tidal volume” (V_T). V_E is the volume of air exhaled, usually equivalent to inspired volume, and V_T is the volume inhaled and exhaled normally, at rest or with exercise; both volumes vary as all volumes do by height and age, usually differs by gender and may differ by race (see references). Minute ventilation = RR x V_T. V_E goes from 8 L/min. at rest to 42 L/min. at 4.6 km/hr, 15% grade (BTPS corrected) in healthy men; V_T varies from 0.6 to 2.6 L/min. (APS).

Specific Comments:

6.1:

Paragraph 1: Sentence 4 should be reworded: “…, and may also inhale chemicals and particles from the indoor use of various sources (e.g., stoves, heaters, fireplaces, consumer products as well as from those that infiltrate from ambient air. Sentence 5 should add the word “behaviors”.

Para. 2: Sentence 1 states at the end “that require cooling”; this is inappropriate; see general comments. The example provided by WHO in sentence 2 does not address the volumes and inhalation rates as found in pediatric pulmonary physiological studies that reference them in terms of length of the newborn/infant/child. The comparison of volumes inhaled between infants and adults that follows may be different if evaluated by length-height calculations, and it doesn’t coincide with the totals for inhalation per day provided in Table 6.1.

Para. 3 ignores the anatomy and physiology of the respiratory system (discussed above) and ignores the doses to the upper respiratory tract (especially the nasal-pharyngeal and tracheo-bronchial regions).

Para.4, I think, is trying to say that children more often breath through their mouth, especially with greater activity and during certain behaviors associated with more oral activity.

Para. 6 refers to the simple way, of using averages, in calculating dose-response relationships. Most of the EPA AQC documents, however, use data that use varying concentrations, with exposures at different activity levels, and when available to those with breathing and/or lung problems (e.g., with obstruction or inflammation). The statement in paragraph 8 may be too simplistic for realistic dose-response calculations as well.

6.2:

Paragraph 1 does not refer to the more important correlation between inhalation and height (as discussed above.

Paragraph 2 and Table 6.1 – why are averages of the inhalation rate data from the key studies used rather than showing the range and variability? Why were males and females combined?

6.3:

6.3.1 – Brochu et al., 2006a – this study utilized oral doses of water to calculate inhalation doses.

6.3.2 – EPA, 2009 – This is a very interesting way to calculate inhalation rates, though it doesn't actually use any respiratory physiological data. Its limitations are indicated to some extent; there is little discussion about the limitations of the assumptions. The data obtained are for body weights and do not reflect differences by height. The tables show differences by gender and activity levels in weight-adjusted inhalation, as expected, but not reflected in the summary tables 6.1-3.

6.3.3 – Arcus-Arth & Blaisdell, 2007 – This study calculated breathing rates from energy-dependent rates assuming that energy equivalents were satisfactory (accurate and precise) equivalents to volumes of oxygen, and not related to actual measurements of the volumes of air inhaled. Limitations of the energy data are indicated as well.

6.3.4 – Stifelman, 2007 – this study has the same problems as the Brochu et al. (2006a) study mentioned above.

6.3.5 – Averaging doesn't appear to use weighted averages or statistical methods of calculating combined distributions from which an average and percentiles could be derived. The differences in results from these studies are significant enough to question the notion of averaging *per se*.

6.4:

6.4.1 – ICRP, 1981 – this approach is far better than those mentioned above. The sources of the inhalation raw data, supposedly being questioned herein as to their accuracy and validity and producing uncertainty in the minds of the authors of this chapter, were evaluated by the ICRP, and the authors of this chapter could have obtained that information from both the ICRP and the original data sources to remove such uncertainty.

Some of the advantages of these ICRP estimates are: they account fairly well for time and activity and were gender specific.

6.4.2 – EPA, 1985 – The data and results from this study could have been researched further to reduce the uncertainty in the authors of this chapter, as its approach is better than that of the studies presented in section 6.3.

6.4.3 – 6.4.7 & 6.4.10 - Studies from the Hackney USC RLA lab – These are excellent studies with excellent physiological measurements from a group and lab that has had very high respect from the pulmonary and physiology professional community. Their methods were accurate and precise, and are considered valid and reliable. More attention should have been paid to the results of their studies for short-term inhalation rates even though their limited numbers of subjects are not necessarily representative of the general USA population. (I wonder if there aren't some similar data from the EPA – RTP HERL chamber studies and those from other similarly highly qualified applied physiologists referenced in the EPA AQGs.) It might be worth considering a "meta-analysis" with appropriate sensitivity analyses, of such data sets and extension of short-term estimates to long-term estimates.

6.4.8 – Adams, 1993 – This study appears to have the potential to contribute a lot to the understanding and data base for short-term inhalation. This reviewer is not as well acquainted with this study as with those mentioned in the last paragraph and would have to review this gray literature report. However, if of high quality, then the comments would be similar to those made in the last paragraph.

6.4.9 – Layton, 1993 – The caveats/concerns expressed in the sentence starting with "However, …" are shared by this reviewer and pertain as well to those presented in 6.3.2 & 6.3.3 above.

6.4.11 – Rusconi et al., 1994 – These data appear to be obtained with adequate attention to methods and QC and could be utilized in broader physiological analyses of inhalation rates. Comparisons to data in pediatric pulmonary physiology literature would have to be performed as well to compare these data obtained in Italians to that obtained in USA and other countries' infants and children. Spirometric data obtained in adults would indicate some differences between USA and Italian subjects.

6.4.12 – Price et al., 2003 – These data obtained from modeling, not meant for the specific purpose of determining exposure or intake dose, need to be validated against actual physiological data prior to being used for purposes other than that stipulated by Price et al.

6.4.13 (mislabeled 6.3.13) – Brochu et al., 2006b – the comments on this approach are those made for Brochu et al., 2006a, above.

Summary Comment: Exposure Factors for Inhalation Rates needs to be reexamined for the reasons discussed.

	Additional references utilized by the reviewer: American Physiological Society (APS) Handbook of Physiology, Section 3, Respiration, Volumes I & 2. APS, Washington, D.C., 1964. Bates, DV. Respiratory Function in Disease; 3rd Ed. Saunders, Philadelphia & Toronto, 1989. Cherniack, R. et al. Respiration in Health and Disease; 2nd Ed. Saunders, Philadelphia, 1972. Forster E, et al. The Lung: Physiologic Basis of Pulmonary Function Tests, 3rd Ed. Chicago, YearBook, 1986. Phelan, PD, et al. Respiratory Illness in Children, 3rd Ed. Blackwell, Oxford, 1990. USEPA. Air Quality Criteria Documents. EPA, RTP, various dates. West JB. Respiratory Physiology. Williams & Wilkins, Baltimore, 1974. West JB. Pulmonary Pathophysiology, 3rd Ed. Williams & Wilkins, Baltimore, 1987.
Zaleski	A general observation is that inhalation rates vary significantly by gender. Up to now, standard practice is to provide gender specific inhalation rates, and that is how rates are provided in the key studies cited in this section. It is unclear why EPA includes only combined gender recommendations in this current document. EPA should provide recommendations by gender. Recommendations expressed on a body weight basis, by age and gender, would be most useful. The chapter's approach taken for long-term estimates, which considers all available data, and averages across studies, seems reasonable. Each methodology for inhalation rate estimation has associated strengths and weakness. However if there are known limitations with a specific approach, these should be acknowledged and enter into the determination of data use. In particular, there are limitations with the EPA 2009 report that can lead to upward bias of inhalation rates. The approach take in EPA 2009 is a step-out with potential to add to our estimates of inhalation rates. However, the analysis is limited by the available data set (inability to link body weight with time activity patterns). A detailed analysis of an earlier draft version of EPA 2009 was previously submitted during the review of the Child Specific Exposure Factors Handbook, and is attached. The comments submitted included a number of suggestions that would better assess the representativeness of the analysis and should be considered before application of the results. In this final EPA 2009 report, no changes were made in the analysis approach or the result tables, but an annex has been added that addresses comments received on the earlier draft report. The annex indicates that inhalation rates obtained with the study methodology are generally similar to those obtained with other methods. However, the annex analysis is indicated to be done for individuals of normal body weight (EPA 2009, p. D-7: Figure D-2 compares ... for several age groupings of normal-weight individuals; and the same for Figures D-4 through D-7). A key concern with the EPA 2009 analysis, that could lead to upward bias

in the study estimates, is that activity data from the Consolidated Human Activity Database were linked to gender and age but without the ability to link to body weight. As a result, high physical activity levels can be associated with individuals of high body weight, leading to unrealistically high inhalation rates. These rates not only raise the upper distribution, but will increase the mean as well. The annex analysis, as presented, does not adequately address this point. Indeed, EPA 2009 acknowledges that upper percentile values are "more uncertain.... and are unlikely to represent an average individual."

Further, in discussion of EPA 2009 on pages 6-7 to 6-8 of the draft EFH, the following key limitations should be included for transparency: a) as just discussed, that inhalation estimates were based upon linking activity to gender and age, but body weight was not considered (this limitation is acknowledged on p. 2-6 of EPA 2009; b) the basis for the metabolic distributions is not well documented (adequate documentation was not readily found in the CHAD 2002 reference cited on p. B-3 of EPA 2009); c) both time activity (Table 2-3 of EPA 2009) and metabolic information are limited (p. 4-12, 4-13 of EPA 2009) for children as compared to adults. Because of the latter observation, EPA 2009 should not be used as the basis for inhalation rates for children. This type of information should be transparently acknowledged for any study that is used.

Also, there are notes on several of the draft EFH tables (e.g. Table 6-1) that some 95th percentiles may be unrealistically high and not representative of the average person (for example, a caloric intake of > 4000 kcal/day is associated with the 95th percentile for the 16 to <21 age category). In this case, it is not clear why the draft EFH upper percentile recommendations are based on 95th percentiles when a lower percentile that may result in a realistic value would be more appropriate. In particular, 95th percentiles based upon EPA 2009 are inappropriate as the uncertainty in these higher percentiles is noted within the primary document. In general throughout the draft EFH, as Chapter 1 indicates that upper percentiles are based upon 90th percentiles or higher, and the current EFH in some cases utilizes the 90th percentiles, a justification should be provided when a change has been made to a different percentile.

It is unclear why Layton (1993), which serves as the basis for recommendations in the current EFH, is no longer considered. As indicated above, utilizing information across study methodologies is appropriate given the strengths and limitations of each one. The key references cited do not include any more recent studies for adults that utilize the approach take by Layton (estimates based upon adult food consumption data).

It is unclear why short-term recommendations are based upon a single study. Again, these should be averaged across studies given the strengths and limitations of each approach. In particular, short-term recommendations should not be based upon the EPA 2009 study for the reasons provided above. As indicated above, recommendations for children should not be based upon EPA 2009..

Chapter 7 – Dermal Exposure Factors

Beamer

See comments for General Questions

Ferguson

1) *Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?*

Answer:

Still troubled by the fact that this is an exposure factor handbook and yet the document still uses the word exposure and dose so interchangeably. Second paragraph of page 7-1, column 1 says…"These are only two of several parameters that influence dermal absorption." While this is technically true, these are only two factors that influence dermal exposure also. The book needs to first focus on exposure, then build up to express what is needed for dose (which is not covered in this book). What affects dose for dermal exposure is the exposure profile on the skin (time on skin and amount on skin), along with the skin and chemical properties (that influence that uptake rate).

Page 7-3, Only paragraph

It is mostly right to say that skin adherence values do not consider the influence of skin moisture on adherence. To some extent, we might see a similarity with results for soil moisture. Greater adherence to some maximum level might be expected. Also, humidity in the air (a type of moisture) can also affect adherence.

Some readings on chemical adherence and moisture (even though not directly for the chemical from the soil matrix):

1) Williams, R. L.; Reifenrath, W. G.; Krieger, R. I. Artificial sweat enhances dermal transfer of chlorpyrifos from treated nylon carpet fibers. J.Environ.Sci.Health. 2005, 40, 535-543.

2) Williams, R. L.; Aston, L. S.; Krieger, R. I. Perspiration increased human pesticide absorption following surface contact during an indoor scripted activity program. J.Expos.Anal.Env.Epidemiol. 2004, 14(2), 129-136.

3) Edwards, R. D.; Lioy, P. J. Influence of sebum and stratum corneum hydration on pesticides/herbicide collection efficiencies of the human hand. Appl.Occup.Environ.Hyg. 2001, 16(8), 791-797.

Somewhere, it might be useful to mention that the entire chemical contained in the soil matrix may not be absorbed into the skin. Diffusion through the soil layer can be slow and the skin may only see the chemical contained the monolayer of soil. Papers by Annette Bunge have discussed some of these concepts.

Table 7-1:

Under age groups for children, before Birth to <1 month, above that put "Both Sexes". Same for similar tables.

Figure 7.1

Consider not dark shading in frequency distributions.

Table 7-17

Was there a time component to how long these activities were for the overall loading? This should be included in the Table.

2) *Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?*

Answer:

This chapter focuses on two exposure factors needed for the calculation of dermal exposure. Surface area of bodyparts for populations and soil loading. The dermal exposure route is a complex route of many mechanisms of exposure or loading of a chemical on the skin surface. There is soil loading, residue transfer, immersion and deposition. I think on Page 7-1 would could express dermal exposure in this manner more explicitly. Surface area and soil loading are factors that are not chemical specific, as the EFH clearly says that it does not provide chemical-specific factors. Surface area exposure during contact with objects or surfaces is another non-chemical specific exposure factor needed for dermal exposure assessment and we should try and find some data for that factor.

Chemical adherence to the skin is an important factor that should be given in the EFH in the future. Currently it is collected at a chemical specific level. We need to find a way to express this factor for a class of compounds or adherence specific scenario.

Many models use data on the duration and frequency of contact with objects and surfaces in the environment for children, typically gathered through videotaping and video-translation methodologies. This type of activity patterns is very similar to the mouthing exposure factors presented in Chapter 4.

Page 7-13. Section 7.3.2.3

The Wong study on children's dermal contact activities seems to stand alone. It is not exactly data on soil loading or surface area of bodyparts (the two factors covered in this chapter). It really stands alone, and is useful data. Can EPA explain how this study would be useful for the user for dermal exposure and are there any more papers that look at this dermal exposure factor?

Page 7-15, Paragraph 1, Column 1

The Que et al., 1985 soil adherence should be expressed in mg/cm^2 to be consistent with other studies covered in this section.

Here are some papers to consider for other needed exposure factors (this is needed and mentioned for non-dietary):

Surface Area during contact

1) AuYeung W, Canales RA, Leckie JO. "The fraction of total hand surface area involved in young children's outdoor hand-to-object contact. Environ Res. 2008 Nov;108(3):294-9. Epub 2008 Aug 29.

Dermal activity patterns or modeling dermal and non-dietary (there may be more in the field)

1) Zartarian, V. G.; Ferguson, A. C.; Leckie, J. O. Quantified dermal activity data from a four-child pilot field study. J.Exp.Anal.Environ.Epidemiol. 1997, 7, 543-552.

2) http://www.ncbi.nlm.nih.gov/pubmed/15028002?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=9Riley WJ, McKone TE, Cohen Hubal EA. "Estimating contaminant dose for intermittent dermal contact: model development, testing, and application." Risk Anal. 2004 Feb;24(1):73-85.

3) http://www.ncbi.nlm.nih.gov/pubmed/10856023?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=14Zartarian VG, Ozkaynak H, Burke JM, Zufall MJ, Rigas ML, Furtaw EJ Jr. " A modeling framework for estimating children's residential exposure and dose to chlorpyrifos via dermal residue contact and nondietary ingestion, Environ Health Perspect. 2000 Jun;108(6):505-14.

3) *For the factors included in the EFH, are you aware of other data sources that have not been identified?*

Publications containing data on soil adherence to human skin that have not been included in the EFH, include the following:

1. Ferguson, A., Bursac, Z., Coleman, S., and Johnson, W., "Computer Controlled Chamber Measurements for Multiple Contacts for Soil-Skin Adherence from Aluminum and Carpet Surfaces," Human and Ecological Risk Assessment, 15(4): 22-49, 2009.

2. Ferguson, A., Bursac, Z., Coleman, S., and Johnson, W., "Comparisons of Computer Controlled Chamber Measurements for Soil-Skin Adherence from Aluminum and Carpet Surfaces," Environmental Research, 109(3), 207-214, 2009.

3. Ferguson, A., Biddle, D., Coleman, S., Bursac, Z., and Johnson, W., "In-Vitro Soil Adherence for Dermal Exposure Using a Controlled Mechanical Chamber," Journal of Applied Sciences Research, 5(2): 232-243, 2009

4. Ferguson, A. Bursac, Z., Biddle, D., Coleman, S., and Johnson, W., "Soil-Skin Adherence from Carpet: Use of a Mechanical Chamber to Control Contact Parameters," Journal of

Environmental Science and Health, Part A, 43(12), 1451-1458, 2008.

One of these papers contains information on multiple contacts with soil, but would also require a discussion on how this type of data would be important and on the fact that soil can transfer back from the hand to the surface. Ultimately really a discussion of maximum loading would be required.

Other papers not covered in EFH:

5. Choate, L. M.; Ranville, J. F.; Bunge, A. L.; Macalady.D.L. Dermally adhered soil: 1. amount and particle-size distribution. Integr.Environ.Assess.Manag.

6. Rodes, C. E.; Newsome, J. R.; Vanderpool, R. W.; Antley, J. T.; Lewis, R. G. Experimental methodologies and preliminary transfer factor data for estimation of dermal exposure to particles. J.Expos.Anal.Environ.Epidemiol. 2001, 11, 123-139.

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

Answer:

To some extent it is understandable why studies that show soil loading by activity have been chosen as key studies. For an easy, quick calculation, this simplifies into a one loading on the skin for the day, based on an exposure scenario.

However, the field has advanced where we need for exposure models, data on a loading per contact event. Controlled studies that look at the data in that manner are quite useful. What gets defined as key and relevant may be subjective, but seems here to be divided along the lines of set activities as opposed micro-loadings or event loadings. But in fact the relevant studies are more controlled studies of adherence, and in terms of confidence ratings might score higher.

EPA tends to call these 'relevant' dermal loading studies of "short activity duration" but, again these are useful for models that look at individual contact events.

Use of data from Gehan and George (1970) and Boyd (1935) seems dated, and EPA should look to conducting newer measurements, given changes in US population average weights for all ages. Or maybe there can be an application of a factor increase on weight into surface calculations, based on newer CDC data on population weight changes.

In light of that comment, Table 7-11 combines the U.S. EPA (1985) measurements (based on the older data) with the NHANES 2005-2006 study. How well did the weights and heights compare for the population?

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

Answer:

See general answers above.

Table 7-3

For currency, it says that the age of data is not expected to affect its utility. If weight changes in the population are dramatic, surface area predictions based on weight may change.

Table 7-3

How does one key study for total surface area and one key study for surface area of bodypart translate to medium confidence. I assume the medium confidence is for the Peer Review only?

Table 7-3. Page 7-8

It says….”Because of small sample size..” can you put the sample size in this table for easy viewing?

Tables 7-4, 7-5

It is to be noted that the Holmes, Kissel, and Shoaf studies come from the same lab. It has its advantages and disadvantages. This creates consistency in methodology, but not necessarily objectivity. This needs to be expressed in the confidence ratings. Also, I think EPA should contact these authors to find out more on quality control and include in document and even improve confidence rating.

6) *Please comment on whether data variability has been adequately characterized and described.*

Answer:

Variability in soil loadings is expressed by activities in the key studies, and there are quite a number of activities to choose from. Variability by race/socioeconomic status is not expressed in the key studies, and maybe not relevant for this exposure factor. Any further expression of variability is limited by the data available for this exposure factor.

Variability in surface area is expressed by different age ages, and male and female adults. Any further expression of variability is limited by the data available.

	7) *Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?* <u>Answer:</u> See general comments.
Finley	See comments for General Questions
Georgopoulos	Chapter 7 specifically limits its focus on the two areas of "measurements of body surface areas" and of "dermal adherence of solids to the skin." References are given for more comprehensive guidance relevant to dermal exposure assessments: these references are specifically USEPA reports from the early 1990s. In this reviewer's opinion, some of the additional exposure factors (other than the chemical-specific aspects, that are beyond the scope of the EFH), that are already mentioned on page 7-1 (variation of the thickness of the stratum corneum over different parts of the human body, variation of this thickness with age/gender, impact of exogenous and endogenous conditions that may effect absorption rates, etc) should, even briefly, addressed in Chapter 7. Specifically, it would be useful to incorporate in this Chapter: • A discussion providing linkages with data on activities contributing to dermal exposure to liquids and gases (e.g. bathing, swimming, etc.) • Representative data on changing skin surface thickness (for different body areas) with development and aging. • Representative non-chemical specific data on dermal permeability transport rates for broad groups of compounds, focusing on the general mechanisms that dominate these rates and the exposure conditions that determine these mechanisms. • A discussion of the influence of activity levels (i.e. of metabolic effects and of corresponding blood rates) on dermal absorption rates, that can significantly influence uptakes through the dermal route. • A discussion of how the dermal absorption of contaminants could be underestimated or overestimated, if appropriate information for the above factors is not - or is not expected to become - available. There are numerous references (in addition to those already listed in Chapter 7) for the "omitted" dermal exposure factors; for example, as mentioned earlier [Thompson *et al.*, 2009]contains some relevant information for the elderly; other suggested "standard" references include [Elias *et al.*, 1981] [Barratt, 1995] etc.
Zaleski	The increase in skin surface area values is directly related to the increase in body weight based upon newer data. This should be made clear within the text.

Chapter 8 – Body Weight Studies

Blaisdell	I agree with the plan to include the NHANES data since the data are more recent. The chapter does not cover the literature on the percent of total produce consumption that is homegrown. Such information is needed when the backyard garden exposure scenario is used. This information is most useful for the broad categories of produce.
Gaylor	Section 8.3.1. 4th paragraph. This paragraph on calculating percentiles would be much clearer if the weights are identified as <u>sample</u> weights as distinguished from <u>body</u> weights. Table 8-1. A mean body weight of 80 kg should not be used for all adults. Table 8-3 lists a mean value of 68.5 kg for adults over 80 years, a value 14% less than 80 kg. It is suggested that the recommended mean body weight for adults over 80 years should be listed as 68.5 kg. Tables 8-8 and 8-9 footnotes. Φ_2 and σ_2 are the mean and standard deviation, respectively, of the $\log_e$ (body weight) for an age group. They are not the mean and standard deviation of the lognormal distribution as incorrectly indicated in the foot notes. The mean of the distribution is still the sum of the body weights divided the sample size. Designating the distribution as lognormal, gamma, or whatever does not change the mean or standard deviation. Identifying the shape of the distribution does alter how percentiles are estimated mathematically. Tables 8-8 and 8-9. It should be indicated that the (antilog $_e \Phi_2$) provides an estimate of the median of the distribution. Tables 8-8 and 8-9. Let x represent body weight and V(x) represent the variance (standard deviation squared) of body weight. The variance of ln x ($\log_e$ x) is approximately $$V(\ln x) \approx (\partial \ln x / \partial x)^2 \cdot V(x) = (1/x)^2 V(x) = V(x) / x^2.$$ The square root of the V(ln x), i.e., the standard deviation of ln x, designated as σ_2 is approximately equal to $\sqrt{V(x)} / x$ which is the coefficient of variation of the body weight. This should be noted for Tables 8-8 and 8-9. For example, for $\sigma_2 = 0.20$ the standard deviation of body weights is 20% of the mean.
Georgopoulos	Some potentially useful references include: [Hermanussen & Burmeister, 1999]. [Frisancho, 2008],[Heymsfield, 2005], [Heyward & Wagner, 2004], [Lentner, 1981], [Thompson et al., 2009] [Willmann et al., 2007] This is work that provides estimates for probability distributions

	of various organ volumes and blood flows in the adult population, in addition to a scaling method that may be used to predict organ parameters as a function of body mass index (BMI). The database presented here is an alternative to the P3M physiological database by Price et al. (2003).
Tran	Brainard and Burmaster (1992) and Burmaster and Crouch (1997) provided the statistics for the bivariate and lognormal distributions, respectively, for height and body weights for application in Monte Carlo simulation. These statistics were, however, derived based on very old body weight data – NHANES II (19767-80). New analysis with the NHANES 99-02 and 03-06 data should be conducted to update these statistics for use in Monte Carlo Simulation. Odgen et al 2004 data are summarized in the revised EFH. The data in this analysis was based on NHANES I, II, II and 99-02. There is a later publication by Odgen et al (2008) reporting BMI for US children and adolescent using the NHANES 03-06 data. (JAMA (299):2401-2405)

Chapter 10 – Intake of Fish and Shellfish

11) Recreational marine fish intake rate data were only available for individuals >18 years of age. Recommended recreational marine fish intake rate values for children have been estimated based on the age-specific ratios of general population children's marine fish intake to general population adult marine fish intake, multiplied by the adult marine recreational fish intake rates. Please comment on this approach and, if relevant, provide suggestions for alternatives, using the available data.

Anderson	First a few general comments on this chapter. The introduction needs to make the point that while fish are exposed to all the pollutants in sediments and the water, fish only become a significant exposure source for those chemicals they bioaccumulate through the food chain. Thus the contaminants of concern are more limited than the universe of chemicals in the environment. It should also distinguish between the lipophilic chemicals and other chemicals since the lipophylic chemicals like PCB are in the fish fat while other chemicals like mercury or arsenic are in the meat portion and can't be removed by cleaning. The mention that there can be an increase in the concentration of chemicals from cooking is not completely correct. To be useful to a exposure assessor or risk assessor the consumption has to be converted to a dose. Concentration times weight equals dose. It is good to warn the exposure assessor that you can't use the raw fish concentration and a cooked weight to estimate the dose, because concentration may very in each. You have to have like measures. The paragraphs on page 10-3 are confusing and could be simplified. The issue is more complex as some literature indicates that even though there is a raw to cooked weight meal size reduction, you can also get contaminant reduction and not just the increase mentioned (need references for this). This is especially true for lipophylic chemicals. Removing the belly fat and skin and not eating it significantly reduces the lipophylic chemicals 30 to 50% in fatty fish. And broiling the fish also melts off the fat and the lipophylic chemicals so there can be a reduction in the dose of a chemical. Then there is the issue of cooking adding new chemicals - ie the grill. So using "as prepared" consumption should also use "as prepared" contaminant concentrations. What has been problematic is that nutritionists favor "as consumed" approaches and environmental assessments use a standardized raw sample because there are so many different ways to cook or process fish that analytic costs sky rocket.. There is a paucity of data on contaminants in cooked/prepared foods. There are lots of nutrition/vitamins, minerals and constituent data for cooked food, but little contaminant data. The major problem with this chapter is that contaminants very greatly in fish and shellfish as do consumption preferences. That needs to be taken into consideration in the exposure assessment and simply assigning a "fish consumption" rate is inadequate to translate into a specific exposure. Probably the most useful table is table 10 which describes consumption rates of different species as there can be orders of magnitude differences in contaminant concentrations. As far as this particular question, most commercial fish are marine and often come from the same waters as the recreational marine fish. It is valuable to describe in an exposure assessment the proportion of recreational fishers in an area along with the fish they target and consume. Most studies suggest that they consume more total fish than non anglers and are likely to target a more limited set of species that are local and of course contaminant concentrations can also be local. Not only do anglers eat personally caught

	fish but they also consume commercial fish and do so at higher rates. It is hard to not come to the conclusion that local recreational fish consumption rates are of much higher value to the assessor than the uncertainty in applying a national estimate. Using proportionality of adult to child marine fish consumption to assign recreational fish (either fresh or marine) consumption to children is probably appropriate. It is unlikely that children eat something other than what the rest of the family consumes. So if recreational fish is not available in a household the child is unlikely to obtain recreational fish meals more frequently than the family (marine or fresh water). In a recreational fish consuming family a child may not like fish at all or not like the available recreational fish and want fish sticks when the family eats recreational fish and thus may consume less than the rest of the family. Meal size is usually proportional to body mass so mg/kg remains fairly constant as a child grows. In a population I would suggest that the proportion of recreational anglers in the population will have a greater influence on the average child consumption than meal frequency distribution differences.
Blaisdell	In response to question 11, the approach taken to determining marine fish intake for children seems to be reasonable. I do not have an alternative suggestion. It is stated on page 10-3 that the CSFII data on which the general population recommendations are based are short-term survey data and should not be used to estimate the distribution over the long term. This statement should be modified to read that the CSFII data has serious limitations when the distribution is applied to estimate risk from long- term exposure to chemicals in fish. Distributions from short-term survey data is commonly used long-term exposure. It is true that fish is less frequently consumed food and thus short- term data is less likely to capture typical intake and thus overestimate the upper percentiles in particular. However, the use of short-term data is common practice when assessing long-term exposure because appropriate longitudinal data are simply not available. There is a similar statement on page 10-26 that should also be modified. The lack of a recommendations for recreational freshwater anglers is appropriate because site- specific factors will always be the predominate determinant of fish consumption in the myriad types of freshwater bodies. Such factors include size of water boy, climate, fishing regulations, availability of alternate fishable water bodies and water body productivity. Perhaps you could mention some of these factors in your justification. It is pointed out on the age groupings from the CSFII data analysis did not match the USEPA's Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposure to Environmental Contaminants because the analysis of the CSFII data predated the recommendation. USEPA is planning to analyze the most recent NHANES data. Perhaps the fish consumption data from the NHANES dietary database could be compiled for the appropriate age ranges and replace the use of the older CSFII data. On page 10-22, the Santa Monica Bay Restoration Project, 1994-Seafood Consumption Habits of Recreational Anglers in Santa Monica Bay, Los Angeles is discussed. It should be mentioned that this study was not adjusted for avidity bias. The OEHHA adjusted the distribution of fish consumption for avidity bias and other factors in the Air Toxics Hot Spots Program Risk Assessment Guidelines Part IV: Exposure Assessment and Stochastic Analysis Technical Support Document available at www.oehha.ca.gov. Although this study is dated, you may want to include the avidity bias and other adjustments to the

	distribution in The Exposure Factors Handbook, if you concur with our analysis.
Finley	**Comment #1-** The method used by EPA (which consists of applying a ratio of children/adult marine fish ingestion rates in the general population x adult marine recreational fish ingestion rates) would seem to provide a reasonable approximation of recreational marine fish ingestion rates for children. However, I do have a few observations. First, the table which purports to summarize the recreational marine fish intake values (Table 10-3) has some formatting problems. Second, I was unable to locate any presentation of the method described above. Hence, while the approach appears to make sense conceptually, it is not possible to evaluate the specific values and factors considered by EPA in deriving the children ingestion rates. I believe this information should be summarized in an appropriate location in Chapter 10.
Stern	This approach is based on the assumption that recreational fish intake follows non-recreational (i.e., store-bought) fish intake. Or, in other words, that fish consumers (including children) eat recreational marine fish instead of or identical to store-bought fish. This is an *a priori* reasonable assumption in the absence of evidence, but not an assumption whose validity is intuitively obvious. One approach to validating this assumption is to investigate whether adult recreational fish consumers who are high consumers of non-recreational fish are also high consumers of recreational fish. This comparison should be made in a population that has good access to store-bought fish rather than a subsistence fishing population that has minimal access or purchasing ability for store-bought fish.
Zaleski	The suggested approach seems like a reasonable approximation, but it should not be used to develop a recommendation. I have attached a file which contains estimates of the ratios utilized to develop Table 10-3, along with those for general population marine fish consumption in Table 10-1. This analysis indicates first, that the ratio for fish intake of a given age to that at age >18 is different for mean intake than for 95th percentiles. The analysis in Table 10-3 appears to use the mean ratio to generate both mean and 95th percentiles. Further, because this approach is just a general approximation, it should not be used in a recommendations table. It could be presented and discussed in the document. In addition, it is noted that the marine fish consumption recommendation in Table 10-3 are based upon 1993 data. There are a number of newer studies available, and a summary table of newer studies, similar to 10-5 and 10-6 but with the additional information indicated below under question 13, would assist in understanding how representative the 1993 data may be for the current population.

	Mean Values							95th Percentiles				
	age range in years							**age range in years**				
	>18	**16-<18**	**11-<16**	**6-<11**	**3-<6**			**>18**	**16-<18**	**11-<16**	**6-<11**	**3-<6**
from table 10-3 atlantic marine fish												
mean	5.6	2.8	3.4	2.5	2.5		95th ptile	18	8.9	11	8.1	8
ratio of age to >18		0.50	0.61	0.45	0.45				0.49	0.61	0.45	0.44
ratio of 95th to mean:	3.2	3.2	3.2	3.2	3.2							
from table 10-3 gulf marine fish												
mean	7.2	3.5	4.4	3.3	3.2		95th ptile	26.1	12.8	16	11.8	11.6
ratio of age to >18		0.49	0.61	0.46	0.44				0.49	0.61	0.45	0.44
ratio of 95th to mean:	3.6	3.7	3.6	3.6	3.6							
from table 10-3 pacific marine fish												
mean	2	1	1.2	0.9	0.9		95th ptile	6.8	3.3	4.2	3.1	3
ratio of age to >18		0.50	0.60	0.45	0.45				0.49	0.62	0.46	0.44
ratio of 95th to mean:	3.4	3.3	3.5	3.4	3.3							
from table 10-1 marine fish per capita												
mean	12.4	6.1	7.6	5.6	5.5		95th ptile	80.7	29.5	56.5	38.4	39.4
ratio of age to >18		0.49	0.61	0.45	0.44				0.37	0.70	0.48	0.49
ratio of 95th to mean:	6.5	4.8	7.4	6.9	7.2							
from table 10-1 marine fish consumer only												
mean	108	126	102	78	66		95th ptile	270	353	262	202	165
ratio of age to >18		1.17	0.94	0.72	0.61				1.31	0.97	0.75	0.61
ratio of 95th to mean:	2.5	2.8	2.6	2.6	2.5							
Table 10-3 values from L. Waite's email table 10-3												

12) Relevant data on recreational marine fish intake presented in the chapter are limited to certain geographic areas and cannot be generalized to the U.S. population as a whole. Therefore, recommendations from these data could not be provided. Instead, the assessor has the flexibility to use data from these relevant studies that are more appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.

Charge Question 12 was deleted from this review per EPA. Reviewers were informed that they do not need to comment on this question.

13) Recommended values for fish intake are not provided for recreational freshwater or Native American populations because the available data are limited to certain geographic areas and cannot be readily generalized to the U.S. population of freshwater recreational anglers or Native Americans as a whole. Instead, data from several relevant studies are provided in the chapter to give assessors the flexibility to choose data that are more appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.

Anderson	I would suggest that assigning recreational marine fish consumption as a national rate ignores the local issue as much as the freshwater recreational fish if not more. Every state has a freshwater recreational fishery but only a few have marine recreational fisheries. Recreational marine fish species on the West coast are quite different from the East Coast as well. Not a large marine recreational fishery in the plains states. In general I think the agency needs to rethink the narrow emphasis on providing national estimates when there is so much regional variability. The same issue holds for using national rates for ethnic groups. The fish consumption chapter probably is the one where national estimates are the least useful and have greater uncertainty and an emphasis on local and regional as well as ethnic information is certainly legitimate. Providing regional or state proportions of the population who are recreational anglers would be very useful. The recent study by Kate Mahaffey 2008 based on the NHANES data shows considerable differences in regional fish consumption and the resulting differences in methyl mercury distribution. I would suggest that trying to develop national estimates (one size fits all) for recreational fish consumption is counter productive and exposure assessors need to be told to seek and utilize regional and local information. Concentrations of contaminants very greatly and that is the critical second step in the assessment process combining consumption with concentration. Probably more than any other chapter, it would be important for the authors to indicate the process they used to identify studies to report. Studies listed are mostly quite old. My knowledge of the literature suggests there are many more current studies of regional or local utility. I don't see the biomonitoring studies or some of the surveys that gathered "meal" information and converted using an estimated meal size. What was the search protocol and how many studies were reviewed and rejected. If these were reviewed and rejected, that needs to be indicated. This is a very long chapter because of all the regional studies summarized and converted to tables, so the perception is that the authors have gleaned all the studies. As mentioned earlier I would think the NHANES data could be used. We also published two Great Lakes Basin consumption studies that generated population rates for sport fish consumption. Perhaps these were rejected, which I could understand, but it would be good to know that all these types of studies underwent evaluation. Were only studies done on US populations considered? More attention needs to be paid to how the studies used and summarized got selected.
Blaisdell	In response to Question 13, I agree that the best approach is not to recommend a particular study but to advise considering the local site-specific situation when selecting among the available studies.

Finley	**Comment #1** I agree that it is not possible to develop a single set of freshwater or Native American fish ingestion rates that could be considered applicable to all scenarios that involve these angling populations, and I concur with EPA's decision to permit flexibility in choice of the most proper set of assumptions. I think the EFH does a good job in summarizing the available studies, particularly the tables at the end of the chapter. Hopefully, any fish ingestion scenario that must be addressed in a site-specific risk assessment can be "matched" to some degree with one of the studies summarized in this chapter. **Comment #2** There are numerous "site-specific" factors that often must be addressed in a fish consumption risk assessment; some of these are discussed in detail in Chapter 10 and some are not. Since the updated EFH is eventually going to be employed as a resource document for risk assessors to use in evaluating fish ingestion scenarios, I think the following should be addressed in more detail at some point, possibly in Section 10.9 ("Other Factors to Consider for Fish Consumption"): -which consumption rates are most appropriate for family members who are consuming (but not catching) the fish; do angling and non-angling pregnant women need to be considered separately (with specific fish ingestion rates)? -how does one best evaluate potential consumption of the "other" parts of the fish/shellfish that are not typically consumed by the general population but might be considered "delicacies" by some individuals? (e.g., fish skin, crab hepatopancreas); similarly, which consumption rates are most appropriate for "whole fish/shellfish" that might be included in some preparations (e.g., stews). -the issue of "access" to fishing locations is an important factor that should be mentioned; quite often the risk assessor is faced with estimating fish ingestion rates for marine or freshwater locations that are highly industrialized and therefore have limited access. Which (if any) of the studies summarized in Chapter 10 best reflect a "limited access" scenario? S -should the presence of warnings or advisories be taken into account and if so, which studies best reflect their influence? -the possibility of "subsistence" fish consumption is invariably raised in fish consumption risk assessments. Which, if any, of the consumption rates (marine or freshwater) in Chapter 10 are most representative of true subsistence rates? Does one simply use the 95%ile values of the "standard" rates or are there separate rates that apply only to subsistence anglers? (perhaps this is described in the Chapter and I just can't find it readily). **Comment #3** There are some fairly recent papers that describe the results of a year-long intercept survey on a stretch of the Passaic River in New Jersey: Ray, R., V. Craven, M. Bingham, J. Kinnell, E. Hastings, and B. Finley. 2007. Human health exposure factor estimates based upon a creel/angler survey of the lower Passaic River (Part 3). J Toxicol Environ Health A. 70(6):512-528. Ray, R., V. Craven, J. Kinnell, M. Bingham, M. Freeman, and B. Finley. 2007. A

	statistical method for analyzing data collected by a creel/angler survey (Part 2). J Toxicol Environ Health A. 70(6):496-511. Kinnell, J: M. Bingham; E. Hastings; R. Ray;V. Craven; M. Freeman. 2007. Survey Methodology for Collecting Fish Consumption Data in Urban and Industrial Water Bodies (Part 1). J Toxicol Environ Health A. 70(6); 477-495 I believe these should be included (and summarized) in Chapter 10.
Stern	My experience bears out the conclusion of the EFH authors that patterns of recreational fish consumption are highly population and geographically specific. They depend on the cultural practices of local sub-populations, the specific types of freshwater fish available, the availability of these fish relative to seasonal weather and the ability of the population to access sites of freshwater fishing areas. In New Jersey, for example, recreational freshwater fishing is popular and there are several freshwater species that are popular for consumption elsewhere in the U.S. However, survey work we conducted in the 1990's indicated that freshwater fish consumption comprises only a very small percentage of total fish consumption. This is because the culture of recreational freshwater fishing in New Jersey is largely a catch-and-release culture (Stern et al., 1996 (see response to question #3). This appears to be in sharp contrast to the fishing culture in (e.g.) the Great Lakes recreational fishery. **Additional Comments** Chap. 10 Pg. 10-3, par. 5 - There is another and perhaps stronger justification for using uncooked intakes and concentrations. Consumers purchase and catch fish relative to the purchase and catch weights. They do not weight fish after cooking. Reported weights are more likely to reflect uncooked weight and interpretation of advisories are likely to be in terms of uncooked weights. Pg. 10-6, Applicability and Utility-Currency – The fact that the most recent CSFII data (i.e., 1994-96, 1998) were used, does not mean that those data were, in fact, current. They are not. Pg. 10-7 - Although the use of the term "per capita" is clarified in the footnotes, this term is somewhat misleading since per-capita implies that the values apply to the entire population when, in fact, only consumers are included. This should be relabeled as "consumers only." The unclear use of "per-capita" appears throughout this chapter. This terminology should be used only to refer to values that apply to the entire population. Pg. 10-11, 10.3.1 - This discussion provides no indication of the under-representation of the patterns of infrequent consumers inherent in the us of a 2-day sampling study such as the CSFII Pg. 10-14, par. 8 - In the context of this database, does "home produced fish" mean self-caught? If so, that should be made clear. Pg. 10-15, par. 2 - The use of "per-capita" here is inconsistent with previous uses in this

chapter. Previously, it was used to mean per-individual within the group of consumers. Here, it is used to mean individual average consumption for the entire population regardless of consumption status. This is confusing.

Pg. 10-16, par. 1 - However, if, as noted, the estimate does not include processed or canned fish, it excludes most tuna intake. Tuna is consistently reported as the most or second most popular fish. Thus, if canned tuna is not included in this estimate, the cited value is, in fact, a significant underestimate

Pg. 10-18, par. 8 - No evidence is provided to support the statement here that “this figure is somewhat conservative…”

Par. 9 - Add “marine” before the last word in the paragraph.

Pg. 10-27, par. 5 - “ U.S.EPA estimated the annual frequency…” Since it was stated immediately prior that the survey did nlt obtain information on fish obtained from recreational sources, it is not clear from where the frequency of recreationally caught fish referred to here was taken.

Pg. 10-29, par. 5 - “…an assumption that the average success and consumption rates for the individual angler during the trips already taken would continue through future trips.” This does not appear to me to be a conservative assumption as stated. It is the standard statistical assumption that future frequencies can be predicted from existing data. It strikes me as a relevant assumption. Furthermore, stating that this is a “conservative” assumption implies that it is biased (in this case, biased high). While future success may differ from that reported, there doesn’t appear to me to be any a priori reason to assume that future success will be less than past success.

Also, the assumption that “Over reporting appears to be correlated with skill level… it is likely that the higher consumption rates may be substantially overstated” is highly speculative and not supported by the data presented. Since “consumption,” not “catch” is being reported, there is no a priori reason to assume a performance bias in reporting.

Pg. 10-34. par. 8 - “Firs, there was some interdependence within households…” The meaning of this sentence is not clear.

Pg. 10-38, par. 2 - “…and then dividing by the total number of household members in the household sample.” This gives average consumption by household member but this is misleading as (e.g.) children will have a significantly lower intake than overage adults.

Pg. 10-39, par. 5 - “…the study was designed to give nearly equal sample size to each tribe.” Ensuring equal sample sizes among tribes does not ensure adequate sample size for any individual tribe.

Pg. 10-41, 10.6.5 - The relevance of the controls to the consumption estimates of the study population and the basis for selection of the controls is not clear.

Pg. 10-46, par. 2 - “Therefore, extrapolation of data to other ethnic groups should be used with caution.” The caution necessary in extrapolating these data to other ethnic groups does not specifically result from the small number of respondents in each group. Rather, this caution is a function of the potentially significant culturally-based patterns among

	ethnic groups. Pg. 10-47, eq. 10-5 - Assuming that ‘C’ in equation 10-5 corresponds to concentration, the equation is correct. However, if ‘C’ corresponds to intake as per the definition of the variables in the text, then the equation is incorrect. 10.9.2 - The text should provide some guidance as to when lipid adjustment is appropriate. Pg. 10-54 - Since “per capita” has been used to mean different things in this document, its use here should be clarified. Does “per capita” here mean the entire population – whether or not they consume fish?
Zaleski	I agree with the need to have population specific information and for the flexibility of the assessor to determine this, and so foregoing a recommendation table. A useful addition, however, would be to include some additional general statistics from the available data sets in Table 10-5, such as reported intake ranges and average across studies by age on a kg body weight basis, as well as additional discussion, if possible, of factors that may be associated with study differences. This would better indicate the relative magnitude of interpopulation variability and factors for the exposure assessor to consider in selecting a study that may be most representative of a population of interest. Other sources of information: • The USDA website indicates more recent sources of food consumption data, which should include fish consumption data that should be considered within this document: http://www.ars.usda.gov/Services/docs.htm?docid=15044 • Mayfield et al., 2007. Survey of fish consumption patterns of King County (Washington) recreational anglers. Journal of Exposure Science and Environmental Epidemiology 17:604-612. Section 10.3.2.1 – as indicated on page 10-13, this study is over thirty years old; suggest discussion could be cut much shorter than the current 2 pages. In general, for this section, where recommendations are based upon the CSFII two non-consecutive day survey, if possible some discussion as to if there was any relationship between weekday vs. weekend fish consumption and seasonal consumption (for example, near shore resort areas, does fish consumption increase during weekend recreation? does fish consumption increase during fishing season and decrease when availability of fresh fish is lower? and if so, how is this considered in the annual average?).

Chapter 9 – Intake of Fruits and Vegetables
Chapter 11 – Intake of Meats, Dairy Products and Fats
Chapter 12 – Intake of Grain Products

14) We are aware that food consumption data from the National Health and Nutrition Examination Survey (NHANES) "What We Eat in America" are available and NCEA is partnering with the U.S. EPA's Office of Pesticide Programs to get these data analyzed and incorporated into the final Handbook. This analysis is expected to be available in May 2010. Are you aware of other published data concerning food consumption that should also be considered?

Anderson	NCEA needs to contact each of the federal agencies who have supported the development of the data bases utilized and learn what they have under development, if any. Another source of data on children may well be the National Children's Study. EPA is already supporting this activity. So as it gets underway, the data being collected should be assessed for its potential utility for exposure factors.
Blaisdell	Chapter 11, Intake of Meats, Dairy Products and Fats Section 11.3.2 mentions data from the 1987-88 in Table 11-8, yet this survey is not mentioned in the title or elsewhere. If memory serves, I believe the results from this survey were criticized in a GAO report because a nonresponse bias test was not performed. A minor point, these data are pretty old anyway. If you are planning to analyze the more recent NHANES data as mentioned in Chapter 9, and resources permit, perhaps it would be good to obtain the meats, dairy products and fats. I would suggest reviewing the literature on the percentage of total consumption that is home raised for site-specific risk assessment (e.g. airborne emissions from stationary sources.)
Guiseppi-Elie	I not aware of additional published food consumption data for the US. The following website might be useful for ancillary information: http://www.iom.edu/About-IOM/Leadership-Staff/Boards/Food-and-Nutrition-Board.aspx There are some UK and European databases that might likewise provide ancillary information.
Lobscheid	I am not aware of other published data concerning food consumption. I believe that the "What We Eat in America" (WWEIA) data set is currently the most complete and representative data set available to assess a variety of food groups, and water

,consumption by the US population. Will the Office of Pesticide Program's analysis be done on the NHANES 2003-2004 data set, or earlier, or later?

Specific Comments on Chapter 9 (*Intake of Fruits and Vegetables*):

- In Chapter 9, Table 9-1, why are the mean and 95th percentile total vegetable intakes the same on a "per-capita" and "consumers only" basis?

- In Table 9-2, page 9-4, in the row associated with "Quality Assurance", please clarify the following "….quality control of the secondary data analysis was not well described" and specifyt the following (underlined) "quality control of the EPA analysis of the USDA CSFII survey was not well described".

- In Section 9.3.1.1, page 9-5, Instead of listing the individual fruits and vegetables in paragraph 2, refer instead to Appendix 9A, i.e., "The fruit and vegetables items/ groups selected for the US EPA analysis included fruits and total vegetables, and individual fruits and vegetables listed in Appendix 9A".

- In Section 9.3.1.1, page 9-6, it is not clear how the individual fruits and vegetables were selected for assessing their intake. A description or the criteria used for assessing intake of individual fruits and vegetables would be helpful.

- In Section 9.3.2.1, page 9-7, please change "using vegetables and fruits in a day" to "consuming vegetables and fruits in a day." The use of "consuming" instead of "using" is preferred throughout the chapter (e.g., Table 9-12, page 9-37, Table 9-13, page 9-38; .Table 9-19, page 9-44;

- In Section 9.3.2.5, page 9-8, Change the following sentence: "In addition multiple regression models were used to determine which demographic…" to "In addition multivariate regression models were used to determine…"

- In Table 9-3, through Table 9-11 and Table 9-27: please consider changing "Race" to "Ethnicity. Consider also doing the analysis for "Hispanic" as an ethnicity as well using the 1994-1996 CSFII and 1998 CSFII data.

- In Table 9-3, How could there be 100% of all 3-5 year olds, and 100% of all 13-19 year olds, consuming vegetables, but the 1st percentile be "0.0"?

- In Table 9-4: How could the 1st, 5th, and 10th percentile of the "Consumer-only intake of fruits" be "0.0", for the "whole population" and all the other subpopulations, with the exception of "birth to 1 year"? Consumer-only intake means that only those individuals who reported consuming the food are included in the analysis so the 1st, 5th, and 10th percentiles should all be > 0.0.

- In Table 9-6: I suggest having separate intake of individual fruits and individual intake of vegetables in separate tables, not ordered alphabetically in the same table.

- Table 9-19, page 9-44 and Table 9-20, page 9-45 and page 9-46: Instead of "PC" as a header, write out "Percent consuming" with a superscript "a" (or "b" for Table

19-20) associated with footnote "a Percent consuming at least once in 2 days"

- Table 9-20, page 9-44: Consider changing the text associated with footnote "a" to read "Indicates a statistic that is potentially unreliable because of a small sample size and a large SE"

- Table 9-21:

Include units for the median servings in the Table or column header caption (e.g., "servings per day")

  - Move the "*" next to the subject characteristic (i.e., "Ethnicity *"
  - Specify the unit of weight (lbs).

- Table 9-27: The "**" footnote should be "P<0.01 non participants significantly different from WIC participants on the variable" instead of "P>0.01 non participants significantly…"

- Table 9-31: the footnote "**" should read "significantly different from non-Hispanic at the P<0.01" instead of "significantly different…at the P>0.01"

Specific Comments on Chapter 12 (*Intake of Grains*):

- I think it is a very good idea to self-contain the information in each chapters and so appreciate seeing that the description of Consumer-only intake, per capita intake, total grain intake, and as-consumed intake, and dry weight intake is described in Chapter 12, and not referenced to Chapter 9. It would be useful to specify in Chapter 12, Section 12.1 (paragraph 2) however, that although the definitions are "described in Chapter 9, they are repeated here in their entirety."

- In Section 12.1, page 12-1, the last sentence of the third paragraph states "For more information on cooking losses and conversions necessary to account for such losses, the reader is referred to Chapter 13 of this handbook." I believe that the correct reference is Chapter 9 (Intake of Fruits and Vegetables), not 13 (Intake of Home-Produced Foods).

- In Table 12-1, why are the "per-capita" and "Consumers only" mean and 95th percentiles are the same?

- In Section 12.3.2.5, page 12-8: Replace "multiple regression model" with "multivariate regression model"

- How could the sample size (N) of the Cereal consumers, In Table 12-6, "Consumer Only Intake of Individual Grain Products (g/kg-day as consumed)", be greater than the sample size (N) in Table 12-4, "Consumer Only Intake of Total Grains (g/kg-day as consumed)"? The cereal consumers should either be the same value as the sample size of the "consumer only-intake of Total Grains ", or less, since the Cereal consumers are a subset of the consumer-only intake of total grains.

- In Table 12-3, through Table 12-14, and also in Table 12-24, please consider changing "Race" to "Ethnicity. Consider also doing the analysis for "Hispanic" as an ethnicity as well using the 1994-1996 CSFII and 1998 CSFII data.

- In Table 12-15, please define the constituents of the following column headers: "total grains", "other baked goods", "cereals, pasta" (does this include hot and cold cereals?), "mixtures, mainly grain" (this is not very clearly defined in footnote "b").

- In Table 12-19:

    - please include footnote defining the column header "Total" and another footnote to define "Mixtures, mainly grains"

    - how come the "Total" column of the "Cereals and Pasta" is less than the sum of the "ready-to-eat", "rice' and "pasta" for the "<1 year" to "<=5 year" age groups?

- "Table 12-201" needs to be changed to "Table 12-20". Also, in this Table, how come the "Total" column of "Cereals and Pasta" is less than the sum of the "ready-to-eat", "rice", and "pasta" for each of the age groups b/w "6-9 years" to :"12-19 years" in the "Males" and "Females" and also for the "<= 19 years" age group for the "Males and Females" category? Lastly, please include footnote defining the column header "Total" and another footnote to define "Mixtures, mainly grains"

- In Table 12-22:

    - Consider writing out "Percent Consuming" instead of "PC" in the Table column headers.

    - For footnote "b" consider changing the footnote to read: "Indicates a statistic that is potentially unreliable because of a small sample size and a large SE"

- in Table 12-23: Please indicate the units on the "daily servings", i.e., is the "servings per day"? or "g/day"?). Also, include the units on Weight ("Weight [lbs]")

- in Table 12-26, footnote "**" should be "P<0.01 non-participants significantly different from WIC participants on the variable" instead of "P>0.01 non-participants significantly…"

Ryan

General Response to Chapters 9, 11, 12, 13, and 14

The primary studies on dietary intake include those outlined in the presentations here. These are large-scale investigations. However, many of the large studies, e.g., CSFII, USDA studies, etc., are now quite old- representing eating habits common in the mid-to-late 1990s, now upwards of 15 years ago. Eating habits have changed as have contaminant levels likely found in the foods. Even total caloric intake has modified during that time period. Further, obesity is becoming endemic in the United States. Bearing all of these comments in mind, it may be useful to look at even more of the smaller-scale investigations, and individual studies to determine likely intakes of all food substances. It may be possible, for example, to use thse small-scale investigations to "scale" the factors from these earlier studies to reflect current trends. This of course applies equally well to Chapters 9, 11, 12, 13, 14.

The NHEXAS investigations, now also about 15 years old and thus perhaps no longer as relevant as newer studies, also gathered a good deal of data on dietary intakes of these foodstuffs using multiple methods ranging from duplicate diets, through food diaries, and even dietary checklists. These data are readily available and could be used in these contexts. All three of the investigations offered statistical representativeness of specific areas. One offers some insight as to the variability of such intakes over an annual time period. The data are readily available from EPA, yet none of the studies is mentioned.

The NHANES investigations took data on intake of certain foods and might add useful information to these studies.

Chapter 9 Specific Comments

The majority of the studies selected as key in Chapter 9, were for very specific populations and had modest sample sizes. For example, the Vitolins, et al., investigation looked only are older rural adults. The Fox, et al., Ponza, et al., and Menella, et al., investigation had a large sample size, but was a study of infants and toddlers only. While certainly relevant for this group, the population as a whole was not represented.

Chapter 11 Specific Comments

The studies listed as "key" in this Chapter are the same as those listed for Chapter 9, hence the same comments apply. They are repeated here for easy transfer. The majority of the studies selected as key in Chapter 11, were for very specific populations and had modest sample sizes. For example, the Vitolins, et al., investigation looked only are older rural adults. The Fox, et al., Ponza, et al., and Menella, et al., investigation had a large sample size, but was a study of infants and toddlers only. While certainly relevant for this group, the population as a whole was not represented.

Chapter 12 Specific Comments

The studies listed as "key" in this Chapter are the same as those listed for Chapter 9 (and 11), hence the same comments apply. They are repeated here for easy transfer. The majority of the studies selected as key in Chapter 12, were for very specific populations and had modest sample sizes. For example, the Vitolins, et al., investigation looked only are older rural adults. The Fox, et al., Ponza, et al., and Menella, et al., investigation had

	a large sample size, but was a study of infants and toddlers only. While certainly relevant for this group, the population as a whole was not represented.
Tran	FDA Total Diet Study (TDS) -- The foods collected in the Total Diet Study (referred to as the TDS food list) represent the major components of the diet of the U.S. population. Currently, there are about 280 foods collected and analyzed in the TDS. The FDA has compiled the food consumption amounts for each TDS food have been compiled for the total US population and 14 age/sex subgroups (M/F 6-11 mos, M/F 2 yrs, M/F 6 yrs, M/F 10 yrs, F 14-16 yrs, M 14-16 yrs, F 25-30 yrs, M 25-30 yrs, F 40-45 yrs, M 40-45 yrs, F 60-65 yrs, M 60-65 yrs, F 70+ yrs, M 70+ yrs . These consumption amounts are collectively referred to as the TDS diets. The latest version of the TDS diets is TDS Diets, Version 3 (2003 food list + 1994-96, 1998 CSFII data) and can be downloaded at http://www.fda.gov/downloads/Food/FoodSafety/FoodContaminantsAdulteration/TotalDietStudy/UCM184702. For completeness, a reference/link to this dataset should be added to the EFH. Other data/references that should be considered are provided below in comments specific to the relevant data sections in chapters 9, 11, 12 and 14 General comments: In the introduction of each chapter, it is indicated that the relevant data are provided in addition to the key data/recommendation to provide reader with added perspective on the current state-of-knowledge pertaining to various food intakes. However, a number of the "relevant data" provided in the revised EFH are based on dated food consumption surveys (NFCS 1977-78, 87-88, CSFII 94-95, ERS 1970-90) and clearly do not provide users with current state-of-knowledge of the US diet. These old data should be removed and replaced with more current/relevant information (see specific comments below). Specific comments Chapter 9. Intake of Fruits and Vegetables Section 9.3.2.1 – USDA (1980, 1992, 1996a and 1996b): The data presented in this section are very old (NFCS 1977-78, 87-88, CSFII 94-95). The purpose of these old data being in the EFH is not clear to the reviewer. Table 9-13 could be helpful in discerning temporal trends in fruits and vegetable consumption; however, this table needs to be updated to include CSFII 94-96, 98 and the later NHANES 99-06 data. Section 9.3.2.2 – USDA (1993) – Food Consumption, Prices, and Expenditure: The USDA Economic Research Service (ERS) data presented in this section are based on annual food supply/availability. While they may be useful in screening assessment, since they do not account for food waste/spoilage, these estimates are conservative/high end intake estimates. Further, the ERS data presented in this section are old (1970-92). More recent data are available from ERS. A more thorough search of the USDA-ERS website (http://www.ers.usda.gov/Data/FoodConsumption/) will yield more current consumption data based on production statistics than what is currently in the EFH. At this website, query and exporting of data tables can be conducted to generate output needed for the EFH. Below is a citation of a typical and more recent report from ERS. A copy is also attached to these comments.

Wells HF, Buzby JC. 2008. Dietary of major trends in US Food Consumption, 1970-2005. USDA-Economic Research Service, Economic Information Bulletin No. 33. March 2008.

In this report, per capita intake rates (based on food availability) are available for fruits – table 3; vegetables --table 4

Section 9.3.2.3 -- USDA 1999: Table set 17 published by USDA in 1999 is also based on the CSFII 94-96, 98. Given the limitation of this reference (age of survey and data analysis/presentation limited one day of survey, mean per capita and g/day only) the value of this reference to the current update of the EFH is not obvious to this reviewer. If general fruits and vegetable intake data need to be presented for context, there are more recent publication of more current NHANES data on the intake of fruits and vegetables in context of my pyramid serving sizes, including:

Kimmons J, Gillespie C, Seymour J, Serdula M. Blanck M. 2009. Fruit and vegetable intake among adolescents and adults in the United States: percentage meeting individualized recommendations. Medscape J Med, 11(1): 26

Several tables of fruits and vegetable intakes in context of pyramid serving sizes based on NHANES 03-04 are provided in this reference.

Batres-Marquez SP, Jensen HM, Upton, J. 2009 Rice consumption in the United States, recent evidence from food consumption surveys. JADA; 109(10): 1719-1727.

Table 4 of this paper provides data on average daily servings based on NHANES 2001-2002, for food guide pyramid food groups for adults 20+, including: vegetables, potatoes, dark-green vegetables, deep-yellow vegetables, and fruit.

Guentehr, PM, Dodd KW, Reedy J, Krebs-Smith SM. 2006. Most Americans eats much less than recommended amounts of fruits and vegetables. JADA, 106(9):1371:1379 .

Table 2 of this paper provides data on mean daily intakes of total fruits, total vegetables, and total starchy vegetables, dark-green vegetables, orange vegetables, legume, other vegetables by the US population and select children, males/female age groups. Data are based on NHANES 1999-2000.

The CDC also publishes fruit and vegetable intake data based on the Behavior Risk Factor Surveillance System (BRFSS). Intake rates are presented in no. servings per day (CDC, MMWR Weekly, March 16, 2007/56(10):213-217, Fruit and Vegetable Consumption Among Adults, US 2005).

9.3.2.4. Scmiciklas-Wright et al 2002: The serving size data (table 9-19) from this reference is also based on CSFII 94-96, 98. This serving size data can be useful when bolus dose is of interest. These data tables should also be updated when the key study data tables on in take rates in g/day and g/kg/day (now based on the CSFII94-96, 98) are replaced with the more current NHANES 03-06 (or later) data.

Chapter 11. Intake of meats, dairy products and fats

Section 11.3.2.1 – USDA (1980, 1992, 1996a and 1996b): These data are quite old

(NFCS 1977-78, 87-88), CSFII 94-95); it is not clear for what purpose these data are presented here. Tables 11-7 to 11-12 are not particularly helpful for ascertaining current consumption rates

Section 11.3.2.2 – USDA 1999a – table set 17: Table set 17 published by USDA in 1999 is also based on the same CSFII 94-96, 98 that were analyzed by EPA into food commodity intake format (and presented in the key study in the current EFH). Given the limitation of this reference (age of survey, data analysis/presentation based on one day, mean per capita only) the data from this old reference are of limited utility to users. Once EPA has updated the key data and recommended intake rates are updated (from CSFII 94-96, 98 to current NHANES), these data tables could be removed.

Fat intake: USDA has published tables of nutrient intake, including total fat intake, based on the more recent NHANES survey (03-04 and 05-06) at its website. (www.ars.usda.gov/ba/bhnrc/fsrg); see tables 2 and 3). Further fat content of foods can be directly obtained from the nutrient database at the USDA ARS website ((http://www.ars.usda.gov/Services/docs.htm?docid=8964). Hence, fat intake estimates based on more current NHANES consumption data can be derived from this public database.

11.3.2.3. Scmiciklas-Wright et al 2002: The serving size data (table 11-17) from this reference is also based on CSFII 94-96, 98. This serving size data should also be updated when the key study data tables on in take rates in g/day and g/kg/day are replaced with the more current NHANES 03-06 (or higher) data.

There are other published papers reporting meat/dairy intakes based on more current consumption data that could be cited in the EFH, including:

Fulgoni V. et al. 2007. Dairy consumption and related nutrient intake in African American adults and children in the US: CSFII 94-96, 98 and the NHANES 1999-2000. JADA, 107:256-264.

In this study, the mean daily intake of total dairy, milk, cheese by select age groups and gender based on NHANES 99-00 (see table 2 of paper) in food guide pyramid serving size.

Batres-Marquez SP, Jensen HM, Upton, J. 2009 Rice consumption in the United States, recent evidence from food consumption surveys. JADA; 109(10): 1719-1727.

Table 4 of this paper provides data on average daily servings based on NHANES 2001-2002, for food guide pyramid food groups for adults 20+, including: dairy, meat/poultry/fish; fat, added sugar.

Wells HF, Buzby JC. 2008. Dietary of major trends in US Food Consumption, 1970-2005. USDA-Economic Research Service, Economic Information Bulletin No. 33. March 2008.

In this report, per capita intake rates (based on food availability) are available dairy products – table 5; fats – table 6; meats – table 7

	Chapter 12. Intake of Grain Products Section 12.3.2.1 – USDA (1980, 1992, 1996a and 1996b): These data are quite old (NFCS 1977-78, 87-88), CSFII 94-95); it is not clear for what purpose these data are presented here. Tables 12-16 and 12-17 are not particularly helpful for ascertaining current consumption rates Section 12.3.2.2 – USDA, 1999a – Food Consumption, Prices, and Expenditure 1970-98: As indicated earlier, these ERS data are based on annual food supply/availability and could be useful in screening assessment, but are conservative/high end intake estimates. More recent data are also available from the ERS (see ERS website above). Wells et al 2008 (see citation above under c9), reported the per capita intake rates (based on food availability) for grain products (table 2) Section 12.3.2.3 – USDA 1999a – table set 17: Table set 17 published by USDA in 1999 is also based on the same CSFII 94-96, 98 that were analyzed by EPA into raw agricultural commodity (RAC) format. Given the limitation of this reference (age of survey, data analysis/presentation based on one day, mean per capita only) the data from this reference are of limited utility to users. 12.3.2.4. Scmiciklas-Wright et al 2002: the serving size data (table 12-21 and 12-22) from this reference is also based on CSFII 94-96, 98. This serving size data should also be updated with the more current NHANES 03-06 (or higher) data. Other available data that could be incorporated: Batres-Marquez SP, Jensen HM, Upton, J. 2009 Rice consumption in the United States, recent evidence from food consumption surveys. JADA; 109(10): 1719-1727. Table 4 of this paper provides data on average daily servings based on NHANES 2001-2002, for food guide pyramid food groups for adults 20+, including: grain, whole grains.
Zaleski	The USDA website indicates more recent sources of food consumption data that should be considered within this document: http://www.ars.usda.gov/Services/docs.htm?docid=15044

Chapter 13 – Intake of Home-Produced Foods

Guiseppi-Elie	See comments for General Questions
Lobscheid	**Specific Comments on Chapter 13 (*Intake of Home-Produced Foods*)** The following sentence in Section 13.4.1 " Table 13-71 contains information on the types of vegetables grown by home gardeners in 1986." Should be corrected (underlined portion) to read "Table 13-71 contains information….by home gardeners in <u>2008</u>."
Ryan	See comments for General Questions

Chapter 14 – Total Dietary Intake

Guiseppi-Elie	See comments for General Questions
Lobscheid	See comments for General Questions
Ryan	See comments for General Questions
Tran	This chapter provides overall intake rates by major food groups (dairy, meats, fish, eggs, grains, vegetables, fruits, fats). Nuts/legumes intakes were omitted. Nuts/legumes intake data are available and should be incorporated. The intake rates are based from same source CFSII 94-96, 98 and analyzed by EPA in 2007. The data from tables 12-3, 11-3 and 9-3 are the same as data presented in table 14-5. However, it is noted that the age bins in this chapter are different from those in chapters 9, 11 and 12. It is not clear why this inconsistency exists. For some specific age groups in table 14-4 and 14-5 (very young children < 1yr), for some food groups, the sample sizes are too small to estimate upper percentiles. These upper percentiles are not accurate and should be noted or not presented at all. Total food intake in tables 14-3, 14-4 and 14-5 should have footnotes as in text indicating that it is sub-total of diet (no beverages, nuts, sugars/candy/sweets included).

Chapter 15 – Human Milk Intake

Anderson	See comments for General Questions
Lobscheid	**Specific Comments on Chapter 15 (*Human Milk Intake*)** • In Table 15-3, through Table 15-6 Suggest providing the "source", i.e., reference as a footnote, as it is in Table 15-1. • In Tables 15-3 through Table 15-6, include a footnote "f" in the column header for "Composite Age Groups f " where "f" is defined as "defined as the EPA life stages age groups; see Introduction, Section 1.7 for more information" • In Table 15-3, unless footnote "c" is changed to clarify the following underlined portion:"middle of the range of upper percentiles <u>calculated for each individual age across all key studies</u>," the upper percentile of the 3-5 month composite age groups should be <u>1007</u> (= (888 + 1126) / 2), not 1024 and the upper percentile of the 6-11 month composite age groups should be <u>1059</u> (=(978+1140)/2), not 1024. • In Table 15-4, unless footnote "c" is changed to clarify the following underlined portion:"middle of the range of upper percentiles <u>calculated for each individual age across all key studies</u>," the upper percentile of the 3-5 month composite age groups should be <u>152</u> (= (140 + 163) / 2), not 149 and the upper percentile of the 1-2 month composite age groups should be <u>181</u> (=(161+200)/2), not 187. • in Table 15-5, unless footnote "d" is changed to clarify the following underlined portion: "middle of the range of upper percentiles <u>calculated for each individual age across all key studies</u>," the upper percentile of the 3-5 month composite age groups should be <u>41</u> (= (36+45) / 2), not 42 and the upper percentile of the 6-11 month composite age groups should be <u>43</u> (=(39+46)/2), not 42. • If the footnote "c" (and "d" for Table 15-5) clarification is made to Tables 15-3 and 15-4, then I suggest making the same clarification to Footnote "d" of Table 15-6. • In Table 15-6, correct the column header to read " …and Upper Percentile Consumptionb (across <u>all</u> Key Studies…" • In Table 15-7, change "completely Breast-fed" to "<u>Exclusively</u> Breast-Fed" • In Table 15-9, specify "<u>Mean</u> body weight (kg)" instead of "Body Weight (kg)" and also include the standard deviation of the BW • In Tables 15-10, it is not clear what the "Intake by Age Category" refers. Please consider presenting the data in this column by the EPA life-stages. • In Table 15-12, change table caption to read "Breastfed Infant Characteristics a" instead of "Mean Breastfed Infants Characteristics a". Also, please place the

	"Ethnicity" (N) values on separate rows. • Is Table 15-15 needed in Chapter 15, *Human Milk Intake*? I think it belongs to the Body Weight Chapter (Chapter 8) • In Table 15-16, the "Skewness Statistic" is confusing. Suggest removing this column • In Table 15-20, change "NS = No statistical difference." To "NS = not significantly different (and indicate p level, i.e., $p>0.05$ or $p>0.01$) • In Table 15-25: change "a Referent Group" to "a Reference group" • In Table 15-30 and 15-31 and 15-32, the "absolute difference (%, SE) is very confusing. Please remove the "a" superscript from the column header, as some of the probabilities are not at $p<0.05$. Also, why does the SE have a probability associated with it, instead of the % difference? Lastly, change footnote "c" to read "not significantly different at $p<0.05$" instead of "No statistical difference" • Table 15-36 is missing column headers • In Table 15-34, how come the percentage of breast-feeding mothers (=17) be greater at 12 months, that 6 months (=13) for the "Maternal Education, Any Grade School" group?
Stern	<u>Chap. 15</u> Pg. 15-2, par. 2 - *"Recommendations for upper percentiles, when multiple studies were available…"* There needs to be some indication of the uncertainty inherent in this procedure – e.g., how different were the individual upper percentile estimates? Pg. 15-5 - This table is useful and informative. However, it would be additionally useful to have a measure of variability in the estimates of the means – e.g., SEM. Also "upper percentiles" here should be defined. Pg. 15-9, par. 1 - *"Infants were categorized as completely breastfed or partially breastfed."* Here and elsewhere, in light of the previous discussion, "completely breastfed" needs to be defined. Does this terminology mean no bottle feeding, or does this mean no other source of nutrition? Pg. 15-11, par. 4 - What is meant by "weighted intake record?" Pg. 15-12, par. 1 - *"In Method 1, the average population daily intake…In Method 2, intake over time…"* It is not clear what is being done in either of these methods. Pg. 15-24, Table 15-17 - Define AAP and ERF.

Pg. 15-28 – Define MSA and “Poverty income ratio.”

Pg. 15-31 - Should “milk” be “animal milk?”

Pg. 15-33 - On what basis were the “weighted averages” weighted?

Chapter 16 – Activity Factors

Beamer	See comments for General Questions
Ferguson	1) *Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?* <u>Answer:</u> See general comments above. *Page 16-1, Paragraph 1* This first important paragraph does not read smoothly. Consider re-phrasing the first sentence. Activities bring them into contact with surfaces and objects in their environment or into microenvironments that contain these concentrations. The first sentence is too long in general. The third sentence seems awkward or hanging. Also, children are at risk to certain chemicals but also to <u>higher levels</u> of many chemicals due to their activities (so increased exposure). *Page 16-1, Paragraph 3* Videotaping can also be used as a method to capture human activity factors, especially the details of contact activities for dermal contact with surfaces and objects and mouthing activities for non-dietary exposure. Now technically the mouthing behavior given in chapter 4 is really another set off activity factors and could have been organized in this chapter or at least mentioned in this chapter. Handwashing events from relevant studies are covered in the activity chapter (16-67), but is useful for both dermal exposure, dietary and non-dietary exposure calculations. Not sure if we being consistent in how the exposure factors are being presented. The types of exposure factors needed for a calculation/estimate really depends on the type of exposure model/calculation. *Page 16-1, Paragraph 4* Last sentence repeats what was said in paragraph 1 on culture and social status affecting activity patterns. *For 16.2.2 Occupational Mobility and 16.2.3. Population Mobility* There is an introduction to how population mobility can be used as an activity factor for calculating exposure, but no similar introduction for occupational mobility. Maybe have a separate introduction to mobility factors and their usage in exposure estimates. *Table 16-1* Please include the comment that these activities are averaged over seasons. The numbers for swimming are large enough to convert to minutes/day (divide by 30). Doers needs to

be explained in the table or early in the text of Page 16-1 through 16-2, before Table 16.1

Page 16-12, Section 16.3.1.2.

For the U.S. EPA study, what was that age that was considered too young to be interviewed on their own activity patterns?

Page 6-12, Column 2, Paragraph 3

Here it mentions that some activities may overlap, such as activities sports and exercise. Can the tables highlight or mention where overlaps occur. This will help avoid overestimates for exposure.

Page 16-1, Paragraph 5

First sentence ends abruptly.

Page 16-13, Section 16.3.2.1

How many subjects are in the Hill, 1985 study?

Table 16-74

These tables for the Juster et al., 2004 study should give the number of subjects. Other tables are lacking the number of subjects (e.g., USDL 2007 , Carey 1988, Nader 2008)

2) *Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?*

Frequency and duration of contact with surfaces and objects for dermal exposure is not covered in this chapter. In fact, on Page 16-1, Paragraph 4, when Hubal et al., 2000 (author also talks about this in a later paper and the utility of different type of activity patterns, micro vs. macro) talks about children's wider distribution of activities being more challenging, dermal activity patterns is a consideration. This could be covered in this activity chapter or in the dermal exposure chapter to complement the soil loading factors, and surface area of body part.

3) *For the factors included in the EFH, are you aware of other data sources that have not been identified?*

<u>Answer:</u>

How does the CHADS database of activities fit into this activity factors chapter? The CHAD database is referenced here under the Hubal et al., 2000 paper (Page 16-16), but are any studies that were included in CHAD also referenced separately here in this activity chapter. That overlap should be made clear. The Graham and McCurdy, 2004 analysis is based also on the CHAD database (Page 16-17).

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

Answer:

The Wiley study and the NHAPS study are the key studies used for activity patterns. They are both substantial studies with a wealth of data, with medium to high confidence ratings. The Carey study 1988 and the US Bureau of the Census (2008b) are also key studies for occupational and population mobility.

The Graham and McCurdy study also appears to be substantial with a large N especially for certain age groups (21 to 44, 6 to 10) that it should also be evaluated as a key study for certain activity patterns. I realize though it is based on the CHADS database of varying studies and such issues as quality assurance and consistency might be hard to assess.

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

Answer:

See comments under general section above.

Table16-2

It says quality assurance methods were not well described in study reports. Can EPA not get that information for the U.S.EPA (1996) report?

6) *Please comment on whether data variability has been adequately characterized and described.*

There are numerous tables in this chapter, and so the user has to search carefully to find the tables that express variability in the activity patterns. Variability in activity patterns based on key studies is defined by age, and averaged over seasons in the main key tables from 2 main studies. Variations by season and geographic region are presented later in Table 16-9 for the Wiley data, though for example. Racial, educational and educational differences in some activities are also expressed for the US 1996 studies in a number of tables (Table 16-16 through 16-20, Tables 16-24, 16-26, 16-31, 16-33, 16-36, 16-39, 16-41,16-43). Relevant studies, such as USDL 2007 and Carey 1988 also have activity patterns based on race and ethnicity. Of the chapters I reviewed, this chapter offers the most variability in the data.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

Answer:

See general comments.

Lebowitz

General Comments:

The statements in 16.1 are good and govern what is presented.

The key studies are good, but there are other key studies, including some that are considered only relevant herein. EPA has funded studies of sufficient magnitude to give valid and reliable data on time-activity patters for representative populations in different regions, including the NHEXAS studies (whose data are on the EPA website), and STAR studies of children's activities in relation to exposures (especially related to ingestion), such as by the Univ. of Minnesota group, O'Rourke et al., Fenske et al., and Freeman et al. (The NHEXAS data show significant differences by region of the country.) They should be considered as well.

Specific Comments:

16.2.1 – Mean and 95th percentiles appear to be those recommended, but it would be wiser to use median and 90th percentiles, since the distributions are non-Gaussian. Examples of median data presented are in earlier tables in this chapter.

16.2.2 – As shown, median tenures vary entirely by age group within gender, and should be stated as such.

16.3.1.1 – The Wiley data should be supplemented by other data from relevant studies and from NHEXAS.

16.3.2 – Comparisons should be made between relevant studies conducted previously and more recent data to determine if the data actually show a change in time-activity patterns in subsequent years/decades. (The Wiley study is also "old" by the criteria used to judge these "relevant" studies, and the NHAPS data are now 14 years old as well.) Further, just because they were conducted only in one state should rule them out, especially if California or if data from other states/regions are available in relevant studies. Thus, I don't think confining these good studies to the relevant category is appropriate.

Presenting data on occupational tenure and on mobility are good. It's unfortunate one doesn't have more complete data on how each occupational category spends its time – it varies widely based on occupational exposure studies.

Presenting all these tables is very good and useful. Present more, so that risk assessors can choose as to which data are most relevant to their purpose.

Chapter 17 – Consumer Products

Bennett	In the discussion of the CTFA study in section 17.3.1, I think is important that it is noted that the mass of product used was estimated by the companies. This can be found as a footnote to Table 17-3, but there is no information on how the companies estimated these values or anything to give us any idea of the degree of confidence in these values.
Tran	**Question 1 – Presentation and format** Five new studies on cosmetic and personal care products (Weegels et al, 2001; Loretz et al 2005, 2006 and 2008; and Hall et al 2007), one on new household pesticide use (Bass et al 2001), and one on baby care products (Sathyanarayana et al 2008) were added to the consumer products chapter. These new data add strength to the information in this chapter. However, with the expansion of information, there is a need to better organize this chapter into sections and data tables by types of consumer product categories, i.e. cosmetics/personal care, cleaning products, paints, pesticides, etc… As presented some of the studies have use data on multiple product types and users would have to go through all tables to decide which factor to use. Also, the products included under the household maintenance products (table 17.1) cover a wide range of consumer products ranging from cleaning products to laundry detergents to fertilizers. This product category should be re-organized into several product categories. **Question 2: factors most needed for exposure assessment?** For cosmetic/personal care products, the provided factors (amount/frequency) are adequate for screening level exposure assessments (with default assumption of 100% retained/absorbed, etc…). For cleaning product scenarios, use amount, frequency and duration data are available from the Weststat 1987 and Abt 1992 dataset allowing for screening level assessments. **Question 5. Confidence rating** Since there is no key study/data recommendation, it would be helpful to include an overall summary table of the studies indicating strength, limitations and relevance given the age of each study cited in this chapter. It is noted that some of the use rates in table 17-3 (based on CTFA 1983 survey) is lower than the use rates in the more current CTFA surveys (e.g. shampoo uses). This raises questions on the relevancy of the old CTFA data when assessing today's consumers' exposures. **Question 6. Variability captured?** Both amount use and frequency of use data are available from the Hall et al. and Loretz et al cosmetic/personal care data; mean and percentile estimates are also available and useful for exposure assessment. The older dataset (Westat 1987, Abt 1992, and EPA 1996) also provided useful percentile estimates. The baby care products dataset (Sathvanarayana et al 2008) is limited to % using and of limited utility.

	Question 17 – Future research area For cosmetic and personal care products, there are no data for teenagers and children in the revised EFH. Also, the baby care data from Sathyanarayana et al (2008) are limited to % using and there is no information on amount/ frequency use that are needed for a quantitative exposure assessment. Toothpaste/oral care, soap and detergent use data for the US population are not summarized in the revised EFH. Future research /update could consider these data gaps. The use data for cleaning products are also old and could be updated in the future.
Zaleski	• On p. 17, section 17-1 mentions 2 information sources on consumer products (Household Products Database and the Source Ranking Database) but recognizes that they do not provide exposure factors information. While these may be useful resources, it is unclear why they are included in the Exposure Factors Handbook. Much of the information in this chapter is summarized in a general manner. Additional detail on the specific product types that are included in each category should be presented within the document. This type of information is needed to enable the data to be applied appropriately. For example, in Table 17-4, it is unclear which products fall under the category water repellants/protectors, which may include liquids or sprays. It is likely that use amounts and patterns differ for each. Also, the WESTAT 1987a document contains additional useful information as to where product usage occurs (indoors or outdoors, garage, etc.) and if ventilation is used. This information is very important to estimating potential consumer exposure, in conjunction with the use amount, duration, and frequency. If possible, re-analysis that evaluated the potential relationship between use amount, location, and ventilation would be very valuable. Consumer product use patterns vary based upon age, gender, and multiple other factors. Therefore, the study population should be clearly described for each table included in this chapter (for ex. NHAPS is a US National study, Bass was 107 households with children in Arizona, etc.) On p. 17-6, additional information should be provided as to the population of the Weegels and van Veen study (in what geographic region was this done?). Other sources of information not mentioned include: • the European Commission's Joint Research Center EIS-Chemrisks website http://web.jrc.ec.europa.eu/esi-chemrisks/ • RIVM (National Institute for Public Health and the Environment, the Netherlands) Fact Sheets http://www.rivm.nl/en/healthanddisease/productsafety/ConsExpo.jsp#tcm:13-42823 • Human and Environmental Risk Assessment on Ingredients of Household Cleaning Products Guidance Document Methodology include information on EU consumer habits and practices:

http://www.heraproject.com/files/HERA%20TGD%20February%2020005.pdf

Chapter 18 - Lifetime

Bennett	In the last paragraph of section 18.2, the document discusses the fact that IRIS does not use a 70 year lifetime in the calculation of the cancer slope factors. There should be a statement explaining how IRIS calculates the slope factors to provide clarity to the reader.
Ferguson	1) *Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?* <u>Answer:</u> The lifetime exposure measure is crucial for calculating lifetime exposure to any chemical for chronic health effects such as cancer. Lifetime measure can also be used to obtain average daily exposure for acute exposures. Page 18-1, Paragraph 4 Why is 70 used for U.S EPA risk assessment? Is this based on old data? And if this is the case, how does the user integrate the toxicity data based on 70 years, with exposure data now based on 78 year averages for lifetime. Table 18-2. Do you know if this ACS publication considers obesity trends and its effects on longevity into the projections for 2020? Table 18-3 EPA may want to highlight how expectation of Life at Birth has increased from 1970 to 2005, but some leveling has occurred from 2000 to 2005. What is this due to? Is there just a limitation to how much we can extend life through medical treatment/advances or are we beginning to see the effects of obesity and even stress aspects in our communities? Page 18-4, Paragraph EPA could add a comment on how the data in Table 18-19 is derived. Is it simply the life expectancy minus a particular age? 2) *Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?* <u>Answer</u> In terms of length of life, the factors presented in this chapter are those most needed to conduct exposure assessment.

3) *For the factors included in the EFH, are you aware of other data sources that have not been identified?*

<u>Answer</u>:

No

4) *NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."*

<u>Answer</u>:

The U.S. National Center for Health Statistics, 2008 seems like the most reliable source for this type of statistic or exposure factor. Life expectancy is not something that has to be measured or estimated, it is based on actual data on death rates/and age at death. So it is understandable that this is a key study receiving a high confidence rating.

5) *Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.*

<u>Answer</u>:

See above under general comments

6) *Please comment on whether data variability has been adequately characterized and described.*

<u>Answer:</u>

This is one chapter or set of exposure factors that we do see variability for races (i.e., black and white) and sexes. It is a pity that the Latino community is not represented in this exposure factor. Many states (e.g., Florida and California) have a sizable Latino community (this will continue to grow rapidly, also in other states). Hopefully, the U.S., National Center for Health Statistics will collect this data going forward. EPA should however look for another source of data.

7) *Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g.,*

	CDROM, web based, other)? <u>Answer:</u> See general section.
Gaylor	Section 18.1. 2nd sentence. This statement is mathematically incorrect. Hence, the sentence is not true and should be deleted. For example, suppose the weighted average lifetime dose = d_o over a lifetime of L_o years. Now, suppose the lifetime is extended by an additional L_e years and the weighted average dose during the extended period is d_e. Therefore, the weighted average lifetime dose (d) over ($L_o + L_e$) years is $$d = (d_oL_o + d_eL_e) / (L_o + L_e) .$$ Hence, $d \geq d_o$ when $$(d_oL_o + d_eL_e) / (L_o + L_e) \geq d_o$$ $$(d_oL_o + d_eL_e) \geq d_o (L_o + L_e)$$ $$d_eL_e \geq d_oL_e$$ $$d_e \geq d_o .$$ That is, the weighted average dose over the longer lifetime will be ≥ the average dose over the shorter lifetime when the average dose during the extended period (d_e) is greater than the average dose during the shorter lifetime (d_o). Conversely, $d \leq d_o$ when $d_e \leq d_o$.
Lebowitz	<u>**General Comments**</u>: This is an adequate Chapter and useful for risk assessors for carcinogenic risk. In such applications, the research into radiation exposures, such as that for radon, would be a useful addition to indicate how exposure and risk assessment could be performed for lifetime exposures. It would be useful for exposure assessment, and thus for risk assessment, of non-carcinogenic agents if it included methods to incorporate long-term exposures to such agents, including indoor, ambient and occupational exposures. Such methods could incorporate activity patterns, including specific occupational tenures and mobility found in Chapter 16. Estimates of lifetime exposures have been performed in various studies, including those in the radon studies, and in the Adventist Cohorts (cf., Abbey's group's work) for non-carcinogenic agents. Exposure estimates for long-term occupational exposures have been conducted and/or reviewed by NIOSH for several agents of interest to EPA, and less detailed exposure-response relationships in the general population have been conduced by

several, including the author (Environ Res. 14:56-67, 1977).

Methods have been evaluated as well for extending short-term to long-term exposures and these reports in the literature should be explored.

Chapter 19 – Residential Building Characteristics

15) Chapter 19 presents data on residential building characteristics that may be relevant for assessing human exposures in the residential setting. Please comment on whether there are any other data or factors, for which there are available data, that are important for inclusion in future revisions to this chapter?

Anderson	It would seem that information on schools and day care indoor environments would be a good addition to the residential environment. I don't know where such data exists, but it may be available and if not it might be able to add to other data collection instruments.
Bennett	There are a number of areas where the Handbook could benefit from additional parameters. I have grouped the comments into general subject areas. **Air Flow within Compartments of Buildings** It should be specified throughout the chapter which factors are related to single family homes. There should be some discussion on multi-unit dwellings and the fact that air can flow from one unit to another, thereby transferring pollutant sources from one unit to another. Sax *et al.* suggested concentrations of some VOCs within apartment units unaccounted for by known activities within the apartment are from pathways within the building (Sax, *et al.*, 2004). Diamond and colleagues reviewed several apartment building ventilation studies, which showed that air flow between apartment units via the common apartment hallway may be substantial but that these rates tend to be fairly specific to building type, occupant behaviors, unit location, and meteorological conditions (Diamond R.C., *et al.*, 1996). Dodson and collected limited measurements (Dodson 2008). Data on this phenomena are limited and therefore specific factors are unlikely to be able to be recommended, but it would still be worthwhile to include a discussion. Diamond, R. C., et al. 1996. Ventilation and infiltration in high-rise apartment buildings. Lawrence Berkeley Laboratory. Berkeley Dodson, R. E., Levy, J. I., Shine, J. P., Spengler, J. D. and Bennett, D. H., 2007. Multi-zonal air flow rates in residences in Boston, Massachusetts. Atmospheric Environment 41, 3722-3727. Sax, S. N., Bennett, D. H., Chillrud, S. N., Kinney, P. L. and Spengler, J. D., 2004. Differences in source emission rates of volatile organic compounds in inner-city residences of New York City and Los Angeles. J Expo Anal Environ Epidemiol 14 Suppl 1, S95-109. When discussing air flows through a home, air flows from the garage to the home need to be included. In addition to automobiles, people often store gasoline, oil, paints, lacquers, and yard and garden supplies in garages, which can be a source of VOCs such as benzene, toluene, ethylbenzene, m,p-xylene and o-xylene (BTEX), both from evaporative emissions and start-up/shut-down emissions (Batterman, *et al.*, 2006a). As a result, some studies have found elevated indoor VOC concentrations in residences with attached garages compared to those without attached garages. (Adgate, et al., 2004, Gordon, *et al.*, 1999, Graham, *et al.*, 1999, Lansari, *et al.*, 1996, Thomas, *et al.*, 1993, Wallace, 1991).

For example, available studies estimated that over 50% of benzene concentrations in a home may be attributable to the garage (Dodson et al. 2008, Batterman, *et al.*, 2007, Furtaw, *et al.*, 1993, Noseworthy and Graham, 1999).

Air flow rates between a garage and a residence have been reviewed (Emmerich S., *et al.*, 2004) and estimated in several studies (Dodson et al 2007, Batterman S., *et al.*, 2006b, Batterman S., *et al.*, 2006 Batterman S., *et al.*, 2006, Graham L., *et al.*, 1999, Graham L., *et al.*, 2004,Tsai and Weisel 2000, Isbell M.A., *et al.*, 2005). While there have not been any large scale studies, there have been quite a few smaller studies such that the EPA may be able to produce a recommended value.

Adgate, J. L., Church, T. R., Ryan, A. D., Ramachandran, G., Fredrickson, A. L., Stock, T. H., Morandi, M. T. and Sexton, K., 2004. Outdoor, indoor, and personal exposure to VOCs in children. Environ Health Perspect 112, 1386-92.

Batterman, S., Hatzvasilis, G. and Jia, C. R., 2006a. Concentrations and emissions of gasoline and other vapors from residential vehicle garages. Atmospheric Environment 40, 1828-1844.

Batterman, S., Jia, C. R., Hatzivasilis, G. and Godwin, C., 2006b. Simultaneous measurement of ventilation using tracer gas techniques and VOC concentrations in homes, garages and vehicles. Journal of Environmental Monitoring 8, 249-256.

Batterman, S., Jia, C. R. and Hatzivasilis, G., 2007. Migration of volatile organic compounds from attached garages to residences: A major exposure source. Environmental Research 104, 224-240.

Dodson RE, Levy JI, Shine JP, Spengler JD, Bennett DH. Multi-zonal Air Flow Rates in Residences in Boston, Massachusetts. *Atmos Environ*, 2007; 41 (17): 3722-3727.

Dodson, R.E., J.I. Levy, J.D. Spengler, J.P. Shine, and D.H. Bennett. Influence of Basements, Garages, and Common Hallways on Indoor Residential Volatile Organic Compound Concentrations. Atmospheric Environment. 2008, 42(7):1569-1581.

Emmerich, S., et al. 2004. Air and pollutant transport from attached garages to residential living spaces - literature review and field tests. International Journal of Ventilation. 2. 265-276

Gordon, S., Callahan, P., Nishioka, M., Brinkman, M., O'Rourke, M., Lebowitz, M. and Moschandreas, D., 1999. Residential environmental measures in the National Human Exposure Assessment Survey (NHEXAS) pilot study in Arizona: preliminary results for pesticides and VOCs. Journal of Exposure Analysis and Environmental Epidemiology 9, 456-470.

Graham, L., O'Leary, K. and Noseworthy, L. 1999. Indoor air sampling for infiltration of vehicle emissions to the house from the attached garage. Environment Canada. ERMD Report #99-26768-2

Graham, L. A., Noseworthy, L., Fugler, D., O'Leary, K., Karman, D. and Grande, C., 2004. Contribution of vehicle emissions from an attached garage to residential indoor air pollution levels. Journal of the Air & Waste Management Association 54, 563-

584.

Isbell, M. A., Stolzberg, R. J. and Duffy, L. K., 2005. Indoor climate in interior Alaska: simultaneous measurement of ventilation, benzene and toluene in residential indoor air of two homes. Science of the Total Environment 345, 31-40.

Lansari, A., Streicher, J. J., Huber, A. H., Crescenti, G. H., Zweidinger, R. B., Duncan, J. W., Weisel, C. P. and Burton, R. M., 1996. Dispersion of automotive alternative fuel vapors within a residence and its attached garage. Indoor Air-International Journal of Indoor Air Quality and Climate 6, 118-126.

Noseworthy, L. and Graham, L. 1999. Chemical mass balance analysis of vehicle emissions in residential houses from attached garages. Environment Canada. ERMD Report #99-26768-3

Thomas, K. W., Pellizzari, E. D., Clayton, C. A., Perritt, R. L., Dietz, R. N., Goodrich, R. W., Nelson, W. C. and Wallace, L. A., 1993. Temporal variability of benzene exposures for residents in several New-Jersey homes with attached garages or tobacco-smoke. Journal of Exposure Analysis and Environmental Epidemiology 3, 49-73.

Tsai, P. Y. and Weisel, C. P., 2000. Penetration of evaporative emissions into a home from an M85-fueled vehicle parked in an attached garage. Journal of the Air & Waste Management Association V50, 371-377.

Wallace, L. A., 1991. Comparison of risks from outdoor and indoor exposure to toxic chemicals. Environmental Health Perspectives V95, 7-13.

When discussing air flows within a home, the manuscript states that most homes have some kind of central heating and air conditioning system. I think that there should be a note that this does vary regionally, with many of the older cities not have central heating that transfers air, but rather radiant heating. For example, central heat is very uncommon in many parts of the northeast.

Deposition, Infiltration, Filtration, and Infiltration

In the deposition and filtration section, there is no mention of the loss of outdoor particles as they move through the building shell, or losses from infiltration. This is critical for evaluating the impact of outdoor particles on indoor levels. The document states at the end of section 19.4.5 that particles smaller than 10
Numerous studies have shown losses through the building shell.

Particles of outdoor origin enter the home through purposeful openings such as doors and windows, as well as cracks and crevices in the building envelope. As particles travel through the cracks, they can be removed by impaction, diffusion, or interception mechanisms. The penetration efficiency (P), the fraction of particles of a specific diameter that pass through the building envelope, is dependent on the number and geometry of the cracks as well as the velocity of the air passing through the cracks, which is a function of the air exchange rate (Liu and Nazaroff 2001, 2003). The roughness and shape of the crack are also influential (Jeng et al. 2006, 2007, Tian 2008). It is expected that particle loses vary by home, due to differences in home characteristics, suggesting the need for taking measurements on a wide range of homes. Particle losses also vary temporally due to changes in air exchange rates, wind velocities, relative humidity, and temperature differences, suggesting the need for modeling results dynamically and understanding the impact of these factors. The penetration efficiency also depends on the particle size, with lower efficiencies for small particle sizes (<0.1 □ deposition and for larger particles (>1.5 □m) due t gravitational loses. Therefore, the different particle size fractions of the regulated fine and coarse particle mass are not expected to exhibit the same penetration factors.

Once in the home, particles are deposited onto indoor surfaces [deposition rate (k)]. Again, this process is strongly influenced by particle size. The deposition rates have been found to vary between homes due in part to differences in air flow velocities within the home, the quantity and surface of furnishings in the home, the interior surface-to-volume ratio, and the difference in temperature differential between the air and surfaces and particle roughness (Lai and Nazaroff 2000; Thatcher, Lai, Moreno-Jackson et al. 2002, Lai 2006).

Due to penetration and deposition losses indoors, particle concentrations are lower relative to outdoor concentrations in the absence of indoor sources. The infiltration factor (F_{inf}) has been defined as the fraction of outdoor particles that penetrate indoors and remain suspended (Wilson and Suh 1997; Wilson, Mage and Grant 2000). Therefore, determining infiltration efficiency and understanding its relationship to the different parameters such as home characteristics, air exchange rates, temperature, etc. is very important in our efforts to assess individual and population exposures to particles of outdoor origin. Studies have also determined this factor by determining the indoor outdoor ratio of particles of outdoor origin (Meng et al. 2007).

For long time periods, e.g. a few hours, with reasonably constant outdoor concentrations and air exchange rates, in the absence of indoor sources, the infiltration factor can be determined using a steady state model and is defined as the ratio of the indoor to outdoor concentrations. Several studies have determined infiltration ratios during periods when contributions of indoor sources are negligible (e.g. night-time periods). During these periods, infiltration factors were determined for various size fractions using regression techniques assuming steady state conditions (Abt, Suh, Catalano et al. 2000; Long, Suh, Catalano et al. 2001). The assumption of steady state neglects changes in outdoor concentrations and air exchange with time. Furthermore, infiltration ratios were determined using a random component superposition model (Ott, Wallace and Mage 2000). According to this approach the infiltration ratio equals the slope of the regression of indoor on outdoor concentrations, again neglecting the impact of temporal changes. The authors suggest that over long time periods the average infiltration rate is the same for all homes (Wallace, Mitchekk, O'Connor et al. 2003).

Studies have also calculated P and k values separately, in some cases by controlling environmental conditions such as particle levels and ventilation conditions. For example, penetration and deposition rates were determined for 6 homes in Hong Kong by raising indoor particle concentrations, which was achieved by opening windows and doors (Chao, Wan and Cheng 2003). Subsequently, the windows and doors were closed and the decay of particles indoors was measured. Thatcher et al. (Thatcher, Lunden, Revzan et al. 2003) determined P and k values in two test homes in California using a dynamic model.

For these tests, particle concentrations were uniformly raised throughout the home, and then were allowed to decline to determine k. It is important to note that they were able to bring achieve well mixed conditions prior to determining k, as reductions in particle concentration from mixing of particles through the home are mathematically indistinguishable from reductions due to particle deposition. The investigators then determined penetration efficiencies by reducing indoor concentrations using pressurized filtered air and then allowing concentrations to increase through natural home ventilation to determine P. Schneider et al. determined penetration values for an uninhabited apartment using a dynamic model (Schneider, Jensen, Clausen et al. 2004). A small slit was made in the apartment through which there was assumed to be no penetration loss. Deposition loss rates were taken from Thatcher et al. (Thatcher, Lunden, Revzan et al. 2003). Using the measured particle penetration, the ratio between predicted and measured concentration values was analyzed with air-exchange and meteorological conditions to determine a correction factor, which was based on the wind velocity, outdoor relative humidity, and air-exchange rate (Schneider, Jensen, Clausen et al. 2004).

While altering the environmental conditions is an effective way for determining house-specific penetration efficiencies and deposition rates, it is not practical to conduct these experiments in a significant number of homes, especially over an extended time period. Long et al. (2001) used a steady-state model during nighttime non-source periods (when residents were asleep eliminating the possibility for sources) to obtain average estimates for P and k for a group of nine homes in Boston, but not for individual homes. An infiltration factor was calculated using a dynamic model for these homes by Bennett and Koutrakis (2006). Allen et al. (Allen, Larson, Sheppard et al. 2003) determined the air exchange rate, penetration efficiency, and deposition velocities for 44 homes in the Seattle area, using particle light scattering measurement data. Other efforts to evaluate infiltration include Mosley et al. (2001) and Thornburg et al. (2001).

Some mention of this large body of work should be mentioned in the residential section.

Abt, E., Suh, H. H., Catalano, P. J. and Koutrakis, P. (2000). Relative contribution of outdoor and indoor particle sources to indoor concentrations. *Environmental Science & Technology*, 34, 3579-3587.

Allen, R., Larson, T., Sheppard, L., Wallace, L. A. and Liu, L. J. S. (2003). Use of real-time light scattering data to estimate the contribution of infiltrated and indoor-generated particles to indoor air. *Environmental Science & Technology*, 37, 3484-3492.

Bennett DH and Koutrakis, P. Determining the Infiltration of Outdoor Particles in the Indoor Environment Using a Dynamic Model. Journal of Aerosol Science, 2006, 37:766-785.

Chao, C. Y. H., Wan, M. P. and Cheng, E. C. K. (2003). Penetration coefficient and deposition rate as a function of particle size in non-smoking naturally ventilated residences. *Atmospheric Environment*, 37, 4233-4241.

Jeng, CJ; Kindzierski, WB; Smith, DW (2007) Particle penetration through inclined and L-shaped cracks JOURNAL OF ENVIRONMENTAL ENGINEERING-ASCE 133 (331-339)

Jeng, CJ; Kindzierski, WB; Smith, DW (2006) Particle penetration through rectangular-shaped cracks. JOURNAL OF ENVIRONMENTAL ENGINEERING AND SCIENCE 5 (S111-S119).

Lai, A. C. K. and Nazaroff, W. W. (2000). Modeling indoor particle deposition from turbulent flow onto smooth surfaces. *Journal of Aerosol Science*, 31, 463-476.

Lai, ACK,(2006) Particle deposition and decay in a chamber and the implications to exposure assessment. WATER AIR AND SOIL POLLUTION 175 (323-334)

Liu, D. L. and Nazaroff, W. W. (2001). Modeling pollutant penetration across building envelopes. *Atmospheric Environment*, 35, 4451-4462.

Liu, D. L. and Nazaroff, W. W. (2003). Particle Penetration Through Building Cracks. *Aerosol Science and Technology*, 37, 565-573.

Long, C. M., Suh, H. H., Catalano, P. J. and Koutrakis, P. (2001). Using Time- and Size-Resolved Particulate Data to Quantify Intoor Penetration and Deposition Behavior. *Environmental Science & Technology*, 35, 2089-2099.

Meng, QY; Turpin, BJ; Lee, JH, et al.(2007) How does infiltration behavior modify the composition of ambient PM2.5 in indoor spaces? An analysis of RIOPA data. ENVIRONMENTAL SCIENCE & TECHNOLOGY 41(7315-7321).

Ott, W., Wallace, L. A. and Mage, D. (2000). Predicting particulate (PM10) personal exposure distributions using a random component superposition statistical model. *Journal of the Air & Waste Management Association*, 50, 1390-1406.

Schneider, T., Jensen, K. A., Clausen, P. A., Afshari, A., Gunnarsen, L., Wahlin, P., Glasius, M., Palmgren, F., Nielsen, O. J. and Fogh, C. L. (2004). Penetration of indoor concentration of 0.5-4 mm particles of outdoor origin in an uninhabited apartment. *Atmospheric Environment*, 38, 6349-6359.

Thatcher, T. L., Lai, A. C. K., Moreno-Jackson, R., Sextro, R. G. and Nazaroff, W. W. (2002). Effect of room furnishings and air speed on particle deposition rates indoors. *Atmospheric Environment*, 36, 1811-1819.

Thatcher, T. L., Lunden, M. M., Revzan, K. L., Sextro, R. G. and Brown, N. J. (2003). A concentration rebound method for measuring particle penetration and deposition in the indoor environment. *Aerosol Science and Technology*, 37, 847-864.

Wallace, L. A., Mitchekk, H., O'Connor, G. T., Neas, L. M., Lippmann, M., Kattan, M., Koenig, J., Stout, J. W., Vaughn, B. J., Wallace, D., Walter, M., Adams, K. and Liu, L. J. S. (2003). Particle Concentrations in Inner-City Homes of Children with Asthma: The Effect of Smoking, Cooking, and Outdoor Pollution. *Environment Health Perspectives*, 111, 263-272.

Wilson, W. E., Mage, D. T. and Grant, L. D. (2000). Estimating separately personal exposure to ambient and nonambient particulate matter for epidemiology and risk assessment: Why and how. *Journal of the Air & Waste Management Association*, 50, 1167-1183.

Wilson, W. E. and Suh, H. H. (1997). Fine particles and coarse particles: Concentration relationships relevant to epidemiologic studies. *Journal of the Air & Waste Management Association*, 47, 1238-1249

Mosley, R. B., Greenwell, D. J., Sparks, L. E., Guo, Z., Tucker, W. G., Fortmann, R. and Whitfield, C. (2001). Penetration of ambient fine particles into the indoor environment. *Aerosol Science and Technology*, 34, 127-136.

Liwei Tian; Guoqiang Zhang; Jinghua Yu, et al. (2008) Impact of surface roughness on particle penetration through building envelope leakage. International Journal of Energy Technology and Policy   Pages: 534-42   Published: 2008

Thornburg, J., Ensor, D. S., Rodes, C. E., Lawless, P. A., Sparks, L. E. and Mosley, R. B. (2001). Penetration of Particles into Buildings and Associated Physical Factors. Part 1: Model Development and Computer Simulations. *Aerosol Science and Technology*, 34, 284-296.

Embedded Dust

In addition to the dust that is easily sampled, there is an additional loading of dust that is not easily removed. Fortune, et al. investigated the mass of dust obtained from vacuuming and vacuuming with a beater-bar machine to remove deeply embedded dust in eight homes (Fortune, et al. 2000). The results indicated that the actual dust loading in carpet was approximately ten times the amount removed by conventional vacuuming. This dust needs to be accounted for in the model, as it is a potential reservoir for pesticide storage and it needs to be included in the fugacity capacity of the carpet.

Fortune CR, Blanchard FT, et al. 2000. *Analysis of aged in-home carpeting to determine the distribution of pesticide residues between dust, carpet, and pad compartments*. RTP, NC: EPA-NERL.

Georgopoulos

Chapter 19 potentially provides a strong link with indoor air modeling; in fact, by taking an approach that is not generally followed in this Handbook, this Chapter identifies a specific set of available software models for indoor air modeling (on page 19-3). However, the selection of these particular software implementations (described in the text of page 19-3 as “Leading examples of indoor air models”) omits a wide range of available – and increasingly popular – approaches and formulations, including Computational Fluid Dynamics (CFD) models.

Numerous indoor air quality modeling approaches have been reported in the literature; however, depending on the modeling scenario, only few of them address - typically a limited subset of - physical and chemical processes that affect complex air pollution mixtures (e.g. photochemical oxidants) indoors [Freijer & Bloemen, 2000; Hayes, 1989, 1991; Nazaroff & Cass, 1986]. It would be beyond the scope of EFH to present in detail the current status of indoor air modeling methods. However, it could briefly state the fact that existing indoor air concentration models are available as a wide range of empirical regression relationships, parameterized mass balance models (that can be either "single-zone" - that is, single well-mixed room - or "multi-zone" models), and

CFD-based models.

Various studies have compared the different formulations of zonal models and of more complex, CFD, models [Teshome & Haghighat, 2004]. Some indoor air models have also considered atmospheric chemistry, that can be especially important in the presence of indoor sources such as gas stoves, etc. [Georgopoulos *et al.*, 1997], while others considered potential limitations of uniform mixing assumptions [Sorensen & Weschler, 2002]. These can be important issues when calculating personal exposures and need to be addressed in conjunction with developing and evaluating indoor emission inventories for specific contaminants. It should be noted that the focus of this Chapter is specifically on residential settings: as mentioned earlier, it is hoped that in the future consideration of other indoor microenvironments (schools, offices, restaurants, shopping malls, etc.) will be incorporated in the EFH (please also see answer to Question 16, below).

Some selected references to useful recent studies follow:

[Dodson et al., 2007] Interzonal air flow for indoor air quality assessment

[Grøntoft & Raychaudhuri, 2004] Tables of surface deposition velocities for common indoor pollutants.

[He *et al.*, 2005] Table 1 gives a summary of the experimental conditions of the residential house studies on particle deposition rates

[Meng *et al.*, 2009] Table 1 provides AER for different fan/AC operations and building age/type

[Wallace *et al.*, 2004] Deposition rates based on central fans and in-duct filters

[Yamamoto *et al.*, 2009] AER based on Relationship among Indoor, Outdoor and Personal Air (RIOPA) study

[Hellweg *et al.*, 2009]

An essential reference that can be useful in relation to indoor air modeling in general (but not listed in the Handbook, probably due to its primary focus on occupational exposures) is the corresponding AIHA Guidance [AIHA, 2000]. This document contains valuable information that could, however, be equally useful in characterizing residential microenvironments (note that a 2009 update of the AIHA Guidance is now available).

It would be useful – since specific software for indoor models is listed in this chapter anyway, to at least include some references to major available CFD platforms and to specific indoor air models and a brief discussion of the type of information these models (a) require as inputs and (b) produce from their calculations in the context of an exposure analysis. To facilitate selection of references relevant to CFD modeling for future updates of EFH , a set of tables is included here (from Georgopoulos *et al.*, 2007), listing available CFD modeling software as well as sets of CFD studies of both airflow and contaminant dispersion in various indoor microenvironments.

Table 1. List of major CFD software platforms and supporting tools

Software Title	Developer	OS	Included Utilities, Other Notes
CFD Platforms			
STAR-CD 4.06	CD-adapco	Win	Includes Star-Design; CD-adapco also has STAR-CCM+
Ansys Academic Research CFD 12.1	Ansys, Inc.	Win, Linux, Unix	Provides access to FLUENT and CFX; Airpak and POLYFLOW products are also available with Ansys
Phoenics 2008	CHAM	Win	Perpetual License available; computing features similar to Fluent
FLOW-3D 9.4	Flow Science Inc.	Win	Linux version will be available soon; flexible licensing options
NUMECA	NUMECA	Win, Linux	Can read input/output files from other CFD software's like FLUENT
Multiphysics 3.5	Comsol	Omni-platform	Interfacing with Matlab possible, Ansys has a similar product
OpenFOAM 1.6 (Field Operation And Manipulation)	OpenCFD Ltd.	Linux, Unix	Open source CFD toolbox written in C++
Auxiliary Software for CFD Visualizations			
TecPlot 360 2009 R2	Tecplot, Inc.	Win, Linux	Includes CFD Analyzer; an add-on specific for CFD visualization
GAMBIT 2.4	Ansys, Inc.	Win, Linux, Unix	Mesh generation software for FLUENT; has ACIS geometry kernel
AutoCad 2010	AutoDesk	Win	Has ACIS geometry kernel

Table 2. Selected CFD studies of indoor airflow and microclimate

Type of study	Software	Reference
Studies that do not take into account the presence of humans		
Mathematical framework of a new zero-equation turbulence model	PHOENICS	Chen & Xu, 1998
Comparison of laminar, k-ε and RNG k-ε models with experimental results	Fluent	Posner et al., 2003
Development of an algorithm for robust coupling between CFD and energy simulation	E+ MIT - CFD	Zhai & Chen, 2003
Studies that take into account the presence of humans		

Analysis of flow around a human body	Not specified	Murakami et al., 1999
Combined simulation of airflow with moisture transport, radiation and heat released from human body	Not specified	Murakami et al., 2000
Simulation for designing optimal indoor climates (atrium)	Not specified	Murakami et al., 2001
Thermal comfort study in a lecture theatre	Fluent/ Uns 5.3	Cheong et al., 2003a
A simplified numerical method for faster convergence of indoor airflow problems (office space)	STACH - 3	Zhao et al., 2003
Study of airflow in a computer room	Gambit , Fluent	Abanto et al., 2004
Analysis and design of micro-climate around a human body	Not specified	Murakami, 2004
Comparison of the SST kappa–omega model with the simple kappa-epsilon, RNG kappa-epsilon and laminar model (office space)	CFX	Stamou & Katsiris, 2006

Table 3. Selected CFD studies of indoor contaminant emission and dispersion that do not take into account the presence of humans in the modeled space

Type of study	Software	Reference
Modeling evaporation controlled emissions in ventilated rooms using CFD	Not specified	Topp et al., 1997
Environmental modeling inside the Archeological Museum of Athens	PHOENICS	Papakonstantinou et al., 2000
Comparison of the outputs of CFD with “screening” level models for contaminant concentration prediction in a workplace	Fluent 4.2	Feigley et al., 2002
Modeling of gas phase reactions in ventilated rooms using CFD	STAR - CD	Sorensen & Weschler, 2002
Calculation of the mixing time of a pollutant in an unventilated,	Not specified	Gadgil et al., 2003

	mechanically mixed isothermal room		
	Effect of internal partitioning in air quality of a room with mixing ventilation (small scale room)	VORTEX	Lee & Awbi, 2004
	Study on transient diffusion of contaminants	STACH - 3	Yang et al., 2004
	Comparison of different ventilation systems in terms of indoor particle decay	Not specified	Bouilly et al., 2005
	Effect of inlet and outlet locations and emitted gas density on indoor contamination concentrations	Fluent	Khan et al., 2006
	Effect of temperature differences in the dispersion of contaminants indoors (Experimental study)	Not specified	Lee et al., 2006
	Examination of the well – mixed assumption on short term dispersion of contaminants	Gambit / Fluent	Richmond-Bryant et al., 2006
	Comparison of the RNG LES model with the simple *k*-ε and RNG *k*-ε (small-scale room)	Fluent	Tian et al., 2006

Table 4. Selected CFD studies of indoor contaminant emission and dispersion that take into account the presence of humans in the modeled space

Type of study	Software	Reference
Simulation of individual exposure	Not specified	Brohus, 1997a
Measurement of personal exposure using a breathing thermal manikin	Not specified	Brohus, 1997b
Simulation of personal exposure in ventilated rooms (PhD thesis)	FLOVENT	Brohus, 1997c
Study of the air quality in the breathing zone in a room with displacement ventilation	VORTEX	Xing et al., 2001
Analysis of contaminated indoor air characteristics	Not specified	Hayashi *et al.*, 2002

	Comparison of the outputs of CFD with simpler models for contaminant concentration prediction in a workplace	Fluent 4	Bennett et al., 2000, 2003
	Comparison between experiment and simulation in terms of transport and distribution of a tracer gas in a partitioned enclosure	Fluent/ Uns 5.3	Cheong et al., 2003b
	Study of micro-environment around a human body	Not specified	Gao & Niu, 2004
	Proposal of an integrated accessibility of contaminant source model to direct ventilation strategy against contamination (office space)	STACH - 3	Zhao et al., 2004
	Effect of air supply location in a Hong-Kong office with displacement ventilation system	Not specified	Lin et al., 2005
	Simulation of respiration process and inter-person exposure	Fluent	Gao & Niu, 2006
	Comparison between experiment and simulation in terms of particle transport and distribution	Fluent	Zhang & Chen, 2006
	Transport characteristics of saliva droplets produced by coughing (conference room and bedroom)	Not specified	Zhu et al., 2006

Guiseppi-Elie	This Chapter presents a number of factors that are relevant for residential buildings but does so primarily in a qualitative manner. Even the two parameters for which recommendations are provided, the information is limited, dated and recommendations come with low confidence ratings. EPA should consider the factors currently identified in the chapter an area for concerted effort. A key pathway for consideration is the vapor intrusion. Currently, guidance is provided via the modeling efforts associated with the Johnson and Ettinger model. A number of the factors identified in the Chapter are relevant to this pathway including air exchange rates and building dimensions.
Lobscheid	In Section 19.2, page 19-3, the citations for the “leading” indoor air models are essentially

all for Price et al. (2003), with the exception of CONTAM, MCCEM, and THERdbASE. Please include the specific references pertaining to the Technical documentation and/or Model Development of each of these indoor air models. For example, MIAQ was developed at the California Institute of Technology by Nazaroff and Cass (1989) and is described in the following peer-reviewed publication: Nazaroff WW and GR Cass (1989). Mathematical modeling of indoor aerosol dynamics. Environmental Science and Technology 23: 157-166. Additionally, consider providing the web address for where the indoor air models currently listed can be downloaded (or if not available, then the contact person or EPA agency to contact for more information) as part of the citation in the references. I think that most (all?) of these Indoor Air models should be publicly available/accessible. Also, in the References, I suggest including a website for downloading or accessing the VERSAR (1990) PFT database.

Of the 76 or so references cited in Section 19.7 *References for Chapter 19*, most are >= 15 years old. I think there needs to be a more current literature review and data analysis using more recent data on housing stock, included in any future EFH Revisions including the Building Characteristics Chapter. Only the following eight references are from 1996 or later:

Murray (1996), Price (2001), Price (2003), Sherman and Dickerhoff (1996), US BoC (2008), US DOE (2005), US EPA (2000), and Wallace (1996).

Because the housing stock has changed rather dramatically since many of the air exchange rate studies reported in Chapter 19 were conducted, I suggest including more recently collected data analysis and models on air exchange processes. Specifically, I suggest the following additional data and/or analysis from **Sherman and Matson (2002), Chan et al (2003) and Chan et al (2005), and Yamamoto et al (2010) and Price et al (2006)** for consideration to be included in future revisions of the EFH (possibly described after the second paragraph of page 19-2 and/or in Section 19.4.2 Infiltration Models on page 19-2):

Sherman and Matson (2002). Air tightness of new U.S. houses: A preliminary report. Technical Report, Lawrence Berkeley National Laboratory, Berkeley, CA. March 2002.LBNL-48671

In the second paragraph of page 19-2, in Section 19-1 and/or Section 19.4.2 Infiltration Models. on page 19-2,, suggest inserting newer air leakage analysis by Sherman and Matson (2002) on the Air Tightness of New US Houses. Their analysis found that "newer" construction is "significantly tighter than the housing stock as a whole" and that the "air tightness of new construction is no longer improving." The Sherman and Matson (2002) analysis was based on a database of over 70,000 air leakage entries from numerous (over 30) energy efficient and conservation programs throughout the US. Chief among the air leakage data contributors are the Ohio Weatherization Program (nearly 80% of measurements), AKWarm (in the state of Alaska, with over 10% of measurements), and the Wisconsin Energy Conservation Corporation (approximately 5% of all measurements).

The following three figures (Figures 3, 4, and 6 of Sherman and Matson's (2002) report) are show their results of the trends of normalized leakage (i.e., total leakage cm2 normalized by square footage of the home m2) in "new houses" and "new conventional houses" (those that were not built as part of any energy efficiency program), and "energy efficient" homes (mostly built as part of the "Energy Star of Building America programs") and "new" is defined as home construction b/w 1993- 2000):

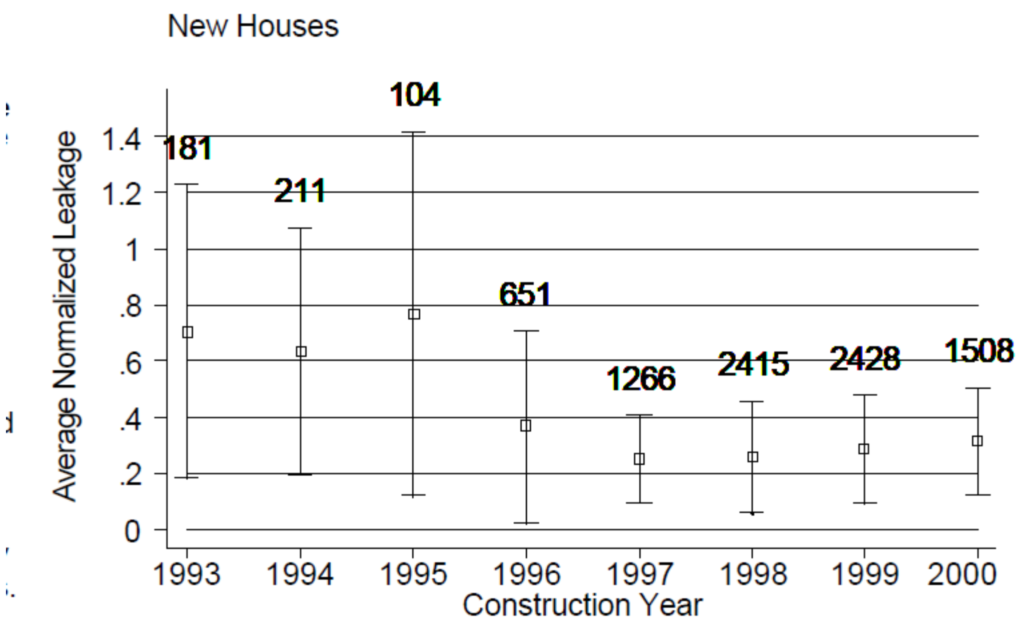

Figure 3 from Sherman and Matson (2002). This figure shows the "Normalized leakage for new houses by year of construction. Size bars indicate the standard deviation of the sample for each year and Numbers above bars indicate sample size."

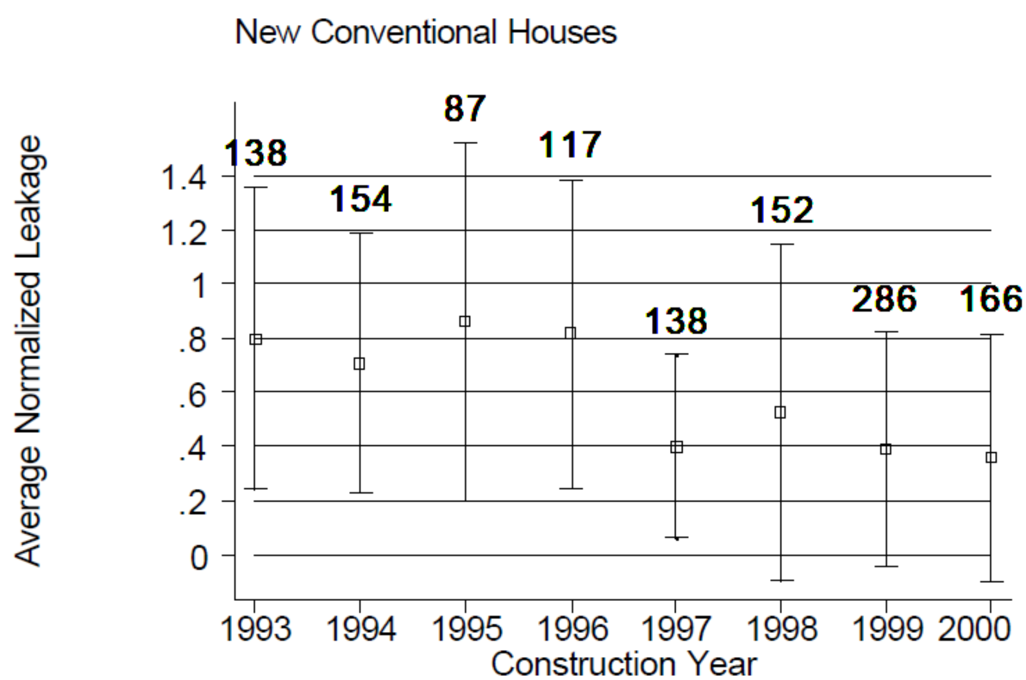

Figure 4 from Sherman and Matson (2002). This figures shows the "Normalized leakage for conventional houses by year of construction. Size of bars indicates the standard deviation of the sample for each year. Numbers above the bars indicate sample size."

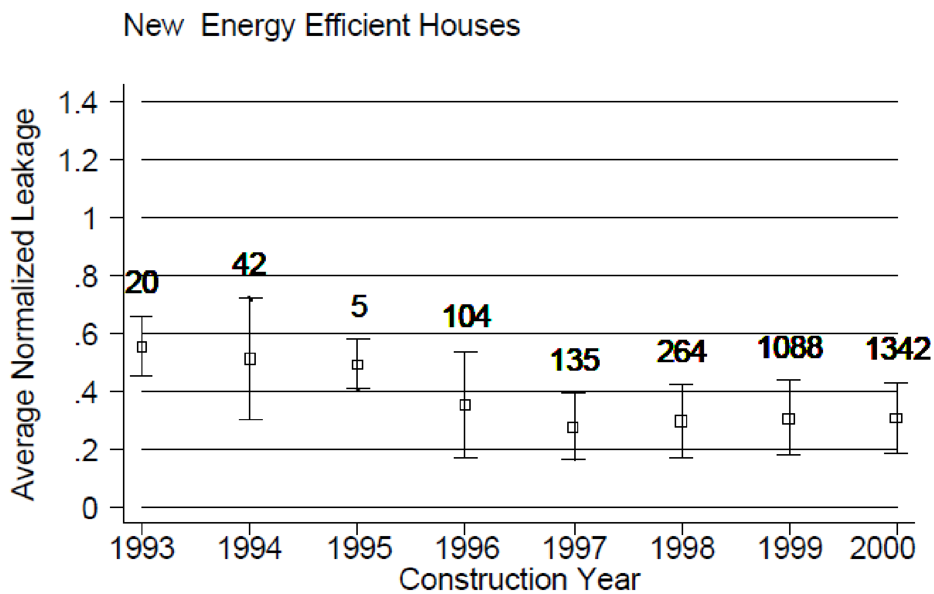

Figure 6 from Sherman and Matson (2002). This figure shows the "Normalized leakage for new, energy efficient homes by year of construction. Size of bars indicates the standard deviation of the sample for each year. Numbers above the bars indicate sample size."

Chan, WR, PN Price, MD Sohn et al (2003). Analysis of US Residential Air Leakage Database Lawrence Berkeley National Laboratory, January 2003. LBNL Report Number 53367.

and

Chan, WR, WW Nazaroff, PN Price et al (2005). Analyzing a database of residential air leakage in the United States. Atmospheric Environment 39:3445-3455.

Chan et al (2003 and 2005) found that normalized leakage (air leakage normalized by floor area) for single-family detached residences is a function of the years since home built and floor area. Therefore, "older and smaller home are more likely to have higher normalized leakage areas than newer and larger ones." They present the following equation (Eqn 11 of Chan et al., 2005) for estimating ACH: based on normalized leakage (dimensionless), height (H, m), and a scaling factor, F (dimensionless, and varying typically b/w 10-30 with F= 16 giving best fit for national data)

$$= 48\left(\frac{2.5\ \mathrm{m}}{H}\right)^{0.3} \frac{\mathrm{NL}}{H\,F}\,[\mathrm{h}^{-1}],$$

The following Table (Table 3 from Chan et al., 2005) "summarizes the normalized leakage distribution weighted for all dwellings in the US".

Table 3
Statistics of estimated normalized leakage distribution weighted for all dwellings in US

House type	Estimated normalized leakage percentiles							Estimated	
	5th	10th	25th	50th	75th	90th	95th	GM	GSD
Low income	0.30	0.39	0.62	0.98	1.5	2.2	2.7	0.92	1.9
Conventional	0.17	0.21	0.31	0.48	0.75	1.1	1.4	0.49	1.9
Whole US	0.17	0.22	0.33	0.52	0.84	1.3	1.7	0.54	2.0

The following figure (Figure 8) copied from Chan et al.(2005) compares the best-fit AER estimated in their analysis with other AER analysis.

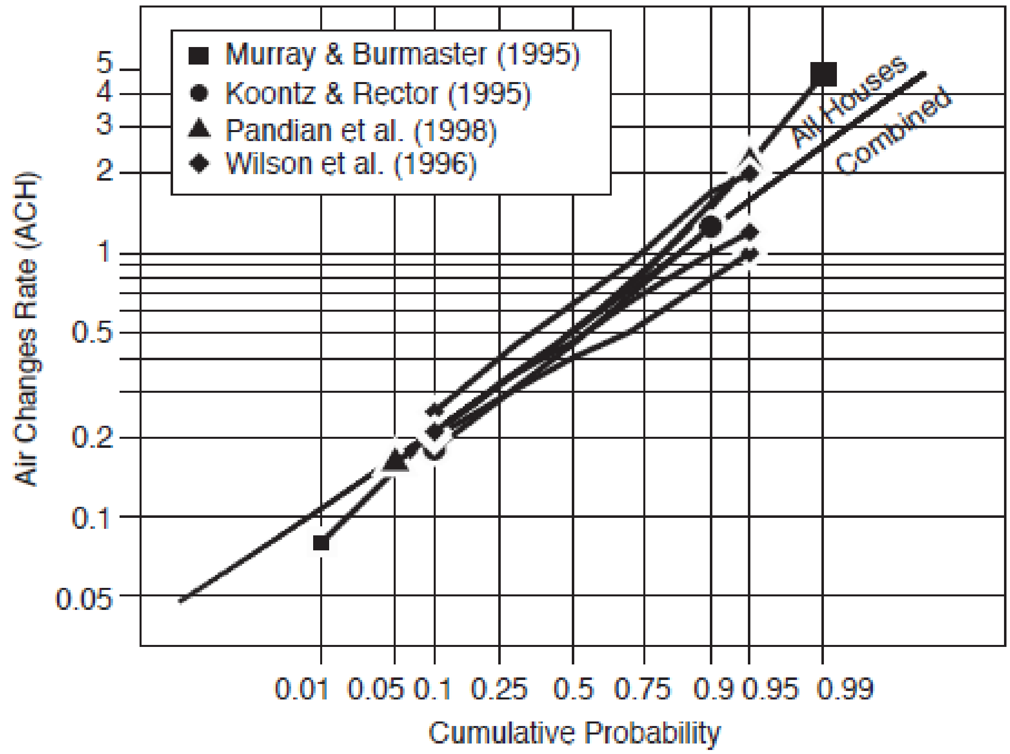

Figure 8 of Chan et al (2005) and attached caption. "Comparison of best-fit air exchange rates estimated from linear regression models obtained in this analysis, and values found in EPA Exposure Factors Handbook (US EPA, 1997). The distributions reported by Pandian et al. (1998) are inclusive of all the studies listed. In Wilson et al. (1996) all residences measured are located in California (three distributions are shown: measurements from Los Angeles being most leaky, followed by San Diego and Northern California). The other references analyze collections of multiple projects. Koontz and Rector (1995) assigned weights to the results to compensate for geographic imbalance of measurements. Murray and Burmaster (1995) presented results as functions of weather using the degree-day metric."

Yamamoto, N, DG Shendell, AM Winter and J Zhang (2010). Residential air exchange rates in three US metropolitan areas: results from the Relationship among Indoor, outdoor, and Personal Air Study 1999-2001. Indoor Air 20: 85-90.

New Residential Air Exchange Rates (AER) have been reported from analysis of the Relationship Among Indoor, Outdoor, and Personal Air Study (RIOPA) 1999-2001 study by Yamamoto et al. (2010) and I suggest that it be incorporated in future revisions of the EFH (within the AER section, currently 19.4.1). The abstract of Yamamoto et al (2010) is copied here:

"We report approximately 500 indoor–outdoor air exchange rate (AER) calculations based on measurements conducted in residences in three US metropolitan areas in 1999–

2001: Elizabeth, New Jersey; Houston, Texas; and Los Angeles County, California. Overall, a median AER across these urban areas and seasons was 0.71 air changes per hour (ACH, or per hour; n = 509) while median AERs measured in California (n = 182), New Jersey (n = 163), and Texas (n = 164) were 0.87, 0.88, and 0.47 ACH, respectively. In Texas, the measured AERs were lower in the summer cooling season (median = 0.37 ACH) than in the winter heating season (median = 0.63 ACH), likely because of the reported use of room air conditioners as Houston is typically hot and humid during the summer. The measured AERs in California were higher in summer (median = 1.13 ACH) than in winter (median = 0.61 ACH). Because the summer cooling season in Los Angeles County is less humid than in New Jersey or Texas, natural ventilation through open windows and screened doors likely increased measured AER in California study homes. In New Jersey, AER were similar across heating and cooling seasons, although the median AER was relatively lower during the spring."

In addition, Yamamoto et al (2010) also assessed intra-home variability as two measurements were taken in each household during different seasons.

Price, PN., A. Shehabi, and R. Chan. 2006. Indoor-Outdoor Air Leakage of Apartments and Commercial Buildings. California Energy Commission, PIER Energy-Related Environmental Research Program. CEC-500-2006-111. Report can be downloaded at: http://www.energy.ca.gov/2006publications/CEC-500-2006-111/CEC-500-2006-111.PDF

This report compiles data on AERs collected from 14 different studies on apartment buildings in the US and Canada. The authors acknowledge that the air leakage data of apartment building are very scarce. Nevertheless, they found that the "observed air change rates, mostly from 0.5 to 2 ACH, are higher than data from single-family houses in weather conditions such as these: typical air exchange rates in houses in these conditions would be of the order of 0.2 to 1 ACH (Pandian et al., 1998; Wilson et al, 1996)."

Additionally, I suggest the following additional studies/analysis on Residential Air Exchange research for inclusion in future EFH revisions:

Pandian, MD, JV Behar, WR Ott et al (1998). Correcting errors in the nationwide data base of residential air exchange rates. Journal of Exposure Analysis and Environmetnal Epidemiology 8(4): 577-586.

Wilson, AL, SD Colome, Y Tian et al (1996). California residential air exchange rates and residential volumes. Journal of Exposure Analysis and Environmental Epidmiology 6(3): 311-326.

In Section 19.4.5, for particle deposition please consider including the data and analysis contained in the following two references:

(1) **Thatcher, TL, AC Lai, R Moreno-Jacksona, RG Sextro, WW Nazaroff (2002).** Effects of room furnishings and air speed on particle deposition rates indoors. Atmospheric Environment 36 (2002) 1811–1819. They Measured deposition loss rate coefficients (h-1) for particles of different median diamater (ranging between 0.55- 8.66 mm), and with fans on or off and at different mean airspeed's (varied by means of changing the voltage to four small, instrument-cooling fans within a room). The deposition loss rate was

characterized in three types of experimental rooms : (1) bare room surfaces (unfurnished with metal floor), (2) carpeted room (unfurnished) ,and (3) a fullyf urnished room (including carpeting, chairs, table bookcase and curtains). The following table (Table 2 of Thatcher et al., 2002) presents their measurement results of the deposition loss rate:

Table 2
Measured deposition loss rate coefficients (h^{-1})[a]

Median particle diameter (μm)	Fans off			$V = 5.4$ cm/s			$V = 14.2$ cm/s			$V = 19.1$ cm/s		
	B	C	F	B	C	F	B	C	F	B	C	F
0.55	0.10	0.12	0.20	0.10	0.13	0.23	0.09	0.18	0.23	0.14	0.16	0.27
0.65	0.10	0.12	0.20	0.10	0.13	0.23	0.10	0.19	0.24	0.14	0.17	0.28
0.81	0.10	0.11	0.19	0.10	0.15	0.24	0.11	0.19	0.27	0.15	0.19	0.30
1.00	0.13	0.12	0.21	0.12	0.20	0.28	0.15	0.23	0.33	0.20	0.25	0.38
1.24	0.20	0.18	0.29	0.18	0.28	0.38	0.25	0.34	0.47	0.33	0.38	0.53
1.54	0.32	0.28	0.42	0.27	0.39	0.54	0.39	0.51	0.67	0.51	0.59	0.77
1.91	0.49	0.44	0.61	0.42	0.58	0.75	0.61	0.78	0.93	0.80	0.89	1.11
2.37	0.78	0.70	0.93	0.64	0.84	1.07	0.92	1.17	1.32	1.27	1.45	1.60
2.94	1.24	1.02	1.30	0.92	1.17	1.46	1.45	1.78	1.93	2.12	2.27	2.89
3.65	1.81	1.37	1.93	1.28	1.58	1.93	2.54	2.64	3.39	3.28	3.13	3.88
4.53	2.83	2.13	2.64	1.95	2.41	2.95	3.79	4.11	4.71	4.55	4.60	5.46
5.62	4.41	2.92	3.43	3.01	3.17	3.51	4.88	5.19	5.73	6.65	5.79	6.59
6.98	5.33	3.97	4.12	4.29	4.06	4.47	6.48	6.73	7.78	10.6	8.33	8.89
8.66	6.79	4.92	5.45	6.72	5.55	5.77	8.84	8.83	10.5	12.6	11.6	11.6

aV represents mean airspeed in room core; B implies bare room surfaces; C indicates carpeted room; F indicates fully furnished.

(2) **He, C., L Morawska, and D Gilbert (2005).** Particle deposition rates in residential houses. Atmosperhic Environment 39(21): 3891-3899 . He et al (2005) found that the "lowest deposition rates were found for particles in the size range from 0.2 to 0.3 μm for both minimum (air exchange rate: 0.61±0.45 h−1) and normal (air exchange rate: 3.00±1.23 h−1) ventilation conditions. The results of statistical analysis indicated that ventilation condition (measured in terms of air exchange rate) was an important factor affecting deposition rates for particles in the size range from 0.08 to 1.0 μm, but not for particles smaller than 0.08 μm or larger than 1.0 μm."

Specific Comments on Chapter 19 (*Residential Building Characteristics*)

- This Chapter is not organized as clearly as other chapters in the EFH. There is no section header for Key Studies and Relevant Studies for house volume and air exchange rate.

- Table 19-1: suggest that it be indicated in footnote "a" that this is the median value across all single family detached and mobile housing units" Actually, the value of 401 m3 is the median , not the average as is presently in Table 19-1 (as currently stated in Table 19-7). Therefore my suggestion for footnote "a" is the following: "a Median value presented in Table 19-7 recommended for use as a central estimate for all single-detached homes, including mobile homes."

- Table 19-1: footnote "b" "Mean of two 25th percentile values (Table 19-4)-recommended to be used as a lower percentile estimate" should be corrected (underlined portion) as: "Mean of two….(Figure 19-2b) recommended to…"

- Table 19-1, footnote "c": consider clarifying the region the central estimate applies, by adding the following text (underlined): "Median value recommended to be used as a central estimate based across all US Census Regions (Table 19-14)"

Section 19-1, page 19-1:

- Remove "code –intensive" from the following sentence: "Nazaroff and Cass (1986) and Wilkes et al. (1992) have used ~~code-intensive~~ computer programs feature…"

- provide Citations for the Indoor Air Quality Building and Assessment Model (I-BEAM) and for the Multi-Chamber Concentration and Exposure Model (MCCEM)

- Table 19-1, footnote "d": consider clarifying the region the lower percentile applies, by adding the following text (underlined): "10th percentile value (across all US Census Regions) recommended to be used as a lower percentile value (Table 19-14)."

Section 19.3.1.1, page 19-6: The sentence "These data were compared to the results of the residential volume distributions form the 1995 Residential Energy Consumption Survey (RECS) (Thompson, 1995)" should be correct to: "These data were compared…from the 1993 Residential Energy Consumption Survey (RECS) (Thompson, 1995)." Further, the Thomspon , 1995 reference is actually a personal communication. Since the 1993 RECS is over 15 years old, suggest updating the comparison, using the 2005 RECS data. This would also give insight as to how relevant the PFT database is to characterize current residential volumes.

Section 19.3.3, page 19-6: Consider moving the text in footnote "a" of Table 19-5 and Table 19-6 (both have same information provided in footnote "a") to the text of Section 19.3.3, i.e., move the following from footnote "a" to Section 19.3.3, page 19-6: "The total average square footage per housing unit for the 2001 RECS was reported as 1975 square feet. This figure….The only available figures that permit comparison….in all housing units—for 2001 the total square footage was 2,005 and for 2005 the total was 2,029 square feet."

Section 19.3.2.1, page 19-7: Consider removing the last two sentences and stating instead the conversion factor (0.0293 m3/ft3 or 3.3 ft per m). Additionally, instead of the last two sentences, consider mentioning and citing Table 19-8 in this section for characterizing the dimensional quantities for residential rooms because it is directly related to converting b/w *ft* and *m* units.

Section 19.3.2.2 *Surface Areas* should be renamed "Surface-to-volume (loading Ratios)"and placed after Section 19.3.2.3 *Products and Materials*. Consider deleting the sentence "Table 19-8 provides the basis for calculating loading ratios for typical-sized rooms." (refer instead to Table 19-8 in Section 19.3.2.1 *Room Volume*) and replace with "Loading ratios are calculated based on typical sized rooms, presented in Table 19-8."

In Section 19.3.2.3 Products and Material, consider specifying which type of residences are “typical”, i.e., which residence type does the following statement refer to:

“surface area are based on typical values for residences…” Additionally, please specify in Footnote “a” of Table 19-9 the type of residence (single family detached (including mobile home), single-family attached (townhome or duplex) or multifamily (apartment building) residence that the values refer to).

In Section 19.3.3, on page 19-8: I believe that the insertion/clarification (underlined) should be made to the following sentence:

“Three types of mechanical systems are: (1) systems associated with heating, ventilating, and air conditioning (HVAC); (2)…”

In Section 19.3.4.2: Modify the last sentence to read “Table 19-11 defines the four Census Regions”

In Section 19.4.1.4 ,page 19-11: Move the following sentence from this section, to a footnote in Table 19-15 associated with column header “Climate Region”:

“ The coldest region was defined as having 7,000 or more heating degree days, the colder region as 5,500-6,999 degree days, the warmer region as 2,500-5,499 degree days, and the warmest region as fewer than 2,500 days.”

In Section 19.4.2, page 19-11, Eqn 19-1 is identical to Eqn 19-2. I believe the correct equation needs to be inserted for Eqn 19-1 (Eqn 19-2 is correct).

In Section 19.4.3.1.2, page 19-12: please insert the units for “overall particle deposition rates”, i.e., [h^{-1}].

In Section 19.4.4, page 19-13, I suggest including some examples of interzonal airflow models

In Section 19.4.5.2, page 19-13, Please insert the following underlined text: “Mass loading of floor surfaces (Table 19-20) was measured in the study of Thatcher and Layton (1995) by thoroughly cleaning the house and sampling accumulated dust, after one week of normal habitation and no vacuuming.”

In Section 19.5, page 19-14, suggest including some basic concepts and exposure factors related to assessing residential radon gas exposures as well as for assessing mold or spore exposures indoors, in addition to the airborne contaminants, waterborne contaminants and soil/house dust indoor sources.

In Section 19.5.1,

- on page 19-14, suggest replacing “direct discharge sources” with “direct emission sources”. Generally, suggest that “discharge” be replaced with “emission” throughout Section 195.1.

- on page 19-14, suggest inserting other references besides Reiwani et al (1986) for “Emissions factors for combustion products of general concern (e.g., CO, Nox) have been measured for a number of combustion appliances using room-sized chambers (Reiwani et al. + insert additional references)

- on page 19-14, replace "Table 19-32" with "Table 19-21" in the first sentence of the second paragraph of the right hand column.

- on page 19-14 and 19-15. The section on the "exponential formulation" is confusing. For one, shouldn't the exponent in Eqn 19-3 be negative, i.e., Ec/Eo exp ($-k_s\ t_c$), and likewise for Mc/M exp ($-k_s\ t_c$), to represent a exponential decay? Also, it is not clear how to solve the relationships to estimate k_s , the decay factor. Third, I think that Eqn 19-4 is incorrectly presented, what is the term "Eo/ks" on the far right of the equation? I think Eqn 19-4 is actually estimating the total amount (mass) released , M, and needs to be clarified and correct. Lastly, neither Eqn 19-3 nor Eqn 19-4 are cited in the text.

- on page 19-15. Consider changing the last sentence of Section 19.5.1 from "…but this concept is best considered using the multiple-zone model" to "…but this concept is best considered using multi-zone models (see Section 19.4.4).

In Section 19.5.2- Source Descriptions for Waterborne Contaminants

- on page 19-15: edit the first sentence from "Residental water supplies may convey chemicals…" to "Residential water supplies may be a route for exposure to chemicals through ingestion, dermal contact, or inhalation."

- On page 19-15: edit the following sentence from "The exposure potential for a given situation will depend on the source of the water, …" to "The exposure potential for a given chemical will depend on…"

- On page 19-15, "Primary types of residential water use (summarized in Section 19.4.5)…" These are not summarized in Section 19.4.5 (*House Dust and Soil Loadings* Section).

- On page 19-15, please specify the underlined portion in the sentence "Release rates (S) are formulated as:…"

- I think something is missing in Equation 19-5, as the units on the right hand side of the equation don't work out to [g/h], i.e., the units of S.

- The "K" (whether K_{LI} or K_{GI}) needs to be specified on the left hand side of Equation 19-6.

In Section 19.5.3- Soil and House Dust Sources

- on page 19-16, the following portion (underlined) of the first sentence of this section should be corrected "The rate process descriptions compiled for soil and house dust in Section 19.5.3…" It is not clear what section this is intended to refer to.

In Figure 19-1: recommend changing "Removal" to "Deposition"

In Figure 19-2: cite the DOE survey and PFT Database in the legend

In Table 19-7: include "(m3)" as units after "…by Volume" in table caption. Also, on the row titled "Median" state instead "Median Volume (m3)". Additionally, it is confusing as to what the "Total" column under Year-round refers to. The sum of the "owner occupied" and "renter occupied" do not add up to this "Total".

In Table 19-14, please correct the column header. Is "North Central Region" supposed to be "Midwest"? There are only 4 Census Regions (Northeast, Midwest, South, and West). "North Central Region" is actually one of the Census *Divisions*.

In Table 19-17: remove h^{-1} from values and place units in column header, i.e., "Deposition Rate (h^{-1})"

In Table 19-18: it would be useful to indicate on this table that all homes were single-family detached residences, and indicate (with a footnote) which two were mobile homes. Additionally, it would be useful to include a footnote, indicating which houses did not use a vacuum cleaner for housecleaning (i.e., the two that exhibited the highest dust loadings-33.7 g/m2 and 812.7 g/m2)

Table 19-21: Suggest changing the following

"Direct Discharge" to "Direct Emission Rate"
"Combustion" to "Combustion emission rate"
"Volume Discharge" to "Volume Emission rate"
"Mass discharge" to "Mass emission rate"
"Diffusion limited" to "Diffusion limited emission rate"
"Exponential" to "Exponential emission rate"

It is not clear in Table 19-21 what is referred to by "Transport" and the subcategories of "Description" and the "components" do not seem to clarify what processes are involved.

Stern	I am not aware of any additional research that would reasonably supplement the data presented in chapter 19. However, I am not convinced that, given the very high variability inherent in these data, it is reasonable to refine these estimates in a way that would be meaningful and useful. Rather, it would be more useful to gather or generate data on residential volume and air exchange rates relative to factors such as age of the housing stock, population density, annual average temperature, and average winter temperature. Data stratified in this way could not only potentially lead to more specific and more useful data, but would also allow exposure assessors to estimate population-specific parameters. **Additional Comments** Chap. 19 General Section 19.3, Building characteristics Studies is an informative monograph, but not really part of an EFH database. The basis for the assumption of 8 ft ceilings should be discussed. It would seem that housing volume and ACH would be negatively correlated. This is not mentioned. Pg. 19-7, par. 4 - Define "loading rations/" Pg. 19-11, eq. 19-1 - The definition of the variables does not correspond to the equation. Equation 19-2 is identical to equation 19-1. Pg. 19-12, 19.4.3.1 – It is not clear why this section has been placed here. It would not likely be looked for in this section of the EFH and it is not clear that it is relevant to an EFH Pg. 19-13, 19.4.5 - This section could reasonably be moved to the soil/dust ingestion chapter. Pg. 19-14, eq. 19-3 - I think that the correct term is e^{-kt}. As written, there is no minus sign. Pg. 19-16, eq. 19-7 - The 'd' subscript is not defined.

Future Products from EPA's Exposure Factors Program

16) Are there any additional factors that need to be addressed in future revisions to the Handbook? Why are they of priority for EPA risk assessments? Are you aware of any sources of data for these new factors?

Anderson	I don't think there is a need for additional chapters, but I would expect that the "activities" chapter is one where additions might be welcome and should be looked for. While inhalation and water ingestion rates don't very much because they are mostly physiologically determined, activities can change dramatically over time. This the time spent on cell phones and other indoor and outdoor activities can change rapidly fairly rapidly and may affect likelihood of exposures. Another area where I think expansion might be warranted would be to include in each of the chapters population distribution of the factors. For instance, while total water may not change much, the percent of individuals using bottled water has increased considerably. That will be reflected in the water consumed by those consuming such water as a proportion of total water, but for the assessor it may also be helpful to know the proportion of the population within that group. The same could be said for the fish consumption chapter. Knowing what proportion of individuals consume any "sport caught fish" is a useful figure to have, not just how much fish such individuals consume. A group that is receiving more and more attention is those who are at the tails of the population distribution for any exposure factor. Thus those consuming high quantities of certain fish are a target group for intervention and could be important to an assessor if the "tail" individuals are not evenly distributed in the population. Another focus would be on the issue of disparities. Subsistence anglers may be more prevalent among urban, low income or unemployed or in specific racial or ethnic groups. Such issues are most important for the assessor completing a local exposure assessment where a nationally representative population is unlikely and group distributions skewed. Lastly, the role of occupational exposure factors are not considered and in some localities could represent significant exposure opportunities. How to address such factors is problematic and my only lead to an "alert" that such issues need to be considered when assessments are being conducted. The distribution of outdoor work, time in an automobile and other activities are disproportionately distributed by occupation. IUt may be important for exposure assessors to know the proportion of pregnant women in the workforce, extent of heavy exertion etc.
Beamer	Dermal exposure is a complex process, where individuals may be exposed via many different mechanisms even for just one contaminant, as described in Chapter 7. For Chapter 7, there are several additional parameters that would be useful to estimate dermal exposure from additional mechanisms and provide assessors with more options. Although the current studies in the literature may not be representative of the entire US population, they could be included to provide some values for exposure assessment purposes. As stated on page 7-1, frequency and duration of contact also affect dermal exposure.

Although some of the activity factors described in Chapter 16 could be used to assess dermal exposure from bathing/ showering and swimming, they do not provide frequency of contact and duration with other objects that may contain contaminants. Many of the studies in Chapter 4, also report frequency and duration of hand contact activities (Zartarian et al., 1997b; Beamer et al., 2008; Freeman et al., 2001; Reed et al., 1999; Black et al., 2005) and several additional studies by the same authors (AuYeung et al., 2006; Freeman et al., 2005). Estimates of hand contact duration are presented in Table 4-20. Although this could relate ultimately to non-dietary ingestion exposure it may be more appropriate for Chapter 7 on dermal exposure factors.

Another exposure factor that may be of interest to Chapter 7, would be residue transfer. Some residues like pesticides can transfer directly to the hands of the children. Although this may depended on a number of factors, and perhaps on the chemical of interest, residue transfer efficiency values for the chemicals currently in the literature may be helpful to risk assessors attempting to estimate dermal exposure without specific estimates. Many studies have been completed in this area and could be evaluated for inclusion and are listed below.

It is not clear if the solid adherence factor in Section 7.2.2, represent the amount of solids per contact event or amount over a day as aggregate contact events. If the solid adherence factor in Chapter 7 is meant to represent the aggregate amount of solids that adhere to hands after specific activities, it may be useful to also have an understanding of solid adherence per contact event for other activities not included.

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Camann D., Harding H., Geno P., and Agrawl S. Comparison of Methods to Determine Dislodgeable Residue Transfer from Floors (EPA/600/R96/089) United States Environmental Protection Agency, Research Triangle Park, NC, 1996.

Camann D.E., Majumdar T.K., and Harding H.J. Comparison of Salivary Fluids with Respect to Pesticide Transfer Efficiency from carpet to Saliva-Moistened Hands (SWRI Project 01-7131) Southwest Research Institute, San Antonio, TX, 1995.

Clothier J. Dermal Transfer Efficiency of Pesticides from New Vinyl Sheet Flooring to Dry and Wetted Palms (EPA/600/R00/029) United States Environmental Protection Agency, Research Triangle Park, NC, 2000.

Cohen Hubal E.A., Suggs J.C., Nishioka M.G., and Ivanic W.A. Characterizing residue transfer efficiencies using a fluorescent imaging technique. J Expo Anal Environ Epidemiol 2005: 15: 261–270.

Fortune C. Round-Robin Testing of Methods for Collecting Dislodgeable Residues from Carpets (EPA/600/R97/107) United States Environmental Protection Agency, Research

	Triangle Park, NC, 1997a. Fortune C. Evaluation of Methods for Collecting Dislodgeable Pesticide Residues from Turf (EPA/600/R97/119) United States Environmental Protection Agency, Research Triangle Park, NC, 1997b. Geno P., Camann D., Harding J., Villalobos K., and Lewis R. Handwipe sampling and analysis procedure for the measurement of dermal contact with pesticides. Arch Environ Contam Toxicol 1996: 30: 132–138. Hsu J.P., Camann D.E., Shattenberg H.J., Wheeler H.G., Villalobos K.M., Quarderer S., and Lewis R.G. New Dermal Exposure Sampling Technique. In: Measurement of Toxic and Related Air Pollutants, VIP-17 Air & Waste Management Association, Pittsburgh, PA, 1990, 489–497. Krieger R., Bernard C., Dinoff T., Fell L., Osimitz T., Ross J., and Thongsinthusak T. Biomonitoring and whole body cotton dosimetry to estimate potential human dermal exposure to semi-volatile chemicals. J Expo Anal Environ Epidemiol 2000: 10: 50–57. Ross J., Fong H.R., Thongsinthusak T., Margetich S., and Krieger R. Measuring potential dermal transfer of surface pesticide residue generated from indoor fogger use: using the CDFA roller methods. Chemosphere 1991: 22: 975–984.
Bennett	There are a number of factors related to residential environments. It might be useful to include some information about frequency of consumption of foods that come in various types of packaging, as there is growing concern about migration of compounds from food packaging, however, this may be beyond the scope of this document.
Blaisdell	In response to Question 16, I am not aware of additional factors other than mentioned above.
Ferguson	**Some of these questions have been answered above, so I will copy and paste the relevant sections here to refresh and highlight. They are mostly based on the chapters I reviewed.** Frequency and duration of contact for the dermal route of exposure (micro-activity patterns). I mentioned some available papers under the dermal chapter above. Surface area during contact for mouthing behavior and for dermal activity patterns. I mentioned one paper on this topic under the non-dietary chapter. These will help refine the estimates of exposure for these routes, identify relevant sources and pathways of exposure.
Finley	I believe all of the critical exposure factors have been addressed

Gaylor	I am not aware of any additional factors needed for the conduct of risk assessments.
Georgopoulos	Future revisions of the Handbook should be enhanced with information that would allow a more thorough understanding of complex but actual variabilities within exposed populations. Specifically, they should develop distributions of factors characterizing: • Variabilities in the attributes of "real world" indoor microenvironments (i.e. schools, restaurants, shopping malls, gymnasiums, museums, offices, movie theaters, etc.), of vehicular microenvironments (cars, buses, trains, airplanes, etc.), as well as of outdoor microenvironments (e.g. street canyons, urban and suburban streets, parks, schoolyards, etc.), • Geographic variabilities in spatial distributions of both environmental attributes (terrain, land use, land cover, etc.) and of demographic, cultural ,and socioeconomic factors, • Biological variabilities related to exposure and intake/uptake processes, that are related to genetic variation as well as to relevant physiological and pathophysiological states (obesity, malnourishment, chronic disease, etc.).
Guiseppi-Elie	There are a significant number of factors that are currently listed for which data is lacking that it seems a better idea to focus on these first. However, in light of the question, building characteristics associated non-residential settings would be a useful area not currently covered.
Lebowitz	Additional factors that need to be addressed are found in my reviews of chapters 2, 16 & 18. They are priorities because the current use of the EFH for risk assessment based on exposure assessment are insufficient. I have provided information on where these factors could be found.
Lobscheid	More research is suggested on the prevalence and amount of local and/or homegrown food intake (Chapter 13) across the US population. Updating the data on home-grown produced food intake is needed (data are more than 20 years old). But, I am not aware of more recent studies (other than the 1987-1988 NFCS, i..e, the "Key" study in Chapter 13) that characterize this exposure factor though. However, on the National Gardening Association web-site they do have information on how to collaborate on conducting surveys and data collection. Such a research collaboration might be useful in the future to collect data on home-grown produce (fruit, vegetable, and herb) intake. Consider including exposure factors on Office Buildings and/or Commercial Building Characteristics (including schools and other educational facilities, restaurants, and public meeting places) in addition to Residential Building Characteristics. We spend over 90% of our time indoors and this time is spread over many types of indoor microenvironments, not just indoor residential. I think it would be useful to include data on commercial buildings, similar to the residential-specific characteristics. I-BEAM is already mentioned in Section 19-1, page 19.1 as a model to estimate indoor air quality in Commercial

	Buildings, so in addition to providing more information about I-BEAM, I suggest the following three potential data sources for commercial and/or office building exposure factors: ASHRAE Standard Ventilation for Acceptable Indoor Air Quality (Standard 62.1-2007). Price, PN., A. Shehabi, and R. Chan. 2006. *Indoor-Outdoor Air Leakage of Apartments and Commercial Buildings*. California Energy Commission, PIER Energy-Related Environmental Research Program. CEC-500-2006-111, and references therein. This Report can be downloaded at: http://www.energy.ca.gov/2006publications/CEC-500-2006-111/CEC-500-2006-111.PDF Energy Information Administration (EIA) (2003). Commercial Building Energy Consumption Survey (CBECS) and includes building characteristics of Commercial Buildings located throughout the US. The 2003 CBECS data is available and the 2007 CBECS data is currently undergoing quality assurance. More information can be found at: http://www.eia.doe.gov/emeu/cbecs/
Ryan	Not at this time. I think will be a good discussion point for the meeting
Stern	Biomonitoring is an important aspect of exposure assessment that is not touched on in this version of the EFH (although certain physiological parameters in the EFH do inform aspects of biomonitoring exposure assessment. CDC has published the results of biomonitoring for a useful list of common contaminants and contaminants of particular environmental health concern obtained from NHANES. It is not clear if the EFH would benefit from reproducing those data, but at a minimum, it would be useful to have a pointer/link to those data in the EFH. One, specific aspect of biomonitoring that would be very useful in the EFH is the 24-hour urinary creatinine excretion. Most studies that obtain data on exposure based on urine levels of contaminants of concern (or their metabolites) employ spot urine sampling. This gives a concentration of the contaminant in urine, but not a total daily excretion. Creatinine concentration in the spot urine sample is often used to normalize that concentration for urine diluteness on the assumption that creatinine is excreted at an essentially constant rate throughout the day, This assumption is more or less appropriate depending on several factors such as age, muscle mass and exercise status. In addition to the adjustment of contaminant concentration for urine diluteness, however, creatinine concentration in urine can also be used to estimate the mass of contaminant excreted in 24 hours. If the total 24-hour mass of urinary creatinine specific to the age, sex, body mass, etc of the subject is known, then the creatinine adjusted spot urine concentration of the contaminant can be multiplied by the 24-hour mass of creatinine excreted to give an estimate of the 24-hour mass of contaminant excreted. This is a useful parameter for exposure assessment. In addition, it would also be useful to have data readily available for creatinine adjustment of urine dilution particularly for children where this adjustment is not necessarily straightforward. Data on creatinine excretion as a function of various physiological parameters are available in the scientific literature, but it would be useful to have those data evaluated and to have recommended values available for use in exposure assessment.

Tran	No comments
Zaleski	Physiological data to support PBPK modeling such as lung volume, blood volume, etc. would be useful. This information can also be useful for evaluating some of the recommendations in this document (for ex., what is the breathing rate needed to sustain long-term inhalation rate recommendations based upon lung volume, for both adults and children?). In addition, information on residential air exchange rates under different types of active ventilation would also be useful.

17) Please comment on any areas where future research could be conducted to fill data gaps?

Anderson	Many of the factor chapters base their values on data that is more than 5 years old and in some instances more than a decade out of date. In most instances only a single “key” data set is utilized. These are the ones most critical to repeat. There are a number of national samples that are regularly or continually collected and the ability to add questions to such surveys needs to be pursued. The NHANES is an excellent example of a survey that could be utilized more. EPA needs to discuss their needs with NCHS
Beamer	There is now a need to conduct research in mouthing and dermal contact activities of adults and older children to complement the studies in Chapter 4. Similarly, analyses should be completed of the existing studies to determine if mouthing and dermal contact behaviors change as a function of the activities in Chapter 16. Research could also be conducted to determine residue transfer as a function of chemical and physical properties of contaminants, to enable dermal exposure assessment calculations from more mechanisms. There is currently no data on the efficiency of saliva to remove contaminants from objects. This would be helpful to combine with the mouthing frequency and duration estimates in Chapter 4. Similarly due to the many questions raised about Chapter 5 above, additional research should be done to assess soil and dust ingestion.
Bennett	In the residential parameters area, I think additional research should be conducted on parameters related to particulate transfer in the home environment. Also, air exchange between units in multi-unit buildings should be studied. Finally, more work on the absorption of SVOCs into indoor surface materials. In terms of consumer products, research needs to be conducted to determine the mass of the product that people use at a given time, as well as a better understanding of how these products are used (e.g. do people follow package directions).
Blaisdell	In response to Question 17, soil ingestion rates are poorly characterized and should be a priority for future research. Longitudinal data (repeated measures on the same individual) is almost totally unavailable and thus short term data (generally collected for one or two days is all that is available for long term risk assessment (e.g. water, produce, meat consumption). Breathing rate data suffer from various deficiencies including lack of longitudinal data, which means that upper percentiles are generally overestimated. A longitudinal large doubly labeled water study on a representative population would address these deficiencies.
Ferguson	Toxicological and pharmacological data to match the new age groups as defined by EPA,

	or simply pointing to where this data can be accessed. This crosses over into dose, but still relevant. Surface area during contact for mouthing behavior and for dermal activity patterns. This affects the magnitude of exposure. Additional data is needed. Frequency of removal activities for especially the ingestion and dermal routes. How many times do people wash their hands and swim per day (some of this is found in the activity chapter, needs to be related to loadings on body parts), and the relevance of this for exposure and removal of contaminants from exposure boundaries.
Finley	Soil ingestion is often the major "driving factor" in risk assessments of contaminated properties, yet EPA has assigned "low" confidence to the recommended soil ingestion rates. I suggest that if EPA wishes to use the IEUBK approach of Hogen to develop recommended rates (instead of tracer studies), then we would benefit from more evaluations of blood lead as predicted by IEUBK in areas impacted by lead.
Gaylor	No significant data gaps were noted for conducting risk assessments.
Georgopoulos	Please see answers to Questions 16 (above) and 19 (below).
Guiseppi-Elie	A key focus area is that associated with the use of age bins, particularly for children. While these have been identified as useful for risk assessments, data is often not because of small sample size. This is true for both water and food intake. Research is needed to address bias in methodology to evaluate mouthing behavior. There is a need for longer term food surveys to address short-term survey bias. Update of activity patterns.
Lebowitz	In addition to utilizing existing knowledge, data sets and methods not currently used in the EFH, I would recommend future studies to significantly expand exposure assessment in children in a form that would provide valid, reliable and generalizable data. Further modeling could be utilized as well to combine existing data sets and to expand knowledge on lifetime exposures.
Lobscheid	I have the following five suggestions for where future research may be conducted in the future to fill data gaps: Because the USDA CSFII (1994-96, 98) is slightly outdated, nearly 15 years old, collecting a nationally-representative sample of food intake in the near future would be very useful and provide relevant data on the food consumption patterns of the US population. Including longitudinal data on food intake would be useful too, especially to

	understand intra-individual variability in food intake. In addition to the increased prevalence across the US population of gardens providing home-grown fruits and vegetables, the consumption of local foods, i.e., at local farmer's markets has also increased over the past 20 years, as has the prevalence of gardens at schools. I would consider collecting or including existing intake data on consumption of locally produced farmer's market foods (fruits and vegetables and eggs and meats) as that could also be a potential pathway of concern similar to home-produced foods. Lastly, related to local food production, I have collected a small data set of how far farmer's travel to sell their produce at Bay Area farmer's markets, but additional data collection efforts would be helpful in order to characterize the distance that "local" food travels in different regions to local farmer's markets. This would help to determine exposures to airborne chemicals that may contaminate farmer's market produce, dairy and meat products. It would be helpful in future EFH revisions to include a key study that provides intakes for raw and processed fruits and vegetables. The US EPA's analysis of the 1994-1996 CSFII and 1998 CSFII analysis in Chapter 9 is done only on an as-consumed fruit and vegetables basis because, as Section 9.1 states, "that is the fashion in which data were reported by survey respondents.". But, in future revisions of the EFH to distinguish between exposures due to raw vs processed fruits and vegetables contamination of either food type. Frequency and duration of specific cooking activities such as cookstove or stovetop, and oven use. Presently, the Consolidated Human Activity Database (CHAD) has available the total cooking time, but that does not specify the type of cooking activity. This would help assess exposure variability in exposures due to ultrafine particle and criteria air pollutant emissions from cooking, for example. Even more useful would be if the variability in cooking frequency and duration would be reported based on type of residence (single family detached, apartment, and mobile home), or number of occupants in household, or specific meal type (breakfast, lunch, dinner or "other" cooking), the household income level, for example. Assessing long-term dietary intake to get at intra-individual variability in food intake. especially the seasonality of fruit and vegetable consumption.
Ryan	It is apparent that many of the factors chosen for the EFH are based on very small datasets or data sets that do not have general representativeness for the full population of the United States. Further, there are few data on longitudinal variability in such data; essentially all studies are cross-sectional. Research in these areas should continue and be expanded upon.
Stern	Soil ingestion continues to be a highly uncertain parameter, but is, nonetheless, a critical parameter for risk-based decision-making. Given the uncertainties inherent in the use of the naturally occurring soil tracers used to date, it is not likely that further studies using these tracers will further refine the estimates. However, use of an exogenous tracer that is entirely excreted in feces for which there is essentially no background exposure could refine the soil ingestion estimates. An exogenous tracer would, of course, have to be non-toxic and acceptable to property owners. A material that fits these requirements is colloid

	gold. It is non-toxic, environmentally st stable, not metabolized, detectable in minute concentrations by ICPMS and not likely to cause objections from property owners if permission is requested to spread gold on their soil. In the early 1990's, preliminary studies were undertaken at UMDNJ to investigate this approach and some useful knowledge was gained as to the physical considerations involved in integrating this exogenous material into soil. Unfortunately, for reasons other than the integrity of the approach, the work did not proceed. I believe that this would be an extremely useful area for research that EPA could fund.
Tran	In the case of dietary intakes, future focus should be improving the pace of data update to upkeep with the frequent release of consumption data from NHANES.
Zaleski	Future research would be especially helpful in the areas of soil and dust ingestion. In addition, in the introductory chapter, further analysis and discussion of the impact of newer data on previous recommendations would provide greater insight into what areas may be most critical for future research. For example, if available data have been relatively consistent for a given exposure factor over time, this may not be a priority for future study (unless there is knowledge that a specific change in population behavior relevant to the specific factor has occurred).

18) Please comment on how you would like the U.S. EPA/NCEA to release future updates to the Handbook?

Anderson	I would suggest that the Handbook be gradually converted to an on-line resource – see previous discussion and that updates be provided annually. Until it can become a analytic data system, moving the handbook from hardcopy to searchable pdf that comes on a CD and can be loaded and stored on a computer hard drive would be an interim step. What would be especially useful would be to put the relatively few "key" study data sets into an analytic data system that would allow the user to create the categories and distributions that they need, rather than the static tables currently in the Handbook. Thus if the user wants all the child age breakouts they can get them, but if they want an integrated "child" estimate, the age groups can be combined by the analytic engine. There are many such analytic tool boxes available so EPA should work to get the raw data from the authors if at all possible and design compilation tools. As new surveys and studies are done and funded by EPA, obtaining the raw data should be part of the contract agreement.
Beamer	I think all updates should be available on the web.
Bennett	I think it is appropriate to release future versions on line. It may also be appropriate to try to post information regarding the release on the web sites of professional organizations that are most likely to use the Handbook to increase awareness of the release.
Blaisdell	In response to Question 18, the USEPA website but compact disc and paper copies should be available.
Ferguson	Not sure if EPA already has this, but create a listserv where people can register for updates. Updates can be highlighted on the EPA webpage also. People need to be notified of these updates though, through newsletters of exposure groups and various exposure/risk/epidemiological societies. Build databases of e-mail for people in the exposure and risk field and notify them of these updates
Finley	I think the current downloadable format works just fine.
Gaylor	Online access makes the Handbook immediately available. Availability of a CD and hard copy would be useful.
Georgopoulos	As mentioned earlier, future updates of EFH would be more effective in the form of a user-oriented interactive "shell," interfacing with multiple, continuously updated, databases, that would also allow the user to develop, via customized scripts, linkages with available exposure models for either individuals or populations. Such a structure should

	be available in both online and downloadable versions, accessing different “levels” and features of the database (“full and “basic”). One should also reasonably expect “mobile” implementations (such as iPhone or BlackBerry “apps”) to be developed for online searching and accessing the future EFH database contents.
Guiseppi-Elie	Ideally, chapters should be updated as new and relevant information becomes available. This would be best achieved with a web-based format.
Lebowitz	In hard copy, on CDs, and on their website.
Lobscheid	I would prefer that the Handbook be released online, and that a CD-ROM version of the handbook be offered upon request.
Ryan	I have made suggestions regarding the updates and future releases in answers to other questions. In particular, there should be easily-downloadable pdf version available on a website. Further, there should be a database of various factors that can be queried and that gives information of data quality, date variability, and data uncertainty.
Stern	Given the ubiquity of online information and the widespread ability to access such information, the EFH should primarily be released online with CDs as a secondary method of access and hard copy only by special request. However, please note that the double column format presented in the current draft is not user friendly for computer access as the it does not lend itself to easy scrolling.
Tran	As indicated under question 7, a web-based approach with data query and extraction capability would be most useful given the number of tables and data involving dietary factors.
Zaleski	Future releases would be useful as a web document, with the ability to download the complete document or open a table of contents and clink on links to specific sections would be very useful. Maintaining the ability to download the complete document allows the user to search the entire document at once, and also enables access to all information without having to repeatedly download files. An accompanying database of distributional data from the studies would be useful as well.

19) What additional information might be added in the future that would help the exposure assessment community better interpret and apply the data from the Handbook?

Anderson	I would suggest keeping the Handbook as a "numbers" reference and not try to use it as a vehicle to update the field of exposure assessment or as a broad communication tool. The expanded content only leads to controversy. If this becomes an on-line reference as part of an exposure assessment webpage then a list serve or other means to update the professional community could be set up to indicate when new policy or guideline reports come out. Keep in mind that it has been more than 10 years since it was revised. Unless the intent is to provide regular updates, having a "state of the art" section will become outdated rather rapidly and be of historic interest only. I would keep the content as "timeless" as possible and use other means to convey policy and guidance change to the practicing community.
Beamer	Perhaps only adding a list of models that can be used with the Handbook to complete exposure assessments.
Bennett	If the Handbook is intended to serve the needs of people conducting exposure and risk assessments, I think the document is sufficient. If the intent is to reach a broader audience, perhaps a packet of 1-page descriptions of the process and potentially of some of the key parameters of interest understandable to the lay audience could be developed.
Blaisdell	In response to Question 19, it may be appropriate to provide the raw data on individuals extracted from NHANES on the various age ranges in spreadsheet format on the web so they could be used for different purposes
Ferguson	Need the complementary handbooks of the modeling framework or algorithms for using these exposure factors. Some of these handbooks exist, but it seems useful to pull the basic algorithms together into one handbook for all the different routes. This sounds expensive but creating stand-alone models (created in Mathlab, S-Plus or any other software), where data can be entered and simple calculations made for exposure amounts. Have a discussion of the concept of using micro, meso, and macro activity patterns for calculating exposure. This affects the types of exposure factors that are needed, the type of algorithm and ultimately the interpretation of the results. Along with this we need an exposure scenario book. Example of where exposure occurs, what factors would be relevant for that exposure and how to use various models for a particular exposure. Various handbooks already created by EPA may reference scenarios, but pulling it together would be useful. This could be discussed in terms of the types of chemicals that we are likely to be exposed to for the various routes of exposure and various groups. This thought process would help identify susceptible groups for question 20 below.

Finley	Perhaps a couple of "examples" would help, i.e., simulated exposure settings that guide the assessor through the best possible choices, particularly for those pathways where the most representative value is not entirely clear (e.g., fish ingestion).
Gaylor	See all of the above comments.
Georgopoulos	• Exposure science is rapidly incorporating biological concepts and related quantitative methods as drivers for developing frameworks of comprehensive exposure analyses. The 2005 NIEHS Workshop on "Exposure Biology" gave a good overview of some of the efforts in this area of "Exposure Biology" that considers not only the macroscopic physiological and biochemical aspects of various exposure/dose related processes (intake and uptake through inhalation, ingestion and dermal absorption); but also the underlying molecular, genomic and cellular mechanisms that explain intraindividual and interindividual variability at the phenotype (macroscopic) level with respect to the efficacy of the above processes (see, e.g. Georgopoulos, 2008; Ginsberg et al., 2004; Makri et al., 2004; Nong et al., 2006). This integrative approach may eventually provide valuable links of exposure to susceptibility and health outcome metrics. • Interactive coupling of exposure calculations with Physiologically-Based Pharmacokinetic (PBPK) modeling has been in use for over a decade, and is currently being the research focus of many groups aiming to improve exposure assessments through "inverse dosimetry" modeling (often called "exposure reconstruction") from available biomarker data, for either individuals or populations. (see, e.g. National Research Council, 2006; USEPA, 2006, Georgopoulos etal. 2009) • Another development that is not given proper consideration in the Handbook is the evolution of Geographic Information Systems (GIS) into commodity items, and the widespread evolution of publicly available geodatabases, often combined with detailed satellite imagery (e.g. GoogleEarth Pro, etc.) and detailed demographic information (housing, business, etc.): these tools and databases can greatly enhance screening exposure assessments, designs of field studies, integration of models and data, etc. (see, e.g., Georgopoulos, 2008; Georgopoulos & Lioy, 2006)
Guiseppi-Elie	There is a general move towards more real world risk assessment, i.e., taking into account cumulative or integrated exposures over time and space as well accounting for biologically relevant exposures. There is in the current draft a short paragraph on cumulative exposures in the introduction section. A useful addition would be how to address the need for more realistic assessments within the constraints of the available data and methods. Similarly the concept of the Exposome is worth introducing and might be more fully realized by the time of the new EFH.

Lebowitz	This question is somewhat redundant – see my responses to questions 16 & 17.
Lobscheid	Consider placing a section towards the beginning end of the each chapter, following the "Recommendation" section, that summarizes the research and/or data needs for each exposure factor. These Data and Research needs would be determined on the basis of improving the Confidence ratings of the Key studies, i.e., if these data and research needs would be fulfilled, then the confidence interval would be "high" for all the GAFs. I suggest to mention/specify at the end of the Introduction of each Chapter that for children (birth to <21 years), the data and analysis has also been performed based on the EPA's life-stage approach and included in the EPA's Child Specific Exposure Factors' Handbook (CSEFH) (2008) and that the information contained in a given chapter is consistent with that provided in the CSEFH. If the data tables contain different life-stages than in the CSEFH, it would be worthwhile to indicate that in the specific EFH Chapter also- i.e., "although the information is consistent with that provided in the CSEFH (2008), the data is presented in by different childhood age groups."
Ryan	I believe that essential information is already here and that, given new data from new studies as suggested in 17) the presentation will be relatively completer. My quibble is generally with the large amount of data that must be assimilated to get to where you want. All data should come with quality descriptors and metadata describing such.
Stern	As above, a clear explanation of the rationale and methodology for deriving the recommended values in the EFH is important for the reader to understand the use and limitations of those values and allow the exposure assessor to judge the appropriateness and quality of the recommended values.
Tran	Recommendation of an introductory chapter (see response to question 1) that provides users with a basic introduction to the data and method of dietary exposure assessment would be helpful to guide users to appropriately apply the dietary factors in an exposure assessment.
Zaleski	If available, actual links to the data sets would be great.

20) The Handbook addresses children as a susceptible population and includes data on older adults where available. So as to assist the Agency with planning for potential future projects, please comment on any other susceptible populations of interest that could be included in future updates to the Handbook, and suggest data sources for these populations.

Anderson	Although most often a subset of the 'older adults" the population with specific chronic diseases such as asthma, kidney disease, etc may be a particularly vulnerable set of sub populations. Their distribution in the population is not random so exposure assessors need to understand if the exposure they are assessing, especially in a local or regional area, will disproportionately impact such individuals and if they are concentrated in the area being assessed. NCHS is the source of information on these populations. Hospital discharge data, Census information, Medicare and Medicaid data may be useful. The BRFS (behavioral risk factor survey) conducted in every state is a source of such information as well.
Beamer	The Handbook ultimately may want to address other susceptible populations. For example American Indians who still live according to their cultural heritage. The Lifeline group has been very successful at collecting these sort of data.
Bennett	Perhaps people with certain respiratory diseases such as asthma could be included but I do not think there is available data on these populations.
Blaisdell	In response to Question 20, there needs to be more research on activity patterns, residence times and intake variates in environmental justice communities both urban and rural.
Ferguson	The handbook already alluded to some of these groups and I mentioned some above: pregnant women, the elderly, and the overweight or obese groups of individuals. Additional minority groups need to be addressed, in particular minority groups such as Latinos. Some activity/exposure factors may be varied for these groups. Farmworker groups and their particular exposure factors (e.g., time spent in field, etc.) can also be researched and presented). Various other occupational settings of high exposure need to be addressed. Yes the exposure handbook addresses primarily residential settings for the community at large. Who addresses exposure for the occupational settings past recommendations for OSHA for primarily air contaminants? The dermal and non-dietary routes are sometimes important in these settings, and this exposure handbook should be useful in those settings also.
Finley	I believe nursing infants and pregnant women are considered separately in some, but not all, of the exposure pathways. These populations might warrant further investigation.
Gaylor	The current coverage of possibly potentially susceptible subpopulations appears adequate for most risk assessments.

Guiseppi-Elie	Maybe susceptible populations may not be the correct term but additional populations might be identified based on gemome-exposome relationships.
Lebowitz	I would like to see the use of data already collected and further studies to fill gaps for those with existing cardio-pulmonary pathophysiology and diseases (cf. the Abbey references provided in my review of Chap. 18, and occupational groups (ditto), and the elderly (cf. work of the Spengler's & Speizer's groups at Harvard).
Lobscheid	I think exposure factors related to the food intake of pregnant women would be useful, i.e., the total seafood intake, total fat intake, total meat intake, total fruits and vegetable intake. This information can be used to potentially assess fetal exposures to environmental chemicals that may be found in foods and can potentially cross the blood-brain barrier. Unfortunately, I do not know of any data sources that are available to assess these exposure factors.
Ryan	This list could be nearly endless. Some groups of interest include: 1) "Super" Elderly, e.g., >90 the fastest growing segment of the population. 2) Pregnant women (and developing fetuses) 3) Those with various chronic conditions a. COPD b. Heart Disease c. Metabolic Diseases, e.g., Diabetes 4) Obese Individuals (A growing population in the US) 5) Immunocompromised indivudals 6) Eventually- Those with Specific Polymorphisms separate from those with Metabolic Diseases
Stern	Because of the importance of gestational exposures, it is essential to have data that can be used to estimate the exposure of women during various stages of pregnancy. Some of these data are readily available (e.g., body weight at delivery and nutritional status (from CDC), blood volume). For others, it may be necessary to carry out non-invasive research. Clearly, this is an important data gap.
Tran	From a dietary exposure/GI absorption standpoints the immune compromised individuals would be of interest. However, it would require linkage of dietary and health status data (in NHANES) to obtain intake rates for this subgroup.

Zaleski	Rather than “susceptible”, from an exposure factors handbook perspective I think the key is to look for populations that have potentially greater exposures. So from this point of view, the ability to access actual data sets and explore potential relationships between demographic information and exposure potential would be very useful. In addition, the ability to explore interdependence of variables would be helpful to address this area. Also, while I support the utility of age-specific information, it should be recognized that due to differences in original data sets, there can be an inconsistent basis across exposure factors for age-specific data. Since some of these factors may be interrelated, it would be useful to address this in more detail.

Additional Reviewer Comments

Ferguson	**Some Comments Regarding Public Comments (as regards to chapters reviewed)** A) The first set of comments concern Atrazine. This is confusing for me, not sure about its relationship to any of the chapters and exposure factors that I have read. No chemical is considered individually B) Public Comment by M. Ridgy M. Ridgy is asking for recommendations for age groups used in the USEPA Superfund style risk assessments. I think some basic recommendations can be made. C) There was an anonymous public comment that the EFH does not provide any data on exposure to cigarette smoke. Readers are reminded that the handbook does not provide factors specific to any chemical. However, Tables 16-42 and 16-43 provide information on time spent in the presence of smokers. The person is also looking for information on number of cigarettes smoked daily, etc. D) Comments by American Chemical Society American Chemical Society has some simple questions regarding the study by Xu et al., 2009 in regards to the object category for non-dietary ingestion and changes in surface area that may be affected by body weight changes. I believe these can be easily addressed. E) The comments by the Tri-Service Environmental Risk Assessment Work Group are extensive. In general, they can be reviewed by EPA. Some comments are simple to fix such as repeating table headings for long tables. Some are more difficult such as the new age groupings and matching toxicological data. EPA does recognize that toxicological data will need to be collected for this age groupings or that recommendation will need to be made. <u>Some comments from them…</u> For section 1.6, the Tri-Service is asking for programs where exposure factors are needed. Apart from EPA programs (e.g., pesticide programs), many in the research field use these exposure factors to develop models, make estimates and recommendations. The Tri Service is asking for better clarification between exposure and dose in chapter 1. I agree and have mentioned some of these points under my comments for Chapter 1. The are also asking for clarification of the statement " integrating exposure through the lifestages" (page 5-17 of their comments). Does EPA mean simply, calculating the exposure for each life stage and then adding for that lifetime exposure? The Tri-Service makes a comment regarding correcting the 2nd paragraph of 7-1. I agree the sentence needs to be corrected and that the amount of chemical delivered to the target organ does not affect absorption.

Georgopoulos

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Lebowitz	**Responses to public comments from the Docket Folder Summary related to Chapters 1,2,16 & 18 M. Lebowitz, PhD** I have not commented on suggestions re: format, wording, etc., found in these docket documents. (Dock 0004) – I agree with the general comments on Chapter 2, as expressed in my review as well. These comments should be taken very seriously. In addition to the work cited, other works of a similar nature need to be evaluated as well. (Dock 0008) NCEA has provided the rationale for using the age groups they chose for the EFH. Where exposure data exist by different age groups they are available. (Dock 0009) – The EFH did not (and should not except by example) present data for specific environmental agents. (Dock #? – TSERAWG) – Comments 3, 8, 27 & 28 re: 1.3, .7, 6.3.1 & 6.3.3 (respectively) – I don't know how EPA would wish to respond to this. Comment 5 re: 1.4.2 – This might be useful to EPA and other users of the EFH. Comment 11 re: 1.91 – I agree – clarification is necessary. Comment 13 re: Chap. 2 – I agree with the comment, and why it is necessary to rewrite this chapter. Comment 24 re: Chap. 6 – It probably would be helpful to have such a matrix, expanded when further appropriate studies are included in a revision.

Comment 54 re: 16.5.2 – I agree.

(Dock #? – ACC):

I agree with much of what they say, including their points 1-3. I especially agree with their comments on chapter 6, inhalation rates, except the comment on the Layton (1993) study – see my review for further discussions.

Additional References provided by M. Lebowitz

<u>Chapter 1</u> – Introduction

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Ott et al., Exposure Analysis (Taylor & Francis, 2007) – Chapters 1 & 2

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<u>Chapter 2</u> – Variability & Uncertainty

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	Chapter 6 – Inhalation Rates Ott et al., Exposure Analysis (Taylor & Francis, 2007) – Chapter 4 USEPA. (1986, 1996). Particulate Matter, Air Quality Criteria. R.T.P., N.C. American Thoracic Society (ATS) 1995. Standard inhalation rates at various activity levels. Chest 110:597-599. Lebowitz MD. "Epidemiological studies of the respiratory effects of air pollution." Eur Respir J 9:1029-54, 1996. Lebowitz MD. "Concepts of respiratory changes in aging." In: B. Kent and RN Butler (Eds.) Human Aging Research: Concepts and Techniques. New York: Raven Press, pp. 263-276, 1987. Chapter 16 – Activity Factors NAS Comm. on Advances in Assessing Human Exposure to Airborne Pollutants. NAS Press, 1991 – Chapters 1 & 2. Ott et al., Exposure Analysis (Taylor & Francis, 2007) – especially pp. 14, 15, 57, 450-79 Spengler JD, Lebowitz MD, Hart RW, Lippmann M, Moschandreas DJ, et al. Indoor Pollutants. Washington, D.C.: National Academy Press, 1981. O'Rourke MK , Van de Water P, Jin S, Rogan S, Weiss A, Gordon S, Lebowitz MD. "Evaluations of primary metals from NHEXAS Arizona." JEAEE 9:435-45, 1999. Chapter 18 – Lifetime Ott et al. (op cit.) – pp. 36, 472-78. Buck, R., Hammerstrom, K., Ryan, P.B. 1995. Estimating long-term exposures from short-term measurements. J Exposure Analysis & Environ Epidemiol. (5):359-373, 1995. Lebowitz MD. "Noncarcinogenic respiratory disease." In: Bertollini R, Lebowitz MD, Saracci R, Savitz D. (Eds.): Environmental Epidemiology: Exposure and Disease, Ann Arbor: CRC/Lewis, 1995, pp. 161-184. Lebowitz MD. "Age, period, and cohort effects: influences on differences between cross-sectional and longitudinal pulmonary function results." AJRCCM 154: S273-77, 1996.
Lobscheid	This Document contains A. Lobscheid's Specific Comments on the EFH, specifically on the: Executive Summary

Tables of Contents
Acronyms and Abbreviations List
Introduction
Chapter 9 (Intake of Fruits and Vegetables)
Chapter 12 (Intake of Grain Products)
Chapter 13 (Intake of Home-Produced Foods)
Chapter 14 (Total Food Intake)
Chapter 15 (Human Milk Intake)
Chapter 19 (Residential Building Characteristics).

<u>Specific Comments on the Executive Summary:</u>

- cite "Example Exposure Scenarios" document on page iii
- insert underlined in paragraph 2:
    - "The handbook was first published in 1989 and was updated in 1997 (<u>EPA, 1997</u>).
    - "It also reflects the revisions made to the Child-Specific Exposure Factors Handbook, which was updated and published in 2008 <u>(EPA, 2008)</u>.
- Note that the interim *draft* Child Specific Exposure Factors Handbook is cited in the references. Please update to the *final draft*.
- On p. viii, insert (underlined) "Key recommendations (<u>age-specific</u>) from the Handbook are summarized in Table ES-1;… "
- Include web address (where available) for each of the references in the reference list.
- The following suggestions are intended to improve the clarity and organization of Table ES-1.

Suggestions for improvement include:

- Insert underlined in table caption: "Table ES-1. Summary of <u>age-specific</u> Exposure Factor Recommendations"
- Have tables organized by chapter, and separate chapter tables by a page break. If there are multiple tables for a given chapter, separate tables using (a), (b), etc. For example, consider the following table captions:
    - For Chapter 3, "(a) Per Capita and consumer only ingestion of drinking water" and "(b) Ingestion of Water while Swimming"
    - For Chapter 4: "mouthing frequency and duration"

- For Chapter 5: “Soil and Dust Ingestion”
- For Chapter 6, “(a) long-term inhalation rates”, and “(b) Short-term inhalation rates, by activity level”
- For Chapter 7: “(a) Total Body Surface Area” and “(b) Surface area of body parts” and ‘(c) Total Body Surface Area”
- For Chapter 8: “Body Weight”
- For Chapter 9: “Per-Capita and Consumers-only Total Fruit and Vegetable Intake”
- For Chapter 10: “Total, marine, and Freshwater/Estuarine Fish Intake in the General population and Marine Fish Intake in the Recreational Population”
- For Chapter 11: “(a) Meats, Dairy Products, and Fat Intake”, “(b)Total Dairy Products Intake ”, “(c) Total Fat Intake”
- For Chapter 12: “Grains Intake”
- For Chapter 13: “Home produced food intake” consider having the following column headers and combining the four separate tables:

Home produced fruits		Home produced vegetables		Home-produced meats		▪ Home-caught fish	
Mean g/kg-day	95th percentile g/kg-day	mean g/kg-day	95th percentile g/kg-day	mean g/kg-day	95th percentile g/kg-day	mean g/kg-day	95th percentile g/kg-day

- For Chapter 14: “Total food Intake”
- For Chapter 15: “Human milk and lipid intake”
- For Chapter 16: “(a) Activity Factors for time spent indoors and/or outdoors (minutes/day)”, “(b) Activity Factors for time spent showering and/or bathing (minutes/day)”, “(c) Activity factors for time spent playing on sand/gravel, grass, or dirt (minutes/day)”, “(d) Activity Factors for time spent swimming (minutes/month)”, “(e) Activity factors for occupational mobility (years)”, “(f) Activity Factors for Population mobility (years)”
- Chapter 18: “Mean Life Expectancy”

- Why are there no key recommendations summarized from Chapter 10 (Freshwater Fish, Native American Substistence population, and Other Populations?), Chapter 17, and Chapter 19?

Specific Comments on the *Table of Contents*:

- Insert the underlined in the caption for Table 17-51: "Average number of Toothpaste Applications per Use day"
- Insert the underlined in the caption for Table 17-52: "Average Number of Toothpaste Product…"
- Insert the underlined in the caption for Table 17-53: "Average Amount of Toothpaste Product…"
- Remove "Expection of Life…" from caption of Table 18-3 and Table 18-4 and state instead "Life Expectancy…"
- Section 19.5 rename "Sources" to "Characterizing Indoor Sources"
- Suggest renaming the caption of Figure 19.1 from "Elements of Residential Exposure" to "Factors Considered in Conducting Indoor Exposure Assessments"

Specific Comments on the "*Acronyms and Abbreviations*" List:

- Consider EVR, instead of ENR, as acronym for "Equivalent Ventilation Rate". This would mean changing the acronym for "Ventilation Rate per square meter of body surface area" from EVR to possibly VRsa
- Consider changing the acronym for Fecal Dry Weight (Fi) to Fdw
- Remove the "+" following IRdw and replace with a "="
- Include PFT for Perfluoracarbon Tracer (PFT database is described in Chapter 19 Residential Building Characteristics)
- Include ACH for Air Changes per Hour (h-1)
- Include HVAC for Heating Ventilating and Air Conditioning
- Include HRV for Heat Recovery Ventilators
- Include ERV for Energy Recovery Ventilators

Specific Comments on the *Introduction*:

- Sect 1.3 (Background): cite "…Child-Specific Exposure Factors Handbook that was published in September 2008 (EPA, 2008)"

	• Sect 1.3 (Background), Page 1-2: change "racial" to "racial/ethnic"
	
	• I recommend a different way to organize the references listed in Section 1.6. My suggestions include:
	  o Include the program office or agency associated with each document
	  o Include the web address for locating the document online
	  o Include whether document is final or draft (e.g., "Estimating Exposures to Dioxin-like compounds" is a DRAFT document)
	
	• Section 1.7, page 1-7, insert the citation (underlined here) in the following sentence: "This revision of the handbook attempts to present data in a manner consistent with the US EPA's recommended set of age groupings for children (<u>US EPA, 2008a</u>).
	
	• Section 1.8, Page 1-10, insert the citation (underlined here) in the following sentence: "Table 1-3, along with Chapter 6 of the Supplemental Guidance report (<u>EPA, 2005b</u>) have been developed…
	
	• Section 1.9, page 1-10: Edit the following sentence : "Individuals become in contact with the chemical through inhalation, ingestion, or skin/eye contact." to "Individual <u>come</u> in contact with the chemical <u>either</u> through inhalation, ingestion, dermal, or eye contact."
	
	• Section 1.9.1, page 1-11 states that "…body weight is correlated with food consumption rates and inhalation rates." Insert the following (underlined) to this sentence: "…body weight is correlated with food consumption rates and inhalation rates (<u>for more information, see Chapter 6, Inhalation Rates</u>)."
	
	• Why are the last paragraphs of Section 1.9.2, page 1-13, bulleted? I think leaving them as paragraphs would streamline the presentation. The dashes under the second bullet can remain, i.e.., with the following insertion: "If only a range of values is known for an exposure factor, the assessor has several options. <u>These options include</u>:"
	
	• Consider renaming Section 1.11 to "Organization <u>of Handbook</u>"
	
	• Consider removing the acronym definition in the ADAF column header from Table 1-3,
	
	• In Figure 1-1, consider changing "The text under the boxes indicates….characterize each box in the exposure-dose-effect continuum." to: "The text under the boxes indicates….characterize each <u>step</u> in the exposure-dose-effect continuum.

Zaleski	Attachment A. DETAILED REVIEW OF LORDO ET AL., 2006 1. Time-activity data are linked to basal metabolic rate estimates only by age and

gender:

The analysis assigns a randomly sampled body weight from a distribution based upon age and gender only to 20 randomly sampled activity patterns from the same age and gender. The analysis does not consider that activity patterns are dependent to some extent on body weight. Particularly, individuals of highest body weight are likely to partake in lower levels of physical activity. Utilizing the BMR equation and METs values, energy expenditure and therefore inhalation rate will be overestimated. Because the analysis multiplies BMR by METs values which are all > 1, the potential absolute bias will be greater at the higher levels. This will affect the higher percentile values of the distribution, which are often used for risk estimation. In addition, this will affect the central tendency values such as the arithmetic mean. The difference is likely to be significant, based upon ranges for time spent at various activity levels (Table C-3 of Lordo et al., 2006). For example, for moderate activity, the difference between the 5th percentile and the maximum time spent can be up to 9.3 hours, depending upon age group.

Some questions to consider:

- Applying the same approach, has EPA estimated inhalation rates for data sets in which body weight, gender, age and time activity patterns are known? While EPA indicates these sets are small and are not representative of the national populations, they would serve as an analysis check.

- For a given low, medium, and high activity day, can the inhalation rate based upon a low body weight and a high body weight be estimated, to better understand the potential impact of this assumption?

- Can the analysis be reviewed to identify what body weights and time activity patterns are associated with the higher and lower distribution percentiles, to see if they are appropriate?

2. As the EPA report indicates, recent trends towards increased obesity, overweight incidence, and less active lifestyles contributes to uncertainty in the representativeness of the Schofield equations (p. 5). Literature data also indicate the need to update the Schofield equations: the equation for BMR used overestimates measured BMR in many cases, including studies of American communities (Henry, 2005). As the BMR value is multiplied by a METs value > 1 for each activity, the overestimation is compounded further. BMR increases more slowly with weight at heavier weights, and linear equations that ignore this will overpredict BMR (Horgan and Stubbs, 2003). A study of Australian infants indicates that the Schofield BMR body weight only equations overpredict BMR as compared to measured sleeping metabolic rate (Reichman et al., 2002). The study indicates that the Schofield equations were based upon 299 measurements of 0-3 year olds, with ~100 being of 0-7 day olds. The equation was found to be closest to measured for younger infants (average 1.6 months, 5.1 kg) with the data showing a bias with increasing metabolic rate and therefore age. Based upon means, at 3, 6, 9, and 12 months (body weights 6.5, 8.2, 9.6, and 10.2 kg), predicted BMR using the Schofield body weight-only equation exceeded SMR by 11, 16, 18 and 17% respectively). Reichman et al. indicate this study is consistent with others which suggest the prediction equations are not reliable, and suggest that more than one standard equation for the 0-3 year age may be more appropriate. This information should be considered when applying the Schofield

BMR equation for estimation of inhalation rates.

3. The METs distributions assigned to activity codes are provided in Appendix B of Lordo et al., 2006, but details, including references, for their basis are not. The CHAD users guide referenced did not include detailed information other than the distributions. It is not clear how well the specified METs distributions represent the various activities and the various age groups, especially children. The underlying references and analysis should be provided.

4. Activity patterns may be associated with day of week (weekend vs. weekday) (Graham and McCurdy 2004, McCurdy and Graham, 2003). In this study, they appear to be randomly assigned regardless of week day. Was the potential impact of this examined? (i.e., is energy expenditure generally greater on a weekend to weekday, and if so by how much?)

5. Available physiological information should also be considered as a check on calculated inhalation rates. For example, only very limited information is available in the 1997 Exposure Factors Handbook on tidal volume for children, but for < 1 year a maximum volume of 50 ml/breath is reported. For the 0-1 year age range, using an upper bound of 18.23 L/min (Table 4-1b), leads to an estimated 400 breaths/minute. This is a very limited example as it is likely that maximal tidal volume for this group is greater than the single point provided, but is used to demonstrate that comparative analyses, integrating all information, can be useful. Also, recent literature on maximal sustainable human metabolic rate, where food is unlimited and physical activity is limited only by energy mobilization, can be considered as another consistency check (Westerterp, 2001).

6. Statistically the model building process is very well explained and documented in Appendix A. However, the adequacy/accuracy of the regression model can not be assessed from the information as presented. The real data are not presented, only the predictions [the R-square values in Table 2 Appendix A refer to the agreement between the two regression models - not the model and the observed data]. More specific comments on Appendices A and B follow.

7. It is indicated that a limitation of the Layton analysis is that it utilized a constant ventilatory equivalent (VQ), whereas VQ depends upon fitness level. However, as the Lordo analysis does not include a direct link between body weight and activity pattern, it seems a similar limitation of connection between activity patterns and fitness level would apply for the current analysis as well. Further, in the Layton analysis, three separate approaches for average daily energy intake or expenditure (used to then estimate inhalation rate) were used and compared for consistency: food consumption adjusted upward to account for potential underreporting; ratio of total daily expenditure to basal metabolism; and time-activity data. The first two approaches yielded consistent results, the third approach yielded similar results for males but higher estimates for females. Note, the dietary energy approach assumes steady state (no change in body weight), this will underestimate inhalation rates if weight loss is occurring, and overestimate if weight gain is occurring. Given the uncertainties in any one single method, this comparative approach in which consistency was obtained across methods provides a stronger basis than a single methodology.

References:

Graham, S.E. and T. McCurdy. 2004. Developing meaningful cohorts for human exposure models. Journal of Exposure Analysis and Environmental Epidemiology 14: 23-43.

Henry, C.J.K. 2005. Basal metabolic rate studies in humans: measurement and development of new equations. Public Health Nutrition 8(7)A, 1133-1152.

Horgan, G.W. and J. Stubbs. 2003. Predicting basal metabolic rate in the obese is difficult. European Journal of Clinical Nutrition 57(2): 335-340.

McCurdy, T. and S.E. Graham. 2003. Using human activity data in exposure models: Analysis of discriminating factors. Journal of Exposure Analysis and Environmental Epidemiology. 13: 294-317.

Reichman, C.A., R.W. Shepherd, O. Trocki, G.J. Cleghorn and P.S.W. Davies. 2002. Comparison of measured sleeping metabolic rate and predicted basal metabolic rate during the first year of life: evidence of a bias changing with increasing metabolic rate. European Journal of Clinical Nutrition. 56:650-655.

Westerterp. K.R. 2001. Limits to sustainable human metabolic rate. Journal of Experimental Biology 204: 3183-3187.\

Specific Comments on Appendix A and B.

Appendix A:

Statistically the model building process is very well explained and documented. However, the overall predictive ability of the model can not be assessed because the real data are not presented, only the predictions [the R-square values in Table 2 Appendix A refer to the agreement between the two regression models - not the model and the observed data]. The model was "tested" for some standard values for the median prediction, and they are fairly reasonable (see next note for an exception) and in-line with published results for activity levels [METS] below about 6. The METS listed get fairly large with upper truncation limits at 17. These METS of 17 are associated with ventilation rates of over 130 L/min that are unsustainable in real humans.

The confidence bands (based on the Monte Carlo sampling scheme) that are placed on the medians seem very wide. The original data are needed, however, to assess if this is a problem.

Table 6 in Appendix A lists the recommended inhalation rates from the 1997 US EPA. The report indicates the newly developed medians are "generally comparable" to those from the 1997 report. Below is a table that presents the 1997 values and an interpretation of the newly estimated values based on Figure 3 from Appendix A.

ADULTS	(L/min)		
Activity level	1997	Current Report	
		Male	Female
Low	16.7	16	10
Medium	26.7	50	27
High	53.3	75	55

Children	(L/min)		
Activity level	1997	Current Report	
		Male	Female
Low	16.7	10	8
Medium	20.0	27	25
High	31.7	55	45

The new estimates are often quite a bit higher for the total estimate. A comparison of the model results with the observed Adams data would be very useful.

Appendix B.

The activity levels presented in Table B-1 can be quite high. The distributional assumptions, especially with the log-normal, can have individual simulated values that are biased toward the very high values- even with the truncation values. Table B-1 needs some additional validation and also some corrections, especially in the 'Watch ...' rows. References for the data that form the basis of these distributions should be provided.

Appendix A
Charge to External Peer Reviewers

Technical Charge to External Peer Reviewers

Contract No. EP-C-07-024
Task Order No. 4
January 12, 2010

External Review of the Exposure Factors Handbook: 2009 update

PRE-MEETING WRITTEN COMMENTS ARE DUE NO LATER THAN FRIDAY, FEBRUARY 19, 2010

BACKGROUND

The U.S. Environmental Protection Agency (EPA) is conducting an external peer review of the *Exposure Factors Handbook (EFH).* The overall goal of external peer review is to enhance the quality and credibility of Agency decisions by ensuring that the scientific and technical work products underlying these decisions are based upon sound science and reflect recent peer-reviewed literature.

The EFH was prepared by the National Center for Environmental Assessment (NCEA), within EPA's Office of Research and Development (ORD). The EFH serves as a resource for exposure assessors for calculating exposures and provides a summary of statistical data on various exposure factors used in assessing human exposures. These factors include: drinking water consumption; soil ingestion and mouthing behavior; inhalation rates; dermal factors including skin surface area and soil adherence factors; consumption of retail and home-grown foods, human milk intake, body weight, consumer product use, activity pattern data, life expectancy, and residential characteristics. The EFH was last revised in 1997. Since then the *Child-specific Exposure Factors Handbook* was updated and published in 2008. The updated version of the *Exposure Factors Handbook* incorporates the revisions made to the *Child-specific Exposure Factors Handbook* and information from the published literature up to June 2009.

Organization of the Review

All reviewers should comment on General Questions 1 through 7, Question 8 (Chapter 1), and Questions 16 through 20. There are specific charge questions for Chapters 2, 5, 9, 10, 11, 12 and 19 below. If you are assigned those chapters (or choose any of them as additional chapters you'd like to review), please comment on the appropriate charge questions below.

Assigned Chapters

Reviewers have been assigned to focus their review and comments on specific chapters, as listed below: After completing the assigned chapters, please review other chapters you feel qualified to review or are of interest to your research: Please try to get through as much of the document as time allows.

Reviewer	Assigned Chapters
Henry Anderson	1, 3, 6, 10, and 15
Paloma Beamer	1, 4, 5, 7, and 16
Deborah Bennett	1, 5, 17, 18 and 19
Robert Blaisdell	1, 2, 6, 8, 9, 10, and 11

Reviewer	Assigned Chapters
Alesia Ferguson	1, 4, 7, 16, and 18
Brent Finley	1, 3, 5, 7, and 10
David Gaylor	1, 2, 6, 8, and 18
Panos Georgopoulos	1, 2, 3, 6, 7, and 19
Annette Guiseppi-Elie	1, 3, 4, 11, 12, 13, 14, and 19
Michael Lebowitz	1, 2, 6, 16, and 18
Agnes Lobscheid	1, 9, 12, 13, 14, 15, and 19
P. Barry Ryan	1, 9, 11, 12, 13, and 14
Alan Stern	1, 4, 5, 10, 15, and 19
Nga Tran	1, 8, 9, 11, 12, 14, and 17
Rosemary Zaleski	1, 6, 10, and 17

CHARGE QUESTIONS

The following charge questions identify the scientific issues to be discussed and evaluated by the peer review panel. The review questions consist of seven broad questions that apply to the Handbook in its entirety, eight questions regarding specific chapters of the Handbook, and five questions pertaining to future products from EPA's Exposure Factors Program.

General Questions (All Reviewers)

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

6) Please comment on whether data variability has been adequately characterized and described.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

Chapter 1 (All Reviewers)

8) The Introduction contains a summary of the latest guidance and developments in exposure assessment. Please comment on whether we have captured the most important and relevant guidance and developments in exposure assessment.

Chapter 2 (Blaisdell, Gaylor, Georgopoulos, Lebowitz)

9) We acknowledge that there have been significant developments in the area of uncertainty analysis. Several new references have been added to the chapter on uncertainty and variability. Please comment on whether the information provided is useful as an overview of uncertainty and variability

Chapter 5 (Beamer, Bennett, Finley, Stern)

10) Data on soil/dust ingestion are limited. Has NCEA done an adequate job in reviewing, presenting, and summarizing the available data? Is the differentiation between soil and dust ingestion clear?

Chapter 10 (Anderson, Blaisdell, Finley, Stern, Zaleski)

11) Recreational marine fish intake rate data were only available for individuals >18 years of age. Recommended recreational marine fish intake rate values for children have been estimated based on the age-specific ratios of general population children's marine fish intake to general population adult marine fish intake, multiplied by the adult marine recreational fish intake rates. Please comment on this approach and, if relevant, provide suggestions for alternatives, using the available data.

12) Relevant data on recreational marine fish intake presented in the chapter are limited to certain geographic areas and cannot be generalized to the U.S. population as a whole. Therefore, recommendations from these data could not be provided. Instead, the assessor has the flexibility to use data from these relevant studies that are more appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.

13) Recommended values for fish intake are not provided for recreational freshwater or Native American populations because the available data are limited to certain geographic areas and cannot be readily generalized to the U.S. population of freshwater recreational anglers or Native Americans as a whole. Instead, data from several relevant studies are provided in the chapter to give assessors the flexibility to choose data that are more appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.

Chapters 9, 11 and 12 (Blaisdell, Guiseppi-Eli, Lobscheid, Ryan, and Tran)

14) We are aware that food consumption data from the National Health and Nutrition Examination Survey (NHANES) "What We Eat in America" are available and NCEA is partnering with the U.S. EPA's Office of Pesticide Programs to get these data analyzed and incorporated into the final Handbook. This analysis is expected to be available in May 2010. Are you aware of other published data concerning food consumption that should also be considered?

Chapter 19 (Bennett, Georgopoulos, Guiseppi-Elie, Lobscheid, Stern)

15) Chapter 19 presents data on residential building characteristics that may be relevant for assessing human exposures in the residential setting. Please comment on whether there are any other data or factors, for which there are available data, that are important for inclusion in future revisions to this chapter?

Future Products from EPA's Exposure Factors Program (All Reviewers)

16) Are there any additional factors that need to be addressed in future revisions to the Handbook? Why are they of priority for EPA risk assessments? Are you aware of any sources of data for these new factors?

17) Please comment on any areas where future research could be conducted to fill data gaps?

18) Please comment on how you would like the U.S. EPA/NCEA to release future updates to the Handbook?

19) What additional information might be added in the future that would help the exposure assessment community better interpret and apply the data from the Handbook?

20) The Handbook addresses children as a susceptible population and includes data on older adults where available. So as to assist the Agency with planning for potential future projects, please comment on any other susceptible populations of interest that could be included in future updates to the Handbook, and suggest data sources for these populations.

Appendix D.
List of Observers

United States
Environmental Protection Agency
National Center for Environmental Assessment

Peer Review Workshop of EPA's Draft Exposure Factors Handbook

Sheraton Crystal City Hotel
Arlington, VA
March 3-4, 2010

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Appendix E.
Agenda

Peer Review Workshop of EPA's Draft Exposure Factors Handbook

Sheraton Crystal City Hotel
Arlington, VA
March 3-4, 2010

Agenda

Day One: WEDNESDAY, MARCH 3, 2010

8:00 a.m. **Registration**

8:30 a.m. **Opening Remarks and Introductions** .... *Jenny Helmick, ERG, Facilitator*

8:50 a.m. **Observer Comment Session** .... *Jenny Helmick*

9:00 a.m. **Reviewer Discussion**... *Barry Ryan, Panel Chair*

9:15 a.m. **General Questions 1, 7 & 5 (All Reviewers)**

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web-based, other)?

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

9:40 a.m. **Chapter 2: Variability and Uncertainty (Blaisdell, Gaylor, Georgopoulos, Lebowitz) – General Questions 5-6 & Specific Question 9**

6) Please comment on whether data variability has been adequately characterized and described.

9) We acknowledge that there have been significant developments in the area of uncertainty analysis. Several new references have been added to the chapter on uncertainty and variability. Please comment on whether the information provided is useful as an overview of uncertainty and variability.

10:10 a.m. **Chapter 3: Ingestion of Water and Other Select Liquids (Anderson, Finley, Georgopoulos, Guiseppi-Elie) – General Questions 3-6**

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

10.30 a.m. BREAK

10:45 a.m. **Chapter 4: Non-Dietary Ingestion Factors (Beamer, Ferguson, Guiseppi-Elie, Stern) – General Questions 3-6**

11:05 a.m. **Chapter 5: Soil and Dust Ingestion (Beamer, Bennett, Finley, Stern) – General Questions 3-6 & Specific Question 10**

10) Data on soil/dust ingestion are limited. Has NCEA done an adequate job in reviewing, presenting, and summarizing the available data? Is the differentiation between soil and dust ingestion clear?

11:30 a.m. **Chapter 6: Inhalation Rates (Anderson, Blaisdell, Gaylor, Georgopoulos, Lebowitz, Zaleski) –General Questions 3-6**

11:50 a.m. **Chapter 7: Dermal Exposure Factors (Beamer, Ferguson, Finley, Georgopoulos) – General Questions 3-6**

12:10 p.m. **Chapter 8: Body Weight Studies (Blaisdell, Gaylor, Tran) – General Questions 3-6**

12:30 p.m. LUNCH

1:30 p.m. **Chapter 9: Intake of Fruits and Vegetables (Blaisdell, Lobscheid, Ryan, Tran) – General Questions 3-6 & Specific Question 14**

14) We are aware that food consumption data from the National Health and Nutrition Examination Survey (NHANES) "What We Eat in America" are available and NCEA is partnering with the U.S. EPA's Office of Pesticide Programs to get these data analyzed and incorporated into the final Handbook. This analysis is expected to be available in May 2010. Are you aware of other published data concerning food consumption that should also be considered?

1:55 p.m. **Chapter 10: Intake of Fish and Shellfish (Anderson, Blaisdell, Finley, Stern, Zaleski) – General Questions 3-6 & Specific Questions 11 &13**

11) Recreational marine fish intake rate data were only available for individuals >18 years of age. Recommended recreational marine fish intake rate values for children have been estimated based on the age-specific ratios of general population children's marine fish intake to general population adult marine fish intake, multiplied by the adult marine recreational fish intake rates. Please comment on this approach and, if relevant, provide suggestions for alternatives, using the available data.

13) Recommended values for fish intake are not provided for recreational freshwater or Native American populations because the available data are limited to certain geographic areas and cannot be readily generalized to the U.S. population of freshwater recreational anglers or Native Americans as a whole. Instead, data from several relevant studies are provided in the chapter to give assessors the flexibility to choose data that are more

appropriate for their particular scenario or location. Please comment on this approach and, if appropriate, provide suggestions for alternative approaches, using the available data.

2:25 p.m. **Chapter 11: Intake of Meats, Dairy Products and Fats (Blaisdell, Guiseppi-Elie, Ryan, Tran) – General Questions 3-6 & Specific Question 14**

2:50 p.m. **Chapter 12: Intake of Grain Products (Guiseppi-Elie, Lobscheid, Ryan, Tran) – General Questions 3-6 & Specific Question 14**

3:15 p.m. **Chapter 13: Intake of Home-Produced Foods (Guiseppi-Elie, Lobscheid, Ryan) – General Questions 3-6**

3:35 p.m. BREAK

3:50 p.m. **Chapter 14: Total Dietary Intake (Guiseppi-Elie, Lobscheid, Ryan, Tran) – General Questions 3-6**

4:10 p.m. **Chapter 15: Human Milk Intake (Anderson, Lobscheid, Stern) –General Questions 3-6**

4:30 p.m. **Chapter 16: Activity Factors (Beamer, Ferguson, Lebowitz) – General Questions 3-6**

4:50 p.m. **Chapter 17: Consumer Products (Bennett, Tran, Zaleski) – General Questions 3-6**

5:10 p.m. **Chapter 18: Lifetime (Bennett, Ferguson, Gaylor, Lebowitz) – General Questions 3-6**

5:30 p.m. **Chapter 19: Residential Building Characteristics (Bennett, Georgopoulos, Guiseppi-Elie, Lobscheid, Stern) – General Questions 3-6 & Specific Question 15**

15) Chapter 19 presents data on residential building characteristics that may be relevant for assessing human exposures in the residential setting. Please comment on whether there are any other data or factors, for which there are available data, that are important for inclusion in future revisions to this chapter?

6:00 p.m. ADJOURN

Day Two: THURSDAY, MARCH 4, 2010

8:30 a.m. **Review of Agenda and Process for Day Two** .... *Barry Ryan, Panel Chair*

8:35 a.m. **Chapter 1: Introduction (All Reviewers)**

8) The Introduction contains a summary of the latest guidance and developments in exposure assessment. Please comment on whether we have captured the most important and relevant guidance and developments in exposure assessment.

9:10 a.m. **General Question 2 (All Reviewers)**

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

9:25 a.m. **Future Products from EPA's Exposure Factors Program (All Reviewers)**

16) Are there any additional factors that need to be addressed in future revisions to the Handbook? Why are they of priority for EPA risk assessments? Are you aware of any sources of data for these new factors?

17) Please comment on any areas where future research could be conducted to fill data gaps?

18) Please comment on how you would like the U.S. EPA/NCEA to release future updates to the Handbook.

19) What additional information might be added in the future that would help the exposure assessment community better interpret and apply the data from the Handbook?

20) The Handbook addresses children as a susceptible population and includes data on older adults where available. So as to assist the Agency with planning for potential future projects, please comment on any other susceptible populations of interest that could be included in future updates to the Handbook, and suggest data sources for these populations.

10:30 a.m. BREAK

10:45 a.m. **Other Issues (All Reviewers)**

11:00 a.m. **Development of Conclusions and Recommendations** .... *Reviewers*

11:55 a.m. **Closing Remarks** .... *Jenny Helmick, ERG & Jacqueline Moya, EPA*

Noon ADJOURN

Appendix F

Peer Review Workshop
for EPA's Draft Exposure Factors Handbook

Post-Meeting Comments

Comments
Alesia Ferguson, PhD
University of Arkansas Medical Sciences
Department of Environmental and Occupational Health
Febuary 13th, 2010, last update March 16th, 2010

Responses are divided in to a "General Section" and then by chapter. I responded to each of the question if applicable.

<u>Chapters in this review: Chapter 1, Chapter 4, Chapter 7, Chapter 16, and Chapter 18</u>

General Answers

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

<u>Answer:</u>
In general the Handbook is organized in a reasonable and clear format. Most tables are easily understood and usable to those performing exposure assessments. I may have specific comments on individual tables in each chapter. Each chapter begins with a description of the exposure route and most needed/obvious exposure factors. Then each chapter presents the main exposure factors in one or two tables that appear early on in the chapter, where the data comes mainly from the key studies. Following this, the key studies are presented in more details following by detailed tables from key studies and most relevant studies and their related tables. In this manner EPA is making the data from the key studies easily accessible. However, EPA does make the user aware of the other data tables that can be used in detailed or more specialized exposure assessments. Some tables can be improved by highlighting difference in tables or areas of emphasis.

I would put all references at the end of chapters, after all the tables.

The details of calculating exposure assessments for each route are not typically given. There are some general ideas on required factors for the assessment. However, the user is referred to other EPA documents that present quantitative methods for exposure assessments for each route. There are occasions where more examples or better explanations can be given. These are detailed below for each chapter in my set of reviews. Chapter 1 contains the bulk or most details for making the exposure calculations and the reader should always review this chapter first. In fact each chapter should say "refer back to chapter one for guidelines on making exposure calculations".

The reader should note, the EFH is not organized by exposure route necessarily, or the activity patterns specific for each route would be found in the related chapter and the principles for making the route calculation would be found also in that chapter. In other words, I do not think each chapter fully stands alone with all the necessary factors for making the exposure assessment for that route of exposure.

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

<u>Answer:</u>
Please see comments for each chapter below.

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

<u>Answer:</u>
These are detailed for the chapters below.

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

<u>Answer:</u>
A key study is defined as the 'most useful for deriving exposure factors' (definition by EPA in Chapter 1). There is some amount of subjectivity in that definition. Currently, it is mostly based on the identified attributes and confidence ratings used to select studies. However, one more attribute to judge a study is how often the data is used to make exposure calculations in the exposure field. Of course this might require tracking down a lot more data, and usage of data. However, this is something to consider in the future.

In the glossary (G-7), you define a key study as ..“A study that is useful for deriving exposure factors”. That fits the definition of a relevant study also. Consider expanding the definition for key study as defined in the main document.

Please see other specific comments below for each chapter.

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

In general the confidence ratings to select studies and rate factors provide a clear rationale and reflect the disadvantages and/or limitations of the studies. Please see comments on each study below. I feel in some cases, if resources allowed, EPA could contact some of the study authors to determine some factors necessary for improving the confidence ratings, such as quality assurance and methodologies used.

6) Please comment on whether data variability has been adequately characterized and described.

<u>Answer:</u>
Data variability is best described for age groups and sexes throughout the document where studies provide. Data variability is not well described for races or socioeconomic status for most factors (Activity factors have the most expression in variability in the chapters I was assigned). This is mostly due the lack of studies focused on these differences. However, on this issue I have specific comments below for the chapters reviewed.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

<u>Answer:</u>
Web based access from the EPA web-site is a must. I think this is the method most people will access such a large document. However CDROM and paper copy should be available to order for others to order at a reasonable cost.

Chapter 1: Introduction

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

<u>Answer:</u>
Under the general comments, I have commented on the EFH overall.

It is quite useful that EPA has created these life stages rather than subpopulations in terms of exposure factors. If we are calculating lifetime exposure, then we can sum exposures over life-stages. There are still occasions that we will make exposure calculations for subpopulations. There may be exposure only experienced by a subpopulation due to the nature of the chemical or the nature of activity patterns unique to a subpopulation. Through public comments and by EPA's own comments, we see that toxicological data is available or does not coincide with these new age groupings. Until this information catches up, or is collected in this manner, EPA should attempt to give some reasonable recommendations for overlapping the datasets. (For example, toxicological data for age group 1 through 5 should be used for age group 2 through 12, until further data is available).

Page 1-1, Second Column
Under the background section, EPA talks about the main revisions to the EFH. However, it would be useful to say whether the change is <u>**minor**</u> or <u>**major**</u> and even briefly what the change is under this section. That may take only one added sentence for each of those 11 bulleted points, for easy reference.

Page 1-2, Paragraph 2:Column 1, Minor change to first sentence
Switch the position of behavioral and physiological. Right after this first sentence you explain the behavioral differences and then the physiological difference. Just for consistency and flow.

Page 1-2, Paragraph 2
I am not clear what the EPA document's (i.e.'Guidance on selecting age groups….') children age groups are based on, just from this section. Briefly mention whether it is based on developmental stages or physiological difference or some combination.

Some readings on children and exposure (may be useful to read/quote):

1) Moya, J.; Bearer, C. F.; Etzel, R. A. Children's behavior and physiology and how it affects exposure to environmental contaminants. Pediatrics. 2004, 113(4).
2) Thompson, K. M. Changes in children's exposure as a function of age and the relevance of age definitions for exposure and health risk assessment. Medscape Gen Med. 2004, 6(3), 1-37.

Page 1.10, Section 1.9

This is an 'Exposure Factors Handbook', and the approach in this section is to explain exposure from a dose perspective. So exposure is called External Dose. This section should be dedicated to having 3 simple exposure equations for inhalation exposure, ingestion exposure (dietary and non-dietary) and dermal exposure, if possible. Then there should be a focus on how exposure becomes dose, and the calculation of average daily dose. The reader can get confused between the two. It might require a discussion of picking a an exposure boundary and defining the exposure in that manner and the dose a continuation of that with added factors. I realize ultimately we are interested in that internal dose, but it is important here to makes these distinctions because we gather data according to exposure factors and dose factors and then wish to appropriately use them in physical representations.

Page 1.10, Section 1.9.1 Paragraph 3, Column 2.

In the sentence… "Factors presented in this handbook that affect dermal exposure are skin surface area and estimates of the amount of soil that adheres to skin". I hope the reader does not confuse this sentence to mean that these are the only factors. Maybe follow-up with…"Other factors not covered in this handbook are important in the calculation of dermal exposure." See comments for the dermal exposure chapter.

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

<u>Answers</u>

Page 1-7, Last Paragraph, Column 2

We keep saying that that there is no guidance for age groups for presenting adult data, but the reader should be aware how activity patterns (e.g., time spent at home, time spent at work), really begins to change for the elderly. At that advanced stage, the human body becomes compromised due to the development of illnesses, chronic disease and, therefore, more susceptible to lower chemical concentrations. This should be considered in exposure assessments. I think EPA does address this further along in the chapter. It is worth repeating here.

Page 1-8, Second paragraph, Column 1

We are using the terms age bins and life-stages interchangeably? Also, for this section, EPA mentions that there were recommendations for EPA to consults with experts, and conduct long term research in the various fields in order to address the toxicokinetic and behavioral changes for children. Is this something EPA plans to do in order to improve the age bins/life-stages for the next version of the EFH?

Page 1-10, paragraph 3

In the equation, is the reader aware of what ADAF means? I do not see this term in the Glossary, although I do see ADD (Average Daily Dose) and others.

Page 1-10, Paragraph 4, Column 1

"Once in the environment, the chemical…………soil, dust, and diet." You could follow this sentence up by saying these fate and transport mechanisms result in various chemical concentration that the individual is exposed to.

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

<u>Answer:</u>

See comments under individual chapters.

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

<u>Answer:</u>

See general comments, or comments for each chapter.

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in

the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

Answer:

Page 1-3, Paragraph 4, Column 1

EPA talks about the selection criteria for judging a paper, one of which is whether the approaches to capture the exposure factor is direct or not. The nature of each exposure factor is unique. Sometimes, they cannot be judged by the same criteria. For example, a lifetime measure (i.e., how long people live, chapter 18) is an easier, more direct factor to obtain. Just follow past trends and gather death certificates on numerous people and there it is. But a factor such as soil loading on the skin, is by nature a more difficult factor to measure directly (and costly for substantial data-points). Sometimes we have to wait for the field to develop that more direct method of data collection. So, by nature it is going to receive a lower score under "soundness" or "adequacy". All is not even or fair in the world of exposure. This should be stated in the introduction chapter.

6) Please comment on whether data variability has been adequately characterized and described.

Answer:

See individual chapters, and general comments.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

Answer:

See answer in general section above.

Chapter 1 (All Reviewers)

8) The Introduction contains a summary of the latest guidance and developments in exposure assessment. Please comment on whether we have captured the most important and relevant guidance and developments in exposure assessment.

<u>Answer:</u>

The main change seems to be these life-stages over subpopulations and the grouping of exposure factors where possible into these life stages for especially children. This is commendable given distinguishable changes in activity patterns and physiology. I think the field will as a result drift to calculating/measuring/observing exposure factors in this manner, and eventually toxicological data to match.

It is good that the necessary guidance documents are listed. It can be overwhelming for the user to track down these documents and so it would have useful to highlight main recommendations from these guidance documents. I have already mentioned that the main updates (listed on Page 1-1) should be further explained with one of two sentences.

The reader should be aware that some of these recommendations from guidance documents are later covered in Sections 1.9.

Page 1-4, Paragraph 1

Here it says that 'recent studies are more likely to use state of art methodologies that reflect advances in the field'. I am not sure if EPA used the latest papers in the field….see comments on Chapter 7 for dermal factors.

Page 1-6, Last Paragraph, Column 1.

This sections list the factors required for making an exposure assessment. Since the chapters do not give guidance on how to calculate exposure for a particular route (well, it is spotty and uneven), the beginning of each chapter sound point the reader back to this section and the various guidance documents. Also, for each chapter, the reader should be guided back to section 1.9 that talks about the fundamental principles of an exposure assessment.

Chapter 4: Non-dietary Ingestion Factors

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

Answer

One has to follow the data presentation and explanations carefully in this chapter. This chapter is divided into presenting data on mouthing frequency and mouthing duration. This data is separated also into data on mouthing objects and mouthing of the hands or bodyparts. Occasionally one study may have data on 2 of these factors or all of these factors. In that case the details of the study are repeated. I suggest a different format for this chapter. Present the general study once and then sections under that show whether a particular study has the 4 elements: frequency-objects, duration-objects, frequency-mouth/bodyparts, duration-mouth/bodyparts. Of course it should keep track of whether it was considered a key study or relevant study for each of those four exposure factors.

Page 4-1, Paragraph 3, Column 1

Some studies are quoted as examples of techniques for gathering non-dietary ingestion exposure factors. I would try and use some of the original or earliest studies. For example, Zartarian 1998, came well before Black (2005) for using videotaped methodologies to capture non-dietary activity patterns.

Page 4-1, Paragraph 3, Column 2

Although Ferguson et al., 2006 states that a child can be aware of the videographers, creating play acting and biases, I believe the paper also said children tend to ignore that camera after some time has passed.

Page 4-5, Paragraph 1, Column 1

Is there supposed to be a table for the Zartarian et al., 1997a study? Why present it without giving some data. Is it still a relevant study then.

Page 4-8, Paragraph 4, Column 1

One advantage of the Black et al. 2005 study was that it presented both survey responses and videotaped information of mouthing behavior. Can EPA mention whether these were in agreement or not?

Page 4-8, Paragraph 5, Column 1

For the Xue et al., 2007 study, 7 studies are mentioned. Can all be listed in this bracket? In general there are tables of data for the Xue et al. studies and they should list the included studies (e.g., table 4-10 and 4-11).

Table 4-9

There are three numbers in the table. In the bracket it appears to be the mean and the standard deviation. What is the number outside the bracket? This is not clear to me.

Table 4-12

Make a vertical line between the data for mouth and both hands. Also what is the age group, or range for this table? Same comment for Table 4-20.

Table 4-13

What are non-dietary objects? Are paper and toys not also non-dietary objects. Is the non-dietary row the total for all the others? This is not clear.

Table 4-23 and Table 4-24.

Does the total non-dietary include the hands? If that is the case, the total non-dietary should be greater than the Hands column. In the description for non-dietary, hands are listed. Table 4-24 seems correct, but Table 4-23 does not seem correct.

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

<u>Answer:</u>

This chapter gives no guidance on how to use duration and frequency of mouthing in order to calculate non-dietary exposure. Can EPA point to some guidance documents or study where reasonable calculations can be found for non-dietary ingestion exposure. The first paragraph could more specifically say that when objects or the hands are mouthed, environmental contaminants on these objects or bodyparts are removed and enter the mouth. Sequence of events may be important, such as whether a handwashing event occurred after contact with soil and before the hand is placed in the mouth.

EPA mentions on Page 1, paragraph 5 (column2) that this handbook does not address contaminant transfer from bodyparts or objects. This is a factor that is needed to make an exposure assessment for non-dietary ingestion exposure. The amount that transfers or the area of the object or bodypart mouthed is needed.

It is possible that some of the videotaped studies presented could review existing videotapes to gather that data. EPA should consider funding such a study.

This paper contains some information and data:

1) AuYeung W, Canales RA, Leckie JO. "The fraction of total hand surface area involved in young children's outdoor hand-to-object contact. Environ Res. 2008 Nov;108(3):294-9. Epub 2008 Aug 29.

Page 4-2, Paragraph 3, Column 1

The sentence reads.. " Recommendations for hand-to-mouth durations are not provided since those estimates may not be relevant to environmental exposure." It is unclear to me why these durations would not be relevant. Can EPA explain this further? It is because all the contaminant is assumed to be removed immediately and so frequency, not duration matters.

2) For the factors included in the EFH, are you aware of other data sources that have not been identified?

Answer: No

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

Answer:

It is troubling that Xue et. al., 2007, and 2009 is chosen at the main key study because it summarizes data from six other studies, yet it receives a low score for almost every confidence rating category.

If some of the larger studies included in Xue et.al., were evaluated separately, and considered key studies separately would confidence be even medium in some categories?

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

Answer:

Answered above under general comments.

6) Please comment on whether data variability has been adequately characterized and described.

Answer

I think for this chapter there could be a summary table of the studies and the study participants (so we can see variability across all these studies). We know that, for example, the Beamer et al., 2008 paper looks at 23 farmworker (Latino children). Although, no one has really compared the mouthing behavior of this group to any other group, it is worthwhile to mention this and even for someone to do that comparison.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

Answer

Web based access from the EPA web-site is a must. I think this is the method most people will access such a large document. However CDROM and paper copy should be available by order.

Chapter 7: Dermal Exposure Factors

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

Answer:

Still troubled by the fact that this is an exposure factor handbook and yet the document still uses the word exposure and dose so interchangeably. Second paragraph of page 7-1, column 1 says…"These are only two of several parameters that influence dermal absorption." While this is technically true, these are only two factors that influence dermal exposure also. The book needs to first focus on exposure, then build up to express what is needed for dose (which is not covered in this book). What affects dose for dermal exposure is the exposure profile on the skin (time on skin and amount on skin), along with the skin and chemical properties (that influence that uptake rate).

Page 7-3, Only paragraph

It is mostly right to say that skin adherence values do not consider the influence of skin moisture on adherence. To some extent, we might see a similarity with results for soil moisture. Greater adherence to some maximum level might be expected. Also, humidity in the air (a type of moisture) can also affect adherence.

Some readings on chemical adherence and moisture (even though not directly for the chemical from the soil matrix):

1) Williams, R. L.; Reifenrath, W. G.; Krieger, R. I. Artificial sweat enhances dermal transfer of chlorpyrifos from treated nylon carpet fibers. J.Environ.Sci.Health. 2005, 40, 535-543.

2) Williams, R. L.; Aston, L. S.; Krieger, R. I. Perspiration increased human pesticide absorption following surface contact during an indoor scripted activity program. J.Expos.Anal.Env.Epidemiol. 2004, 14(2), 129-136.

3) Edwards, R. D.; Lioy, P. J. Influence of sebum and stratum corneum hydration on pesticides/herbicide collection efficiencies of the human hand. Appl.Occup.Environ.Hyg. 2001, 16(8), 791-797.

Somewhere, it might be useful to mention that the entire chemical contained in the soil matrix may not be absorbed into the skin. Diffusion through the soil layer can be slow and the skin may only see the chemical contained the monolayer of soil. Papers by Annette Bunge have discussed some of these concepts.

Table 7-1:

Under age groups for children, before Birth to <1 month, above that put “Both Sexes”. Same for similar tables.

Figure 7.1

Consider not dark shading in frequency distributions.

Table 7-17

Was there a time component to how long these activities were for the overall loading? This should be included in the Table.

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

Answer:

This chapter focuses on two exposure factors needed for the calculation of dermal exposure. Surface area of bodyparts for populations and soil loading. The dermal exposure route is a complex route of many mechanisms of exposure or loading of a chemical on the skin surface. There is soil loading, residue transfer, immersion and deposition. I think on Page 7-1 would could express dermal exposure in this manner more explicitly. Surface area and soil loading are factors that are not chemical specific, as the EFH clearly says that it does not provide chemical-specific factors. Surface area exposure during contact with objects or surfaces is another non-chemical specific exposure factor needed for dermal exposure assessment and we should try and find some data for that factor.

Chemical adherence to the skin is an important factor that should be given in the EFH in the future. Currently it is collected at a chemical specific level. We need to find a way to express this factor for a class of compounds or adherence specific scenario.

Many models use data on the duration and frequency of contact with objects and surfaces in the environment for children, typically gathered through videotaping and video-translation methodologies. This type of activity patterns is very similar to the mouthing exposure factors presented in Chapter 4.

Page 7-13. Section 7.3.2.3

The Wong study on children's dermal contact activities seems to stand alone. It is not exactly data on soil loading or surface area of bodyparts (the two factors covered in this chapter). It really stands alone, and is useful data. Can EPA explain how this study would be useful for the user for dermal exposure and are there any more papers that look at this dermal exposure factor?

Page 7-15, Paragraph 1, Column 1

The Que et al., 1985 soil adherence should be expressed in mg/cm^2 to be consistent with other studies covered in this section.

Here are some papers to consider for other needed exposure factors (this is needed and mentioned for non-dietary):

Surface Area during contact

1) AuYeung W, Canales RA, Leckie JO. "The fraction of total hand surface area involved in young children's outdoor hand-to-object contact. Environ Res. 2008 Nov;108(3):294-9. Epub 2008 Aug 29.

Dermal activity patterns or modeling dermal and non-dietary (there may be more in the field)

1) Zartarian, V. G.; Ferguson, A. C.; Leckie, J. O. Quantified dermal activity data from a four-child pilot field study. J.Exp.Anal.Environ.Epidemiol. 1997, 7, 543-552.

2) Riley WJ, McKone TE, Cohen Hubal EA. "Estimating contaminant dose for intermittent dermal contact: model development, testing, and application." Risk Anal. 2004 Feb;24(1):73-85.

3) Zartarian VG, Ozkaynak H, Burke JM, Zufall MJ, Rigas ML, Furtaw EJ Jr. " A modeling framework for estimating children's residential exposure and dose to chlorpyrifos via dermal residue contact and nondietary ingestion, Environ Health Perspect. 2000 Jun;108(6):505-14.

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

Publications containing data on soil adherence to human skin that have not been included in the EFH, include the following:

1. Ferguson, A., Bursac, Z., Coleman, S., and Johnson, W., "Computer Controlled Chamber Measurements for Multiple Contacts for Soil-Skin Adherence from Aluminum and Carpet Surfaces," Human and Ecological Risk Assessment, 15(4): 22-49, 2009.
2. Ferguson, A., Bursac, Z., Coleman, S., and Johnson, W., "Comparisons of Computer Controlled Chamber Measurements for Soil-Skin Adherence from Aluminum and Carpet Surfaces," Environmental Research, 109(3), 207-214, 2009.
3. Ferguson, A., Biddle, D., Coleman, S., Bursac, Z., and Johnson, W., "In-Vitro Soil Adherence for Dermal Exposure Using a Controlled Mechanical Chamber," Journal of Applied Sciences Research, 5(2): 232-243, 2009
4. Ferguson, A. Bursac, Z., Biddle, D., Coleman, S., and Johnson, W., "Soil-Skin Adherence from Carpet: Use of a Mechanical Chamber to Control Contact Parameters," Journal of Environmental Science and Health, Part A, 43(12), 1451-1458, 2008.

One of these papers contains information on multiple contacts with soil, but would also require a discussion on how this type of data would be important and on the fact that soil can transfer back from the hand to the surface. Ultimately really a discussion of maximum loading would be required.

<u>*Other papers not covered in EFH:*</u>

5. Choate, L. M.; Ranville, J. F.; Bunge, A. L.; Macalady.D.L. Dermally adhered soil: 1. amount and particle-size distribution. Integr.Environ.Assess.Manag.

6. Rodes, C. E.; Newsome, J. R.; Vanderpool, R. W.; Antley, J. T.; Lewis, R. G. Experimental methodologies and preliminary transfer factor data for estimation of dermal exposure to particles. J.Expos.Anal.Environ.Epidemiol. 2001, 11, 123-139.

4) NCEA has grouped available studies in each chapter into “key” and “relevant studies.” “Key studies” were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as “key.”

<u>Answer:</u>

To some extent it is understandable why studies that show soil loading by activity have been chosen as key studies. For an easy, quick calculation, this simplifies into a one loading on the skin for the day, based on an exposure scenario.

However, the field has advanced where we need for exposure models, data on a loading per contact event. Controlled studies that look at the data in that manner are quite useful. What gets defined as key and relevant may be subjective, but seems here to be divided along the lines of set activities as opposed micro-loadings or event loadings. But in fact the relevant studies are more controlled studies of adherence, and in terms of confidence ratings might score higher.

EPA tends to call these ‘relevant’ dermal loading studies of “short activity duration” but, again these are useful for models that look at individual contact events.

Use of data from Gehan and George (1970) and Boyd (1935) seems dated, and EPA should look to conducting newer measurements, given changes in US population average weights for all ages. Or maybe there can be an application of a factor increase on weight into surface calculations, based on newer CDC data on population weight changes.

In light of that comment, Table 7-11 combines the U.S. EPA (1985) measurements (based on the older data) with the NHANES 2005-2006 study. How well did the weights and heights compare for the population?

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

<u>Answer:</u>
See general answers above.

Table 7-3
For currency, it says that the age of data is not expected to affect its utility. If weight changes in the population are dramatic, surface area predictions based on weight may change.

Table 7-3
How does one key study for total surface area and one key study for surface area of bodypart translate to medium confidence. I assume the medium confidence is for the Peer Review only?

Table 7-3. Page 7-8
It says….”Because of small sample size..” can you put the sample size in this table for easy viewing?

Tables 7-4, 7-5
It is to be noted that the Holmes, Kissel, and Shoaf studies come from the same lab. It has its advantages and disadvantages. This creates consistency in methodology, but not necessarily objectivity. This needs to be expressed in the confidence ratings. Also, I think EPA should contact these authors to find out more on quality control and include in document and even improve confidence rating.

6) Please comment on whether data variability has been adequately characterized and described.

Answer:
Variability in soil loadings is expressed by activities in the key studies, and there are quite a number of activities to choose from. Variability by race/socioeconomic status is not expressed in the key studies, and maybe not relevant for this exposure factor. Any further expression of variability is limited by the data available for this exposure factor.

Variability in surface area is expressed by different age ages, and male and female adults. Any further expression of variability is limited by the data available.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

Answer:
See general comments.

Chapter 16: Activity Factors

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

Answer:
See general comments above.

Page 16-1, Paragraph 1
This first important paragraph does not read smoothly. Consider re-phrasing the first sentence. Activities bring them into contact with surfaces and objects in their environment or into microenvironments that contain these concentrations. The first sentence is too long in general. The third sentence seems awkward or hanging. Also, children are at risk to certain chemicals but also to higher levels of many chemicals due to their activities (so increased exposure).

Page 16-1, Paragraph 3

Videotaping can also be used as a method to capture human activity factors, especially the details of contact activities for dermal contact with surfaces and objects and mouthing activities for non-dietary exposure. Now technically the mouthing behavior given in chapter 4 is really another set off activity factors and could have been organized in this chapter or at least mentioned in this chapter. Handwashing events from relevant studies are covered in the activity chapter (16-67), but is useful for both dermal exposure, dietary and non-dietary calculations. Not sure if we being consistent in how the exposure factors are being presented. The types of exposure factors needed for a calculation/estimate really depends on the type of exposure model/calculation.

Page 16-1, Paragraph 4

Last sentence repeats what was said in paragraph 1 on culture and social status affecting activity patterns.

For 16.2.2 Occupational Mobility and 16.2.3. Population Mobility

There is an introduction to how population mobility can be used as an activity factor for calculating exposure, but no similar introduction for occupational mobility. Maybe have a separate introduction to mobility factors and their usage in exposure estimates.

Table 16-1

Please include the comment that these activities are averaged over seasons. The numbers for swimming are large enough to convert to minutes/day (divide by 30). Doers needs to be explained in the table or early in the text of Page 16-1 through 16-2, before Table 16.1

Page 16-12, Section 16.3.1.2.

For the U.S. EPA study, what was that age that was considered too young to be interviewed on their own activity patterns?

Page 6-12, Column 2, Paragraph 3

Here it mentions that some activities may overlap, such as activities sports and exercise. Can the tables highlight or mention where overlaps occur. This will help avoid overestimates for exposure.

Page 16-1, Paragraph 5

First sentence ends abruptly.

Page 16-13, Section 16.3.2.1

How many subjects are in the Hill, 1985 study?

Table 16-74

These tables for the Juster et al., 2004 study should give the number of subjects. Other tables are lacking the number of subjects (e.g., USDL 2007 , Carey 1988, Nader 2008)

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

Frequency and duration of contact with surfaces and objects for dermal exposure is not covered in this chapter. In fact, on Page 16-1, Paragraph 4, when Hubal et al., 2000 (author also talks about this in a later paper and the utility of different type of activity patterns, micro vs. macro) talks about children's wider distribution of activities being more challenging, dermal activity patterns is a consideration. This could be covered in this activity chapter or in the dermal exposure chapter to complement the soil loading factors, and surface area of body part.

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

<u>Answer:</u>

How does the CHADS database of activities fit into this activity factors chapter? The CHAD database is referenced here under the Hubal et al., 2000 paper (Page 16-16), but are any studies that were included in CHAD also referenced separately here in this activity chapter. That overlap should be made clear. The Graham and McCurdy, 2004 analysis is based also on the CHAD database (Page 16-17).

4) NCEA has grouped available studies in each chapter into "key" and "relevant studies." "Key studies" were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as "key."

<u>Answer:</u>

The Wiley study and the NHAPS study are the key studies used for activity patterns. They are both substantial studies with a wealth of data, with medium to high confidence ratings. The Carey study 1988 and the US Bureau of the Census (2008b) are also key studies for occupational and population mobility.

The Graham and McCurdy study also appears to be substantial with a large N especially for certain age groups (21 to 44, 6 to 10) that it should also be evaluated as a key study for certain activity patterns. I realize though it is based on the CHADS database of varying studies and such issues as quality assurance and consistency might be hard to assess.

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

Answer:

See comments under general section above.

Table16-2

It says quality assurance methods were not well described in study reports. Can EPA not get that information for the U.S.EPA (1996) report?

6) Please comment on whether data variability has been adequately characterized and described.

There are numerous tables in this chapter, and so the user has to search carefully to find the tables that express variability in the activity patterns. Variability in activity patterns based on key studies is defined by age, and averaged over seasons in the main key tables from 2 main studies. Variations by season and geographic region are presented later in Table 16-9 for the Wiley data, though for example. Racial, educational and educational differences in some activities are also expressed for the US 1996 studies in a number of tables (Table 16-16 through 16-20, Tables 16-24, 16-26, 16-31, 16-33, 16-36, 16-39, 16-41,16-43). Relevant studies, such as USDL 2007 and Carey 1988 also have activity patterns based on race and ethnicity. Of the chapters I reviewed, this chapter offers the most variability in the data.

8) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

Answer:

See general comments.

Chapter 18: Lifetime

1) Please comment on the organization of the Handbook. Does the EFH document present the information, including data provided in the tables, in a clear, easily understood, and usable format? What can be done to improve the format?

Answer:
The lifetime exposure measure is crucial for calculating lifetime exposure to any chemical for chronic health effects such as cancer. Lifetime measure can also be used to obtain average daily exposure for acute exposures.

Page 18-1, Paragraph 4
Why is 70 used for U.S EPA risk assessment? Is this based on old data? And if this is the case, how does the user integrate the toxicity data based on 70 years, with exposure data now based on 78 year averages for lifetime.

Table 18-2.
Do you know if this ACS publication considers obesity trends and its effects on longevity into the projections for 2020?

Table 18-3
EPA may want to highlight how expectation of Life at Birth has increased from 1970 to 2005, but some leveling has occurred from 2000 to 2005. What is this due to? Is there just a limitation to how much we can extend life through medical treatment/advances or are we beginning to see the effects of obesity and even stress aspects in our communities?

Page 18-4, Paragraph
EPA could add a comment on how the data in Table 18-19 is derived. Is it simply the life expectancy minus a particular age?

2) Please comment on whether the factors currently addressed in the EFH are those that are most needed to conduct exposure assessments?

Answer

In terms of length of life, the factors presented in this chapter are those most needed to conduct exposure assessment.

3) For the factors included in the EFH, are you aware of other data sources that have not been identified?

Answer:

No

4) NCEA has grouped available studies in each chapter into “key” and “relevant studies.” “Key studies” were the most useful for providing recommendations for the exposure factor of interest. For each individual chapter, please comment on the selection of studies that have been classified as “key.”

Answer:

The U.S. National Center for Health Statistics, 2008 seems like the most reliable source for this type of statistic or exposure factor. Life expectancy is not something that has to be measured or estimated, it is based on actual data on death rates/and age at death. So it is understandable that this is a key study receiving a high confidence rating.

5) Please comment on whether the confidence ratings used to select studies and rate factors provide a clear rationale and adequately reflect the advantages and/or limitations of the studies addressed in the document. Please provide suggestions for alternative approaches for addressing confidence ratings, if appropriate.

Answer:

See above under general comments

6) Please comment on whether data variability has been adequately characterized and described.

<u>Answer:</u>
This is one chapter or set of exposure factors that we do see variability for races (i.e., black and white) and sexes. It is a pity that the Latino community is not represented in this exposure factor. Many states (e.g., Florida and California) have a sizable Latino community (this will continue to grow rapidly, also in other states). Hopefully, the U.S., National Center for Health Statistics will collect this data going forward. EPA should however look for another source of data.

7) Please comment on the usefulness of current data presentation (i.e., paper copy). Is this format appropriate and/or are there other formats that you would find useful (e.g., CDROM, web based, other)?

<u>Answer:</u>
See general section.

Some Comments Regarding Public Comments (as regards to chapters reviewed)

A) The first set of comments concern Atrazine. This is confusing for me, not sure about its relationship to any of the chapters and exposure factors that I have read. No chemical is considered individually

B) Public Comment by M. Ridgy
M. Ridgy is asking for recommendations for age groups used in the USEPA Superfund style risk assessments. I think some basic recommendations can be made.

C) There was an anonymous public comment that the EFH does not provide any data on exposure to cigarette smoke. Readers are reminded that the handbook does not provide factors specific to any chemical. However, Tables 16-42 and 16-43 provide information on time spent in the presence of smokers. The person is also looking for information on number of cigarettes smoked daily, etc.

D) Comments by American Chemical Society
American Chemical Society had some simple questions regarding the study by Xu et al., 2009 in regards to the object category for non-dietary ingestion and changes in surface area that may be affected by body weight changes. I believe these can be easily addressed.

E) The comments by the Tri-Service Environmental Risk Assessment Work Group are extensive. In general, they can be reviewed by EPA. Some comments are simple to fix such as repeating table headings for long tables. Some are more difficult such as the new age groupings and matching toxicological data. EPA does recognize that toxicological data will need to be collected for this age groupings or that recommendation will need to be made.

<u>Some comments from them…</u>

For section 1.6, the Tri-Service is asking for programs where exposure factors are needed. Apart from EPA programs (e.g., pesticide programs), many in the research field use these exposure factors to develop models, make estimates and recommendations.

The Tri Service is asking for better clarification between exposure and dose in chapter 1. I agree and have mentioned some of these points under my comments for Chapter 1.

The are also asking for clarification of the statement " integrating exposure through the lifestages" (page 5-17 of their comments). Does EPA mean simply, calculating the exposure for each life stage and then adding for that lifetime exposure?

The Tri-Service makes a comment regarding correcting the 2^{nd} paragraph of 7-1. I agree the sentence needs to be corrected and that the amount of chemical delivered to the target organ does not affect absorption.

<u>Future Products from EPA's Exposure Factors Program (All Reviewers)</u>

<u>Some of these questions have been answered above, so I will copy and paste the relevant sections here to refresh and highlight. They are mostly based on the chapters I reveiwed</u>

16) Are there any additional factors that need to be addressed in future revisions to the Handbook? Why are they of priority for EPA risk assessments? Are you aware of any sources of data for these new factors?

Frequency and duration of contact for the dermal route of exposure (micro-activity patterns). I mentioned some available papers under the dermal chapter above.

Surface area during contact for mouthing behavior and for dermal activity patterns. I mentioned one paper on this topic under the non-dietary chapter.

These will help refine the estimates of exposure for these routes, identify relevant sources and pathways of exposure.

17) Please comment on any areas where future research could be conducted to fill data gaps?

Toxicological and pharmacological data to match the new age groups as defined by EPA, or simply pointing to where this data can be accessed. This crosses over into dose, but still relevant.

Surface area during contact for mouthing behavior and for dermal activity patterns. This affects the magnitude of exposure. Additional data is needed.

Frequency of removal activities for especially the ingestion and dermal routes. How many times do people wash their hands and swim per day (some of this is found in the activity chapter, needs to be related to loadings on body parts), and the relevance of this for exposure and removal of contaminants from exposure boundaries.

18) Please comment on how you would like the U.S. EPA/NCEA to release future updates to the Handbook?

Not sure if EPA already has this, but create a listserv where people can register for updates. Updates can be highlighted on the EPA webpage also. People need to be notified of these updates though, through newsletters of exposure groups and various exposure/risk/epidemiological societies. Build databases of e-mail for people in the exposure and risk field and notify them of these updates

19) What additional information might be added in the future that would help the exposure assessment community better interpret and apply the data from the Handbook?

Need the complementary handbooks of the modeling framework or algorithms for using these exposure factors. Some of these handbooks exist, but it seems useful to pull the basic algorithms together into one handbook for all the different routes. This sounds expensive but creating stand-alone models (created in

Mathlab, S-Plus or any other software), where data can be entered and simple calculations made for exposure amounts.

Have a discussion of the concept of using micro, meso, and macro activity patterns for calculating exposure. This affects the types of exposure factors that are needed, the type of algorithm and ultimately the interpretation of the results.

Along with this we need an exposure scenario book. Example of where exposure occurs, what factors would be relevant for that exposure and how to use various models for a particular exposure. Various handbooks already created by EPA may reference scenarios, but pulling it together would be useful. This could be discussed in terms of the types of chemicals that we are likely to be exposed to for the various routes of exposure and various groups. This thought process would help identify susceptible groups for question 20 below.

20) The Handbook addresses children as a susceptible population and includes data on older adults where available. So as to assist the Agency with planning for potential future projects, please comment on any other susceptible populations of interest that could be included in future updates to the Handbook, and suggest data sources for these populations.

The handbook already alluded to some of these groups and I mentioned some above: pregnant women, the elderly, and the overweight or obese groups of individuals. Additional minority groups need to be addressed, in particular minority groups such as Latinos. Some activity/exposure factors may be varied for these groups. Farmworker groups and their particular exposure factors (e.g., time spent in field, etc.) can also be researched and presented). Various other occupational settings of high exposure need to be addressed. Yes the exposure handbook addresses primarily residential settings for the community at large. Who addresses exposure for the occupational settings past recommendations for OSHA for primarily air contaminants? The dermal and non-dietary routes are sometimes important in these settings, and this exposure handbook should be useful in those settings also.

Comments from Agnes Lobscheid

Post-meeting comments on the US EPA's Exposure Factors Handbook Update

1) Have multiple volumes of prior EFH available on-line available for download or viewing in pdf. Consider having this organized by each exposure factor chapter of the EFH. For each chapter, organize all the information for specific exposure factor in tables with the most current information presented first. This would be very useful for retrospective exposure assessments. Additionally, web-based databases of all the information in the EFH tables would allow for the ability to search and query previous years data for retrospective exposure assessment and trend analysis.
2) Suggest separate exposure factors book for building factors which would include both Residential and Commercial (including office buildings) and other public meeting space buildings. This is tricky though because it is not clear how much of human activity affects the building factors, such as AER (what proportion of the ACH is due to the human activity, e.g., opening windows, vs. that due to leakage and/or infiltration and how does climate affect both?). So, for those Exposure factors that have a clear human activity pattern, e.g., opening windows to change the AER, include the activity factors in the "Activity Factors" (Chapter 16 of current EFH draft update).
3) I highly recommend that all the publicly available databases have the websites provided in the references so that the online, or pdf-users, of the EFH can link directly to the dataset and see the data and/or carry out their own analyses.
4) Incorporate exposure factors that relate to exposures to pregnant women and fetuses. In my pre-meeting comments I suggested that pregnant women would be a susceptible subpopulation of interest for collecting additional ingestion intake exposure factors. During the course of the panel meetings it is clear that fetal ingestion exposure factors, and inhalation, dermal and ingestion exposure factors for pregnant women, are lacking and are needed in future EFH updates.
5) Please consider renaming Chapter 15 ("Human Milk Intake") to either "Human Breast Milk Intake" or "Infant Diet". If the latter, I suggest including formula and other infant food intake (including water, fruits and vegetables, meats, dairy, and fats, and grain products) in the chapter as well.
6) Suggest including a *Background* Chapter, following the *Introduction* Chapter. This background section would expand on information contained in the *Introduction* Chapter, including additional information on:
    - Selection criteria and methodology for selecting the studies, which then were all analyzed and ranked by the General Assessment Factors for inclusion in the EFH
    - What is different about this version and the previous EFH (1997) version (major revisions). This section would include most of the information on the age bins (Currently Section 1.7 *The Use of Age Groupings When Assessing Exposure*, of the EFH draft update).
    - Additional references to assess exposures and risk (such as those listed in the Introduction to the draft EFH update) and list/table of models that can be applied to assess human exposures (as Panos Georgopolous had suggested in the Pre-Meeting Comments and discussed during the panel-

review meeting in Washington on March 3rd and 4th). I suggest that the additional references and guidance be organized in a Table (see below- Comment #8).

- Suggestions for future research to fill in data gaps and research needs. These could be prioritized separately for ingestion, dermal, and inhalation pathways. Alternatively, place a section towards the beginning of each chapter (before the tables) titled "Recommendations for future research" that summarizes data needs, such that if these data needs were met, then the confidence rating would be "high" for all the GAFs.
- A section on the "frontiers" of Exposure Assessment. For example, this section could include an introduction of the concept of the exposome, the increasing use of biomarkers to characterize exposures, research and data available on characterizing microenvironmental exposure assessment, etc.

7) I suggest that the *Introduction* include the following sections (and in the suggested order):
   - Purpose of the EFH
   - Intended Audience
   - A section on what the EFH includes, including a summary of what is included in the current handbook – with caveats. This section would refer to the "Background" Section for the main revisions to the 1997 EFH version as well as the new age groupings. I suggest explaining a little about the new standardized age bins based on the Guidance for Selecting Age Groups for Monitoring and Assessing Childhood Exposure to Environmental Contaminants (US EPA 2005), but explaining the detailed development of these new age-bins (i.e., 2000 workshop and other material on page 1-8 of the current EFH draft update) in the newly proposed Background Section. Also, mention in this new "What the EFH includes" section the availability of web-based databases for ingestion intake, if available.
   - A section on what is not in the EFH- i.e., which exposure factors (such as dermal exposure and residential and/or building characteristics) that will be incorporated to a much more fuller extent later. But, also stress that the EFH is continually striving to incorporate the variability in the exposure factors across the population, and as new data is collected and vetted, they will be considered for inclusion in future EFH updates.
   - Selection of Studies for the Handbook, including the universe from which the studies were selected, the database libraries (e.g., PubMed, Science Direct, etc) that were utilized.
   - Fundamental Principles of Exposure Assessment. In addition to a proper and consistent definitions, and consistent use of "exposure" and "dose," this section needs to include a Roadmap and additional figures that relate how various exposure factors can be combined to assess ingestion, inhalation, and dermal exposures, and cumulative exposures. I suggest that there be separate roadmaps for ingestion exposures (both direct and indirect), inhalation exposures, and dermal exposures. I would include a subsection on cumulative exposures within this section (the current section 1.10 is suitable). In addition, I would include the following subsections:

    - "Probabilistic Exposure Assessment" (a revision of Section 1.9.2)
    - "Exposure factors for assessing risks and hazards" (currently material from Section 1.9 on page 1-11 to 1-12)
    - "Considering Life Stages when Calculating Exposure and Risk" (Section 1.8 of the current EFH draft update).
  - A section titled "Updates to this version of the EFH." This section could list a timetable of when updates for entire chapters (such as dermal exposure and building characteristics chapter) can be expected to be released (even just the year of expected release). This section would also contain information on how to get on the email notification list to receive information on updates of any exposure factor in a specific chapter, or updates to any portion of the EFH.
  - Organization of the handbook
  - References

8) I suggest the following table be inserted in the newly proposed Background section that would contain all the guidance documents (those currently listed in Chapter 1, pages 1-6 to 1-7). It would be useful to have this table in interactive form, i.e., one can just click on the specific report in a pdf version of the EFH, and then it would link to the report:

Table ##. Supplementary US EPA reports that may be useful as guidance material for exposure assessment. An indication of whether the reports address indirect and direct exposures is also provided as well as the EPA Program Office that developed the report. Reports are listed in chronological order.

Report	Indirect Exposures	Direct Exposures	Date	EPA Group/ Office or Agency	EPA report no.
Methods for Assessing Exposure to Chemical Substances, Volumes 1-13	Check if appropriate	Check if appropriate	1983-1989	Office of Toxic Substances, Exposure Evaluation Division	Provide information
Standard Scenarios for Estimating Exposure to Chemical Substances During Use of Consumer Products			1986a	Office of Toxic Substance, Exposure Evaluation Division	
Selection Criteria for Mathematical Models Used in Exposure Assessments: Surface Water Models			1987	Exposure Assessment Group, Office of Health and Environmental Assessment	
Selection Criteria for Mathematical Models Used in Exposure Assessments: Groundwater Models			1988	Exposure Assessment Group, Office of Health and Environmental Assessment	
Risk Assessment Guidance for Superfund, Volume I, Part A, Human Health Evaluation			1989	Office of Solid Waste and Emergency Response	

Report	Indirect Exposures	Direct Exposures	Date	EPA Group/ Office or Agency	EPA report no.
*Manual **					
Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions			1990	? (not listed in references)	
Risk Assessment Guidance for Superfund, Volume I, Part B, Development of Preliminary Remediation Goals			1991a	Office of Solid Waste and Emergency Response	
Risk Assessment Guidance for Superfund, Volume I, Part C, Risk Evaluation of Remedial Alternatives			1991b	Office of Solid Waste and Emergency Response	
Guidelines for Exposure Assessment			1992a	Office of Research and Development, Office of Health and Environmental Assessment	
Dermal Exposure Assessment: Principles and Applications			1992b	Office of Health and Environmental Assessments	
Estimating Exposures to Dioxin-Like Compounds(**)			1994a	Office of Research and Development	

Report	Indirect Exposures	Direct Exposures	Date	EPA Group/ Office or Agency	EPA report no.
Soil Screening Guidance			1996a	Office of Solid Waste and Emergency Response	
Series 875 Occupational and Residential Exposure Test Guidelines - Final Guidelines - Group A - Application Exposure Monitoring Test Guidelines			1996b	None given in references	
Series 875 Occupational and Residential Exposure Test Guidelines - Group B - Post Application Exposure Monitoring Test Guidelines			1996c	None given in references	
Policy for Use of Probabilistic Analysis in Risk Assessment at the U.S. Environmental Protection Agency			1997b	Science Policy Council.	
Guiding Principles for Monte Carlo Analysis			1997c	Office of Research and Development, Risk Assessment Forum,	
Sociodemographic Data for			1999	None given in references	

Report	Indirect Exposures	Direct Exposures	Date	EPA Group/ Office or Agency	EPA report no.
Identifying Potentially Highly Exposed Populations					
Options for Developing Parametric Probability Distributions for Exposure Factors			2000a	Office of Research and Development	
Risk Assessment Guidance for Superfund, Volume I, Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments			2001a	Office of Solid Waste and Emergency Response	
Risk Assessment Guidance for Superfund Volume III, Part A, Process for Conducting Probabilistic Risk Assessments			2001b	Office of Solid Waste and Emergency Response	
Framework for Cumulative Risk Assessment			2003b	Risk Assessment Forum	
Example Exposure Scenarios			2003c	Office of Research and Development	
Risk Assessment Guidance for			2004	Office of Solid Waste and Emergency	

Report	Indirect Exposures	Direct Exposures	Date	EPA Group/ Office or Agency	EPA report no.
Superfund, Volume I, Part E, Supplemental Guidance for Dermal Risk Assessment				Response	
Cancer Guidelines for Carcinogen Risk Assessment Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens			2005a	NCEA	
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens			2005b	Risk Assessment Forum	
Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants			2005c	Office of Research and Development	
Protocol for Human Health Risk Assessment for			2005d	?? none given in references	

Report	Indirect Exposures	Direct Exposures	Date	EPA Group/ Office or Agency	EPA report no.
Hazardous Waste Combustion Facilities					
Aging and Toxic Response: Issues Relevant to Risk Assessment			2005e	??none given in references	
A Framework for Assessing Health Risk of Environmental Exposures to Children			2006d	Office of Research and Development	
Child-Specific Exposure Factors Handbook			2008a	Office of Research and Development	
Concepts, methods, and data sources for cumulative health risk assessment of multiple chemicals, exposures, and effects: a resource document			2008b	Office of Research and Development	

Direct exposures refer to direct ingestion, inhalation and dermal pathway exposures

Indirect Exposures refer to indirect exposure through the ingestion (water in food and from swimming, and soil) and dermal pathway

*Interim final report

**draft report