Summary Minutes of the US Environmental Protection Agency Science Advisory Board Review of the Draft SAB Panel Reports: *Consultation on the EPA's Emergency Consequence Assessment Tool and Incident-based Microbial Risk Assessment Framework* and the *Advisory on the Agency's Draft White Paper Entitled 'Modifying EPA Radiation Risk Models Based on Bier VII'*

Public Teleconference Meeting
September 5, 2007
1:00 pm – 3:00 pm (Eastern Time)
Meeting Location: Via Telephone Only

Purpose of the Meeting: The Meeting was held to allow for the Chartered SAB to review and approve the subject draft reports. The meeting agenda is in Attachment A. The Roster of SAB participants is in Attachment B.

Members Participating in the Meeting:

Dr. M. Granger Morgan, Chair	Dr. Baruch Fischhoff
Dr. Kenneth Dickson	Dr. Galloway
Dr. James Hammitt	Dr. Rogene Henderson
Dr. Steve Heeringa	Dr. Agnes Kane
Dr. Meryl Karol	Dr. George Lambert
Dr. Jill Lipoti	Dr. Mike McFarland
Dr. Judith Meyer	Dr. Rebecca Parkin
Dr. Steve Roberts	Dr. Kathy Segerson
Dr. Thomas Theis	Dr. Valerie Thomas
Dr. Terry Young	Dr. Lauren Zeise

Others Participating in the Meeting:

SAB Staff: Dr. Vivian Turner, DFO, Dr. Jack Kooyoomjian, DFO; Mr. Tom Miller, DFO, Ms. Kathleen White, DFO, Dr. Vanessa Vu, Director

Public Commenters: Dr. Arjun Makhijani, Institute for Energy and Environmental Research, and Ms. Joni Arends, Concerned Citizens for Nuclear Safety. See contact list for others asking for call-in information and who were potentially on the call (see Attachment C) (a roll was not called for the public beyond those who had registered to make public comments).

MEETING SUMMARY

Wednesday, September 5, 2007

This meeting was announced in the *Federal Register* on August 16, 2007 (FR 72 46057-46058) (see Attachment D of the physical file and on the SAB website at http://www.epa.gov/fedrgstr/EPA-SAB/2006/January/Day-30/sab583.htm).

1. **Convene the Meeting**

Mr. Thomas Miller, SAB Designated Federal Officer, convened the meeting and identified those on the call. He noted that: 1) the meeting was an official meeting of the Chartered Science Advisory Board, chaired by Dr. Granger Morgan; 2) the meeting complies with requirements of the FACA and EPA policy for expert advisory committees; and 3) the SAB members participating in this meeting had submitted updates to their confidential statements of financial interest and the Deputy Ethics Official for the SAB Staff Office had determined that Members do not have "conflict of interest" or "appearance of impartiality" issues within the meaning of the relevant ethics and conflict of interest requirements that apply to this advisory activity.

Mr. Miller stated that Member's responsibilities during this meeting were to evaluate the draft SAB Panel report and decide whether the report:

a) adequately addressed the Agency charge questions;
b) is clear and logical; and
c) conclusions drawn or recommendations made are supported by the body of the Panel's report.

Mr. Miller noted that SAB proceedings provide an opportunity for public observation and participation and that participation can be through providing written comments to the SAB or by making short oral statements during the public meeting. Mr. Miller noted that for today's meeting, two members from the interested public had asked for and been granted time on the agenda to make a brief oral statement. He noted that written comments are available on the SAB Website at www.epa.gov/sab on the BEIR draft report.

Dr. Granger Morgan then carried out the agenda. Dr. Morgan summarized the intent of the meeting and the agenda (see Attachment A) and identified the reports to be reviewed.

2. SAB HSAC Draft Letter of ***Consultation on the EPA's Emergency Consequence Assessment Tool* and the EPA *Incident-based Microbial Risk Assessment Framework*** (see Attachment E).

Dr. Fischhoff, Chair, Homeland Security Advisory Committee introduced the letter which resulted from a consultation with EPA on these two tools which are under development by the EPA National Homeland Security Research Center (NHSRC). Dr. Fischhoff Chaired the ECAT portion of the review meeting while Dr. Parkin Chaired the MRA portion. The HSAC provided positive comments in general that encourage further development of these tools. As they currently exist, it is not clear that they would do the things desired by the designers.

Dr. Morgan then asked the SAB Reviewers to comment on the draft report. Attachment F provides a compilation of the written comments of Board members on the draft report. Members generally deferred to those comments and during the meeting only mentioned specific comments that they believed to be in need of highlighting.

Dr. Lipoti deferred to her written comments after noting that Dr. Fischhoff's introduction had helper her understand several issues that were previously unclear.

Dr. McFarland noted that the letter did not systematically address each of the charge questions but that it did highlight major points which seemed appropriate given the intent of this type a Consultation letter. Dr. Morgan agreed that this addition of information to the consultation notice should be discussed at a future SAB meeting.

Dr. Theis also referred to his written comments and he believed that the suggestions of HSAC were fine. He suggested that it was appropriate to state that the approach was not yet fully developed and thus responding to a charge is somewhat difficult. It might also be appropriate to note in the letter how the tools fit within the network of activities that are linked together within the National Response Plan (NRP). It might be appropriate to tone down the kudos to the review committee itself. Dr. Segerson also provided written comments. She noted that the draft reflected a tension between the committee and EPA and that might have contributed to the tone issue mentioned earlier. She suggested clarifying the point. Dr. Fischhoff agreed that this could be done. The point was that the letter is from himself as HSAC Chair, and Dr. Morgan as SAB Chair, and he wished to thank the HSAC participants for all their work on the issue. The letter is not a letter from the HSAC *per se*.

Dr. Meyer asked how this letter, especially the risk communications advice, would relate to the "environmental disasters" report that the SAB is now drafting? Dr. Morgan noted that it was separate but that the disasters letter has a strong section on risk communications.

Dr. Kane referred to specific CDC emergency procedures in the microbial risk area and suggested the draft suggest that EPA link to that effort as well. Dr. Kane is to send specific information to Dr. Fischhoff on the CDC effort.

Ms. Joni Arends, Concerned Citizens for Nuclear Safety, asked to be permitted to make an oral statement about this topic because her organization was also interested in this topic. Dr. Morgan agreed and Ms. Arends noted her organization's support for the idea of linking this issue to the National Response Plan.

Dr. Morgan asked Dr. Fischhoff if the SAB comments would present any difficulties to the HSAC in terms of editing the report to account for the comments. Dr. Fischhoff noted that they could be accommodated.

Members made a motion for approval of the draft report contingent upon certain clarifying edits according to the comments made in writing and discussed herein being made. Dr. Morgan called the motion to a vote asking if there was dissent from the motion. None was given and thus the motion passed unanimously. Vettors were not assigned to review the edits and the report can be sent to the Administrator once the edits are accomplished in accordance with this approval.

3. SAB RAC draft Report, ***Advisory on the Agency Draft White Paper Entitled Modifying EPA Radiation Risk Models Based on BEIR VII*** (see Attachment G)

Dr. Morgan noted that two members of the public had requested and been granted time on the agenda to make brief oral statements in regard to the draft RAC advisory on EPA's "white paper." He asked Dr. Arjun Makhijani, President, Institute for Energy and Environmental Research, Takoma Park, MD and Ms. Joni Arends, Concerned Citizens for Nuclear Safety to make there oral statements at this time.

Dr. Makhajani asked for a response to his letter to the SAB Chair and that his time to make a statement be deferred until such time that it would be clear what the RAC Chair's response to his public comments would be. Ms. Arends also asked that her time be deferred. Dr. Morgan agreed to this agenda change.

Dr. Lipoti thanked the SAB and members of the public for their written comments (see Attachment H for the SAB comments and Attachment I for the comments from the public). Dr. Lipoti stated that the review was one focused on the method that EPA will use to develop cancer risk estimates for a suite of radionuclides. They have a significant additional level of activity to accomplish on the way to doing that in the time available.

Dr. Lipoti stated that it was clear from public comments made at the RAC panel meetings that public commenters desired that the panel accept the BEIR VII advice. The panel did accept the BEIR VII advice with the exception of: 1) situations that were not addressed in BEIR, 2) issues for which there now exist data that were not available during the development of BEIR VII, 3) topics where there was compelling evidence for a change from the BEIR recommendations, e.g., in the case of breast cancer, and 4) situations where practicality in the case of what EPA could reasonably do as it used BEIR VII. Dr. Lipoti noted that the public participated and made comments throughout the review process of the SAB and that even though the Panel did not do a point by point reply to each comment made, public participation led to many changes to the draft report.

Dr. Lipoti asked for Board understanding of the need for a longer than usual letter to the Administrator because of the need to get the message across to senior managers and others who might only have time to read that document and not sufficient time to go into the body of the report and read the detailed discussions.

In regard to the many comments made by the public in regard to the "Reference Man" issue, Dr. Lipoti noted that in addressing this, the RAC actually went beyond the charge because of the importance that the RAC accorded the issue. The RAC in fact does not accept the use of Reference Man and has advised that EPA should focus on different age groups and gender differences as well in its methodology. Given the number of public comments, the report must not have been clear enough in the Panel's lack of support for Reference Man alone and she looks to the Board to help in clarifying that point.

Dr. Lipoti noted that, as with all SAB reports, this one is advisory to the Administrator of EPA and to the EPA offices. It is up to EPA to take the advice and incorporate its guidance into the next steps of their process to assess cancer risk. The next step for EPA in regard to cancer assessment is to take their method (as described in the current white paper and as revised as they see the need based on the SAB comments, among others) and to generate their estimates of radiogenic risk which will be carried in a separate document – commonly referred as the "Blue Book." She also noted that EPA estimates already consider age and gender groupings and thus we expect they will continue that practice in the next Blue Book.

Public Comments:

Dr. Morgan then asked for the public commenters to make their oral statements.

a) Dr. Arjun Makhajani, Institute for Energy and Environmental Research: Dr. Makhanaji's written comments are in Attachment I. He noted that the Reference Man issue can be resolved with language that was in Dr. Lipoti's introductory statement just made to the SAB (he suggested that the statement be, "Reference man is a concept that should not be used – cancer risk to different age and gender groups should be considered."). The current draft appears to be a retreat to a "White Man" standard and that doses to male and female children are different. He referred to the Connecticut Yankee case where considering different age groups was prohibited. He noted that the authorized doses are clear additions to background and that all such doses no matter how small are relevant to risk. He noted that the does not mention the ICRP model doses to uterus/fetus. This is wrong because there is data from research on the first 8 weeks of pregnancy. He noted that he does not expect each of his comments to be responded to, but he also does not expect that they will be completely disregarded.
b) Ms. Joni Arends, Concerned Citizens for Nuclear Safety: Ms. Arends reiterated her support for Dr. Makhajani's comments. Her organization has concern with use of the Reference Man approach and the organization supports the changes noted by Dr. Makhajani.

Dr. Morgan then asked Board Members for any comments that they might want to highlight from their earlier written submissions (see Attachment H).

Dr. Zeise stated that the report was well written and that it addressed the charge questions. She reemphasized her written comments on non-melanoma-cancer, needed clarifications on the Reference Man/Reference Family issue, additivity issues, and the length of the letter. Dr. Lipoti noted that for the Reference Family issue, it was in an earlier draft but it was removed. The Panel will consider adding the language to the final report or deferring it to the next review (i.e., the Blue Book) which is next up and where it might fit better.

Dr. Thomas noted that the main point in her comment referred to a statement in the draft about the current state of science versus the need for practicality at EPA in addressing issues even though the science might not be complete. This appears to put the SAB in the position of supporting the use of weak science in EPA's assessment approach instead of suggesting that EPA change its approach. It almost implies that we are saying to put science aside. Dr. Lipoti stated that this was not the intent of the statement. It reflects the rapid change in low-dose radiation understanding that occurred while the White Paper was being developed, the continued change during our review, and change that still occurs and will continue to do so as the Blue Book is developed. We are saying that EPA needs to keep up with this new research at each step of the process and use it as best possible, but not to ignore the changes by setting an arbitrary point in time to cut off incorporation of new knowledge.

Dr. Jerome Puskin of the US EPA noted that in terms of the issues discussed today, the methodology is directed at "unit dose' and that they do not relate to actual doses to people of varying age groups, gender, etc. The issues discussed in association with the "Reference Man" concept are appropriate when the

Agency updates its "Field Guide 13" (i.e., the Blue Book). The issue of age-specific dose is not a part of the current methodology. This is relevant to Dr. Lipoti's noting earlier that the current document could be modified to clarify the Reference Man concerns, or it could be deferred until later, where it actually fits into the EPA process, i.e., development of the Blue Book. Dr. Mary Clarke of the US EPA thanked the Board for its work on this review.

Dr. Morgan summed up by noting that the sense of the Board, as well as the RAC Chair, is that revisions are in order to reflect the comments made by the Board and the public. Clarification of the age and gender issues seem to be important in this. Dr. Henderson made a motion that the report be approved subject to revisions by the RAC Panel to make the final report responsive to the Board's discussions today. Once revised, the report edits will be vetted by Drs. Zeise, Thomas and Lambert for conformance with the discussions. The motion was seconded by Dr. Parkin. Members were asked to vote on the motion. All approved the motion and none dissented.

Dr. Morgan thanked the SAB, Agency, and Public participants for their attention and assistance at the meeting.

The Designated Federal Officer adjourned the meeting at 2:10 p.m.

Respectfully Submitted:

/ Signed /

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Thomas O. Miller
Designated Federal Officer
US EPA Science Advisory Board

Certified as True:

/ Signed /

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Dr. M. Granger Morgan
Chair, EPA Science Advisory Board

Attachments:

A Meeting Agenda
B SAB Roster of Participating Members
C List of Contacts from the Public for this Meeting
D FR Announcement
E *Consultation on the EPA's Emergency Consequence Assessment Tool* and the EPA *Incident-based Microbial Risk Assessment Framework*
F Compilation of SAB Comments
G Advisory on the Agency Draft White Paper Entitled Modifying EPA Radiation Risk Models Based on BEIR VII
H Compilation of Public Comments on BEIR VII White Paper Draft Report

US Environmental Protection Agency
EPA Science Advisory Board
Draft Agenda

Public Teleconference Meeting
1:00 pm - 2:30 pm (Eastern Time)
September 5, 2007

Meeting Location:
Via Telephone at:
Call-In Number: 866-299-3188
Conference Code: 2023439982#

Wednesday, September 5, 2007

1:00 p.m.	**Convene the Teleconference Call**	Mr. Thomas Miller, Designated Federal Officer, US EPA Science Advisory Board
1:05 p.m.	**Chair's Welcome and Summary of the Agenda**	Dr. Granger Morgan, Chair, US EPA Science Advisory Board
1:10 p.m.	**Quality Review of EPA SAB Homeland Security Advisory Committee Letter, *Consultation on the EPA's Emergency Consequence Assessment Tool* and the EPA *Incident-based Microbial Risk Assessment Framework*.**	Dr. Granger Morgan, Chair SAB Dr. Baruch Fischhoff Chair, SAB Homeland Security Advisory Committee The Board
1:40 p.m.	**Public Comments on the White Paper** a. Dr. Arjun Makhijani, IEER b. Ms. Joni Arends, Concerned Citizens for Nuclear Safety	Pending
1:50 p.m.	**Quality Review of EPA SAB Radiation Advisory Committee Report, *Advisory on the Agency Draft White Paper Entitled Modifying EPA Radiation Risk Models Based on BEIR VII*.**	Dr. Granger Morgan, Chair, SAB Dr. Jill Lipotti Chair, SAB Radiation Advisory Committee The Board
2:30 p.m.	**Adjourn the Meeting**	The DFO

U.S. Environmental Protection Agency
Science Advisory Board
September 5, 2007
Telephone Conference Meeting

CHAIR

Dr. M. Granger Morgan, Professor and Head, Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA

SAB MEMBERS

Dr. Kenneth Dickson, Professor, Institute of Applied Sciences, University of North Texas, Denton, TX

Dr. Baruch Fischhoff, Howard Heinz University Professor, Department of Social and Decision Sciences, Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA

Dr. James Galloway, Professor, Department of Environmental Sciences, University of Virginia, Charlottesville, VA

Dr. James K. Hammitt, Professor of Economics and Decision Sciences, Harvard Center for Risk Analysis, Harvard University, Boston, MA
Also Member: COUNCIL

Dr. Rogene Henderson, Scientist Emeritus, Lovelace Respiratory Research Institute, Albuquerque, NM
Also Member: CASAC

Dr. Agnes Kane, Professor and Chair, Department of Pathology and Laboratory Medicine, Brown University, Providence, RI

Dr. Meryl Karol, Associate Dean for Academic Affairs, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA

Dr. George Lambert, Associate Professor of Pediatrics, Department Director Center for Childhood Neurotoxicology, Robert Wood Johnson Medical School- UMDNJ, Belle Mead, NJ

Dr. Jill Lipoti, Director, Division of Environmental Safety and Health, New Jersey Department of Environmental Protection, Trenton, NJ

Dr. Michael J. McFarland, Associate Professor, Department of Civil and Environmental Engineering, Utah State University, Logan, UT

Dr. Judith L. Meyer, Distinguished Research Professor, Institute of Ecology,

University of Georgia, Athens, GA

Dr. Rebecca Parkin, Professor and Associate Dean, Environmental and Occupational Health, School of Public Health and Health Services, The George Washington University, Washington, DC

Dr. Stephen M. Roberts, Professor and Director, Department of Physiological Sciences, Center for Environmental and Human Toxicology, University of Florida, Gainesville, FL

Dr. Kathleen Segerson, Professor, Department of Economics, University of Connecticut, Storrs, CT

Dr. Thomas L. Theis, Professor and Director, Institute for Environmental Science and Policy, University of Illinois at Chicago, Chicago, IL

Dr. Valerie Thomas, Anderson Interface Associate Professor, School of Industrial and Systems Engineering, Georgia Institute of Technology, Atlanta, GA

Dr. Terry F. Young, Consultant, Environmental Defense, Oakland, CA

Dr. Lauren Zeise, Chief, Reproductive & Cancer Hazard Assessment Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Oakland, CA

LIAISONS

Dr. Steven Heeringa, (FIFRA SAP), Research Scientist and Director, Statistical Design Group, Institute for Social Research (ISR), University of Michigan, Ann Arbor, MI

SCIENCE ADVISORY BOARD STAFF

Mr. Thomas Miller, Designated Federal Officer, 1200 Pennsylvania Avenue, NW 1400F, Washington, DC, Phone: 202-343-9982, Fax: 202-233-0643, (miller.tom@epa.gov)

ATTACHMENT C

List of Contacts for September 5, 2007 SAB Telephone Conference Meeting

Joni Arends (Public Commenter)	Dolph Honicker
Eldon Ball	Stephen Joyce
Tarrie Barrie	L R Karpen
Frank Belcastro	Linda Keir
Rosalie Bertell	Robert Kinsey
Marla Boetesch	Bev Logan
Lynde Boughton	Jackie Lombardo
Chuck Broscious	Joe MacNulty
Clark Bullard	Arjun Makhajani (Public Commenter)
Lacy Burritt	Mahnaz
Nancy Burton	Karen Marshall
Tracy Cannon	Barbara Miller
John Cape	Joy Nelson
Craig Clark	Kata Orndorf
Matthew Clinton	Gene Peters
T. Conner	Judi Poulson
Helen Cornelli	Jean Rhodes
Dinda Davis	Michael Ryan
John Davis	Prasad Shirvalkar
Pat and Norm Dressler	G E Schissler
Stephanie Feyne	Sybil Schlessinger
Tunisia Fountain	Jay Snyder
Jeri Fry	Cathi Sullivan
Lydia Garvey	Roger Voelker
Alexandra Geddes	Lynn White
Josh Goldman	Guy Wolfe
Gail Griffith	Elaine Wynne
Art Hanson	

ATTACHMENT D

EPA Science Advisory Board; Notification of a Public Teleconference of the Science Advisory Board

[Federal Register: August 16, 2007 (Volume 72, Number 158)]
[Notices]
[Page 46057-46058]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr16au07-86]

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ENVIRONMENTAL PROTECTION AGENCY
[FRL-8456-2]

EPA Science Advisory Board; Notification of a Public Teleconference of the Science Advisory Board

AGENCY: Environmental Protection Agency (EPA).
ACTION: Notice.

SUMMARY: The Environmental Protection Agency Science Advisory Board (SAB) Staff Office announces a public teleconference of the Chartered Science Advisory Board to conduct a quality review of two draft SAB documents: (a) SAB Homeland Security Advisory Committee Consultation on the EPA's Emergency Consequence Assessment Tool and Incident-based Microbial Risk Assessment Framework, and (b) SAB Radiation Advisory Committee Advisory on the Agency Draft White Paper Entitled Modifying EPA Radiation Risk Models Based on Bier VII.

DATES: The SAB will hold the public teleconference on September 5, 2007. The teleconference will begin at 1 p.m. and end at 2:30 p.m.

(Eastern Time).

Location: Telephone conference call only.

FOR FURTHER INFORMATION CONTACT: Any member of the public wishing to obtain general information concerning this public teleconference should contact Mr. Tom Miller, Designated Federal Officer (DFO), EPA Science Advisory Board (1400F), U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, NW., Washington, DC 20460; via telephone/voice mail: (202) 343-9982; fax: (202) 233-0643; or e-mail at: miller.tom@epa.gov. General information concerning the EPA Science Advisory Board can be found on the EPA Web Site at: http://www.epa.gov/sab.

SUPPLEMENTARY INFORMATION: Pursuant to the Federal Advisory Committee Act, Public Law 92-463, notice is hereby given that the EPA SAB will hold a public teleconference to review two draft SAB documents. The SAB was established by 42 U.S.C. 4365 to provide independent scientific and technical advice to the Administrator on the technical basis for Agency positions and regulations. The SAB is a Federal Advisory Committee chartered under the Federal Advisory Committee Act (FACA), as amended, 5 U.S.C., App. The SAB will comply with the provisions of FACA and all appropriate SAB Staff Office procedural policies.

Background: The purpose of the public teleconference is to conduct a quality review of two draft SAB documents. These documents are the: (a) Science Advisory Board's Homeland Security Advisory Committee Consultation on the EPA's Emergency Consequence Assessment Tool and Incident-based Microbial Risk Assessment Framework, and (b) Advisory on the Agency Draft White Paper Entitled Modifying EPA Radiation Risk Models Based on Bier VII. In reviewing draft reports, the SAB considers whether: (i) The original charge questions to the SAB review panel were adequately addressed in the draft report, (ii) the draft report is clear and logical; and (iii) the conclusions drawn, or recommendations made in the draft report, are supported by the body of the report.

(a) The EPA National Homeland Security Research Center (NHSRC) requested that the SAB provide technical advice on its Emergency Consequence Assessment Tool (ECAT) and its preliminary incident-based Microbial Risk Assessment (MRA) Framework (see 72 FR 20538 of April 25, 2007) which are being developed by the NHSRC. ECAT is an interactive online risk assessment and management software tool to provide health advisors, and other emergency response officials, with rapid access to critical information during an environmental emergency or training exercise. ECAT is designed to assess and provide site-specific numeric estimates of health risks for selected chemical, biological and radiological threat agents; and identify appropriate response actions to mitigate these risks. Additionally, NHRSC asked the SAB for advice on its White Paper describing issues important to the development of a decision framework for assessing health risks and developing clean up

levels associated with a decontamination response following exposure to microbial agents. Additional information about the SAB consultation on these two topics is available on the SAB Web Site at: http://www.epa.gov/sab/panels/hsacadhoc.html.
(b) EPA's Office of Radiation and Indoor Air (ORIA) asked the SAB to provide advice on a draft White Paper: Modifying EPA Radiation Risk Models Based on BEIR VII, dated August 2006 (see 71 FR 45545 of August 9, 2006;

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71 FR 62950 of October 26, 2006; and 72 FR 8379 of February 26, 2007). EPA's White Paper describes an updated methodology for quantifying estimated cancer risks from environmental exposures to radionuclides. The EPA's methodology is based on the National Research Council (NRC 2006) released Health Risks from Exposure to Low levels of Ionizing Radiation BEIR VII Phase 2 which primarily addresses cancer and genetic risks from low doses of low-LET radiation (BEIR VII). Additional information about the SAB's review of EPA's White Paper, and the development of the SAB draft report, can be found on the Web at: http://www.epa.gov/sab/panels/rac_adv_white_paper_rad_risk_models.htm.

Availability of Teleconference Materials: The draft agenda and other materials will be posted on the SAB Web site at: http://www.epa.gov/sab/ prior to the teleconference.

Procedures for Providing Public Input: Interested members of the public may submit relevant written or oral information for the SAB to consider during the public teleconference. Oral Statements: In general, individuals or groups requesting an oral presentation at a public SAB teleconference will be limited to three minutes per speaker, with no more than a total of one-half hour for all speakers. Interested parties should contact Mr. Tom Miller, DFO, in writing (preferably via e-mail), by August 29, 2007, at the contact information noted above, to be placed on the public speaker list for this teleconference. Written Statements: Written statements should be received in the SAB Staff Office by August 30, 2007, so that the information may be made available to the SAB for their consideration prior to this teleconference. Written statements should be supplied to the DFO in the following formats: one hard copy with original signature, and one electronic copy via e-mail (acceptable file format: Adobe Acrobat PDF, WordPerfect, MS Word, MS PowerPoint, or Rich Text files in IBM-PC/ Windows 98/2000/XP format).

Accessibility: For information on access or services for individuals with disabilities, please contact Mr. Tom Miller at (202) 343-9982 or miller.tom@epa.gov. To request accommodation of a disability, please contact Mr. Miller preferably at least ten days prior to the teleconference, to give EPA as much time as possible to

process your request.

Dated: August 10, 2007.

Anthony F. Maciorowski,

Deputy Director, EPA Science Advisory Board Staff Office.

[FR Doc. E7-16147 Filed 8-15-07; 8:45 am]

BILLING CODE 6560-50-P

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

June XX, 2007

EPA-SAB-CON-07-XX

The Honorable Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

SUBJECT: Science Advisory Board's Homeland Security Advisory Committee Consultation on the EPA's Emergency Consequence Assessment Tool and Incident-based Microbial Risk Assessment Framework

Dear Administrator Johnson:

The Science Advisory Board (SAB) Homeland Security Advisory Committee (HSAC) held a public meeting on May 30 and 31, 2007 to provide consultative advice on the Agency's Emergency Consequence Assessment Tool (ECAT, September 2006) and the Draft White Paper on Incident-based Microbial Risk Assessment Framework (MRA, May 2007). The HSAC, augmented by additional experts from the SAB's Radiation Advisory Committee and the Drinking Water Committee, is composed of a remarkably diverse and accomplished group of experts. There was a tremendous amount of enthusiasm and energy displayed by their willingness to serve and the intensity of their involvement is a tribute to the Agency and the importance of the missions that it has undertaken for our nation's security.

The Agency has a long history of requesting early input from independent experts and the SAB welcomes the opportunity to be part of that tradition. The HSAC was very impressed by the hard and thoughtful work done by the Agency's scientists.

As this was a consultation, there will be no consensus report from the SAB. However, the HSAC would like to note several key points that arose in the consultation on these two topics. Written comments from individual Committee members are provided in the official minutes of the consultation.

<u>Comments on EPA's Emergency Consequence Assessment Tool (ECAT)</u>
EPA's National Homeland Security Research Center (NHSRC) within the Office of Research and Development is developing an interactive on-line risk assessment software

tool designed to provide health advisors and other emergency response officials with rapid access to critical information during an environmental emergency or training exercise. The ECAT is designed to assess and provide site-specific numeric estimates of health risks for selected chemical, biological and radiological threat agents; and identify which response actions might be appropriate to mitigate human health risks. The SAB was asked to review the preliminary version of this tool and provide advice and recommendations for its future development and application.

The HSAC offers the following thoughts regarding the ECAT:
1. The ECAT could be useful for EPA's second phase responders, risk assessors, and risk managers. It has particular promise as a training tool, if developed and evaluated according to the appropriate scientific standards (found in educational assessments, human-computer interactions, and related fields). However, its use by first responders, in the initial hours of an emergency would not be feasible.

2. The next developmental phase for the ECAT should include one or two fully developed threat scenarios. Those complete applications of the ECAT should be independently evaluated in terms of their contributions to health protection. One scenario for air contamination and one for water contamination would be good for examining generality. These demonstrations might use the Human Exposure Measurement results from the Urban Dispersion Program tracer field studies and drinking water system tracers studies.

3. For these applications, EPA should show how the ECAT's outputs will affect specific decisions. Those demonstrations should identify the impacts of specific information, accessed at specific times during a specific emergency, reaching specific decision makers, used in specific decisions, disseminated to specific audiences, interpreted in specific ways, and leading to specific protective actions. Evaluating the usefulness of information is an essential element to sound decision making and risk communication.

4. EPA should study the challenges in using the ECAT with actual events. That research should consider issues like choosing the right hazard with dissemination events (where an unknown agent is quietly introduced), determining source terms for models, and communicating to diverse audiences. The research should develop decision rules that consider the expected impacts of possible diagnoses and misdiagnoses. The research should focus on the test cases.

5. EPA should explicitly evaluate the ECAT's potential usefulness before extending it to other domains. That evaluation may conclude that some areas should be eliminated (e.g., because usable models cannot be created), that some areas are only viable if they can use data sources maintained by other organizations, that some areas can be used if their models are validated using tracer studies, and that some areas should only provide access to consulting experts.

6. EPA should develop a dissemination plan for the ECAT, addressing issues of coordination, cost, trust, liability, duplication, etc. That plan should be informed by the relevant science regarding organizational behavior, political science, and public

administration. The plan should consider selective release of the ECAT elements; for example, the collection of databases (in the left-hand toolbar) may have particular value. Risks with unintended users (both friendly and hostile) must be considered.

7. EPA needs to have a robust science program on risk communication. Scientifically sound risk communication entails identifying the information most critical to users' needs and delivering it in a demonstrably effective way. Poor communication can harm citizens, by undermining their ability to protect themselves; it can harm organizations, by undermining public faith in them. Without rigorously developed and evaluated communications, the ECAT may provide no value or negative value. The markers of sound communication science are (a) familiarity with the current research literature, (b) formal analysis of the information needs of specific decision makers facing specific decisions, (c) empirical evaluation of communication impacts, and (d) review by peers.

Comments on EPA's White Paper on Incident-based Microbial Risk Assessment Framework

EPA's NHRSC has prepared a white paper describing issues regarding the development of a decision framework for assessing health risks associated with exposure to microbial agents after an incident and developing cleanup levels associated with a decontamination response. The SAB was asked to provide advice on the development of such a framework.

The HSAC offers the following thoughts on the draft white paper:
1. The document needs clear opening statements with its strategic goals and underlying assumptions, along with concluding assessments of the sensitivity of its conclusions to those assumptions and the limits to its scope.

2. The white paper covers broad topics in very general style. Little specific assessment methodology was provided, thereby limiting the basis for comment. For example, its response parameters were too general to elicit a meaningful exchange of ideas between the HSAC members and the Agency scientists. When a more specific and detailed methodology is established, a follow-up review by the HSAC would lead to a fruitful exchange of thoughts.

3. The white paper embodies a highly simplified view of crisis management. Much more complex conditions are likely to exist and this plan must recognize them and be capable of providing flexibility to address them. Because EPA will not be leading responses in the first 24 hours, it must consider local roles and objectives. In some cases, EPA may not play a direct role in response for consequence management. Thus, clear process recommendations for use by other regulatory entities are necessary.

4. As with any risk assessment, there are numerous limitations, uncertainties, and roadblocks associated with the process. Such challenges should not be considered as insurmountable as described in the document. Rather, the EPA should write the document in a "can do manner" and deal with the limitations separately.

5. The microbial risk assessment framework should be developed to give as quantitative a measure of risk as possible, given the available data, just as one would employ when assessing chemical or food safety (also facing data limits). Sources of uncertainty should be assessed as part of risk characterization, in order to estimate the impacts of assumptions and defaults. The report should consider the risks of decontamination strategy as well as agent risk.

6. Development of background data for biological contaminants is essential and will play a central role in the development of cleanup benchmarks for various environmental settings. Background data already play a comparable role for remediation of chemical contaminants, particularly in complex environments like urban areas. Collection of background data must be an important part of the overall research agendas of EPA and other federal agencies.

7. Performance assessment of analytical methods for environmental detection of microbial agents is an area that should be given considerable attention by the EPA, however, it is not discussed in the submitted white paper. This is a critical step that follows the implementation of the remedy in the immediate-, short- and long-term.

General Comments

1. The HSAC could serve as a consultative body to the Agency as a whole in developing a scientifically sound risk communication program. The HSAC has the three essential kinds of scientific expertise: (a) domain knowledge, for many specific hazards; (b) risk and decision analysis, for identifying decision-relevant information; and (c) social science, for developing and empirically evaluating communications.

2. The HSAC could also assist the Agency in evaluating its overall homeland security research program in order to identify knowledge gaps and to strengthen future programs.

3. Much better feedback mechanisms are needed in order to take full advantage of HSAC members' expertise and to maintain their commitment. Members offered their availability for more frequent consultations, for the committee as a whole or subgroups.

Thank you for your attention and the opportunity to serve the Agency and its mission.

Sincerely,

Dr. Baruch Fischhoff, Chair
Homeland Security Advisory Committee

Dr. Rebecca Parkin, Co-Chair
Homeland Security Advisory Committee

Dr. Granger Morgan, Chair
Science Advisory Board

Compilation of SAB Member Comments for September 5, 2007 Telecon

1. Homeland Security Advisory Committee Letter on ECAT and MRA Consultation:

a) Lead Reviewers

i) Dr. Jill Lipoti:

A consultation does not require consensus from the committee, so much of the advice to the Agency is provided by individual members of the committee. In order to get a sense of the discussion which took place, I looked at the minutes of the HSAC meeting. The minutes were word-for-word what was in the letter to the administrator, but attached to them was individual advice from each of the committee members, which appeared to have been assembled after the conclusion of the meeting. I compared the advice from each of the members to what was written as the summary to make sure that the important points were raised.

Emergency Consequence Assessment Tool (ECAT)

- Many shortcomings of ECAT are pointed out in these comments. So many shortcomings were enumerated, I wondered if it was worth the time of the agency to correct the problems. It certainly didn't seem to support the sentence in the letter that "the HSAC was very impressed by the hard and thoughtful work done by the Agency's scientists." Perhaps this could be omitted.
- In #3, the committee might consider adding that ECAT does not include guidance on determining the safety perimeter for people to be evacuated. If it does not have clear criteria for taking protective actions, it will not be useful for even the second phase responders. (See comments from Dr. Watson.)
- The addition of a decision rules (discussed in #4) should be further emphasized, including some sort of diagnostic approach (as suggested by Dr. Parkin).
- The value of ECAT may be only as a training tool, and as a way to get discussion going among second phase responders so that they can plan for a coordinated approach. This was in #1, and was emphasized in the comments by Dr. Walsh, who also said that ECAT should be released promptly so that it would not be dropped onto responders for the first time in the heat of a real emergency. From the comments, it appears that ECAT is too unwieldy to be useful if first encountered during a stressful response situation. This piece of advice is not in the letter. As a practical matter, I also thought that Dr. Walsh's suggestion for an "ECAT-lite" for download to

responders' laptops was appealing. Dr. Zimmerman's comments also support that idea.

- The risk communication theme was supported and elaborated in several commenters' remarks. The letter reflects all of their points.

Incident-based Microbial Risk Assessment Framework

- In #3, there is a recommendation that EPA must consider local roles and objectives. This statement does not really capture the comment by Dr. Bellamy that the framework should define the roles of all responsible agencies, including how CDC might be expected to interact with EPA. This should be included.
- Most of the commenters mentioned the importance of developing data on background levels of biological contaminants, and the eventual determination of "how clean is clean?" This was adequately covered in #6. Without this determination, it seems that the MRAF is of limited usefulness. The comments by Royal Nadeau were particularly depressing. It would lead to the question about whether EPA should continue to put money and time into further development of MRAF or concentrate on other research.

ii) Dr. Michael McFarland:

Emergency Consequence Assessment Tool (ECAT) and Incident-based Microbial Risk Assessment Framework - Quality Review

On the whole, the SAB panel (Panel) is commended for providing a clear, logical and well written draft letter report highlighting the salient findings and recommendations from its consultative review of the EPA's Emergency Consequence Assessment Tool (ECAT) and Incident-based Microbial Risk Assessment (MRA) Framework. Given its potential to address the large uncertainties associated with effectively managing civilian responses to chemical and/or biological agent releases, the Panel's overarching recommendation that the Agency establish a scientifically-defensible risk communication research program is strongly supported.

In the case of a willful and/or inadvertent release of a chemical or biological agent, ensuring the effective and timely diffusion of relevant and accurate information to the appropriate incident management personnel and other key decision-makers is vital if the adverse impact to public health and the environment is to be minimized. Moreover, a well established risk communication research program will enable the Agency to effectively identify, prioritize and systematically address the myriad of uncertainties associated with emergency response and crisis management information flow including characterizing how such information informs and influences the actions of key decision-makers. In the absence of such

a program, the Agency will continued to face a formidable challenge in meeting its national security mission requirements including those specified under Homeland Security Presidential Directives 7, 9, and 10.

The following section summarizes the responses to the specific SAB quality review charge questions.

- Were the original charge questions adequately addressed in the draft report?

  With regard to ECAT, the Agency submitted nine (9) multiple-part charge questions many of which had overlapping themes. The Panel provided clear and sufficient responses to each of these charge questions focusing on both the advantages and limitations of ECAT in meeting the operational and decision-making needs of the various potential users (e.g., risk assessors/health advisors, on scene responders and risk managers/decision-makers).

  The Agency posed twelve (12) multi-part charge questions to the Panel with respect to the Incident-based Microbial Risk Assessment (MRA) framework whitepaper. In general, the Panel was disappointed with the level of oversimplification and general lack of risk assessment specificity furnished in the MRA framework whitepaper. The Panel concluded that, until the white paper had been sufficiently revised to include greater scientific detail, it would be premature to provide comment on the specific charge questions.

  In the draft letter report, the Panel highlighted many of the scientific deficiencies encountered in the MRA framework. To its credit, the Panel acknowledged that the MRA framework is an important first step in providing public health and emergency management decision-makers with the necessary tools for characterizing the potential threat associated with a biological agent release and offered its assistance in conducting a future scientific review when a more fully developed MRA methodology were made available.

- Is the draft report clear and logical?

  The Panel's draft letter report is clear and logical. The Panel provides compelling public health arguments for the need to establish a scientifically rigorous risk communication program to ensure that the output from ECAT, MRA framework or any other threat evaluation tool fully supports the needs of its intended users.

- Are the conclusions drawn and recommendations made supported by information found in the body of the draft report?

  The Panel's conclusions and recommendations pertaining to both the ECAT and MRA framework are summarized in the draft letter report. The Panel provides clear and unambiguous advice to the Agency with respect to the utility of ECAT and MRA framework in their present versions as well as identifies and outlines specific opportunities for their future refinement.

iii) <u>Dr. Tom Theis</u>:

The HSAC has made several important suggestions to the Agency regarding the further development of the Emergency Consequence Assessment Tool (ECAT) and the Incident-based Microbial Risk Assessment Framework (IMRAF). Particularly relevant are the suggestions to apply ECAT to, first, threat scenarios and, subsequently, to actual events as a means of gaining experience with its use, acquiring knowledge on its parameterization, understanding its limitations, and assessing its overall robustness. Likewise HSAC has offered useful guidance on the further development of IMRAF, particularly the need to incorporate a more realistic approach to crisis management.

These suggestions and thoughts are very important, and seem to represent the major output of the Committee. They are contained in the transmittal letter to the Administrator. Since this was a "consultation", the only other record of Committee deliberations are the meeting notes (i.e. there is no formal report), thus the letter's content and tone are a critically important part of the review process. In this regard, several suggestions are made for improving its clarity and usefulness:

- It is difficult to determine if the charge to the Committee has been adequately addressed because the transmittal letter is organized not by charge question or topic, but rather by Committee suggestions for improvement. As stated, while these suggestions are important, it would seem that all or portions of ECAT charge questions 2, 3, 4, 5, 7, and 8 have not been answered. Perhaps the Committee suggestions could be incorporated into more direct answers to the ECAT charge. If, as seems likely, the Committee found itself unable to respond to the charge questions because ECAT is insufficiently developed then it might be best to state this as a major conclusion to which the Committee's suggestions are directed.
- The Agency's approach to ECAT stresses "simplicity" and "screening" level capabilities (a frequently-used term that the Agency has not consistently defined). The Committee's responses stress scientific complexity and specificity of applications (actually the word

"specific" is used 12 times in the letter of transmittal—nine in one paragraph). Yet the charge for both ECAT and IMRAF consists for the most part of very specific questions. There would seem to be a mismatch among the level of sophistication of the tool and framework, the detail of the charges, and the expectations of the Committee. My experience is that this is a fairly common occurrence, but that it is best to *not* hide this through indirect or non-responses to the charge.

- Similarly, the Agency charge for IMRAF consists of twelve rather specific questions, only one of which (charge #4 under "uncertainties") is answered (letter p.4 #5). Again, it appears that the Committee has found that the original charge is for the most part not answerable given the information provided.
- The Committee may wish to refer, and perhaps request that the Agency incorporate, the latest thinking on emergency response as outlined in DHS's National Response Plan as part of ECAT and IMRAF.
- The letter suffers somewhat from confusing word usage. Item #5 (page 2) refers to "domains" and "areas", but it is not clear what these mean (e.g. "area" could mean the same as domain in the context of "uses" or "users", but might also refer to different types of scenarios, cases, or submodels/modules). The terminology "MRA" (I realize EPA has coined this, not the Committee) as an acronym is redundant with the Agency's 3MRA modeling system (I don't know if there is an Agency "acronym policeman", and some duplication is probably inevitable, but if only for helping search for things on the EPA website acronym uniqueness should be encouraged).
- Since the Letter of Transmittal is the main form of communication for this consultation, it is to be expected that it will be a little longer than most SAB letters to the Administrator. Still, there are two parts (page 1, first paragraph, lines 5-10), and page 4 "General Comments" and following) that have little to do with answering the charge. While it is traditional in these letters to offer justified praise to the Agency and staff involved in the review (as is done on page 1, lines 12-14), for the Committee to draw attention to itself in this manner seems unnecessary and self-serving. In this case these passages also add 20 lines to the text.

b) Other SAB members

i) <u>Dr. Rogene Henderson</u>:

- **The Emergency Consequence Assessment Tool**

  The letter is clear and logical. The comments provided do not go down the list of charge questions, providing specific answers, but rather take into account the broad overall approach and offer relevant advice to aid the Agency in taking the next steps to

improve their ECAT. I found this more helpful than if the group had only answered the specific charge questions given.

- **Incident-based Microbial Risk Assessment Framework**

  The development of a microbial risk assessment framework is a difficult task, as is well described in the Charge to the SAB Panel. The specific charge questions, which are broad and general, reflect the quandary the Agency faces in trying to develop such a framework. The draft letter report indicates that the white paper also "covers broad topics in very general style." This apparently limited the panel's ability to provide advice on many specific methodological issues. However the panel was able to provide sound, reasonable advice in some areas in response to the charge questions. So I would say the response was reasonable and logical and as complete as could be expected at this early stage in the development of the framework.

- **General Comments**

  General Comments: I thought it was most appropriate to emphasize that the HSAC was available for advising the NHSRC in more detail if better feedback mechanisms and more frequent consultations could be established.

ii) <u>Dr. James Galloway</u>:

Since there is no report that goes along with the letter, I suggest the following.

- The letter be greatly decreased in length and focus on the top 2-4 recommendations total for the ECAT and Microbial Risk portions.

- an appendix to the letter be added that gives specific answers to each of the questions that the SAB was asked to comment upon.

iii) <u>Dr. Valerie Thomas</u>:

The letter to the Administrator is clear and helpful and addresses significant points. The letter does not address the charge questions for either ECAT or MRA; it addresses larger, overarching points. I have no problems with this approach.

iv) <u>Dr. James Bus</u>:
Consultation on ECAT

The Letter identifies seven general observations regarding the ECAT prototype which do not directly correlate with nine charge questions posed to the SAB panel. As such, the Letter is difficult to interpret regarding the

Panel's actual perspectives on the value of the prototype to its intended audiences, and the appropriateness of the science and data underpinning the prototype development. The Letter should consider restructuring its responses to more directly mirror the charge questions rather than leaving the reader to indirectly infer primary conclusions and recommendations. Examples of this potential lack of clarity are described below.

- Item 1: Although this item clearly identifies likely target audiences for ECAT, the statement ECAT has "particular promise as a training tool" infers that the SAB does not have confidence in its use as primary tool for advising field responses to real-world events, i.e., is SAB meaning to say that the target audiences should only rely on ECAT for scenario training and not actual field decisions? Thus the consultation lacks a clear bottom-line statement regarding the SAB's position on the value and feasibility of ECAT implementation.
- Item 2: The Letter advises developing only one to two threat scenarios, thus inferring ECAT is potentially a long way from being prepared to address its intended all-hazard scope. This recommendation also infers a lack of confidence that the all-hazard approach of the prototype lacks necessary scientific support, and that significant research and development effort remains before ECAT should be considered for release (even if limited to 1-2 scenarios).
- Items 3 and 4: The recommendation to evaluate ECAT outputs against actual events infers the SAB lacks confidence that ECAT outputs will provide effective advice to emergency scenarios.
- Items 6-7: The SAB has clearly and appropriately emphasized the need for an effective dissemination plan for ECAT which must contain a rigorous consideration of the implications of public communications flowing from ECAT evaluations.

Consultation on Incident-based Microbial Risk Assessment

All of the items appear to suggest the Whitepaper falls significantly short of providing an appropriate framework for responding to microbial contamination events. If this is so, the Letter should contain a bottom-line opening statement to that end, which is supported by text provided in Items 1-7.

c) <u>Dr. Steven Roberts:</u>

Unless I missed something, the product of the HSAC efforts is simply the letter to the Administrator. While I have no criticism of the points raised in the letter, they do not appear to address (or address incompletely) the charge questions posed to the committee. [Note: A similar issue came up in review of a consultation at the last SAB meeting.]

d) <u>Dr. Meryl Karol:</u>

This is a well organized response to the ECAT and MRA. My only suggestion is to clarify the response to item 1 (P. 2) by modifying the final sentence as follows: *However, because the EPA is not the lead responder in the first 24 hr, its use by first responders in the initial hours of an emergency would not be feasible.*

e) <u>Dr Kathleen Segerson:</u>

ECAT/MRA letter to Administrator:

- The tone at the beginning and end of the letter is unusual for a letter to the Administrator (at least the ones I've seen). The end of the first paragraph seems to include some self-praise. Although this praise is well-deserved, I'm not sure why it is included in this letter. Why does the committee feel compelled to point out to the Administrator that it is well-qualified and committed? The fact that the letter also ends with some discussion about the committee's qualifications and role leaves the reader with the impression that perhaps there is some underlying tension between the committee and the Agency regarding this. If the committee is unhappy with the extent to which EPA has sought its advice, there may be better or more appropriate ways to express this. If not, then it is unclear why the letter begins and ends with statements about the committee's expertise and role.
- The comments in the letter regarding ECAT are very general, while the charge questions from EPA were quite specific. The general impression one gets from the letter is that EPA needs to be asking "big questions" about ECAT and its usefulness, while the charge questions seem focused on specific details of the tool. If the committee is, in fact, concerned about the usefulness of EPA's current effort and the direction it is taking, then perhaps that should be stated more explicitly in the letter.

2. <u>Radiation Advisory Committee Advisory on BEIR VII White Paper</u>

a) Lead Reviewers

i) <u>Dr. Lauren Zeise</u>:

The report is very well written and succinctly addresses the charge questions. A few mostly minor issues that surfaced in my review of the report are discussed below. This is followed with some comments and suggestions that are editorial in nature.

Page 20, bottom; page 2, line 23 The statement that non-melanoma skin cancers should not be included in total mortality estimates because it is

inappropriate seems unnecessary. The low mortality of skin BCC means that it will not be a large contributor. The EPA's decision to leave out skin squamous cell carcinoma (SCC) is not explicitly addressed on page 20 by the RAC. It should be since this cancer is not without individual or social cost - Removal can cause significant cosmetic deformity and requires short term and continuing follow-up because of potential metastasis. A clear comment agreeing or disagreeing with the proposal to leave SCC out could be given.

Page 9, uncertainty discussion. The description of figure 10-1 in BEIR VII is a bit off. The figure shows the slope at high doses and then the slope in the low dose region explicitly stating that it is the tangent at zero, not the "progression of linear approximations" stated at line 24 in the RAC report.

Page 12, lines 37-41. "The RAC's approach to giving advice to the EPA is predicated on the basic premise that risk estimates are for use in assessing population risk, rather than risk to a specific individual." EPA in some risk and decision making contexts does consider subgroups at higher risk and it is unclear why this restriction is needed. The general response to charge question 2a regarding stationary populations would work if EPA decided to address a subgroup. EPA has recently adopted a policy for addressing potential increased cancer risk from exposure at young ages in its 2005 *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.* The RAC also states that there is little known about the degree or causes of variation in individual susceptibility. In contrast, the 1998 International Commission on Radiological Protection (ICRP) report *Genetic Susceptibility to Cancer* selected a single best estimate of a 10-fold increase in risk as "appropriate for the purposes of modelling radiological impact" after reviewing human and animal data.

Page 15, lines 1-12. The logic of model geometric averaging was not entirely clear. An alternative for the agency would be to use the plausible models to articulate model uncertainty and then given the uncertainty to select a default. It is also unclear how the averaging enables risk from chronic lifetime exposure if the component models do not (line 12).

Page 24, top. Supralinearity associated with dose fractionation is also seen in animal studies with alpha radiation and could be noted.

Page 2 and page 25. If the new review is going to cover important new data on radiogenic thyroid cancer this should be noted.

In the appendix discussion, the findings of the large collaborative Cardis et al. study showing increased cancer risk in occupational workers at exposures within an order of magnitude of natural background is worth

mentioning in the appendix. In this regard, the discussion called for on page 4 at line 20 perhaps might also take this into account.

Editorial Comments

Letter
The letter to the administrator is well written and is a good summary of the RAC report. However, it includes a lot of detail and could be shortened considerably.

Page 1 line 20 could delete “radiogenic” to remove redundancy
Page 2, line 16 bone is capitalized while other bullet headers aren’t

Page 3 line 29 LSS has not been defined in the letter

Report
Page 8, lines 7-9. Whether or not the factor 2 DDREF applied both to low and high LET radiation should be specified.
Page 8, lines 13-24. BEIR VII focused on low-LET radiation. This should be noted here to provide context for the discussion a little later in this section
Page 9, line 28. word “mandate” is awkward here
Page 22, line 25 would add “major” after “all” since that is an impossible task

b) Other SAB members

- **Dr. Rogene Henderson:**

  I found this to be an exceptionally fine report on an important topic. The Agency should benefit greatly from the review by RAC. All of the charge questions were answered in a clear, logical, and reasonable manner. The conclusions and recommendations were supported by the text. I found it especially worthwhile to include Appendix A, because of the current controversy and the influx of new information concerning the shape of the dose/response curve at low doses.

- **Dr. Granger Morgan:**

  Looks fine.

  - One page 3 start of line 28, there is an extra "in"
  - Page 4 lines 5-7 are unclear. Some editing would help.
  - Page 4 line 10 I'd drop the "In addition,"
  - Page 4 line 32 I'd prefer to drop "(qualitative)"

- **Dr. Rebecca Parkin:**

  Here are my responses re. the white paper reviewed by the RAC.

  Cf. SAB charge questions:

  - The committee has addressed the charge questions in a systematic and thoughtful manner.
  - The report is clear, logical and well-written.
  - The conclusions in the report are largely supported by information provided in the report. While the committee members likely know the literature very well, many readers will not. Therefore, this reviewer suggests that some uses of citations be clarified. For example, clarify in the report that Karagas et al (1999) on p. 3 was a study of New Hampshire cancer rates, and not the entire U.S. Without that specification, the reader is not aware that Karagas et al only speculated that their NH findings might apply elsewhere.

- **Dr. James Galloway**

  - The only comment I have on the 'advisory' is that the committee has done a fine job.

- **Dr. Michael McFarland:**

  In general, the Radiation Advisory Committee (Committee) provided a comprehensive and well written advisory draft report summarizing their evaluation of the Agency's intention of basing its future estimates of low dose radiogenic cancer risk on recommendations found in BEIR VII. The Committee's responses to the four (4) multipart Agency charge questions were clear, scientifically sound and logical. The report's conclusions and recommendations summarized in the letter to the administrator were strongly supported by the scientific findings described in the Executive Summary as well as in the body of the report.

  Although I have a limited knowledge of radiation terminology, in my opinion, it may have been difficult for the uninitiated reader to follow some of the report's discussion. To alleviate some of this difficulty, I would strongly recommend that all acronyms be spelled out fully when they are first used in the report. For example, the acronym BEIR (Biological Effects of Ionizing Radiation) should have been defined early in the report (in addition to Page 37 – List of Acronyms). Other critical terms whose

definitions were necessary for following the scientific discussion, e.g., Sv (Sievert), RBE (Relative Biological Effectiveness) etc. should have been defined earlier in the report as well.

In addition, it may have been helpful to readers if there had been some historical discussion of the fact that BEIR VII is a National Academy of Sciences (NAS) report on radiation risk (issued in July 2005). It may also have been helpful to acknowledge that the NAS BEIR series of reports are the most authoritative basis for radiation risk estimation and radiation protection regulations in the United States (according to the Institute for Energy and Environmental Research). Again, for the uninitiated reader, these facts may be important.

Finally, pending minor editorial revisions, I believe that the advisory report fully addresses the Agency charge questions and provides scientifically-defensible conclusions and recommendations. Given the report's exceptional quality, I strongly support its approval.

- **Dr. Valerie Thomas:**

The Draft Report does respond to the charge questions.

- The report is not clear in its discussions of low-dose risk estimation. It is evident that the Committee has discussed this issue at length and has put considerable thought to crafting its statements. However, by repeating three times – in the letter to the Administrator, the Executive Summary, and the body of the Report, the discussion that begins: "RAC had to consider the important distinction between the current state of scientific knowledge and the need for a practical, operational public health approach…", the report makes this a central focus. The implication of this discussion, and of the material in the appendix, is that the science used in BIER VII for low dose exposures is weak, but the SAB nevertheless endorses its continued use for a short period of time. The impression is that this was a borderline decision, that the RAC could just as well have decided to promote a different approach to low dose risk assessment. The report is equivocal. It seems that the science is not clear, and the report is correspondingly unclear This issue is important enough for the Committee to emphasize it multiple times, yet not important enough for the Committee to recommend that EPA change its approach. If this issue is not of central importance, it should not be emphasized so much; if it

is of central importance, then it is not clear why the Committee endorses EPA's continuing approach.

- The draft report repeatedly says, in effect, that the state of scientific knowledge can't or shouldn't be applied in a practical, operational approach to public health. These statements may cause continuing questions and difficulties in understanding what SAB is trying to say.
- There are also a number of minor respects in which the report is not clear. The Letter to the Administrator largely repeats material in the Executive Summary, but leaves out key information that makes the Letter to the Administrator harder to understand than the Executive Summary. For example, on p. 1, the paragraph with "… the important distinction between the current state of scientific knowledge and the need for a practical, operational public health approach…." is especially hard to understand because the paragraph that follows from the Executive Summary was not included in the Letter, so the basis for the distinction between "science" and "practicality" is especially hard to grasp. Also, on p. 2 line 18, the acronym RBE is used before it is defined. The Letter to the Administrator need not be a repetition of the Executive Summary. A short letter could be better and clearer.
- There are a number of places in the Introduction (p. 6) in which it appears that the Agency has written the text, not the RAC. The independence of RAC from the Agency is not clear. For example, p. 6 line 38, "ORIA was interested in vetting ideas…." It would be better to say that ORIA asked for a review. On p. 7, in that same paragraph, is the statement "RAC was not asked to provide policy direction, and therefore RAC did not consider the implications to EPA standards…." Putting these statements together into one paragraph implies that EPA asked RAC not to consider the implications to EPA standards. Again, on p. 9., lines 11-18, there is text that appears to have been written by the Agency, not by RAC, "At this point… the EPA is seeking advice from the Agency's Science Advisory Board….the Agency plans to implement changes in their methodology…" I assume this text was lifted from the original charge to the committee; this needs to be changed because it implies that EPA wrote parts of the report. Again, p. 9 lines 31-32, "The EPA does not propose to quantify the uncertainty pertaining to low-dose extrapolation, but it would provide a brief discussion of the issue." Again, this appears to have been lifted from communication from EPA to SAB, and shouldn't be included in the report to the EPA.
- The discussion of DDREF is most clear in the appendix (p. 33 lines 21-22); there it is stated that the DDREF corrects for the

decreased biological effectiveness of low dose and dose-rate exposures. This clarification could be moved up to the first time the DDREF is mentioned (in the current version, that is in the Letter to the Administrator). Currently the Letter to the Administrator simply defines the DDREF as a ratio of slopes; the reason for different slopes at different doses isn't mentioned.

- **Dr. Steven Roberts:**

  The RAC report is well written and clearly addresses the charge questions. The basis for conclusions and recommendations are reasonably clear. Other than correcting a few minor typographical errors, I have no suggestions for change.

- **Dr. Kathleen Segerson**

  It is clear from the committee's report that the committee carefully considered and responded to the charge questions. My only comment on this is that the letter to the Administrator seems unnecessarily detailed. The main message of the letter seems to be that the committee endorses EPA's proposed modifications. It does not appear to have identified any major concerns. It seems that this message could (and should) be conveyed in a shorter, less technical letter to the Administrator. The technical summary of the committee's findings that is currently in the letter would perhaps be more appropriate for the executive summary.

SAB Quality Review Draft Advisory dated July 18, 2007 for Charter SAB Quality Review – Do Not Cite or Quote. This review draft is a work in progress, does not reflect consensus advice or recommendations, has not been reviewed or approved by the Science Advisory Board's Charter Board, and does not represent EPA policy.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

- - - Quality Review Draft - - -

EPA-SAB-07-xxx

The Honorable Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Subject: Advisory on Agency Draft White Paper entitled *"Modifying EPA Radiation Risk Models Based on BEIR VII,"*

Dear Administrator Johnson:

The Radiation Advisory Committee (RAC) of the Science Advisory Board has completed its review of the Agency's draft white paper entitled *"Modifying EPA Radiation Risk Models Based on BEIR VII,"* dated August 1, 2006. In this white paper, the Agency's Office of Radiation and Indoor Air (ORIA) outlined proposed changes in the EPA's methodology for estimating radiogenic cancers from exposure to low levels of ionizing radiation. The EPA sought the RAC's advice on the application of BEIR VII's cancer risk estimates and on issues relating to the proposed modifications and expansions desirable or necessary for EPA's purposes.

In providing advice to the Agency, the RAC had to consider the important distinction between the current state of scientific knowledge and the need for a practical, operational public health approach to radiation protection and standards setting. The RAC endorses EPA's proposal to base its approach to low dose risk estimation as recommended by BEIR VII. Specifically, for purposes of establishing radiation protection policy, the RAC endorses the EPA's use of a Linear Non-Threshold (LNT) model combined with the Dose and Dose Rate Effectiveness Factor (DDREF) for estimating risks following low dose exposures. By low dose, the RAC follows BEIR VII's definition; that is, doses below 100 mSv (0.1Sv), in the context of low Linear Energy Transfer (LET) radiation. In endorsing the use of an LNT model for low dose risk estimation, the RAC wishes to emphasize that BEIR VII does not use a linear extrapolation of the risk derived from high doses to estimate the risk following low doses or low dose-rate exposures. The slope of the dose-response relationship at lower doses and dose rates is less than the slope in the high dose region. The ratio of slopes derived in the high and low dose regions is the DDREF. The RAC endorses the concept of using DDREF factors for estimating the risk in the low dose region.

The RAC agrees with the EPA that the BEIR VII methodologies using incidence models and data should be used wherever possible. The RAC accepts the EPA's use of BEIR VII methodologies for deriving risk estimates for cancers of the stomach, colon, liver, prostate, uterus, ovary, bladder, other solid cancers, and leukemia. The RAC did not find compelling evidence to suggest the use of the alternative lung cancer model discussed by EPA and recommends that the EPA use the BEIR VII methodologies for deriving risk estimates for radiogenic lung cancer risk.

There were several areas not addressed by BEIR VII, for which EPA requires a cancer risk estimate. They include:

- ***in utero*** - The RAC concludes that it would be reasonable for the EPA to use the referenced estimates of cancer risk from *in utero* exposure to external radiation sources, and the dose coefficients provided by the ICRP as a basis for developing its risk estimates for *in utero* radiation exposure from internally-deposited radionuclides.
- **Bone** - The EPA proposes to divide the bone cancer risk observed in humans exposed to alpha particles from ^{224}Ra by an RBE to estimate the bone cancer risk from ^{90}Sr. The RAC concurs with this practical, operational approach to radiation protection.
- **non-melanoma skin cancer (NMSC) -** The RAC supports EPA's proposed use of the 1991 International Commission on Radiological Protection (ICRP) model to estimate the incidence and mortality risks of radiogenic NMSC. The RAC concurs with EPA that because of the high baseline incidence rates and low mortality due to NMSC, it is inappropriate to include risk estimates for radiogenic NMSC in the estimate of the incidence and mortality risk for radiogenic cancer.
- **higher LET radiation**
    - **alpha particles -** The RAC is supportive of the use of a generally accepted Maximum Relative Biological Effectiveness (RBE_m) value, such as 20 which is currently being used. The RAC recommends using data specific to particular radionuclides where such human cancer risk data are available (e.g., lung, liver, bone, or bone marrow). For other organs and tissues, the RAC is supportive of the general approach of using the low-LET cancer risk from BEIR VII multiplied by RBE_M.
    - **lower energy photons -** The RAC concurs that an RBE in the range of 2 to 2.5 seems reasonable for low-energy photons and electrons for purposes of setting radiation protection standards
    - **beta particles** – The RAC concurs that an RBE in the range of 2 to 2.5 is reasonable for estimating the cancer risk from exposure to tritium.
- **additional uncertainty –**An additional source of uncertainty in risk estimates is associated with the mechanistic biophysical model that is used in BEIR VII to support the LNT model in the low dose region. In Appendix A, the RAC provides a brief review of current research and recommends that ORIA remain aware of the research continuously updating the biophysical model used to support the estimates of radiation risk following low dose radiation exposure.

The RAC finds that the EPA is warranted in modifying the BEIR VII methodologies in several specific areas where the EPA's particular application requires some adaptation of the

BEIR VII approach. The RAC agrees that the proposed estimation of radiogenic cancer risks for the U.S.A. population for a standard stationary population, that is a 'fixed cohort' based on death rates for the year 2000 is a reasonable adaptation of the BEIR VII approach. The RAC agrees that the EPA's proposed use of the most current cancer-specific incidence and mortality rates available is an appropriate and scientifically valid adaptation of the BEIR VII approach.

The RAC agrees with the EPA's proposed approach for projecting risk estimates from the Japanese A-bomb survivors to the U.S.A. population by combining the age-specific results from the Excess Absolute Risk (EAR) and Excess Relative Risk (ERR) models using the weighted geometric mean before calculating the lifetime attributable risk.

The RAC concurs with EPA's exploration of alternative methods for estimating the relative risk for radiogenic breast cancer. In particular, the RAC concurs with the EPA's proposal to relate current breast cancer mortality rates to retrospective incidence rates rather than current incidence rates to better reflect the influence of life style changes, earlier breast cancer detection and treatment that could influence survival and hence mortality rates over an extended period.

The RAC strongly endorses the EPA-ORIA's desire to estimate uncertainty bounds for its radiogenic cancer risk estimates. The uncertainty bound estimates should incorporate, to the extent possible, all sources of error and/or uncertainty, including the three main sources identified in BEIR VII. Other sources of error and/or uncertainty identified by the EPA-ORIA which should be considered include dosimetry, disease detection, disease classification, temporal patterns, and appropriate RBE values.

The RAC considered several additional complications that could influence uncertainty. One such complication arises in the extrapolation, to lower dose ranges, of radiation effects seen in at dose levels for which statistically significant increases in cancer mortality or incidence have been observed in the LSS and other epidemiological studies of exposed populations. At such lower dose ranges, risk estimates are based on an assumed LNT dose-response model and method of extrapolation from higher-dose/higher-response data. This extrapolation may result in the risk estimates associated with doses in the low-dose range having larger relative uncertainties than those in the higher dose range.

It is important to note that there is an opportunity to implicitly include (qualitative) uncertainties in the choice of risk model per se in the overall (quantitative) uncertainty analysis. That is, a major issue with the choice of the LNT model is whether it is appropriately applied at low doses. In the quantitative uncertainty analysis, this qualitative uncertainty in model choice can be included as a quantitative uncertainty in the DDREF value. The RAC thus strongly endorses the EPA-ORIA's intention to include uncertainty in DDREF in the overall uncertainty analysis.

BEIR VII specifically considered adaptive response, genomic instability, and bystander effects, and concluded that currently there is insufficient evidence to explicitly add these effects to the dose-response model. In the absence of compelling scientific evidence to do otherwise,

the RAC endorses the EPA-ORIA's plan to follow BEIR VII and use the LNT model for calculation of radiation risk.

When estimating radiation-induced cancer risks in any human population it is important to recognize that typically the baseline overall cancer incidence and mortality rates are high and variable, representing >40% and about 23% of the 15 leading causes of illness and deaths in the U.S.A. in 2003, respectively (CDC/NCHS National Vital Statistics System, 2003) Baseline cancer rates have been found to be influenced by various environmental factors such as chronic infections, life style, diet and human factors such as genetic background (WHO, Stewart and Kleihues 2003). In addition, the dose of interest to any "radiation exposed" population is in addition to a highly variable natural background radiation dose (lower limit lifespan dose 60 mSv) that changes as a function of elevation, geographical location and human activities. Depending on the study design, epidemiological studies typically match the "exposed" or "diseased" study population to a "non-exposed" or "non-diseased" comparison population with respect to the variables known to influence baseline cancer rates so as to statistically relate the effect of the exposure to the health outcome of interest as precisely as possible. At radiation exposures in the range of natural background, it is difficult to distinguish radiation-induced changes in risk from the baseline. Thus, as a cautionary note, the RAC recommends that the EPA discuss potential problems associated with the use of LNT dose response model risk estimates in very low dose settings. Currently at these low doses, statistically significant differences between the cancer rates among "exposed" (defined study populations) and "non-exposed" (defined comparison populations) are not observed. These near background doses are only a fraction of those that have been found to be associated with statistically significant differences in cancer frequency between "exposed" and "non-disposed" populations.

Uncertainties in risk estimates also change as a function of time into the future, being smallest in the near time frame. This is due to several factors, including changes in future (actual) populations (as opposed to a 'stationary population'), future background cancer incidence, and future medical advances (since the case fatality rate may decrease as a result of better treatment interventions in the future). Uncertainties thus become greater as the risk estimates are applied further into the future. The RAC recommends that EPA-ORIA include a (qualitative) discussion of these concepts in its final report.

The RAC considers it premature to offer any advice to ORIA on estimating the risk of radiogenic thyroid cancer. A major review of radiogenic thyroid cancer is being completed by the National Council on Radiation Protection and Measurements (NCRP). This information should be considered by ORIA as it will reflect more recent data that could improve the thyroid cancer risk estimates provided by BEIR VII.

In summary, the SAB finds that the draft dated August 1, 2006 and entitled *"Modifying EPA Radiation Risk Models Based on BEIR VII,"* is an important document to provide the basis for EPA's update of radiogenic cancer risk estimates. The RAC appreciates the opportunity to review this draft document and hopes that the recommendations contained herein will enable EPA to implement changes in the methodology for estimating radiogenic cancers and revise the "Blue Book". We look forward to your response to the recommendations contained in this Advisory.

Sincerely,

Dr. M. Granger Morgan	Dr. Jill Lipoti
Chair	Chair, Radiation Advisory Committee
Science Advisory Board	Science Advisory Board

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1. EXECUTIVE SUMMARY

The Radiation Advisory Committee (RAC) of the Science Advisory Board (SAB) has completed its review of the Agency's draft white paper entitled *"Modifying EPA Radiation Risk Models Based on BEIR VII,"* dated August 1, 2006 (U.S. EPA. ORIA. 2006a). In this white paper, the Agency's Office of Radiation and Indoor Air (ORIA) outlined proposed changes in the EPA's methodology for estimating radiogenic cancers. The EPA sought the RAC's advice on the application of BEIR VII's (U.S. NAS/NRC 2006) cancer risk estimates and on issues relating to proposed modifications and expansions desirable or necessary for EPA's purposes.

In providing advice to the Agency, the RAC had to consider the important distinction between the current state of scientific knowledge and the need for a practical, operational public health approach to radiation protection and standards setting. The RAC endorses EPA's proposal to base its approach to low dose risk estimation on BEIR VII. Specifically, for the purposes of establishing radiation protection policy, the RAC endorses the EPA's use of a Linear Non-Threshold (LNT) model combined with the Dose and Dose Rate Effectivenesss Factor (DDREF) for estimating cancer risks following low dose exposures. By low dose, the RAC follows BEIR VII's definition; that is, doses below 100 mSv (0.1Sv), in the context of low Linear Energy Transfer (LET) radiation. In endorsing the use of an LNT model for low dose risk estimation, the RAC wishes to emphasize that BEIR VII does not use a linear extrapolation of the risk derived from high doses to estimate the risk following low dose or low dose-rate exposures. The slope of the dose response relationship at lower doses and dose rates is less than the slope in the high dose region. The ratio of slopes derived in the high and low dose regions is the DDREF. The RAC endorses the concept of using DDREF factors for estimating the risk in the low dose region.

With respect to recent advances in the scientific knowledge of radiation biology and carcinogenesis, the RAC wishes to emphasize that considerable uncertainties remain in the risk estimates for radiation-induced cancers, especially at low doses and low dose rates. The epidemiological data below 100 mSv are not sufficient by themselves for risk estimation and considerable cellular and animal data suggest complexities beyond the application of a simplified deoxyribonucleic acid (DNA) damage model which historically has been used as support for an LNT dose-response model. The RAC also emphasizes the additional complexities introduced with varying Relative Biological Effectiveness (RBE) and dose-rate. Thus, while the RAC endorses EPA's use of the LNT model, the Agency is advised to continue to monitor the science of the biological mechanisms underlying cancer induction at low doses of ionizing radiation and of their influence on the biophysical models used to estimate the cancer risk in this dose range. Additional discussion of the biophysical models of radiation effects in the low-dose region is in Appendix A.

The RAC agrees with the EPA that the BEIR VII methodologies using incidence models and data should be used wherever possible. The RAC accepts the EPA's use of BEIR VII methodologies for deriving risk estimates for cancers of the stomach, colon, liver, prostate, uterus, ovary, bladder, other solid cancers, and leukemia. The RAC did not find compelling evidence to suggest the use of the alternative lung cancer model discussed by EPA and

recommends that the EPA use the BEIR VII methodologies for deriving risk estimates for radiogenic lung cancer risk. However, the RAC finds that the EPA is warranted in modifying the BEIR VII methodologies in several specific areas as discussed below.

The RAC agrees that the proposed estimation of radiogenic cancer risks for the U.S.A. stationary population, that is a "fixed cohort", based on death rates for the year 2000 is a reasonable adaptation of the BEIR VII approach. It is consistent with the EPA's established approach to cancer risk estimation from exposures to chemicals.

The RAC agrees that the EPA's proposed use of the most current cancer-specific incidence and mortality rates available is an appropriate and scientifically valid adaptation of the BEIR VII approach.

The RAC agrees with the EPA's proposed approach for projecting risk estimates from the Japanese A-bomb survivors to the U.S.A. population by combining the age-specific results from the Excess Absolute Risk (EAR) and Excess Relative Risk (ERR) models using the weighted geometric mean before calculating the lifetime attributable risk. This approach is a modification of that used in BEIR VII, but it has the advantage of allowing the estimates of risk from multiple exposures to be integrated, enabling the risk from chronic lifetime exposure to be calculated. Additionally, this method was previously used by the EPA in FGR-13.

The RAC concurs with EPA's exploration of alternative methods for estimating the relative risk for radiogenic breast cancer. In particular, the RAC concurs with the EPA's proposal to relate current breast cancer mortality rates to retrospective incidence rates rather than current incidence rates to better reflect the influence of life style changes, earlier breast cancer detection and treatment that could influence survival and hence mortality rates over an extended period.

The RAC understands that EPA requires a rationale to estimate risks from exposures to higher LET radiation, especially alpha particles, lower energy photons and beta particles, but this subject was beyond the scope of BEIR VII. For alpha particles, the RAC is supportive of the use of a generally accepted Maximum Relative Biological Effectiveness (RBE_M) value, such as 20 which is currently being used. For those radionuclides for which human cancer risk data are available (lung, liver, bone, or bone marrow), the RAC recommends that this information be used directly whenever possible. For other organs and tissues, the RAC is supportive of the general approach of using the low-LET cancer risk from BEIR VII multiplied by RBE_M.

For low-energy photons and electrons, the EPA white paper suggests that the RBE for medical x-rays is about 2 to 2.5. X-rays are not uniquely different from gamma rays with respect to their biological effects, so the RAC recommends that any risk estimate association with exposure to photons should be correlated with energy rather than the method of production. The RAC concurs that an RBE factor in the range of 2 to 2.5 is reasonable for low-energy photons and electrons for purposes of setting radiation protection standards. The RAC concurs that an RBE factor in the range of 2 to 2.5 is reasonable for tritium.

The RAC recognizes that although the BEIR VII committee chose not to provide risk estimates for non-melanoma skin cancer (NMSC) induced by ionizing radiation, EPA has an operational need for such estimates. The RAC supports EPA's proposed use of the 1991 International Commission on Radiological Protection (ICRP) model to estimate the incidence and mortality risks of radiogenic NMSC taking into account more recent findings that most of the NMSCs attributable to low to moderate doses of low-LET ionizing radiation are of the basal cell carcinoma (BCC) type (Shore 2001), and that the incidence rates of BCC have been increasing substantially in recent decades among the general population (Karagas et al. 1999). However, the RAC concurs with EPA that because of the high baseline incidence rates and low mortality due to NMSC, it is inappropriate to include risk estimates for radiogenic NMSC in the estimate of the incidence or mortality risk for radiogenic cancer.

The risk of bone cancer from low-LET radiation is not specified in the BEIR VII report but such information is required to consider the cancer risk from a bone-seeking beta-emitting radionuclide such as ^{90}Sr. The EPA proposes to divide the bone cancer risk observed in humans exposed to alpha particles from ^{224}Ra by an RBE to estimate the bone cancer risk from ^{90}Sr. The RAC concurs with this practical, operational approach to radiation protection.

BEIR VII does not provide risk estimates for *in utero* exposure to radiation, but the EPA requires an estimate for its guidance documents. The RAC concludes that it would be reasonable for the EPA to use the referenced estimates of cancer risk from *in utero* exposure to external radiation sources, and the dose coefficients provided by the ICRP as a basis for developing its risk estimates for *in utero* radiation exposure from internally-deposited radionuclides.

The RAC considers that it is premature for RAC to offer any advice to ORIA on estimating the risk of radiogenic thyroid cancer. A major review of radiogenic thyroid cancer is being completed by the National Council on Radiation Protection and Measurements (NCRP). This information should be considered by ORIA as it will reflect more recent or more relevant data that could improve the thyroid cancer risk estimates provided by BEIR VII.

The RAC strongly endorses the EPA-ORIA's desire to estimate uncertainty bounds for its radiogenic cancer risk estimates. The uncertainty bound estimates should incorporate, to the extent possible, all sources of error and/or uncertainty, including the three main sources identified in BEIR VII (sampling variability in the Life Span Study (LSS) data, transport of risk from LSS to the U.S.A. population, and the appropriate value for DDREF at both high and low doses of low-LET radiation). Other sources of error and/or uncertainty identified by the EPA-ORIA which should be considered include dosimetry, disease detection, disease classification, temporal patterns, and appropriate RBE values.

The RAC considered several additional complications that could influence uncertainty. One such complication arises in the extrapolation, to lower dose ranges, of radiation effects seen in at dose levels for which statistically significant increases in cancer mortality or incidence have been observed in the LSS and other epidemiological studies of exposed populations. At such lower dose ranges, risk estimates are based on an assumed LNT dose-response model and method of extrapolation from higher-dose/higher-response data. This extrapolation may result in

the risk estimates associated with doses in the low-dose range having larger relative uncertainties than those in the higher dose range.

BEIR VII specifically considered adaptive response, genomic instability, and bystander effects, and concluded that currently there is insufficient evidence to explicitly add these effects to the dose-response model. The EPA-ORIA proposes at the present time to follow BEIR VII and use the LNT model combined with a DDREF for calculation of radiation risk. In the absence of compelling scientific evidence to do otherwise, the RAC endorses the EPA-ORIA's plan in this regard.

When estimating radiation-induced cancer risks in any human population it is important to recognize that typically the baseline overall cancer incidence and mortality rates are high and variable, representing >40% and about 23% of the 15 leading causes of illness and deaths in the U.S.A. in 2003, respectively (CDC/NCHS National Vital Statistics System, 2003) Baseline cancer rates have been found to be influenced by various environmental factors such as chronic infections, life style, diet and human factors such as genetic background (WHO, Stewart and Kleihues 2003). In addition, the dose of interest to any "radiation exposed" population is in addition to a highly variable natural background radiation dose (lower limit lifespan dose 60 mSv) that changes as a function of elevation, geographical location and human activities. Depending on the study design, epidemiological studies typically match the "exposed" or "diseased" study population to a "non-exposed" or "non-diseased" comparison population with respect to the variables known to influence baseline cancer rates so as to statistically relate the effect of the exposure to the health outcome of interest as precisely as possible. At radiation exposures in the range of natural background, it is difficult to distinguish radiation-induced changes in risk from the baseline. Thus, as a cautionary note, the RAC recommends that the EPA discuss potential problems associated with the use of LNT dose response model risk estimates in very low dose settings. Currently at these low doses, statistically significant differences between the cancer rates among "exposed" (defined study populations) and "non-exposed" (defined comparison populations) are not observed. These near background doses are only a fraction of those that have been found to be associated with statistically significant differences in cancer frequency between "exposed" and "non-disposed" populations.

It is important to note that there is indeed opportunity to include uncertainties in the model – that is, uncertainties in high-dose versus low dose behavior – in the overall uncertainty analysis. In BEIR VII and the EPA-ORIA's proposed approach to uncertainty estimation, this "additional" uncertainty is contained within the uncertainty in the value for DDREF, since DDREF is only invoked at lower doses. The RAC thus strongly endorses the EPA-ORIA's intention to include uncertainty in DDREF in the overall uncertainty analysis.

Uncertainties in risk estimates also change as a function of time into the future, being smallest in the near time frame. This is due to several factors, including changes in future (actual) populations (as opposed to a 'stationary population'), future background cancer incidence, and future medical advances (since the case fatality rate may decrease as a result of better treatment interventions in the future). Uncertainties thus become greater as the risk estimates are applied further into the future. The RAC recommends that EPA-ORIA include a qualitative discussion of these concepts in its final report.

An additional source of uncertainty in risk estimates is associated with the mechanistic biophysical model that is used in BEIR VII to support the LNT model in the low dose region. In Appendix A, the RAC provides a brief review of current research and recommends that ORIA remain aware of the research continuously updating the biophysical model used to support the estimates of radiation risk following low dose radiation exposure.

These recent advances provide a scientific basis for the observed non-linear dose-response relationships seen in many biological systems (BEIR VII, Ko et al. 2006, Mitchel et al. 2004). They suggest that the mechanism of action of radiation-induced damage is different following exposure to high doses than it is after low radiation doses. It becomes important to consider new paradigms associated with the biological responses to low doses of radiation and to modify and further develop the models used to support the extrapolation of dose-response relationships into dose regions where it is not possible to measure changes in radiation-induced cancer incidence/mortality in human populations.

2. INTRODUCTION

2.1 Background

In 1994, the EPA published a report, referred to as the "Blue Book," which lays out the EPA's methodology for quantitatively estimating radiogenic cancer risks (U.S. EPA. 1994) http://epa.gov/radiation/docs/assessment/402-r-93-076.pdf. A follow-on report made minor adjustments to the previous estimates and presented a partial analysis of the uncertainties in the numerical estimates (U.S. EPA. 1999a) http://epa.gov/radiation/docs/assessment/402-r-99-003.pdf . Finally, the Agency published Federal Guidance Report 13 (U.S. EPA. 1999) http://epa.gov/radiation/docs/federal/402-r-99-001.pdf which utilized the previously published cancer risk models, in conjunction with International Commission on Radiological Protection (ICRP) dosimetric models and the U.S.A. usage patterns, to obtain cancer risk estimates for over 800 radionuclides, and for several exposure pathways. These were later updated (U.S. EPA. 1999b) http://epa.gov/radiation/federal/techdocs.htm#report13.

The National Research Council (NAS/NRC) recently released *Health Risks from Exposure to Low levels of Ionizing Radiation BEIR VII Phase 2* which primarily addresses cancer and genetic risks from low doses of low-LET radiation (BEIR VII) (U.S. NAS/NRC. 2006) http://newton.nap.edu/catalog/11340.html#toc). In the EPA draft *White Paper: Modifying EPA Radiation Risk Models Based on BEIR VII,* the Agency proposes changes to the EPA's methodology for estimating radiogenic cancers, based on the contents of BEIR VII (U.S. EPA. 2006a). The Agency expects to adopt the models and methodology recommended in BEIR VII, but believes that certain modifications and expansions are desirable or necessary for the EPA's purposes. EPA's ORIA requested the SAB to review the Agency's draft White Paper and provide advice regarding the proposed approach to dose-response assessment of radionuclides.

2.2 Review Process and Acknowledgement

In response to ORIA's request, the SAB Radiation Advisory Committee (RAC) was initially briefed on the draft White Paper topic at its public planning meeting of December 21, 2005 which was held at the National Air and Environmental Radiation Laboratory (NAERL) in Montgomery, Alabama (see 70 Fed. Reg. 69550, November 16, 2005). ORIA issued its external draft White Paper entitled *"Modifying EPA Radiation Risk Models Based on BEIR VII,"* on August 1, 2006 (U.S. EPA. 2006a). The charge questions to the SAB were formally submitted on August 31, 2006 (U.S. EPA. 2006b).

There are various levels of reviews which EPA can request from the SAB. These include reviews, advisories, and commentaries. The request from EPA-ORIA was for an "advisory" review of the draft White Paper. ORIA was interested in vetting ideas with a group of scientific experts on how to incorporate the changes in cancer risk models described by BEIR VII and to extend the BEIR VII models to areas not specifically addressed by the BEIR VII committee. ORIA described it as a "mid-course correction" which would allow the RAC to provide advice

on a series of questions which would guide the Agency in incorporating the latest scientific thinking into their risk estimates. The RAC was not asked to provide policy direction, therefore the RAC did not consider the implications to EPA standards which may be an outcome of the changes to the risk estimates.

The SAB RAC met in a public teleconference meeting on September 6, 2006 and conducted a face-to-face public meeting on September 26, 27 and 28, 2006 for this advisory (see 71 Fed. Reg. 45545, August 9, 2006). Additional public conference calls took place on November 28, 2006, December 18, 2006, and March 9, 2007 (see 71 Fed. Reg., 62590, October 26, 2006. These notices, the charge to the RAC and other supplemental information may be found at the SAB's Web site (http://www.sab.gov/sab). The quality review draft advisory dated July 18, 2007 was forwarded to the Chartered SAB on (insert date). This advisory reflects the suggested editorial changes from the Charter Board (see 72 Fed. Reg _____, dated and add new reference to **FR** for Charter Board's quality review to references cited section).

The document *"Modifying EPA Radiation Risk Models Based on BEIR VII,"* August 1, 2006 was well written and provided much needed background. Similarly, with the BEIR VII report, presentations by the ORIA staff and other information provided to the RAC in the course of the public meetings were found to be helpful. During the meetings, the ORIA staff worked diligently to augment their draft *White Paper* with additional pieces of information that the RAC felt were necessary to assist with the advisory. The staff took care to honor all the RAC's requests and demonstrated their patience.

2.3 Current EPA Cancer Risk Models

For most cancer sites, radiation risk models are derived primarily from epidemiologic data from the Life Span Study (LSS) of the atomic bomb survivors. The EPA's models for esophageal, stomach, colon, lung, ovarian, bladder and "residual" cancers and leukemia were adapted from the models published by Land and Sinclair based on a fit to the linear non-threshold (LNT) fit to the LSS data (Land and Sinclair. 1991).

For each solid tumor site, gender, and age-at-exposure interval, there is a model providing a coefficient for the excess relative risk (ERR) per gray (Gy) for cancer mortality, which is assumed to be constant beginning at the end of a minimum latency period until the end of life. Land and Sinclair present two sets of models known as the "multiplicative" and the "National Institutes of Health (NIH)" models that differ in how one "transports" risk from the Japanese LSS population to the United States population. In the multiplicative model, it is assumed that the ERR/Gy is the same in all populations, whereas, in the NIH model, it is assumed that the excess absolute risk (EAR) is the same in different populations for the limited period of epidemiological follow-up. Given the scarcity of information on how radiogenic cancer risk varies between populations having differing baseline cancer rates, the EPA previously adopted an intermediate geometric mean coefficient "GMC" model for each site, where the risk coefficients were taken to be the weighted geometric mean of the corresponding ERR and EAR coefficients for both the multiplicative and the NIH models (U.S. EPA. 1994).

For leukemia, the treatment of the temporal response in the models was more complex, but the approach for transporting risk to the U.S.A. population was analogous. Following the approach of Land and Sinclair, the EPA also developed a GMC model for kidney cancer from the LSS data. The EPA's models for other site- or type-specific cancers, including breast, liver, thyroid, bone, and skin were based on various authoritative reports (NCRP 1980; NRC 1988; ICRP. 1991a, b; Gilbert. 1991.). Based primarily on ICRP recommendations at that time (ICRP 1991a), for low doses and dose rates, each coefficient was reduced by a factor of two, dose and dose-rate effectiveness factor (DDREF), from that which would be obtained from a LNT fit to the LSS data.

2.4 BEIR VII Models

BEIR VII cancer site-specific models derived from the LSS differ from those of Land and Sinclair in several notable ways: (1) they are derived primarily from cancer incidence rather than cancer mortality data; (2) mathematical fitting is performed to better reflect the functional dependence of solid cancer risk on age at exposure and attained age, (i.e., age at diagnosis of a cancer or age at death due to cancer depending on the end-point of interest); (3) a weighted average of risk projection models is used to transport risk from the LSS to the U.S.A. population; (4) a value for the DDREF of 1.5 is estimated from the LSS and laboratory data; (5) quantitative uncertainty bounds are provided for the site-specific risk estimates in BEIR VII.

For breast cancer and thyroid cancer, BEIR VII risk models are based on pooled analyses of data from the LSS cohort, together with data from epidemiologic studies of medically irradiated cohorts (Preston et al. 2002; Ron et al. 1995).

2.5 EPA's Proposed Adjustments and Extensions to BEIR VII Models

In the draft *White Paper: Modifying EPA Radiation Risk Models Based on BEIR VII* (U.S. EPA. ORIA .2006a.), the Agency's ORIA outlined proposed changes in the EPA's methodology for estimating radiogenic cancers, based on the contents of BEIR VII and some ancillary information. For the most part, the Agency expects to adopt the models and methodology recommended in BEIR VII; however, the Agency believes that certain modifications and expansions are desirable or necessary for the EPA's purposes. The objective of BEIR VII was to derive/update cancer risk estimates for radiation exposures of 100 mSv or less, primarily from external photon radiation based on the most current valid epidemiological and experimental data available. In order to satisfy EPA's broader mission, the EPA needs to have a basis for estimation of cancer risks outside BEIR VII's scope.

One significant extension to be considered is the estimation of cancer risks from exposures to higher Linear Energy Transfer (LET) radiations, especially to alpha particles, and also to lower energy photons and beta particles. An important expansion proposed by EPA to be considered is the estimation of risks from exposures to alpha particles, and also to alpha emitters deposited in the lung and the bone. BEIR VII does not present any risk estimates for radiogenic bone cancer. The EPA proposes to estimate bone cancer risk from data on radium injected patients and to multiply that risk by a quality factor to estimate the risk from internally deposited beta-gamma emitting radioactive materials.

BEIR VII does not provide quantitative estimates of risk for skin cancer. It does not fully address prenatal exposures. BEIR VII presents a model for estimating the risk of the radiogenic thyroid cancer incidence, but not of mortality due to radiogenic thyroid cancer.

The EPA proposes to use somewhat different population statistics from BEIR VII. Consideration is given to an alternative model for estimating radiogenic lung cancer. For breast cancer, the EPA proposes an alternative method for estimating mortality, which takes into account changes in incidence rates and survival rates over time.

At this point in its activity on this topic, the EPA is seeking advice from the Agency's Science Advisory Board's (SAB) Radiation Advisory Committee (RAC) on the application of BEIR VII's cancer risk estimates and on issues relating to these modifications and expansions. After receiving the advisory review, the Agency plans to implement changes in their methodology through the publication of a revised Blue Book, which it would expect to submit to the SAB's RAC or a specialty panel supplementing the RAC for final review. The revised Blue Book could then serve as a basis for an updated version of FGR-13.

<u>Uncertainty Estimates</u>

BEIR VII provides quantitative uncertainty bounds for each of its risk coefficients, however, no uncertainty was assigned to the form of the dose-response relationship. It was implicitly assumed that the dose-response relationship followed the hypothetical dose-response curve depicted in its Figure 10-1. This shows a progression of linear approximations, with different slopes within different dose ranges. The relationship between these different slopes provides the definition of the DDREF. This progression allowed the BEIR VII Committee to place uncertainty on bounds of the DDREF. Mechanisms pertaining to the biological effects of low-level ionizing radiation are being investigated. This could eventually mandate a different dose-response model, potentially resulting in changes in estimates of risk at low doses. Assigning probabilities to alternative models would be highly subjective at this time. The EPA does not propose to quantify the uncertainty pertaining to low-dose extrapolation, but it would provide a brief discussion of the issue.

2.6 EPA Charge to the Committee

1) BEIR VII provides incidence models for many cancer sites as a basis for calculating the risk from low-dose, low-LET radiation. Please comment on EPA's application of this overall approach as described in the draft White Paper.

2) In addition to the overall approach described in BEIR VII, the draft White Paper presents specific modifications and extensions. Please comment on the soundness of the following proposals:

a. Calculation of the risk to the life table (stationary) population instead of the actual U.S. population (see Sections II.A.-C.); this is consistent with our current approach.

b. Use of more recent incidence and mortality data from SEER and/or other sources (see Section II.D.); BEIR VII used a previous version of SEER data for the years 1995-1999.

c. Method for combining BEIR VII's models for projecting risk from Japanese A-bomb survivors to U.S. population (see Section II.E.). In contrast to BEIR VII, we propose to combine the two risk models before integration to calculate the lifetime attributable risk.

d. Adoption of an alternative model for radiogenic lung cancer risk which may better account for the effects of smoking than the BEIR VII approach (see Section II.G.).

e. Method for calculating breast cancer mortality risk, accounting for the relatively long time from detection until death (see Section II.H.).

f. Proposed approaches for extending risk estimates to radiations of different LET's - in particular, deriving site-specific risk estimates for alpha or x radiations based on models derived from the A-bomb survivors, who were primarily exposed to gamma rays (see Section III).

g. Estimation of risks for sites not specified in BEIR VII, specifically bone and skin, for which we propose to update our current approaches (see Sections III.A. and V, respectively).

h. Estimation of risk due to prenatal exposure. EPA's current lifetime risk estimates do not include risk from prenatal exposure, and BEIR VII does not provide them. The draft White Paper uses ICRP recommendations to project its risks of childhood cancers induced by in utero exposure. Please comment on the soundness of the approach described in the draft White Paper to apply ICRP as described in Section IV.

3) BEIR VII provides quantitative uncertainty bounds for each of its risk coefficients. EPA proposes to adopt this methodology with some additional discussion of the uncertainties not quantified in BEIR VII. Please comment on the adequacy of this approach (see Section II.K.).

4) In Section VI, the draft White Paper discusses some issues relating to radiogenic thyroid cancer. Does the RAC have any specific suggestions for dealing with this risk; e.g., does the RAC have any advice on gender specificity, effectiveness of iodine -131 compared to gamma rays, or estimation of thyroid cancer mortality?

3. RAC's PHILOSOPHY OF APPROACH FOR RESPONSE TO THE CHARGE

In providing advice in response to the Agencys's specific request, the RAC had to consider the important distinction between the current state of scientific knowledge and the need for a practical, operational public health approach to radiation protection and standards setting. In this Advisory, the RAC wishes to comment on both issues.

For the purposes of providing estimates of the risks of radiation-induced cancers as a basis for setting radiation protection standards, the RAC endorses EPA's proposal to base its approach to low dose risk estimation on BEIR VII. Specifically, for purposes of establishing radiation protection policy, the RAC endorses the use of an LNT model combined with the DDREF for estimating risks following low dose exposures. By "low dose," the RAC follows BEIR VII's definition; that is, doses below 100 mSv (0.1 Sv), in the context of low-LET radiation. In endorsing the use of an LNT model for low dose risk estimation, the RAC wishes to emphasize that BEIR VII does not use a linear extrapolation of the risk derived from high doses to estimate the risk following low doses or low dose-rate exposures. The slope of the dose-response relationship at lower doses and dose rates is less than the slope in the high dose region. The ratio of slopes derived in the high and low dose regions is the DDREF. The RAC endorses the concept of using DDREF factors for estimating the risk in the low dose region.

With respect to recent advances in the scientific knowledge of radiation biology and carcinogenesis, the RAC wishes to emphasize that considerable uncertainties remain in the risk estimates for radiation-induced cancers, especially at low doses and low dose rates. As BEIR VII acknowledges, the epidemiological data below 100 mSv (0.1 Sv) are not sufficient by themselves for risk estimation, and considerable cellular and animal data suggest complexities beyond the application of a simplified DNA damage model which historically has been used as support for an LNT dose-response model. The RAC also wishes to emphasize the additional complexities introduced with varying RBE and dose rate. Thus, while the RAC endorses EPA's use of the LNT model, the Agency is advised to continue to monitor the science of the biological mechanisms underlying cancer induction at low doses of ionizing radiation and of their influence on the biophysical models used to estimate the cancer risk in this dose range. Additional discussion of the biophysical models of radiation effects in the low-dose region is in Appendix A.

4. RESPONSE TO CHARGE QUESTION 1: APPLICATION OF THE OVERALL APPROACH AS DESCRIBED IN THE DRAFT WHITE PAPER

Charge Question 1: *BEIR VII provides incidence models for many cancer sites as a basis for calculating the risk from low-dose, low-LET radiation. Please comment on EPA's application of this overall approach as described in the draft White Paper.*

The Radiation Advisory Committee (RAC) agrees with the EPA that the BEIR VII methodologies using incidence models and data should be used wherever possible. The RAC accepts the EPA's use of BEIR VII methodologies for deriving risk estimates for cancers of the stomach, colon, liver, prostate, uterus, ovary, bladder, and other solid tumors. Furthermore, if one of the four following conditions applies, then the RAC agrees that the EPA is warranted in modifying the BEIR VII methodologies. The four possible conditions are:

1) Information and data are needed about subject matter not addressed in BEIR VII;
2) More recent or more relevant data exist which could improve or otherwise influence the risk estimates;
3) Compelling evidence suggests the use of a more appropriate scientific method; or
4) The EPA's implementation requirements for practicality or applicability necessitate an adaptation or other alternative to BEIR VII methodologies.

The RAC grouped all of the charge issues according to these conditions. For example, under condition one, the RAC considered prenatal exposures, bone and skin cancers, x- and alpha-particle radiations and tritium as areas not addressed by BEIR VII, and for which the EPA has a need to derive a basis for risk estimates. An example of applying condition two is that the use of the most recent Surveillance, Epidemiology, and End Results (SEER) data would improve the risk estimate. Examples of condition three are issues where a more appropriate scientific method was considered, i.e. in development of breast cancer risk estimates and the estimation of uncertainty. An example of condition four is the use of a stationary or a standard population to remove the variability in risk estimates associated with differences in cancer rates in age and race distributions across locations and calendar years in the U.S.A. population.

The RAC concludes that the EPA's use of the gray (Gy) as the unit of radiation absorbed dose is appropriate and agrees that modifying factors should be applied to the risk rather than dose.

The RAC's approach to giving advice to the EPA is predicated on the basic premise that the risk estimates are for use in assessing population risk, rather than risk to a specific individual. This is because specific individuals may be more or less susceptible to radiation-induced cancer than the average for the population. Furthermore, at present there is little known about either the degree of or the causes of variation in individual susceptibility to the effects of radiation.

5. RESPONSE TO CHARGE QUESTION 2: WHITE PAPER MODIFICATIONS AND EXTENSIONS

5.1 Charge Question # 2

In addition to the overall approach described in BEIR VII, the draft White Paper presents specific modifications and extensions. Please comment on the soundness of the following proposals:

a. *Calculation of the risk to the life table (stationary) population instead of the actual U.S. population (see Sections II.A.-C.); this is consistent with our current approach.*

b. *Use of more recent incidence and mortality data from SEER and/or other sources (see Section II.D.); BEIR VII used a previous version of SEER data for the years 1995-1999.*

c. *Method for combining BEIR VII's models for projecting risk from Japanese A-bomb survivors to U.S. population (see Section II.E.). In contrast to BEIR VII, we propose to combine the two risk models before integration to calculate the lifetime attributable risk.*

d. *Adoption of an alternative model for radiogenic lung cancer risk which may better account for the effects of smoking than the BEIR VII approach (see Section II.G.).*

e. *Method for calculating breast cancer mortality risk, accounting for the relatively long time from detection until death (see Section II.H.).*

f. *Proposed approaches for extending risk estimates to radiations of different LET's - in particular, deriving site-specific risk estimates for alpha or x radiations based on models derived from the A-bomb survivors, who were primarily exposed to gamma rays (see Section III).*

g. *Estimation of risks for sites not specified in BEIR VII, specifically bone and skin, for which we propose to update our current approaches (see Sections III.A. and V, respectively).*

h. *Estimation of risk due to prenatal exposure. EPA's current lifetime risk estimates do not include risk from prenatal exposure, and BEIR VII does not provide them. The draft White Paper uses ICRP recommendations to project its risks of childhood cancers induced by in utero exposure. Please comment on the soundness of the approach described in the draft White Paper to apply ICRP as described in Section IV.*

5.2 Response to Charge Question # 2a

Calculation of the risk to the life table (stationary) population instead of the actual U.S. population (see Sections II.A.-C.); this is consistent with our current approach.

The RAC agrees that the proposed estimation of radiogenic cancer risks for the U.S.A. population using a standard stationary population based on the year 2000 death rate, or fixed cohort is a reasonable adaptation of the BEIR VII approach. Specifically, the use of a stationary population produces risk estimates standardized to a population with fixed age and race distributions. This approach removes the variability in risk estimates associated with differences in cancer rates in age and race distributions across locations and calendar years in the U.S.A. population. This approach is also consistent with the EPA's established approach to cancer risk estimation from exposures to chemicals (U.S. EPA. 2005a, U.S. EPA. 2005b, Also **FR** Vol 70, No. 66, pp 17765, April 7, 2005)

5.3 Response to Charge Question #2b

Use of more recent incidence and mortality data from SEER and/or other sources (see Section II.D.); BEIR VII used a previous version of SEER data for the years 1995-1999.

The RAC agrees that the EPA's proposed use of the most current cancer-specific incidence and mortality rates available is an appropriate and scientifically valid adaptation of the BEIR VII approach.

It is anticipated that incidence or mortality data for the years 1998-2002 will be available for the final calculations of radiogenic cancer incidence risk estimates from NCI's SEER program. In contrast, only data from this program for 1995-1999 were available to BEIR VII.

Although other potential sources of valid, nationally representative data will be considered by the EPA, the RAC considers that the most current SEER data are adequate and preferred for consistency with the BEIR VII approach. The EPA may want to consider the latest vital statistics report produced from the 2000 census for mortality rates if they become available before the final report is produced.

5.4 Response to Charge Question #2c

Method for combining BEIR VII's models for projecting risk from Japanese A-bomb survivors to U.S. population (see Section II.E.). In contrast to BEIR VII, we propose to combine the two risk models before integration to calculate the lifetime attributable risk.

The RAC notes that there is considerable uncertainty in the application of risk estimates developed from the Japanese atomic bomb survivors to the U.S.A. population. This uncertainty results from different genetic and lifestyle characteristics of the two populations and differences in the baseline cancer risks. The RAC agrees with the EPA's proposed approach for projecting risk estimates from the Japanese A-bomb survivors to the U.S.A. population by combining the age-specific results from the Excess Absolute Risk (EAR) and Excess Relative Risk (ERR) models using the weighted geometric mean before calculating the lifetime attributable risk. This approach is a modification of that used in BEIR VII but is consistent with the method used previously by the EPA in FGR-13. The RAC notes that the EPA method has the advantage of allowing the risk results from multiple exposures to be integrated, thereby enabling the risk from chronic lifetime exposure to be calculated.

5.5 Response to Charge Question #2d

Adoption of an alternative model for radiogenic lung cancer risk which may better account for the effects of smoking than the BEIR VII approach (see Section II.G.).

The RAC recommends that the EPA use the BEIR VII methodologies for deriving risk estimates for radiogenic lung cancer risk. The RAC does not find compelling evidence to suggest the use of the alternative model discussed by EPA.

The lung cancer risk estimates reported by BEIR VII are primarily based on analyses of the LSS data. These estimates were not adjusted for cigarette smoking which is potentially an important confounder and/or effect modifier. This problem of lack of adjustment for cigarette smoking is further compounded by the fact that lung cancer incidence rates are lower in Japan than the U.S.A. and the lung cancer incidence rate ratio of males to females is considerably higher in Japan than in the U.SA. The BEIR VII Committee was aware of this problem and chose to deal with it by using a risk transport model that more heavily weighted the EAR estimates relative to ERR estimates, i.e. assigning the weight of 0.7 for EAR and 0.3 for ERR. The BEIR VII Committee justified this approach based on mechanistic arguments and the finding reported by Pierce (Pierce el al. 2003), that in the LSS population of Japanese atomic bomb survivors the interaction between low LET radiation and smoking was consistent with an additive effect. This weighting scheme results in a Lifetime Attributable Risk (LAR) that is roughly twice as great among females as among males.

The EPA white paper provided an alternative model to the BEIR VII lung cancer risk estimates. EPA was concerned that the lack of adjustment for cigarette smoking and birth cohort effects would result in an overestimate of risk in the U.S.A. population as well as female to male incidence rate ratio that was too high. EPA proposed to use a pure EAR model for lung cancer, equivalent to a weighting of 1.0 for EAR and 0.0 for ERR risk models.

The RAC requested additional work on this problem from the EPA consisting of the following tasks:

● Compare results of the calculation of LAR using BEIR VII weighting to 100% EAR model and to alternative weighting schemes and/or the use of arithmetic, AM, or geometric, GM, means.

Table 1: Comparison of the EPA White Paper (WP) and BEIR VII Method for Combining EAR and ERR LAR Projections for Lung Cancer Incidence.[1]

	Combination Method RR weight[2] = 0.0		Combination Method RR weight[3] = 0.3		Combination Method RR weight = 0.5		Combination Method RR weight = 0.7		Combination Method RR = 1.0	
Sex	WP	BEIR VII	WP	BEIR VII	WP	BEIR VII	WP	BEIR VII	WP	BEIR VII
Male	179	179	186	193	195	203	206	213	230	230
Female	344	344	401	428	460	495	541	573	714	714

NOTE: Number of cases per 100,000 persons exposed to 0.1 Gy. Because of the uncertainty the results do not incorporate DDREF adjustment.

[1]Results are shown for stationary populations and SEER incidence data for the years 1998-2002.
[2]Weight for projection based on EPA proposal
[3] Weight for projection using BEIR VII.

● Consider how the additive ERR model for smoking and radiation provides evidence for the appropriate weighting scheme.

● Consider papers additional to Pierce (2003) on the nature of the smoking /radiation interaction.

Based upon EPA's response to these requests, Table 1 illustrates the effect upon LAR estimates for lung cancer incidence of several different weighting schemes for the EAR and ERR risk models. The columns labeled White Paper (WP) and BEIR VII reflect differences in how the weighting was applied. BEIR VII used a weighted average of the final age-adjusted ERR and EAR estimates on a log scale, while EPA first weighted each age-specific stratum and then combined the weighted age-specific risk estimates. Inspection of the table reveals that the difference in application of the weights produced very small changes in the WP and BEIR VII LAR estimates. The weighting of 0.0 for ERR proposed by EPA produces LAR estimates that are somewhat smaller than the weight of 0.3 for ERR chosen by BEIR VII, most notably for females. The RAC also notes that the evidence for a purely additive model is not compelling

based upon the literature review performed by EPA. There is some support for an interaction between radiation exposure and cigarette smoking that is intermediate between additive and multiplicative, similar to the weighting scheme selected by BEIR VII.

Accordingly, due to a lack of compelling evidence to depart from the weighting approach used by BEIR VII, the RAC recommends that EPA should not employ alternative weighting schemes.

5.6 Response to Charge Question #2e

Method for calculating breast cancer mortality risk, accounting for the relatively long time from detection until death (see Section II.H.).

The RAC notes that the EPA adopts the approach used by BEIR VII to estimate the risk of breast cancer in females, and that this approach differs from that used by BEIR VII to estimate the risks for the majority of other solid cancers. However, the EPA questions some aspects of BEIR VII's breast cancer risk estimation method, in particular the changing clinical course of breast cancer in conjunction with the relatively long survival period. Thus, the EPA has identified several alternative methods for estimating the relative risk for radiogenic breast cancer in an effort to take into account some of the temporal features that can influence the cancer's clinical course and hence the risk estimates. The RAC concurs with the EPA's decision to explore these alternative methods.

Specifically, the RAC concurs with the EPA's proposal to relate current breast cancer mortality rates to retrospective incidence rates rather than current incidence rates to better reflect the influence of life style changes, earlier breast cancer detection and treatment that could influence survival and hence mortality rates over an extended period.

The RAC notes the potential for development of second cancers during the cancer survival period. Such an event could be spontaneous or related to treatment of the initial cancer. In the case of breast cancer, it could impact mortality reporting and loss of deaths attributed to breast cancer.

The RAC suggests that the EPA explore the feasibility of using the BEIR VII approach with the proposed method (above) with retrospective lagging incidence rates relative to current mortality rates.

5.7 Response to Charge Question #2f

Proposed approaches for extending risk estimates to radiations of different LET's - in particular, deriving site-specific risk estimates for alpha or x radiations based on models

derived from the A-bomb survivors, who were primarily exposed to gamma rays (see Section III).

A significant extension requiring subject matter not addressed in BEIR VII is guidance on how to deal with the estimation of risks from exposures to different LET radiation, especially alpha particles and lower energy photons and beta particles. Knowledge of these risks is required particularly for dealing with the possible health risks from chronic irradiation from alpha, beta, or gamma emissions from internally deposited radionuclides. A key feature of the low-LET radiation exposures used in the analyses available in the BEIR VII report, especially those based on the Japanese atomic bomb survivors, is that they involved a very brief, whole-body exposure to radiation from an external source. In such a situation, all of the organs and tissues of the body were irradiated and the long-term risks to these organs and tissues have been studied directly. When dealing with internally deposited radionuclides, the situation is different because the radionuclide is likely to be distributed non-uniformly in the body, with only a few organs and tissues receiving most of the dose. This can change the spectrum of cancers produced. Also, because of the possible long-term retention of some long-lived radionuclides, the dose can continue to accumulate at a low dose rate over months or years. Dealing with these differences is important but not necessarily straightforward as discussed below.

Higher LET Radiation

The RAC noted that the white paper only considered alpha particles for radionuclides inhaled or ingested.

Alpha Particles

The EPA white paper discusses three possible approaches to estimating the lifetime health risks from internally deposited alpha-emitting radionuclides. These three approaches are discussed below:

<u>a) Data from human populations exposed to alpha-emitting radionuclides.</u>

Reliable risk data are available for the following organs and tissues (U.S. NAS/NRC. 1988: U.S. NAS/NRC. 1999; Koshurnikova et al. 2000; Gilbert et al. 2004):

- Bone cancer from radium dial painters and radium chemists exposed to ^{226,228}Ra;
- Bone Cancer from ankylosing spondylitis patients exposed to ^{224}Ra;
- Liver cancer from patients given Thorotrast (^{232}Th) as an imaging agent;
- Leukemia from patients given Thorotrast (^{232}Th) as an imaging agent;
- Lung cancer from uranium miners who inhaled ^{222}Rn and progeny; and
- Lung cancer from Mayak Russian workers who inhaled ^{239}Pu.

Since the lung, liver, bone and bone marrow are the major organs at risk for internally deposited, alpha-emitting radionuclides, these populations provide important information on carcinogenic risk for alpha-emitting radionuclides. The RAC notes that this information is based on site-specific cancer mortality among groups whose total doses are generally well above the low-dose region.

b) Data from life-span studies of laboratory animals exposed via various routes to graded activity levels of alpha-emitting radionuclides.

Sizeable data bases are available for different species of laboratory animals exposed via various routes to graded activity levels of different beta-, gamma- or alpha-emitting radionuclides and studied for their lifetimes. These studies provide much information on the life-span health effects but the number of variables involved including species, route of exposure, animal husbandry and other factors make it difficult to extrapolate the risk results directly to human populations in a consistent manner. However, they do provide useful information on radionuclides for which no human data are available. Such studies also help define the influence of dose distribution and the relative effectiveness of high- and low-LET radiations in those cases where studies of the high and low-LET emissions were examined in a parallel manner under similar conditions.

c) The most recent cancer risk data from the RERF studies of atomic bomb survivors exposed to low-LET radiation multiplied by a general RBE_M factor for alpha particles.

This third, more general, approach assumes that an appropriate value for RBE_M is known and that it is appropriate to use this value with the cancer risk seen after a brief, high dose-rate exposure received by the atomic bomb survivors to estimate cancers risks in a broad range of organs and tissues for which no data are available for alpha-particle exposure.

As discussed in Section III.A.3, Summary and Recommendations of the White Paper, the EPA proposes to multiply site-specific gamma-ray cancer risk estimates by an RBE of 20 to derive corresponding estimates of cancer risk from alpha radiation, with two exceptions:

a) An RBE = 1-3 for leukemia induced by alpha emitters deposited in bone; and
b) Continued use of models derived from BEIR VI to estimate lung cancer risk from inhaled radon progeny.

The RAC recognizes the problems that the EPA has to deal with in adding consideration of alpha-emitting radionuclides to the information already provided for low-LET radiation in the BEIR VII report. This particular issue is one example of the need for a practical, operational public health approach to radiation protection and standards setting mentioned earlier in this Advisory. On this basis, the RAC is supportive of the use of a generally accepted RBE_M value such as the 20 that they are using currently. For those radionuclides for which human cancer risk data are available for the lung, liver, bone, or bone marrow, the RAC recommends that this information be used directly whenever possible. For other organs and tissues, the RAC is supportive of the general approach (except for bone cancer as discussed in Section 5.8) of using the low-LET cancer risk from BEIR VII multiplied by RBE_M.

Low-energy Photons and Electrons

The EPA White Paper suggests that the relative biological effectiveness (RBE) for medical x rays is about 2 – 2.5. However, x-rays are not uniquely different from gamma-rays

except for their production. Any risk estimate associated with exposure to photons needs to be correlated with the energy of the photon rather than the method of production.

Reviews by ICRU (1986) and Kocher et al. (2005) show that RBEs for low energy photons, < 30 keV, and low energy electrons, <15 keV, are higher than one when compared to higher energy x-rays and ^{60}Co gamma-rays. A probability distribution by Kocher et al. (2005) showed a median radiation effectiveness factor of approximately 2.4 for photons less than 30 keV and for ^{3}H beta particles. Thus, an effectiveness factor for these low energy radiations in the range of 2 to 2.5 seems reasonable.

5.8 Response to Charge Question #2g

Estimation of risks for sites not specified in BEIR VII, specifically bone and skin, for which we propose to update our current approaches (see Sections III.A. and V, respectively).

The risk of bone cancer from low-LET radiation is not specified in the BEIR VII report but such information is required to consider the cancer risk from a bone-seeking beta-emitting radionuclide such as ^{90}Sr. In this case, the EPA proposes to do the reverse of what is discussed above in Section 2f. Instead of multiplying a low-LET cancer risk by an RBE to estimate a high-LET cancer risk, it proposes to divide the bone cancer risk observed in humans exposed to alpha particles from ^{224}Ra by an RBE to estimate the bone cancer risk from ^{90}Sr (NCRP 1991). Once again, this practical, operational approach to radiation protection and standards setting seems appropriate and conservative for the task at hand.

The RAC recognizes that although the BEIR VII committee chose not to provide risk estimates for non-melanoma skin cancer (NMSC) induced by ionizing radiation, EPA has an operational need for such estimates. This presents ORIA with certain methodological challenges given the high incidence and low mortality rates of NMSC among the US general population and the limitations of available data.

The RAC supports EPA's proposed use of the 1991 ICRP model to estimate the incidence and mortality risks of radiogenic NMSC taking into account more recent findings that most of the NMSCs attributable to low to moderate doses of low-LET ionizing radiation are of the basal cell carcinoma (BCC) type (Shore. 2001.), and that the incidence rates of BCC have been increasing substantially in recent decades among the general population (Karagas et al. 1999).

However, the RAC concurs with EPA that because of the high baseline incidence rates and low mortality due to NMSC, it is inappropriate to include risk estimates for radiogenic NMSC in the estimate of the total risk for radiogenic cancer. The RAC also notes that as ionizing radiation is not considered to be a risk factor for melanoma skin cancer there is no rationale for risk estimation in this instance.

5.9 Response to Charge Question #2h

Estimation of risk due to prenatal exposure. EPA's current lifetime risk estimates do not include risk from prenatal exposure, and BEIR VII does not provide them. The draft White Paper uses ICRP recommendations to project its risks of childhood cancers induced by in utero exposure. Please comment on the soundness of the approach described in the draft White Paper to apply ICRP as described in Section IV.

BEIR VII does not provide risk estimates for *in utero* exposure to radiation. Even though the risk from *in utero* exposure is a minor component of the overall radiogenic cancer risk, the EPA requires an estimate for radiation protection and standard setting purposes.

Few human data exist on which to base an estimate of radiogenic cancer risk for *in utero* exposure to radiation from either external sources or internally deposited radioactive materials.

The primary sources of data for external exposures are the Oxford Survey of Childhood Cancer (Stewart et al., 1958.; Mole, 1990) and as reviewed by Mettler and Upton, (1995) and by Doll and Wakefield, (1997) and the studies of Japanese atomic bomb survivors exposed in utero (Delongchamp et al., 1997). When all sources of uncertainty are taken into account, the risk estimates from these studies are not incompatible with each other (Wakeford & Little, 2002).

The dose to the embryo/fetus from internally-deposited radionuclides has been reviewed (NCRP, 1998; ICRP 2000) and ICRP (2001) provides organ/tissue dose coefficients (Sv/Bq) to the embryo/fetus from chronic intake of individual radionuclides by the mother. These data can be used to develop cancer risk estimates for the embryo/fetus exposed coincidentally to radiation delivered at low dose rates from the same sources.

Given the paucity of the epidemiological data available for estimating cancer risks of *in utero* exposure to low or high LET, RAC advises that ORIA continue to monitor advances in the subject area, as well as the science of the biological mechanisms underlying cancer induction in such situations and of their influence on the biophysical models used to estimate the cancer risk of *in utero* exposure.

The RAC concludes therefore that it would be reasonable for the EPA to use the cancer risk estimates from the published studies of populations exposed to photons *in utero* as a basis for developing its estimates of cancer risk for such exposures. The RAC similarly advises EPA to use the dose coefficients provided by ICRP as a basis for developing its estimates for *in utero* radiation exposure from internally-deposited radionuclides.

6. RESPONSE TO CHARGE QUESTION 3: UNCERTAINTIES NOT QUANTIFIED IN BEIR VII

Charge Question 3: *BEIR VII provides quantitative uncertainty bounds for each of its risk coefficients. EPA proposes to adopt this methodology with some additional discussion of the uncertainties not quantified in BEIR VII. Please comment on the adequacy of this approach (see Section II.K.).*

The RAC strongly endorses the EPA-ORIA's desire to estimate uncertainty bounds for its radiogenic cancer risk estimates. Indeed, given the range of possible operational uses of the risk estimates, as much effort should go into estimating the uncertainty bounds as into producing the central or point risk estimates themselves.

Ideally, the uncertainty analysis would involve the development of a probability density function for (site-specific) estimated risk, rather than bounds around a central or point risk estimate. Such an approach, which has previously been considered by other national and international committees, would facilitate risk estimation based on other than the average risk. For example, such an approach might facilitate the identification of a minimum cost-of-errors (or 'loss') risk estimate for operational use (e.g., in risk-informed regulation). Under-estimation and over-estimation of risk potentially lead to under- and over-regulation, respectively, each of which have costs associated with them. However, the RAC believes that such an approach is not likely to be practically achievable, and endorses the EPA-ORIA's approach (central risk estimate with uncertainty bounds, following BEIR VII).

The uncertainty bound estimates should incorporate, to the extent possible, all sources of error and/or uncertainty, including the three main sources identified in BEIR VII (sampling variability in the LSS data, transport of risk from LSS to the U.S.A. population, and the appropriate value for DDREF at both high and low doses of low-LET radiation (or, equivalently, the appropriate use of the LNT dose-response model used for low dose extrapolation)). Other sources of error and/or uncertainty identified by the EPA-ORIA (including dosimetry (of which neutron RBE is a factor), disease detection, disease classification, temporal patterns, and appropriate RBE values) should also be considered.

By this the RAC suggests that the EPA-ORIA should consider performing a quantitative analysis of uncertainty in the components of the risk assessment equations to establish uncertainty in the final estimate of risk. This process should be expanded to include a sensitivity analysis that establishes a ranking of the input parameters. This ranking can provide a valuable tool for determining which components merit further consideration, with the possible acquisition of additional data, and those that do not merit further consideration because the influence of these uncertainties on the final result is small.

There is some value to producing two sets of uncertainty bounds, one representing the bounds on the (site-specific) central or point risk estimate for the method of combining the RR and AR that the EPA finally chooses to use, the other representing combinations ranging from

100% RR through 100% AR. The former gives a measure of the uncertainty of the central risk estimate derived from the method specifically used, and the latter gives an indication of the range in which the true value (independent of method) likely resides.

In coming to these recommendations, the RAC considered several additional complications that could influence uncertainty. One such complication arises because the uncertainties associated with the current risk estimates for radiogenic cancers are smallest for the doses at which statistically significant increases in cancer mortality or incidence have been observed in the LSS and other epidemiological studies of exposed populations. However, such increases have been observed over a limited range of individual doses. At doses below this range, risk estimates are based on an assumed LNT dose-response model and method of extrapolation from higher-dose/higher-response data. This extrapolation may result in the risk estimates associated with doses in the low-dose range having larger relative uncertainties than those in the higher dose range.

Having said that, BEIR VII specifically considered adaptive response, genomic instability, and bystander effects, and concluded that there is insufficient evidence to explicitly add these effects to the dose-response model. The EPA-ORIA proposes at the present time to follow BEIR VII and use the LNT model combined with the DDREF for calculation of radiation risk. In the absence of compelling scientific evidence to do otherwise, the RAC endorses the EPA-ORIA's plan in this regard. The RAC does recommend, however, that the EPA-ORIA include a (qualitative) discussion of modern cellular and molecular biological concepts in its final report. As a cautionary note, the RAC recommends that the EPA discuss the application of its LNT risk estimates in very low dose settings where currently cancer risks are not significantly elevated above background cancer rates and where the doses are a fraction of the background radiation exposure.

It is important to note that there is an opportunity to implicitly include (qualitative) uncertainties in the choice of risk model per se in the overall (quantitative) uncertainty analysis. That is, a major issue with the choice of the LNT model is whether it is appropriately applied at low doses. In the quantitative uncertainty analysis, this qualitative uncertainty in model choice can be included as a quantitative uncertainty in the DDREF value. The RAC thus endorses the Agency's intention to include uncertainty in DDREF in the overall uncertainty analysis.

There is also a need to evaluate uncertainty following exposure to high doses delivered at low dose-rates. In addition to the DDREF, it may be necessary to have a dose rate effectiveness factor (DREF). The major data sets for these types of exposure come from internally deposited radioactive materials both in experimental animals and in humans where the dose rates can be low, but the total lifetime dose can be very high. The prime examples of such exposures in humans are the doses to the lungs of uranium miners from inhaled radon/radon daughters inhaled by uranium miners (1) (U.S. NAS/NRC. 1999. BEIR VI, page 67) and the dose to bone from internally deposited radium in the radium dial painters (2) (Roland 1994).

In the uranium miners, there was an "inverse dose rate effect" when miners were exposed to high total doses (WLM Working Level Months) over a relatively short time period (months to a few years). These miners show a lower risk that seen in miners with the same total dose or

WLM given over many years. However, it was determined that the mechanism of action for high and low dose rate exposures were different and that "…the inverse exposure-rate effect found in the miner data should not modify the risks for typical indoor exposures." (BEIR VI, page 9).

The bone cancer frequency in the radium dial painters remained essentially at zero until the total bone dose from the internally deposited alpha emitting radionuclide reached about 10 Gy, after which it increased rather markedly. This has been used to suggest a threshold dose below which bone sarcomas are not induced by radiation exposure. Similar data were seen in dogs that were exposed to beta emitting ^{90}Sr-^{90}Y by either inhalation (3) (Gillett et al. 1992) or ingestion (4) (White et al. 1993). These low dose-rate exposures caused non-detectable changes in cancer risk or life shortening until the total dose became very high (5) (Raabe et al. 1981).

This discussion illustrates that the cancer risk estimates derived for acute exposure, even with a DDREF of 1.5-2.0, do not result in accurate prediction of cancer risk to populations exposed to high doses delivered at low dose rates. Such information needs to be considered when predicting long term risk from low dose-rate exposures.

Uncertainties in the estimates are also a function of time into the future, being smallest in the near time frame. This is due to several factors, including changes in future (actual) populations (as opposed to a 'stationary population'), future background cancer incidence, and future medical advances (since the case fatality rate may decrease as a result of better treatment interventions in the future). Uncertainties thus become greater as the risk estimates are applied further into the future. The RAC recommends that EPA-ORIA include a (qualitative) discussion of these concepts in its final report.

7. RESPONSE TO CHARGE QUESTION 4: ISSUES RELATING TO RADIOGENIC THRYOID CANCER NOT QUANTIFIED IN BEIR VII AND ISSUES BEYOND THE CHARGE

Charge Question 4: *In Section VI, the draft White Paper discusses some issues relating to radiogenic thyroid cancer. Does the RAC have any specific suggestions for dealing with this risk; e.g., does the RAC have any advice on gender specificity, effectiveness of iodine -131 compared to gamma rays, or estimation of thyroid cancer mortality?*

The RAC believes that it is premature to offer any advice to ORIA on this issue. A major review of radiogenic thyroid cancer is being completed by the National Council on Radiation Protection and Measurements. This information should be considered by ORIA as more recent or more relevant data which could improve the risk estimates provided by BEIR VII.

8. ISSUES BEYOND THE CHARGE

The RAC received written and oral comments from members of the public which raised concern about the need to set radiation protection standards for the most sensitive population for specific cancer end points, instead of the use of "Reference Man." The RAC understands that in the existing Federal Guidance Report 13, EPA-ORIA has already used the current ICRP age groups (infant, 5-10, 15-20 year olds) in both the cancer risk coefficients and the underlying radiation dose coefficient. The RAC recommends that EPA continue this practice so that individuals using the Federal Guidance for assessing compliance can be explicit about ages and make appropriate assumptions.

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APPENDIX A –ON-GOING RESEARCH AND PARADIGMS ASSOCIATED WITH BIOLOGICAL RESPONSES TO LOW DOSES OF RADIATION

According to the BEIR VII report, "Atomic bomb data for solid tumors combined provide statistical evidence of a radiation-associated excess at doses down to around 100 mSv; these combined data are well described by a linear no-threshold dose-response, although some low dose nonlinearity is not excluded (US NAS/NRC. 2006. BEIR VII, p. 245)." "It is abundantly clear that direct epidemiological and animal approaches to low dose cancer risk are intrinsically limited in their capacity to define possible curvilinearity or dose thresholds for risk in the range of 0-100 mSv. For this reason the present report has placed much emphasis on the mechanistic data that can underpin such judgments (US NAS/NRC. 2006. BEIR VII, p.245)."

The uncertainty associated with the use of the epidemiological data to estimate risk in the low dose range has been covered in detail in Charge Question 3: Uncertainties not Quantified in BEIR VII. An additional source of uncertainty in risk estimates is associated with the DDREF and the mechanistic biophysical model that is used in BEIR VII to support the LNT in the low dose region. It is well established that it is not possible to use a linear extrapolation from health effects produced by high radiation doses to predict those induced in the low dose and dose-rate region. To make this low dose estimate, the slope of the dose-response relationship in the high dose region is modified by the (DDREF) which corrects for the decreased biological effectiveness of low dose and dose-rate exposures. The resulting lower slope is then linearly extrapolated into the very low dose and dose-rate region below where useful epidemiological data is obtainable. The major question discussed in this appendix is the applicability of the LNT model in this very low dose region.

Although the BEIR VII committee conducted an extensive review of the cell and molecular literature relative to biological responses at low doses and discussed the recent advances, they concluded that the mechanistic cell and molecular biological research supported the current biophysical model that they use (US NAS/NRC. 2006. BEIR VII, pp. 63-64). However, the rapid increase in information on the biological responses to low doses of radiation suggest new paradigms in radiation biology (Brooks 2005) that may modify the biophysical model used in the BEIR VII report.

BEIR VII uses a biophysical model that suggests that each and every ionization increases the probability of a DNA breakage (Burma et al. 2001) and that this results in a linear increase in the risk for mutations and therefore in the risk for cancer (US NAS/NRC. 2006. BEIR VII, pp. 10-11). This model assumes independent action of cells and a lack of cell communication. The model suggests that there is no change in response as a function of previous radiation exposure and that there is a linear link between unrepaired DNA damage, rare mutational events and the development of cancer. Recent research has been conducted to provide a solid data base on the response of molecules, cells, tissues and organisms to very low doses and dose rates of radiation (Ko et al. 2004.; Azzam and Little 2004.; Little 2006.; Brooks 2005.; Mitchel et al. 2004.). This research has suggested that several of the assumptions used in the BEIR VII biophysical model may no longer be valid (Tubiana 2005). The data base that questions the assumptions used by

BEIR VII include information on dose dependent changes in gene expression, radiation induced changes in redox status of the cells, apoptosis, bystander effects, adaptive responses, and genomic instability (Spitz et al. 2004; Di Masi et al. 2006.; Coleman et al. 2005.; Azzam and Little 2004.; Little 2006.; Brooks 2004.). The BEIR VII report has discussed each of these effects and concluded that until molecular mechanisms of action involved in the induction of low dose biological effects are elucidated, they cannot be utilized in modification of dose-response relationships. This appendix provides a brief review on the mechanistic research being conducted and to suggest the need for continuously updating the biophysical model used to support the estimates of radiation risk following low dose radiation exposure.

It is well known that cells communicate by a variety of direct and indirect mechanisms (Kadhim et al, 2004; Azzam and Little, 2004). Many new radio-biological observations indicate that cells do not respond to radiation independently. This communication results in modification of responses to low dose and dose-rate radiation.

Using recently developed microbeams and other technology to expose individual cells and study the response of the "hit" cells and the response of neighboring cells demonstrated the presence of "bystander effects." These effects demonstrate that a cell traversed by an alpha particle or "hit" by a focused low LET beam communicate with neighboring cells and can produce changes in "non-hit" cells. These changes have been shown to be both "harmful" and "protective" and are most marked following exposure to high-LET radiation (Little 2006.). Bystander effects impact the current use of "hit-theory" in defining radiation risk since the radiation target is much larger than the individual cell. The research demonstrates that cells communicate within each tissue making the assumption of independence of action of individual cells used in the BEIR VII biophysical model inappropriate. Since non-hit cells show biological responses, it may not be appropriate to calculate radiation dose to individual cells or cell types in tissues. (US NAS/NRC. 2006. BEIR VII page 54) Bystander effects also make it more difficult to define the biological target for the interaction of radiation with cells and the induction of cancer. The data suggest that tissues and organs respond as a whole and that the biological response is related to the dose to the whole organ/tissue, which is the metric used by BEIR VII in all the human studies, rather than to the dose to individual cells (Barcellos-Hoff and Brooks .2001.).

It has been demonstrated that following exposures to low doses of radiation there are unique dose-dependent changes in gene and protein expression which were not recognized or identified when the BEIR VII biophysical models were developed (Ding et al. 2005.; Coleman and Wyrobek 2006.; Marchetti et al. 2006.). Low dose activation of such mechanisms supports the existence of non-linear dose-response relationships for low-LET radiation. Identification of these genes is providing a scientific basis for defining metabolic pathways activated by radiation and determining mechanisms of action.

Previous radiation exposure can alter the response producing diminished biological effects. This is called the "adaptive response". Two different types of adaptive responses have been identified (Azzam and Little 2004.). The first is where low doses of radiation decrease the amount of damage observed relative to background levels (Ko et al. 2006.). The second is where a small "priming dose" of radiation given before a high acute "challenge dose" results in a

decreased response relative to the high dose alone (Olivieri et al .1984.). The ability to produce an adaptive response is dependent on genetic background of the cells. Different sets of genes are up and down regulated in cells capable of adaptation compared to cells that cannot adapt to radiation exposure. Cells and tissues that demonstrate an adaptive response following low dose exposures have repair and stress genes up regulated (Coleman et al. 2005.).

Research has been conducted to understand cell/cell and cell/tissue interactions and how they modify cancer frequency (Barcellos-Hoff 2005.). Tissue interactions have been shown to modify the expression of cellular and molecular damage and to be critical in the expression of cancer. There is evidence that under certain experimental conditions, radiation damage can be modified in vitro (Kennedy et al. 2006). Also administration of stable iodine considerably later than the period normally prescribed to block exposure to radioactive iodine was unexpectedly associated with a decreased risk of thyroid cancer incidence among a population at risk of exposure as a result of the Chernobyl accident. The authors suggested that this finding may be related to a modification of radiation-induced cellular or molecular damage in the presence of stable iodine (Cardis et al. 2005). Data from this research verified that the initial DNA damage increases linearly with radiation dose, that DNA damage triggers many molecular responses and that even the initial DNA damage and repair is modified by radiation type, dose and dose-rate (Ishizaki et al. 2004.). Importantly, it has been shown that biological repair of this damage as well as the other cellular and organ responses are very non-linear over the low dose region. These new findings may have significance in quantifying the safety margins associated with regulatory standards.

Genomic instability suggests that, in addition to rare mutational events, frequent radiation-induced changes following exposure may play an important role in cancer induction. Radiation-induced genomic instability is seen at a high frequency in cells many cell divisions after the radiation exposure (Morgan 2003; Ponnaiya et al. 1997.). The instability results in increased frequency of mutations, chromosome aberrations, and cell killing. Radiation-induced genomic instability seems to be one of the early stages in the carcinogenesis process and has been seen both *in vitro* and *in vivo*. These observations challenge the relative importance that initial mutations play in radiation-induced cancer (Kadhim et al. 2004.). The BEIR VII biophysical model suggests that since DNA damage increases as a linear function of acute radiation dose that there must be a linear increase in cancer risk (BEIR VII pp. 245). Genomic instability and the ability to modify responses after the radiation exposure both challenge the linear relationship between initial DNA damage and cancer frequency.

The magnitude of the response for all of these phenomena has been shown to be dependent on the genetic background of the cells, tissues and organisms in which they are being measured (Coleman et al. 2005; Ponnaiya et al. 1997; Azzam and Little 2004.; Little 2006.). A better definition of the range of inter-individual variability and the development of analytical methods and tools may make it possible to identify individuals that are either sensitive or resistant to either the early or late effects of radiation or both. However, currently it is not possible to identify either radiation resistant or radiation sensitive individuals, or to use this information in a regulatory framework.

These recent advances provide a scientific basis for the observed non-linear dose-response relationships seen in many biological systems (US NAS/NRC. 2006. BEIR VII; Ko et al. 2006; Mitchel et al. 2004). They suggest that the mechanism of action of radiation-induced damage is different following exposure to high doses than it is after low radiation doses. It becomes important to consider new paradigms associated with the biological responses to low doses of radiation and to modify and further develop the models used to support the extrapolation of dose-response relationships into dose regions where it is not possible to measure changes in radiation-induced cancer incidence/mortality in human populations.

APPENDIX B –ACRONYMS

A-Bomb	Atomic Bomb
AM	Arithmetic Mean
AR	Absolute Risk
BCC	Basal Cell Carcinoma
BEIR	Biological Effects of Ionizing Radiation
BEIR VII	*Health Risks from Exposure to Low Levels of Ionizing Radiation BEIR VII Phase 2*
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
Co	Chemical symbol for cobalt (^{60}Co isotope)
DDREF	Dose and Dose-Rate Effectiveness Factor
DFO	Designated Federal Officer
DNA	Deoxyribonucleic Acid
EAR	Excess Absolute Risk
EPA	Environmental Protection Agency (U.S. EPA)
ERR	Excess Relative Risk
FR	Federal Register
FGR-13	Federal Guidance Report 13
GM	Geometric Mean
GMC	Geometric Mean Coefficient
GSD	Geometric Standard Deviation
Gy	gray, SI unit of radiation absorbed dose (1Gy is equivalent to 100 rad in traditional units)
H	Chemical symbol for Hydrogen (^{3}H isotope)
I	Chemical symbol for Iodine (^{131}I isotope)
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements, Inc.
IREP	Interactive RadioEpidemiological Program
keV	kiloelectron Volts
LAR	Lifetime Attributible Risk
LET	Linear Energy Transfer
LNT	Linear Non Threshold
LSS	Life Span Study
mSv	milli-Sievert
NAS	National Academy of Sciences (U.S. NAS)
NCHS	National Center for Health Statistics
NCI	National Cancer Institute
NCRP	National Council on Radiation Protection and Measurements
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NMSC	Non-Melanoma Skin Cancer
NRC	National Research Council
OAR	Office of Air and Radiation (U.S. EPA/OAR)
ORIA	Office of Radiation and Indoor Air (U.S. EPA/OAR/ORIA)

PAG	Protective Action Guide
Pu	Chemical symbol for Plutonium (^{239}Pu Isotope)
QA	Quality Assurance
QC	Quality Control
QA/QC	Quality Assurance/Quality Control
R	roentgen
Ra	Chemical symbol for Radium (Isotopes include ^{224}Ra, ^{226}Ra, ^{228}Ra, and ^{236}Ra)
RAC	Radiation Advisory Committee (U.S. EPA/SAB/RAC)
rad	Traditional unit of radiation absorbed dose in tissue (a dose of 100 rad is equivalent to 1 gray (Gy) in SI units)
RBE	Relative Biological Effectiveness
RBE_m	Maximum Relative Biological Effectiveness
REF	Radiation Effectiveness Factor
rem	Radiation equivalent in man; traditional unit of effective dose equivalent (equals rad x tissue weighting factor) (100 rem is equivalent to 1 Sievert (Sv))
RERF	Radiation Effects Research Foundation
R/h	Roentgen per hour; traditional measure of exposure rate
Rn	Chemical symbol for Radon (^{222}Rn Isotope)
RR	Relative Risk
SAB	Science Advisory Board (U.S. EPA/SAB)
SCC	Squamous Cell Carcinoma
SEER	Surveillance, Epidemiology, and End Results
SI	International System of Units (from NIST, as defined by the General Conference of Weights & Measures in 1960)
Sr	Chemical Symbol for Strontium (^{90}Sr Isotope)
Sv	sievert, SI unit of effective dose equivalent in man (1 Sv is equivalent to 100 rem in traditional units)
Th	Thorotrast (^{232}Th Isotope)
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
US	United States
WLM	Working Level Months

End of Document

Compilation of Public Comments on the EPA SAB RAC Draft Report on the EPA Radiation Risk White Paper (September 5, 2007 SAB Telecon)

a) **Dr. Arjun Makhijani**:

30 August 2007

Granger Morgan, Chair, Science Advisory Board
Jill Lipoti, Chair, Radiation Advisory Committee
U.S. Environmental Protection Agency
Washington, D.C.
By e-mail to Miller.Tom@epamail.epa.gov
cc: Jack Kooyoomjian

Subject: Comments on the July 18, 2007 SAB review of the EPA draft White paper "Modifying EPA Radiation Risk Models Based on BEIR VII" provided for the meeting of the SAB by teleconference, 5 September 2007.

Dear Drs. Morgan and Lipoti:

The following are my comments on the July 18, 2007, SAB review of the EPA draft White paper "Modifying EPA Radiation Risk Models Based on BEIR VII" for your consideration at the September 5, 2007, teleconference call and in the process of finalization of the review.

Issue 1: "Exposed" and "non-exposed" populations

On page 4 of the letter, the review states that

> Thus, as a cautionary note, the RAC recommends that the EPA discuss potential problems associated with the use of LNT dose response model risk estimates in very low dose settings. Currently at these low doses, statistically significant differences between the cancer rates among "exposed" (defined study populations) and "non-exposed" (defined comparison populations) are not observed. These near background doses are only a fraction of those that have been found to be associated with statistically significant differences in cancer frequency between "exposed" and "non-exposed" populations.

The same or similar language also appears elsewhere (page 4 of the summary and page 23 of the review). The fact that statistically significant excess cancers due to

exposures resulting from anthropogenic activities cannot be detected is not relevant to protection of public health. The relevant fact is that over 70 years, natural background provides at least 6 rem cumulative dose, usually more. Since there is clear evidence of risk at several rem or more, the linear-no-threshold hypothesis applies and the cancers would be expected to occur. The difficulty of detecting the excess in epidemiological studies should not be allowed to confuse the central issue, which is this:

All anthropogenic doses, no matter how small, are expected to cause increased cancer risk. The best present estimate is that the increased risk is proportional to dose. One Anthropogenic exposures occur on top of cumulative natural exposures, which are large enough to create some cancer risk.

I recommend that the passage on page 4 of the letter and the companion passages (p. 4 of the summary and p. 23 of the report) be deleted and replaced by the three italicized sentences above.

2. Fetal dose and risk

Question 2h of the charge to the committee concerned fetal exposure and risk. It is reproduced below from p. 21 of the review:

> *Estimation of risk due to prenatal exposure. EPA's current lifetime risk estimates do not include risk from prenatal exposure, and BEIR VII does not provide them. The draft White Paper uses ICRP recommendations to project its risks of childhood cancers induced by in utero exposure. Please comment on the soundness of the approach described in the draft White Paper to apply ICRP as described in Section IV.*

The response of the committee is deficient in one fundamental respect because it omits important elements of risk. It also endorses an incorrect approach to estimating certain fetal doses. I consider each of these issues in turn.

Omissions of risk

The charge to the committee was not restricted to cancer risk, but to "[e]stimation of risk due to fetal exposure." Cancer risk may not be the main risk due to radiation exposure in very early stages of fetal development. Early pregnancy failures (for instance in the first two to three weeks) and malformations are also risks when exposure occurs in the first few weeks. The committee should have considered these risks. Granted that some of these risks are difficult to evaluate, notably from internal exposure (see below), but that fact itself is relevant and important enough that it should be explicit. The EPA needs to develop a research agenda to get reliable quantitative estimates of non-cancer risks of early fetal exposure. It also needs to set standards in a way that are protective and reasonably conservative.

Incorrect exposure assessment

The review has endorsed the ICRP approach for estimating fetal radiation dose (p. 2 of the letter, p. 3 of the Executive Summary, and p. 21 of the full review). For instance, p. 3 of the Executive Summary, states

> The RAC concludes that it would be reasonable for the EPA to use the referenced estimates of cancer risk from *in utero* exposure to external radiation sources, and the dose coefficients provided by the ICRP as a basis for developing its risk estimates for *in utero* radiation exposure from internally-deposited radionuclides.

This recommendation should be accompanied by a critical caveat regarding an important limitation of the ICRP risk estimates. Specifically, the ICRP 88 assumption that the dose to the embryo/fetus in the first eight weeks of pregnancy is the same as that to the uterine wall[1] is not valid for alpha emitters and for low-energy beta radiation emitters, such as tritium. The actual deposition of alpha and low-energy beta emitters in the embryo/fetus needs to be determined to estimate dose and risk.

In other words, since the ICRP's model is not valid for the cases cited, a new one is needed for the first eight weeks of development of the embryo/fetus for alpha and low-energy beta emitters. This is especially important since structural organization and a substantial component of organogenesis occur in the embryo/fetus over this period. This period is therefore especially important for the risk of malformations and early pregnancy failures. The context of this comment is provided on page 73 of IEER's report *Science for the Vulnerable* (by Arjun Makhijani, Brice Smith, and Michael C. Thorne). It is on IEER's website at:

http://www.ieer.org/campaign/report.pdf

I specifically pointed out this problem to the RAC in written comments, with specific recommendations as to how the text should be corrected. My letter of March 12, 2007, to the Designated Federal Official, written for the RAC's consideration is attached (See Attachment 1). I have been given to understand that it was transmitted to the members of the RAC. (Some of the language in this letter is drawn from my March 12, 2007 letter).

I am mystified that the July 18, 2007, draft report does not even mention this comment or deal with the issue in any way. The ICRP model is clearly inapplicable to certain radionuclides, including alpha-emitters and tritium. This is

[1] International Commission on Radiological Protection. *Doses to the Embryo And Fetus From Intakes Of Radionuclides By The Mother*. ICRP publication 88. Annals of the ICRP, 31(1/3) 2001. Corrected version. Oxford: Pergamon, May 2002, p. 20.

an issue of immense potential importance that should not be ignored or brushed under the rug. For instance, discharges of tritium from nuclear power plants and tritium contamination of water due to nuclear weapons activities in decades gone by, is widespread. Is the EPA going to assess the impact to developing fetuses based on an evidently incorrect model? And is the RAC willing to go on the record as having endorsed the ICRP model without due consideration of its obvious deficiencies in regard to certain radionuclides for the critical first eight weeks of pregnancy?

It would be understandable if the RAC had not addressed the issue due to an oversight. But given the circumstances, I would think that the RAC and the SAB would not want to find themselves in the embarrassing position of brushing a significant scientific problem under the rug, after it has clearly been pointed out to them. The embarrassment would be compounded since the problem was pointed out as part of public comment to a committee chartered under the Federal Advisory Committee Act (FACA).

In sum, the RAC has failed to properly review the ICRP model. The review must be modified to explicitly discuss the ICRP model for fetal dose, including dose from alpha-emitters and tritium during the first eight weeks of pregnancy. This modification will require substantial work. I recommend therefore that the SAB send back the review to the RAC for detailed consideration of the specifics of the ICRP model for the first eight weeks of pregnancy and of non-cancer risks extending to the first 14 weeks of pregnancy. I expect that there will be one or public meetings during which the public may provide comment on the RAC's work in progress on this point. I also recommend that the non-cancer risks discussed above be part of the same reconsideration and redrafting of the report.

Issue 3: RBE for low-energy photons and tritium beta particles

The review has concluded that an RBE for low-energy photons (<30 KeV) and low-energy beta particles, such as those from tritium, "in the range of 2 to 2.5 seems reasonable" (p. 2 of the letter, p. 2 of the Executive Summary, and p. 20 of the report).

IEER supports that shift away from an RBE of one for these radiation types and the choice of 2 to 2.5 for non-pregnant adults. However, in the case of tritium, the RAC report does not discuss the dependence of the tritium RBE on age at exposure and on the form of tritium (tritiated water versus organically bound tritium). I discussed this in some detail in my letter of March 12, 2007. I also included the table of RBEs that my colleagues and I calculated based on the research of Harrison, Khursheed and Lambert.[2] This is all reproduced in Attachment 1.

[2] J.D. Harrison, A. Khursheed, and B.E. Lambert. "Uncertainties in dose and coefficients for intakes of tritiated water and organically bound forms of tritium by members of the public." *Radiation protection dosimetry*, v. 98, no. 3 (2002), pages 299-311.

I recommend that the SAB adopt the following conclusions regarding low-energy photon and low-energy beta radiation exposure, including exposure to beta radiation from tritium.

1. An RBE in the range of 2 to 2.5 for low-energy photons and electrons, including tritiated water, should be adopted for purposes of setting radiation protection standards for non-pregnant adults.

2. An RBE of 4 to 5 for low-energy photons and electrons, including tritiated water, should be adopted in radiation standards for fetal exposure and for children.

3. The RBE for organically-bound tritium (OBT) is higher than that of tritiated water, possibly by a factor of 2 to 2.5, as indicated by Harrison, Khursheed and Lambert 2002. The EPA should initiate a review of the issue of OBT in order to develop the appropriate regulatory guidance both as regards the RBE and as regards the circumstances in which the use of a higher RBE is warranted.

4. The EPA should also initiate a review as to whether a higher RBE is warranted for prospective fathers in view of the potential exposure of germ-line cells to tritium.

I made the first three suggestions in my March 12, 2007, letter. I have added the fourth here. I note that the RAC also rejected the first three suggestions without discussion of the underlying scientific issues. The RAC and SAB are obliged to take public comment into account. My comments were based on published scientific work and a reasonable and specific critique of the draft. I do not expect that every comment be accepted, of course. But there is no evidence in the July 18, 2007, draft or any other public material that the serious underlying scientific issues were given consideration by the RAC before it forwarded the report to the SAB. On this account as well, the review should be sent back for reconsideration and redrafting.

Issue 4: Section 8 of the review: Issues beyond the charge

On page 25 the, July 18, 2007, draft of the review states

> The RAC received written and oral comments from members of the public which raised concern about the need to set radiation protection standards for the most sensitive population for specific cancer end points, instead of the use of "Reference Man." The RAC understands that in the existing Federal Guidance Report 13, EPA-ORIA has already used the current ICRP age groups (infant, 5-10, 15-20 year olds) in both the cancer risk coefficients and the underlying radiation dose coefficient. The RAC recommends that EPA continue this practice so that

> individuals using the Federal Guidance for assessing compliance can be explicit about ages and make appropriate assumptions.

This section is substantially different than the February 2007 draft of the review, which recommended that the EPA consider the ICRP 89 Reference Family concept as a replacement for "Reference Man."

An endorsement of FGR 13 is not a substitute for getting rid of Reference Man. First of all, the age-specific risk factors in FGR 13 are not gender-specific. The EPA averages male and female risks in its regulatory practice in a way that is entirely inappropriate, given the evolution of radiation risk assessment since FGR 11 and BEIR V. When these latter documents were the most recent science, a sex-specific differentiation of overall cancer risk was not necessary. The risk to females as estimated in BEIR V was about 5 percent greater than the risk to males (in the case of a single exposure of 10 rem). BEIR VII is a radical departure from BEIR V. In this regard FGR 13 is a radical departure from FGR 11 as well. Yet, the review contains no discussion of sex-specific overall risk factors of exposure to radiation (other than the risk model for lung cancer in women). Neither does the report consider the implications of incorporating the age- and sex-specific risk factors for reducing overall dose limits. The implications for female children versus male children are also important, since females are at greater risk when they are young as well. The FGR 13 CD containing the numerical dose and risk conversion factors by radionuclide does not provide any sex-specific risk factors. It averages risks in a way that is prejudicial to females, including female children, since they are now known to be at higher risk overall, and at much higher risk for certain cancers.

Finally, the problem of fetal exposure also has a sex-specific aspect. Males continuously produce germ-line cells, but ova are produced when a female is in utero. Hence, in utero exposure must also consider females and males according to the risks that they face; it must also factor in inter-generational risks. I had recommended not only that the RAC specifically recommend that Reference Man be abandoned (a recommendation that was accepted in the February draft, in milder form, and then rescinded without explanation). I had also recommended that those most at risk be protected. I noted that in some situations the most at risk might be children, in other situations it might be breast feeding or pregnant women, in others, men who want to be fathers, or, in yet others, the embryo/fetus. None of these considerations found their way into the report. Even men in their potential capacity as fathers were not considered.

It should also be noted that FGR 11 is still the basis of the levels of maximum allowable exposure in many circumstances. For instance, FGR 11 and Reference Man are still the basis of ResRad, the computer model that is used to estimate the dose from residual radioactivity in soil and that is used to set clean-up levels at contaminated sites. It is unconscionable that, at a time when the ICRP itself has moved away from a concept of a young "Caucasian" male being at the center of

the radiation protection universe, the RAC should maintain silence on this critical problem. It is even more mysterious that, having recognized it as an issue and made a rather mild recommendation to the EPA to wake up to a world in which there are women, children, and non-Caucasians, the RAC should have retreated, at least implicitly, into a White male domain without explanation.

I am certain that the public would be appalled should the SAB not make an explicit recommendation that the EPA reject any standards and guidance based on Reference Man. An explicit statement referring to the need to change all standards, regulations, and guidance (including models such as ResRad) is necessary. On this matter as well, the SAB should send the review back to the RAC for reconsideration, including taking public comment. I also recommend that when the RAC and SAB reject public comment that some explanation be provided as to the scientific basis for its rejection.

I will be making public comment along the lines of this letter during your September 5, 2007, teleconference call. Your DFO, Tom Miller, advised me to send you written comments in advance so that you could see if before your call and consider it. I look forward to hearing your response to the above concerns, analysis, and recommendations on September 5, 2007.

Thank very much.

Yours sincerely,

/ Signed /

Arjun Makhijani, Ph.D.
President, Institute for Energy and Environmental Research

b) <u>Dr. Clark Bullard:</u>

To Tom Miller
Now is the time for EPA to abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

The White Paper should be revised ASAP to state this in no uncertain terms. Then the Director or the President should carry the message to the public, explaining that this long-overdue action has finally been taken.

It will give Americans a reason to be proud of their government in these troubling times.
Thank you for your consideration.

c) <u>Mr. and Mrs G. and D. Peters</u>

Please revise the draft of the review of the EPA White Paper to explicitly recommend that the EPA abandon "Reference Man" and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

Thank you.

d) <u>Mr. P. R. Shirvalkar</u>

I am writing to encourage you to revise the draft of the EPA White paper on Radiation hazards. In particular, I support that the EPA should abandon the obsolete criterion of the 'Reference Man' and rather should be more practical in considering how radiation impacts individuals in this country. As the EPA is responsible for setting standards of protection for people vulnerable to radiation (pregnant women, children) I urge that you explicitly recommend the use of a 'Reference Family.'

Scientists worldwide will use these standards, based on your recommendations, for reporting results and interpretations of their findings. Further, political actions are surely contingent on such findings.

Thanks for your time.
I would appreciate a conference call listening phone number to listen in on the Radiation Advisory Committee's review on this matter.

e) <u>Ms. E. Tracy</u>

I understand the EPA's Science Advisory Board is meeting Sept 5th to consider the latest draft of its report reviewing the EPA's approach to radiation protection, including the Radiation Advisory Committee's review of the white paper. I understand that the meeting is open to the public, but to listen in by phone I need to know the conference call number to use to call in.

I believe the draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

Please let me know the phone number to use to listen in on the meeting.

f) <u>Mr. J. Davis</u>

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-

specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

g) **Ms. B. Miller**

I am writing to urge the EPA to revise the agency's draft white paper entitled Modifying EPA Radiation Risk Models Based on Bier VII to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in.

It is old news that women's health differs substantially from men's. Women face a significantly higher overall risk than do men of getting cancer from the same exposure to radiation. As a woman, I was appalled to learn that EPA set radiation standards based on Reference Man, a young male. Surely we must base such standards on risks to the most vulnerable!

Once again, I urge the EPA to revise the draft white paper and set radiation standards to protect those most at risk.

h) **Ms. L. White:**

I understand that the EPA's Science Advisory Board will consider the latest draft of its report reviewing the EPA's approach to radiation protection in a teleconference call on September 5, 2007, starting at 1 p.m.

Regarding the draft of the review of the EPA White Paper: It should be revised to explicitly recommend that the EPA **abandon Reference Man and focus on Reference Family and set standards to protect those most at risk: infants, children and pregnant women with gender-specific risks factored in**. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

Also, **I request a conference call number** that I can call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

i) **Ms. J. Lombardo**

Dear Mr. Miller,
http://www.epa.gov/sab/pdf/draft_report_on_bier_vii_white_paper_07-18-07.pdf
The above draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

j) <u>Mrs. P. Dressler:</u>

I the EPA fails to protect us from the onslaught of radiation exposure who will. We as American Citizens who are faced daily with ongoing impact of radiation exposure must have access to what is going on with regard to regulation of the nuclear industry and its impact on all of us. The cancer rate in this country is out of control and much of it could be attributed to radiation exposure.
I request the following inquiries:

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

k) <u>Dr. B. S. Lacy:</u>

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

l) <u>Ms. M. Bottesch:</u>

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

Why is it so hard for this government to protect its citizens? The science is there, the knowledge is there, what's the problem? We are not all MEN - we are women, pregnant women, infants and children. Above all, the precautionary principle should be your guide line. Please see that this is so.

m) Dr. G. Griffith:

I have read the draft review of the White Paper "Modifying EPA Radiation Risk Models Based on Bier VII" and comments, and would urge the Board to abandon the Reference Man standard and adopt the Reference Family concept, with special

attention to elevated risk to the embryo/fetus and all females. The most vulnerable must be fully protected, especially from inter-generational effects.

Thank you for your consideration.

n) Mr. C. Clark:

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

o) **Ms. J. J. MacNulty:**

Regarding the upcoming draft review of EPA White Paper on acceptable radiation standards, I wish to add my voice to those calling for BETTER STANDARDS, to include the increased vulnerability of pregnant women and the unborn, infants, children, the infirm and the aged...in other words, the human family...nor should we ignore our brethren of the plant and animal worlds, other life forms...Please contact me at jmacnulty@adelphia.net regarding protocol for listening in on the conference call to the discussion/review by the Radiation Advisory Council of the EPA offering. Many thanks.

Yours truly,

PS Better still, please cancel the nuclear option, -- so dangerous, so costly, so everlasting, and so slow... and spend our trillions developing safe, sane, sustainable energy options...that is the mandate of your Agency, is it not?

p) Mr. T. V. Connor:

The draft of the review of the EPA white paper should be revised to explicitly recommend that the EPA abandon reference man and set standards to protect those most at risk, including pregnant women, infants and children with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer for the same dose of radiation. These simulations must reflect real-world conditions for all our Citizens. Thank you for allowing my input.

q) Ms. N. Burton:

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

r) <u>Mr. J. Cape:</u>
The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

s) <u>Ms. N. Berkheimer:</u>
I am writing you regarding the draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.
Thank you for taking my thoughts into consideration.

t) <u>Ms. J. Nelson:</u>
Re. human exposure to radiation:
The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
Thank you for your consideration.

u) <u>Ms. S. Schlesinger:</u>
I am writing to express my concerns. I strongly believe that the draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

I would also like to request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

v) **Dinda Evans:**

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee&#65533;s review of the EPA White paper on radiation protection.

The us people don't trust the us government anymore: from Love Canal, Silkwood, Poisoned chinese products (that cost us workers their jobs as well as health, rising homelessness, pollution, rampant immigration that let in terrorists to sell weapons to police forces or reduce us civil liberties or immigration used to attack resources, drive down wages & raise land costs while they give away us jobs to foreign countires or alien workers: It is way past time that the us government and us agencies started protecting us citizens from internal and external forces.

w) **T. U. Fountain:**

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation and children are most at risk. To protect our future, we need to protect our children from exposure to harmful substances such as radiation.

Sincerely,

x) **Mr. A. Hanson:**

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

Sincerely,

y) Mr. F. Belcastro:

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect

those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

z) **Ms. N. Hanson:**
The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

aa) **Mr. R. Voelker:**
The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

bb) **Dr. J. Snyder:**
As a pediatrician, I urge you to reconsider the designation of a "reference man" to set standards with regard to risk assessment to radiation exposures. The one-size-fits-all model is too simplistic, and will put women and children at risk.

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

cc) **Dr. M. J. Ryan**
I am writing re: Reference Man. I urge the following:

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

dd) **Mr. C. Broscious:**

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee►s review of the EPA White paper on radiation protection.

ee) **Ms. E. Wynne:**

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee►s review of the EPA White paper on radiation protection.

ff) **Mr. L. R. Karpen:**

Please send me a conference call number for the September 5 conference call on radiation protection--so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection. Also: The draft of the review of the EPA White Paper should be revised to recommend explicitly that the EPA abandon Reference Man, but instead set standards to protect those most at risk--pregnant women, infants and children, with sex-specific rsks factored in. Women face a much hiugher overall risk of getting cancer than men for the same exposure to radiation.

gg) **Mr. M. Clinton:**

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee?s review of the EPA White paper on radiation protection.

hh) **Ms. L. Garvey:**

I strongly urge you to NIX the 'reference (white male) man' and change it to the reality of those most at risk, to protect them (women & children & people of color).

Do your job- Protect the environment!- You work for American citizens, not industry!

Your attention to this most urgent matter would be much appreciated by all present & future generations of all species. Remember, we are all dependent upon mother nature.

Thank you

ii) **Ms. J. Poulson:**

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee►s review of the EPA White paper on radiation protection. I would like the number for the conference call, too, please. Thanks.

jj) **Mr. J. Goldman:**

I am disappointed that the EPA seems to be reversing its earlier recommendation to abandon Reference Man and instead base the standards on those most at risk, including pregnant women infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation. The draft of the review of the EPA White Paper should be revised to explicitly recommend changing this standard.

Please send me the conference call number so that I can listen to the discussion on the Radiation Advisor Committee's review of the EPA White paper on radiation protection.

Thank you.

Sincerely,

kk) **Dr. R. Bertell:**

The use of the Reference man - basically the "Caucasian soldier, young, male, healthy and 20-30 years old" - was first proposed by the physicists of the Manhattan Project in 1950. It is now almost 60 years since this was made the "standard" for radiation protection, and everyone knows that it is not protective of children or women. It is a racist and sexist standard, which fails miserably to protect those who most need protection! Nuclear fallout from bomb tests and nuclear power reactors have blanketed the whole population with radiation -the embryos, fetuses, infants, children and women, the young and the old, the sick and the well.

I would urge you to explicitly remove this concept and clearly renounce it in your BEIR VII White Paper. The EPA is mandated to protect the health of all citizens! Your mandate is not fulfilled when you rule in favor of protecting only the white adult male. Protecting the weaker members of society provides even more protection for the adult male!

I do not understand how this perverse concept of the Standard Man has corrupted our regulatory framework for so mindlessly for so long.

ll) **Kata Orndorff:**

I am writing to you concerning the EPA White Paper concerning radiation protection. It is very important that the draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

mm) Mr. E. Ball:

The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
Thanks.
Sincerely,

nn) T. Barrie:

I respectfully request that the draft of the review of the EPA White Paper be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk to radiation exposure, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

It only makes sense that any risk model on radiation health effects use the group most likely to have adverse health problems from exposure to radiation. Setting the standard using the effects on the group(s) most at risk will ensure that the majority of the population is fully protected.

Thank you for your kind consideration.

Sincerely,

oo) **Mahnaz:**

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee's review of the EPA White paper on radiation protection.

pp) **Ms. K. Marshall:**

1. The draft of the review of the EPA White Paper should be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
2. I request a conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committee►s review of the EPA White paper on radiation protection.

qq) **Ms. H. M. Corneli:**

I have been concerned about our postures on radioactive material since 5he 1980's when I was a citizen member of the Radiation Protection Council of Wisconsin.

I recommend that your current draft review of the EPA White Paper be revised. It should (1) explicitly recommend that the EPA abandon Reference Man and (2)set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. (Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.) In addition, I request a conference call number that would enable me to listen to the discussion on the Radiation Advisory Committee's review of said EPA White paper.

rr) **Dr. S. Joyce:**

I am sure you have loved ones in life who are not men.
The review of the EPA White Paper should explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in, where applicable. For example, as you know, women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

ss) **Ms. J. L. Fry:**

Just like many other people, because of my work I am not able to make my comments known in person on this matter of Reference Man; and I am not able to participate in the discussion by phone conference call for the same reason. I do

appreciate that such communication is available but I write you now because I must rely upon you to take my wishes to the meeting Wednesday September 5th for me.

Please do request on my behalf that the draft of the review of the EPA White Paper be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants and children, with sex specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.

I appreciate the opportunity to have some input to this process. I sincerely hope the realization of how severe the consequences are to the different segments of our population will become part of the body of knowledge and inform the EPA discussion and work to keep us all out of harms way when it comes to radiation exposure. As our aggregate knowledge increases so too must our decisions based on that knowledge.

I think of the airline industry that has redefined individual weight guidelines because individuals today weight more on the average than they did in the past. We MUST pay attention to these things and take them into consideration as they come to light. The chances for exposure to women and children are greatly increased now after the cold war and as the world looks to nuclear power for its energy.

Please carry my input to the meeting. Thank you for your help in this matter.

tt) **Ms. L. Keir:**
This letter is to support the ICRP's "Reference Family" concept in the Enivironmental Protection Agency's Science Advisory Board's considerations this week. You may consider this as public comment.

For a decade, those of us on the Hanford Health Effects Subcommittee listened to public comment from site population survivors and soldier's and worker's families about the health effects of radiation. Infants, children, and pregnant women surely must be referenced, including their specific risk factors. The EPA's Radiation Advisory Committee as well as the Science Advisory Board, must be aware of the National Cancer Institute's long-delayed announcement that some US counties thousands of miles from weapons site releases have received multirad doses of I-131, as well as other radioactive isotopes.

Our Subcommittee was composed of scientists, industry and government officials, as well as tribal members and site population representatives. We met under the guidance of the Centers for Disease Control and the Agency for Toxic Substances and Disease Registry. We were very diverse in our views, but after heated discussion and much study, we agreed that all future production, testing, cleanup and transport of nuclear material a) must include independent, concurrent medical

and environmental monitoring; and b) risk estimates and assessments should reference models representative of the most sensitive among the populations affected.

Respectfully Submitted

Linda Keir, Member: Hanford Health Effects Subcommittee, 1995-2004

uu) **D. Boughton**

Unlike the vested interests of government and industry but like most citizens of the planet earth, I cannot attend the public hearing nor can I participate by phone but I do wish to be heard.

Unlike the vested interest of government and industry who are undoubtedly represented by "Reference Man" but like most citizens who are male or female and whose age can vary from birth until death and whose weight can vary from five pounds to several hundred and whose racial background can be varied and are not represented by "Reference Man," I request that "Reference Man" be abolished and a realistic representation be accepted.

vv) **Ms. J. Arends:**

Concerned Citizens for Nuclear Safety (CCNS), a Santa Fe-based NGO, has been monitoring and participating in the developments to eliminate the Reference Man and to encourage EPA to adopt standards protective of the most vulnerable: women, pregnant women, infants and children. In that regard,
CCNS requests:

1. The draft of the review of the EPA White Paper must be revised to explicitly recommend that the EPA abandon Reference Man and set standards to protect those most at risk, including pregnant women, infants, and children, with sex-specific risks factored in. Women face a significantly higher overall risk of getting cancer than men for the same exposure to radiation.
2. A conference call number that I could call so that I can listen to the discussion on the Radiation Advisory Committees review of the EPA White paper on radiation protection.

I may be interested in making a public comment during the call. I look forward to your response.

ww) Ms. C. Sullivan:

May I please have a conference call number to hear the discussion by the Radiation Advisory Committee of the EPA White Paper on radiation protection?

I have been reading the review draft and urge RAC to incorporate the following in its recommendations:

1) ---our improved knowledge about the greater health effects of low-level radiation in the fetus and in women. For example, 'Reference Man' must be retired as woefully erroneous for exposures to women, to the developing human fetus, and to reflecting the sex and age based character of radiation risk.

2) ---the urgent need to incorporate improvements to the ICRP model for early (to 3 months) effects of alpha and low-energy beta emitters on both cancer and morphogenesis endpoints in the human fetus. I urge RAC to consider this point as extremely important since nuclear power plants and the US nuclear weapons program have and continue to cause environmental contamination with the beta-emitting tritium.

3) ---the need to broadened the scope of low level radiation health impacts beyond cancer to non-cancer endpoints, (Zhores Medvedev, In The Legacy of Chernobyl, expresses the view that Chernobyl's ultimate health toll will be ~ 1/3 from cancer and ~ 2/3 from other diseases that defeat radiation-weakened immune systems).

Thank you, and again please let me know the phone number for listening to the conference meeting tomorrow the 5th of September.