

U.S. Environmental Protection Agency
Science Advisory Board
Radiation Advisory Committee (RAC)
Summary Minutes of Public Face-to-Face Meeting¹
September 26, 27 & 28 2006

Committee: Radiation Advisory Committee (RAC) of the U.S. Environmental Protection Agency's (EPA's) Science Advisory Board (SAB). (See Roster - Attachment A.)

Date and Time: 9:00 A.M. to 5:30 P.M., September 26, 2006; 8:30 A.M. to 5:30 P.M., September 27, 2006; and 8:30 A.M. to 12:30 P.M., September 28, 2006. (See Federal Register Notice – Attachment B)

Location: U.S. EPA, SAB Conference Suite #3700, 1025 F Street, NW, Washington, D.C. 20004.

Purpose: The purpose of this meeting was to conduct an advisory² on the Agency's draft White Paper, entitled "*Modifying EPA Radiation Risk Models Based on BEIR VII*," August 1, 2006, as well as to be briefed on ORIA activities and plan upcoming meetings of the RAC. The RAC will organize to begin the process of creating a draft advisory within the meeting in direct response to the Environmental Protection Agency's draft White Paper. (See Meeting Agenda - Attachment C.)

SAB/RAC Attendees: RAC Members for all 3 days: Dr. Jill Lipoti, RAC Chair, Dr. Bruce Boecker, Dr. Antone L. Brooks, Dr Brian Dodd, Dr. Shirley A. Fry, Dr. William C. Griffith, Dr. Helen A. Grogan, Dr. Richard W. Hornung, Dr. Jonathan M. Links, and Dr. Richard Vetter were present. (See Attachment A); Dr. K. Jack Kooyoomjian (Designated Federal Officer of RAC - in all three days), Mr. Richard Albores, and Dr. Vanessa Vu (in portions of each day) - SAB Staff Office, participated.

¹ NOTE: Please note that these minutes represent comments that are individual statements and opinions and are not necessarily consensus comments at this stage of the process in the review of any given topic. In all cases, the final SAB report to the EPA Administrator represents the consensus on the topic.

² See the December 21, 2005 minutes where the RAC was initially briefed by the Agency's ORIA staff on the proposed draft White Paper concepts in a face-to-face meeting of the RAC at Montgomery, AL, as well as the minutes of the September 6, 2006 public conference call where the RAC formally began this advisory activity.

Agency Staff Attendees: ORIA, Staff for all 3 days: Dr. Mary E. Clark, Dr. Jerome Puskin and Dr. David Pawel; Juan Reyes, U.S. EPA(9/26, 9/28); Stuart Walker, OSWER(9/26, 9/28)

Public Attendees: Dr. Roger Cooke, Senior Fellow, Resources for the Future, Washington, DC (9/26, 9/27 & 9/28); Mr. Joseph Moon, J.W.Moon Co.(9/26, 9/27, 9/28); Ms. Cindy Folkers, NIRS (9/26, 9/27, 9/28); Ms. Diane. D'Arrigo, NIRS (9/26); Ms. Judith Johnsrud, Sierra Club & NEC (9/26); Ms. Margaret MacDonell, Argonne National Laboratory (9/26, 9/27 & 9/28)

Attendees: (see Attachment C for Agenda participants, and sign-in sheets, Attachments C-1 & C-2.)

Meeting Summary: The discussion generally followed the issues and general timing as presented in the meeting Agenda (Attachment C) except where otherwise noted. (See Attachment S for mark-up of Agenda).

September 26, 2006:

Convene the Meeting:

Dr. K. Jack Kooyoomjian, Designated Federal Officer (DFO), opened the meeting at approximately 9:04 a.m. He introduced himself as the DFO for the Radiation Advisory Committee (RAC), explaining the purpose of the meeting, indicating that the RAC operates under the requirements of the Federal Advisory Committee Act (FACA) and is chartered to conduct business under the SAB Charter. He explained that, consistent with FACA and with EPA policy, the deliberations of the RAC are conducted in public meetings, for which advance notice is given. He explained that he is present to ensure that the requirements of FACA are met, including the requirements for open meetings, for maintaining records of deliberations of the RAC, and making available the public summaries of meetings, as well as providing opportunities for public comment.

Dr. Kooyoomjian also commented on the status of this Committee's compliance with Federal ethics and conflict-of-interest laws. The RAC follows the Committee and Panel Formation Process, as well as determinations made by the SAB staff and others pertaining to confidential financial information protected under the Privacy Act. Each committee member has complied with all these provisions; there are no conflict-of-interest or appearance issues for any of the Panelists, nor did any individual need to be granted a waiver or be recused. Dr. Kooyoomjian further noted that the Form 3110-48 Financial Disclosure and Ethics Training was completed by all RAC members and is on file at the SAB, that there is no need for disclosure, and that there is no particular matter that may pose a potential conflict of interest. He advised that the RAC members introduce themselves and their interests in relation to the White Paper Advisory. He also advised that the biosketches of each RAC member are posted on the SAB website and are available on the handouts area (see Attachment I).

Welcoming Remarks:

Dr. Vanessa Vu, provided some welcoming remarks, noting that this may be the first time that most of the RAC members have met in this new meeting facility in the SAB's Headquarters Building. Dr. Vu explained the process whereby the EPA Program Offices nominate projects through the EPA Science Policy Council, and the EPA/SAB Charter Board confers on the projects and selects those to be examined for the coming year. She indicated that Dr. Mary E. Clark, Assistant Director for Science on the ORIA Staff will introduce the topic. She then handed the meeting over to Dr. Lipoti.

Introductory Remarks, Review of the Agenda, and Introduction of Committee and Guests:

Dr. Lipoti, Chair of the RAC welcomed everyone, gave a brief introduction to the gavel that was hand-crafted by Dr. Bill Bair, a former member of the RAC. She passed around his letter describing the gavel and its unique composition (see Attachment R). Dr. Lipoti gave a brief status on the Quality Review Process of September 22, 2006 for the RadNet review, touching on who the reviewers were and the basic thrust of the comments. On balance, the Charter Board's remarks were complimentary of the work of the RAC's RadNet Review Panel.

Dr. Lipoti, by way of contrast to the RadNet review, felt that the current advisory activity on the Agency's draft White Paper will be more difficult and challenging. Dr. Lipoti pledged to bring the RAC's expertise to bear on building consensus, and urged the RAC members not to censor their comments simply because we have an audience. She also urged the audience not to leap to conclusions based on RAC members' statements during deliberations. She then asked each of the members of the RAC to introduce themselves, their experience as it relates to the topic at hand, and any special research interests in the topic, including that of their colleagues and institutions where they work or activities in professional societies and other affiliations related to the topic. She began the introductions with Dr. Dodd, and each member of the RAC introduced him or her self.

Introductory Remarks:

Overview of Agency Draft White Paper and Charge Questions:

Dr. Mary Clark, Assistant Director for Science introduced herself and the ORIA Staff. Mr. Juan Reyes is the new Director of ORIA's Radiation Protection Division (RPD). Mr. Reyes gave his academic and work background, noting his recent experiences with the Centers for Disease Control's (CDC) Environmental Health Program in RCRA and Superfund activities, and 3 years experience in the Homeland Security area.

Dr. David Pawel introduced himself as a Statistician in Jerry Puskin's group within ORIA. Dr. Puskin highlighted his academic experience at the University of Rochester, 3 years of employment at the NAS/NRC, and his work with the EPA since 1985 dealing with radiation

health risks of ionizing radiation. After these introductions, other participants introduced themselves, including Mr. Stuart Walker of EPA's Superfund Program, Ms. Cindy Folker of the Nuclear Information Service, Mr. Joseph Moon of J.W. Moon Co., Dr. Roger Cooke, Professor of Mathematics at Delft University of Technology of the Netherlands and currently at Resources for the Future, Inc. (RFF) in Washington, D.C. as the Chauncey Star Professor of Risk Analysis.

At 9:36 am Dr. Mary Clark gave an overview of the topic, providing highlights of how this advice will be incorporated into the current risk assessment into the Blue Book and subsequently into the revisions to Federal Guidance (FG) 13. She noted that the Blue Book, as well as FG-13 was previously peer-reviewed by the SAB/RAC.

At 9:45 a.m. Dr. Puskin began his presentation. (Refer to Attachment J, entitled "*RAC Advisory on White Paper: Modifying EPA Radiation Risk Models Based on BEIR VII*," a briefing by J.S. Puskin & D.J. Pawel, ORIA, Sept. 26, 2006). Dr. Puskin touched on the current EPA cancer incidence risk estimates and the proposed revised methodology, highlighting possible modifications and extensions. Dr. Puskin was asked to provide the context of how the EPA is going to use the risk assessments. Dr. Puskin touched upon the BEIR VII solid cancer models, the site-specific "central" estimates, the age-time patterns of excess relative risk (ERR) and excess absolute risk (EAR), the models for breast cancer, calculating lifetime attributable risk (LAR) and other related topics.

Dr. David Pawel touched on the standard population choices (page 7 of Attachment J briefing presentation) and the (LAR) for colon, lung and breast cancers for males and females. He touched on the incidence and mortality data updates and the BEIR VII method for combining models for projecting risk (p. 8 of presentation). He highlighted the proposed EPA method for combining models (p. 9 of presentation), and the age and time-specific patterns in ERR and EAR (p. 10 of presentation), and the EAR model for breast cancer (p. 11 of presentation). In calculating a LAR for lung cancer estimates (p. 12 of presentation), the latency period (L) is typically 5 years. The alternative method and options for calculating breast cancer mortality (p. 14 & 15 of presentation) was discussed. A question and answer (Q&A) session involved a discussion of deaths per unit dose in populations, as compared to individuals, the role of genetics, the White Paper and BEIR VII LAR projections for different sites (colon, lung, breast & bladder, prostate, and stomach) (p. 16 & 17 of presentation), leukemia and solid cancer projections for BEIR VII and the current EPA estimates, as well as those uncertainties that were quantified or were not quantified in BEIR VII..

BREAK - The participants took a break at 10:30 am and re-convened at 10:55 a.m.

Dr. Pawel resumed the presentation with a discussion of lung cancer projections (p.19 of presentation), touching on the differences between lung cancer for males and females, and smoking and lung cancer for U.S. and A-Bomb survivors (1964-1992). In the Q&A session, the RAC participants observed that the impact of cancer on women smokers in the A-bomb survivors is much lower than in comparable populations in the U.S., and infer that this phenomenon was partly attributed to temporal factors, because females in the U.S. may have started smoking much earlier. A discussion followed on the options for assessing risks from

medical x-rays (p. 21 of presentation) and the joint effects of smoking and radiation (p. 22 of presentation), with some of the RAC members observing that the effects of radiation and smoking appear to be multiplicative (rather than additive).

Dr. Pawel touched on the lung cancer risk estimates and a discussion followed of appropriate models. Breast cancer mortality projections based on the absolute risk (AR) model, (p. 25 of presentation) as well as alternative methods (p. 29 of presentation), were presented as options (p. 30 of presentation). Dr. Pawel discussed the current EPA (draft White Paper) and BEIR VII LAR projections (p. 31 of presentation), the uncertainties in low dose gamma-risk estimates, the uncertainties that were quantified in BEIR VII, including the LSS sampling errors, the transport from LSS cohort to the US cohort, the DDREF, as well as the uncertainties not quantified in BEIR VII, such as dosimetry in the epidemiological studies. Other topics discussed included the BEIR VII LAR for cancer incidence, as well as uncertainty for all solid cancers, alternatives for solid cancers, and other types of radiation.

In the discussions that followed, the RAC members observed that there are some uncertainties that can be objectively estimated, but there are others that are not so easily estimated objectively. It was thought by the RAC that EAR and ERR models should come out at the same place (before transport), but that after transport, they would be different, and that this is addressed in BEIR VII. Other types of radiation risks were discussed. It was thought that relative biological effectiveness (RBE) in laboratory animals may be different than that which may occur in humans. A discussion followed on options for assessing risks from medical x-rays, tritium, beta & alpha-particles. A discussion followed on data on the Mayak workers that inhaled large doses of plutonium.

Dr. Puskin summarized that the bottom line in real life shows inconsistency. The RAC took a lunch break at 12:35 p.m. and re-convened at 1:38 p.m.

At 1:38 p.m., Dr. Puskin compared the LSS and radon-derived lung cancer risk estimates (p. 45 of presentation). The exposures are different (acute vs chronic, gamma vs alpha, uniform vs non-uniform), and the models differ (age/temporal dependence, gender dependence, and interaction with smoking). A discussion followed on leukemia and bone cancer. A discussion took place on the following topics: pre-natal exposures (p. 47); terminology, where it was agreed that x-rays are low energy photons; skin cancer (pp. 48 & 49), and the difficulty in counting skin cancers - - - *Is each small spot a separate cancer?*

A discussion followed on thyroid cancer risk estimates (Charge 4, p. 50). BEIR VII and the draft NCRP report both use combined analysis of Ron et al (1995) to arrive at the ERR/Gy. For those younger than 15, arrived at the ERR at 7.7 Gy^{-1} . BEIR VII, but not NCRP, incorporated gender differences. There were no recommendations by BEIR VII regarding any adjustment factor for estimating risks from radionuclides. It is expected that NCRP will provide this.

Uncertainties in High-LET risk estimates (CQ #3, p. 51-54). For those uncertainties not quantified in BEIR VII, should EPA try to quantify uncertainties at low doses?

A discussion followed on the use of risk coefficients and supporting documentation by EPA (p. 55) and by others (p. 56). The RAC discussed how the Agency would use such information to set regulatory levels and regulations, etc., such as in the Superfund cleanups. The presentation and discussion was completed at 2:21 p.m.

Public Comments: At 2:21 p.m., Dr. Lipoti asked if there were any members of the public who wished to address the RAC. At this time, Dr. Roger Cooke, Senior Fellow at Resources for the Future in Washington, DC and a Professor of Risk Analysis in the Department of Mathematics at the Delft University of Technology in The Netherlands, identified himself. He provided verbal and written comments. Please refer to Attachment N-4, entitled “*Uncertainty in Radiological Risk Coefficients and Why it Matters (Regulating under Uncertainty)*,” by Roger Cooke and Margaret MacDonell (8 pages).

Dr. Cooke introduced the concept of retention fractions in various tissues over time, which he coined as “probabilistic inversion.” He discussed the limitations for existing risk coefficients, and the European Union (EU) approach of soliciting for expert judgement on observables and retention fractions. His contention is that sampling the same distribution in different ways can affect the outcomes from biokinetic models. Examples of fractional retention of Cerium, Strontium, and Ruthenium in skeleton and liver were provided, where experts’ quantiles were compared in a variety of ways. The example illustrates some take-home points, namely the following:

- 1) Different strategies for sampling the same distribution can have a substantial impact on the values selected, and
- 2) It is advisable to verify a sampling strategy by comparing with expert judgements on observable retention factors.

Dr. Cooke also presented the classic Newsboy problem of how many newspapers should he buy under uncertainty and selection of an answer given the loss rate ratios. He also discussed the procedure for regulating under an uncertain dose–response relationship, and radiological risk, and quantifying under uncertainty. He completed his comments at 2:41 p.m.

At 2:41 p.m., Ms. Diane D’Arrigo, Radioactive Waste Project Director of the Nuclear Information & Resource Service provided comments on the Agency’s draft White Paper and her contention that EPA’s proposal is to defy BEIR VII (See Attachment N-3). She made a plea for the SAB’s RAC to reject the draft White Paper, and discussed her point of view on LNT. She believed that BEIR VII did not scientifically conclude that thresholds are valid, and BEIR VII rejected claims that low doses are not dangerous. She also discussed her concerns regarding the implications of possible deregulation of mixed wastes and the relaxation of radiation protection standards. She cited Table 6 in the draft White Paper which compares proposed EPA and BEIR VII LAR calculations, citing a total of 28 comparisons in the draft White Paper. She had concerns that if this advice is followed, as proposed by EPA, that the public might be exposed to higher levels than what is recommended by the NAS BEIR VII Committee. She cited a study of cancer induction of radiation workers that is approximately 6 times higher. She noted that she shares the concerns of Mr. Lynn Ehrle for composition of the current RAC. She urges the

Committee to reject adoption of the Agency's draft White Paper, and urged adoption of the Precautionary Principle in dealing with uncertainty. Her presentation ended at 2:53 p.m..

Dr. Lipoti commented that the SAB RAC members are used to challenging each other. Some members take the "devil's advocate" position to make points, and that there is an opportunity for minority opinions as the Committee works toward consensus.

A RAC member commented that it would be helpful to the Committee to have comparisons of the draft White Paper to existing estimates, and not just BEIR VII..

At 2:58 p.m., Ms. Cindy Folkers of the Nuclear Information & Resource Service spoke (See Attachment N-3). She is not sure that the comparison suggested by the RAC member is a valid comparison, and that ... "*We as taxpayers, are owed an explanation to a lower expected standard.*" A RAC member commented that they believed that this is a very inflammatory charge, and that they believe to the contrary that EPA is moving toward a more protective standard by focusing on better understanding of the science issues.

At 3:03 p.m., Ms. Judith Johnsrud spoke. She did not have any written comments. Her comments were embodied in her verbal presentation. She indicated that she lives in Pennsylvania, and is speaking on behalf of the Sierra Club as a Senior Advisor on Radiation, as well as a representative of the New England Coalition (Nuclear Power Reactors in New England). Further, she noted that her comments are of a philosophical nature. She had the privilege of serving on DOE's low energy radiation program (as did Dr. Brooks, a RAC member) on low dose inputs. She is a Geographer concerned with Macro Issues. Ms. Johnsrud believes that questions are being raised that have profound impacts on radiation protection. She believes that we are in a situation where the nuclear industry plans to expand. At the same time, the ICRP may recommend a relaxation of the standards or permit an exclusion from regulatory control.

Ms. Johnsrud noted that in the past, the NRC has relaxed control on radioactive materials and prevention of individuals from being exposed. As she read the draft White Paper, in terms of other activities in ICRP, NCRP, which are "risk informed," she believes the term "risk informed" sets off a red light on manipulation of data and regulatory controls. She asked the RAC members and those present if they have heard the term, "Precautionary Principle." She thinks that we know enough about biological effects of radiation to exercise prudent caution.

Ms. Johnsrud also brought up the potential hazards of global warming and decline (scarcity of) in raw materials in our technological society. She remarked that while some of this may seem unrelated, it is her view and she believes that this is an opportunity to "speak severely" to the EPA in a way that it will improve protection of the public from the numerous worries upon the public, especially on those things that are unknown. In her view, it is far better to overdo it now (i.e., more protective standards), than to suffer the consequences later.

The public comments ended at 3:10 pm, and the Committee took a break.

NOTE: Mr. Lynn Howard Ehrle provided public comments via email to the SAB/RAC DFO, Dr. Jack Kooyoomjian, on 9/24/06 in the late evening, and they were received on 9/25 just prior to the meeting. Mr. Ehrle was not present at the public meeting. His comments were provided to the Committee and placed on the handouts table, along with other written public comments (See Attachment N-2).

Reconvene RAC and Continued Discussion:

Dr. Lipoti reconvened the Committee at 3:33 p.m., suggesting that the RAC needs to look at a few of the last slides in the Agency presentation (See Attachment J), and stressed that the RAC is here to help the Agency.

One Committee member asked for the Agency to explain how the “Blue Book” is used in the first place. Dr. Puskin explained that the Blue Book is a tabulation of the risk calculations and scientific justification for the risk estimates. It is a goal to have enough of the methodology transparent so that others could reproduce the numbers. The goal is to derive quantitative uncertainty bounds and quantify the uncertainty sufficiently well that it can be utilized in Federal Guidance 13 (FG-13). Information on food, water, air exposure of each age group category, gender specific information, etc. should provide sufficient information to calculate doses to each organ as well as doses throughout a person’s lifetime. Dr. Puskin noted that Dr. David Pawel, along with Rich Legett at Oak Ridge National Laboratory (ORNL) are putting together the risk estimates. Dr. Puskin further noted that they have uncertainty bounds by site from BEIR VII, and that there are ways to approach the uncertainty bounds for FG-13. Some of the uncertainty bounds are straight forward, but others are not.

Dr. Mary Clark noted that this advisory on the draft White Paper modifying radiation risk models based on BEIR VII is similar to the Radon Initiative, where the RAC reviewed a White Paper. She advised the RAC that we (the Agency) have more information in the draft White Paper than which exists in BEIR VII. We need to consider the alphas, betas, and different target organs and hundreds of radionuclides. One RAC member spoke up to formally recognize that both risk assessment and risk management must have interplay for the Agency to complete the exercise, and observed that there is no risk management in ORIA’s current request to the SAB’s RAC.

It was recognized that Dr. Roger Cooke’s presentation focused on how to use uncertainty in the risk assessment and risk management process. A discussion followed on the philosophical approaches in risk management, and the need to spend more time on adequately characterizing risk assessment in order for the Agency to be equipped to do a credible job in the risk management area. It was felt that there should be some guidance on the range of validity, particularly with applications in the Federal Guidance 13 area. A discussion followed on such items as the range of validity and relevance for the A-Bomb survivors data, and clarification of points relating to the calculation of lifetime attributable risk on page 7 of the Agency’s draft White Paper. The scenario was posed where changing the number might have little impact on risk, and where it may not make much of a difference on the decision to be made.

A discussion followed on the merits of whether the incidence and mortality rates should

be extrapolated, and what happens to the risk per unit dose for the people that are survivors. It was postulated that tumors get to be in the 100% range for exposed individuals who reach 100 years old (perhaps less than 1% of the population). A discussion followed on how to calculate the total cancer for a specific risk/year and what this might achieve, as well as how this risk reflects on the stationary population, and how the Agency's numbers would be lower than the BEIR VII estimates. It was thought it would be useful to clarify risk per unit intake. The Committee recognized that uncertainties and caveats need to be looked at on the overall strengths and weaknesses. For instance, it was also thought that the method to calculate breast cancer mortality risk should account for the relatively long time from detection until death (CQ 2e).

At 4:42 pm a discussion followed on CQ #2f pertaining to proposed approaches for extending risk estimates to radiations of different LET's, and 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. In this case, the Agency is citing data that was not available during the BEIR VII review. A brief discussion also took place on CQ #2g pertaining to estimation of risks for sites not specified in BEIR VII, specifically bone and skin, for which the Agency proposed to update their current approaches. A brief discussion followed on CQ #2h on estimation of risk due to prenatal exposure.

A discussion followed on CQ #3 dealing with BEIR VII quantitative uncertainty bounds for each of its risk coefficients. The Agency proposes to adopt this methodology with some additional discussion of the uncertainties not quantified in BEIR VII.

A discussion followed on CQ #4 dealing with radiogenic thyroid cancer. While this matter was discussed briefly, it was concluded by the RAC that providing advice in this area would seem to be premature, especially since there is a major review currently under way by the National Council on Radiation Protection and Measurements (NCRP). There was a thought that the RAC could bring in Dr. Henry Royal as a speaker to make presentations to the RAC, and it was also noted that Dr. Lynn Anspaugh, a past RAC member was involved with the NCRP on this topic.

The Committee recognized that a discussion on CQ #1 dealing with incidence models for cancer sites for calculating the risks from low-dose low-LET radiation needs to take place.

There being no further business to discuss for today, Dr. Lipoti adjourned day 1 of the meeting at 5:28 pm.

September 27, 2006:

Convene the Meeting:

Dr. K. Jack Kooyoomjian, Designated Federal Officer (DFO), opened the meeting at 8:45 a.m. As with yesterday's meeting, he introduced himself as the DFO for the Radiation Advisory Committee (RAC), explained the purpose of the meeting, indicating that the RAC operates under

the requirements of the Federal Advisory Committee Act (FACA) and is chartered to conduct business under the SAB Charter. He explained that, consistent with FACA and with EPA policy, the deliberations of the RAC are conducted in public meetings, for which advance notice is given. He explained that he is present to ensure that the requirements of FACA are met, including the requirements for open meetings, for maintaining records of deliberations of the RAC, and making available the public summaries of meetings, as well as providing opportunities for public comment.

Members of the public introduced themselves. This included Ms. Cindy Folkers of the Nuclear Information and Resource Service, as well as Mr. Joseph W. Moon, President & CEO of J.W. Moon Co, Inc. Ms. Margaret MacDonell of Argonne National Laboratory and Dr. Roger Cooke of RFF were present, but chose not to comment on September 27, 2006.

Dr. Lipoti, Chair of the RAC opened discussion at 8:48 am with the topic of planning the day's activities. She opened the floor to the RAC members for discussions on issues they wish to raise as the RAC undertakes the day's activities. The Committee members offered a number of points that they thought should be touched upon, such as LAR's and uncertainty ranges, updating the SEER data to bring to bear "better science," and under what conditions should we change the BEIR VII methodology, especially when and where the Agency should or should not use data when the numbers might be very close or the same to the BEIR VII estimates. The RAC members thought it would be helpful to discuss under what conditions they should try to recognize and resolve "friendly" scientific disagreement and to understand and appreciate the differences in the philosophical approach and the scientific approach to BEIR VII.

It was recognized by the Agency staff that small changes in BEIR VI (not BEIR VII) were done previously, such as adjustments to re-calculate risk for the U.S. population. The question is" *On what basis do we change from the BEIR VII recommendation?*"

The Agency staff explained that the Agency needs to be able to say what the technical rationale is, especially when the Agency contemplates changes from the BEIR VII recommendations. For instance, there are more recent data than what was available to the NAS BEIR VII Committee.

One part of BEIR VII that may be controversial is the use of the "single hit" biophysical model, which some scientists may view as outdated. In the 1990's the Agency used the ICRP model. The Agency wants the SAB/RAC to review the NAS' BEIR VII report and to comment on the Agency's rationale in refining the BEIR VII recommendations. Clearly, there are some areas where the SAB/RAC has more expertise than the ORIA staff, and the SAB/RAC could comment on the proposed methodology and rationale. Another area that the SAB/RAC could offer assistance is to comment on the effect of combined uncertainties consistent with EPA's responsibility pertaining to regulation of radionuclides and environmental contaminants, and how this may apply to Federal Guidance 13 for advice. This may also be helpful for recommendations on exposure of the general public to medical uses of x-rays.

There was a sense that the SAB/RAC could convey to the Agency's ORIA Staff how the

uncertainty estimates could be made more explicit and clearly understood. The RAC felt that it could reasonably address if the method proposed by ORIA is acceptable, the best way, the least acceptable way, or if there were one of several alternatives to consider. The RAC members discussed other complicating factors and how some other issues might factor into a weighting scheme.

The Committee covered CQ #2a through CQ #2h pertaining to the modifications and extensions to the overall approach as described in BEIR VII.

The Committee took a break at 10:30 am, and reconvened at 10:45 am for a discussion of assignments and a writing session. While the Committee took a Lunch Break at 11:45 am to 1:00 pm, they also conducted a writing session at this time.

Reconvene - - -1:30 pm:

The Committee reconvened at 1:30 pm, and Dr. Lipoti began with a discussion of CQ #1 dealing with the BEIR VII incidence models for many cancer sites as a basis for calculating the risk from low-dose, low-LET radiation. Discussions covered a broad range of topics and issues, including dose, RBE, tissue sensitivity, population versus individual risk, the average individual versus the specific individual, what we mean by the term “average” individual within a group, regulatory levels for non-carcinogens, how EPA is driven by various laws, sensitivity of specific groups of individuals, what is meant by the hypothetical population (or “standard” or “statistical” or “stationary” population), where the number of people of each age are proportional to the survival function, and the probability that each person lives to the age of 70 years.

A discussion took place on CQ #2b pertaining to the issue of updating using more recent SEER data. With regard to CQ #2d on the lung model for cancer risk, it was thought the a sensitivity analysis would be helpful. It was also observed by the RAC members that smoking and radiation interaction should be discussed.

For CQ #2g, pertaining to estimation of risks for sites not specified in BEIR VII, specifically bone and skin, it was thought that the estimation of risks for skin cancer is qualitatively a different disease. The logic is driven by mortality and not incidence. A discussion followed on the SEER data not counting incidence. A discussion followed on such items as non-melanoma skin cancer.

A discussion followed on CQ #2f pertaining to proposed approaches for extending risk estimates for radiations of different LET's based on models derived from the A-bomb survivors who were primarily exposed to gamma rays. It was thought that the suggested approach might be compatible with the data. It was noted that the ICRP lung model was constructed for it to be compatible with radon. A question was asked about the leukemia issue, and it was thought that as long as the RBE is low, that will never be the predominant issue. It was not clear exactly what to do with CQ #2f.pertaining to x-rays at this time.

At 2:47 pm, the Committee discussed CQ #2h pertaining to estimation of risk due to

prenatal exposure. It was observed that there is not much epidemiology in this area, but the radio-biology is fairly significant. Some discussion took place suggesting that the numbers would be close to the Oxford Study. Also, it was suggested that some of CQ #2h will go into CQ#2f, and that CQ#2h will refer back to CQ#2f.

The Committee took a break at 3:00 pm and re-convened at 3:30 pm with an invitation for public comments.

Public Comments:

At 3:30 pm, Dr. Lipoti called for public comments.

Mr. Joseph Moon, a Certified Health Physicist provided personal comments and observations as a member of the public and from his perspective as a Certified Health Physicist. He remarked that wished he had a video camera of expressions from the biostatisticians on the Committee. He felt that to capture the truth is almost impossible, truth being almost like water. It takes the shape of the container it is poured into. The smaller the vessel, the easier it is to get consensus. Mr. Moon supports Dr. Dodd's suggestion to look at real field data. He has used dose factors (not the risk factors). He strongly cautioned the Committee to look at risk factors before they convert it to units. He viewed this Committee as the "last guardian of truth," as to what is being presented to the government. Mr. Moon spoke with respect to incidence versus mortality that we want to focus our minds on is incidence of cancer as a key driver - - not dying from it (i.e., mortality). It was his opinion that no insurance or advanced medical care that could save a life translates to mortality. He is particularly concerned about the incidence of breast cancer of 35% in the latest census data, observing that this may be a result of increased screening, but increased LET exposure may also be a contributing factor.

Mr. Moon was concerned about slide #21 showing U.S. Lung Cancer 20 times higher on smokers than non-smokers. In contrast, the A-Bomb data shows 8 times higher. At this point, Dr. David Pawel of the ORIA Staff Office explained the genesis of the data and what was being demonstrated.

At 3:42 pm, Ms. Cindy Folkers of the Nuclear Information Resource Service (See 9/15/06 written comments in Attachment N-5) dove-tailed Mr. Joseph Moon's comments on breast cancer. She asked pertaining to CQ #3 pertaining to uncertainties not quantified in BEIR VII, ...*"Who is going to be the one that defines the errors and defines what is considered a loss?"* She would like a number associated with those doses that are below the range. She had some criticism on the epidemiology studies, as well. She cited the IARC study of children's cancer from Chernobyl. She doesn't think the Chernobyl study was scientifically sound, because they (the researchers in Russia & Belarus) insisted that the increase in childhood leukemia was **not** related to radiation exposure. She believes that we may be missing genomic effects and bystander effects. She believes to protect society, we should protect those who are least able to protect themselves from radiation (fetus, child). Ms. Folkers observed that we do not know a lot about synergistic effects (e.g., radiation, caffeine, heavy metals, dioxin, etc.) She cited the SEER data where out of 42 people, one (1) gets cancer.

At 3:52 pm, Ms. Folkers discussed some of the ICRP issues. She noted that the baseline that we are working from may not be the real baseline, and she would protect to the highest ability to exercise precaution. Also Mr. Joseph Moon discussed the use of Federal Guidance FGR-11(not FG-13).

NOTE: Ms. Margaret MacDonell of Argonne National Laboratory was present, along with Dr. Roger Cooke from RFF, but they chose not to comment today.

There being no additional comment to be offered by the public, the public comment period closed at 4:00 pm.

Continued Discussion:

At 4:00 pm, a discussion took place on CQ #3 pertaining to the Agency's approach to deal with uncertainties not quantified in BEIR VII. The Committee generally agreed with the Agency's goals and thought of conceptualizing uncertainties in terms of relative and absolute risk. The Committee thought it might also be sensible to have two confidence intervals, and that "the truth," independent of the confidence limits might lie somewhere in between. It was thought that the uncertainties are dose-dependent.

It was thought that low-dose extrapolation is the range of greatest uncertainty and lacks good, solid epidemiological data. It was observed by the Committee that you can't simply extrapolate from the high dose situation. There was a brief discussion on bystander effects. It was observed that low dose radiation activates a different set of genes. There is a real dose-dependence on what set of genes are actually turned on. The ORIA Staff reminded the RAC members that the Agency did not ask the SAB/RAC to calculate risks at low doses. The ORIA Staff were looking to acknowledge uncertainties qualitatively and to obtain some rationale as a work in progress. The ORIA Staff suggested that the basic premise is not to make changes to BEIR VII, unless they (the ORIA Staff) can articulate the recommended change in a more compelling argument. The Committee clarified that they are looking toward the central risk estimate in answering the charge questions for the Agency, that is, the expression of uncertainty around the point estimates. The Committee is not saying to change the LNT (Linear Non-Threshold) model. The issue is how one calculates small risk numbers by large populations, and where such risks are sometimes real. What we know about the biological model is helpful, but not compelling.

There being no additional business to discuss, Dr. Lipoti ended the discussion at 5:00 pm.

Dr. Mary Clark advised the Committee that Mr. Juan Reyes, the ORIA Indoor Environments Division Director, will be back tomorrow (9/28/06). She discussed briefly the EPA organizational chart.

There being no additional business to discuss, the Committee adjourned at 5:10 pm.

September 28, 2006:

Dr. Kooyoomjian, the SAB/RAC DFO convened the meeting at 8:40 am with brief opening remarks pertaining to this as a continuation of the public meeting of September 26 and 27, 2006. At 8:45 am he turned the meeting over to Dr. Vanessa Vu, SAB's Staff Office Director for some brief remarks. Dr. Vu thanked the Committee for taking the time to conduct this advisory, and commented that the Committee will also have the opportunity to engage in an upcoming MARSAME review, which was prepared by a Multi-Agency Workgroup.

At 8:47 am, Dr. Lipoti provided brief opening remarks summarizing the current status of the Committee's response to the Charge Questions, and particularly revisions to CQ #3 dealing with uncertainties not quantified in BEIR VII. Dr. Lipoti summarized the CQ #2 (2a through 2h) writing assignments. The Committee discussed some of the issues needing to be resolved as they proceed with their writing assignments, and used this opportunity in the face-to-face setting to discuss openly with the public present what issues are of concern with each CQ assignment and how they would propose to tackle their writing assignments.

For the discussions on CQ #4 dealing with issues relating to radiogenic thyroid cancer not quantified in BEIR VII, the Committee concluded that they should not venture into this exercise until the NCRP report on thyroid cancer is available.

There was a sense from the Committee that they were comfortable recommending that the Agency ORIA Staff Office should follow the advice contained in BEIR VII, unless they find a particular study that has significant merit.

Updates on Proposed Advisory Activities for FY 2007: At 9:32 am, Mr. Juan Reyes, Director of ORIA's Radiation Protection Division, gave an update on proposed advisory activities for FY 2007. He noted that sometimes the Agency staff have to take the science that sometimes is not complete to make a decision. He simply reflected that this is decision-making in the "real-world," which has to take place in the absence of perfect information. As such, guidance for many practices at the state, local and federal levels must be developed.

At 9:36 am, Dr. Mary Clark, Assistant Director for Science in ORIA, touched on the upcoming request by the Agency for the SAB to review MARSAME (the Multi-Agency Radiological Survey and Assessment Manual on Materials and Equipment). She reflected on the fact that the SAB/RAC reviewed MARSSIM approximately 10 years ago (EPA-SAB-RAC-97-008, September 30, 1997). One of the suggestions of the SAB/RAC was that the MARSSIM is not complete without developing various supplements. The SAB/RAC suggested developing a supplement dealing with Materials and Equipment, as well as a supplement dealing with subsurface soils (MARSAS).. The SAB/RAC also reviewed MARLAP (Multi-Agency Radiological Laboratory and Analytical Protocols). Dr. Clark noted that the Agency staff is committed as a part of the Multi-Agency Work Group to do the MARSAME update to the MARSSIM as a part of the supplements and bring this back to the SAB/RAC. She stressed that

every federal agency, department and commission has to sign off on the public draft. It is planned that the MARSAME Draft Document will be noticed in the **Federal Register** to the public around January 2007. At that time, the SAB could solicit for nominations for forming the specialty panel to review MARSAME. She also noted that the Agency has a commitment to bring the draft revised Agency Blue Book containing the risk assessments for the individual radionuclides back to the SAB/RAC for a formal review.

Mr. Richard Albores, Deputy Director for Management within the SAB Staff Office postulated that the RAC's newly-formed MARSAME Review Panel would likely have one face-to-face meeting for MARSAME. Probably the SAB/RAC review of the Blue Book will occur sometime in FY 08. Dr. Lipoti stressed that there is an important decision point to be made here, and she thinks that with the topic of reviewing the Agency's draft Blue Book, the SAB/RAC through its specialty panel that would be formed will need at least two conference calls to wrap up this activity, noting also that the SAB/RAC may not take a position just yet on thyroid cancer.

Continued Panel Discussion of Agency's Draft White Paper:

A Committee discussion followed on the appreciation of the need for the Agency to make decisions, even in the absence of information. However, the Committee observed that the question of "What is the most scientifically defensible way to make that decision?" must be asked. This must be done both as a mid-course correction, as well as to provide the opportunity to continually challenge the assumptions.

At 10:07 am, the Committee discussed CQ #3 draft materials. They discussed such topics as sources of the uncertainty bounds, treating sources of uncertainty independently, recognizing the complication that some of the dosimetry errors of the A-Bomb survivors have not been published as yet, temporal patterns that might be looked at, the sampling, transport, and other errors in dosimetry, as well as diagnostic mis-classifications, the many cases where extrapolation models could be used, and the need to consider some text focusing on the sources of uncertainty. It was thought that some statements of fact about what we know or don't know at low doses would be helpful. It was further thought that a cautionary note would be helpful on application of risk estimates in very low dose settings

Discussion occurred on the suggestions offered following the publication of BEIR VII. and whether this new information is compelling enough to suggest something different from the BEIR VII recommendation.

BREAK: The Committee took a break at 10:36 am and re-convened at 11:12 am.

Continued Panel Discussion of Agency's Draft White Paper:

The Committee discussed CQ #2e on the method for calculating breast cancer mortality risk, accounting for the relatively long time from detection until death. It was observed that there is the potential of developing secondary or spontaneous cancers because of the therapeutic treatment received. Discussion followed on the lag time between incidence and mortality, with

the 20 years being used by ORIA perhaps as being too long a lag time. It was thought that a more biologically or clinically-based lag time would be more helpful. The Committee basically agreed with ORIA's application of the BEIR VII model with application of the retrospective survival rates. It was recognized by the Committee that there are subsets of genetic susceptibility for breast cancer, and the Agency's proposed approach was recognized as an enhancement to BEIR VII.. The Agency draft White Paper assumed a distribution of lag times. It was felt that the language could be more clear on this, and that using the distribution of lag time is worth exploring. The Committee leaned to the guidance that if the Agency was to do something different than what was presented in BEIR VII, it should be on the basis that there is "compelling evidence."

The Committee took a little time to coordinate their calendars and to schedule a public conference call for Friday November 10 from 12:00 noon to 3:00 pm.(POSTSCRIPT: Due to a Federal holiday on November 10th(Veteran's Day of 11/11, but observed on 11/10), the Committee later had to be re-pollled and a new date of November 28, 2006 was established for the public Conference Call).

At 11:45 am, Dr. Vu discussed briefly the types of reviews that the SAB conducts, touching on what is involved with consultations, advisories, reviews, letter reports, etc.

Public Comments: At 11:51 am, Dr. Lipoti invited any member of the public to offer comments. At this time, Dr. Roger Cooke, Senior Fellow, Resources for the Future, Washington, DC commented on uncertainty quantification, and why we know what we know. He discussed internal dosimetry, calibration variables, and that some people object to the use of "expert judgement." He remarked that the ability of people to quantify uncertainty is very uneven. He postulated that one approach that he felt is more objective is to construct performance-weighted averages. He discussed themes of fitting models, raising expert awareness, and "objectifying" subjectivity. He strongly supported EPA's efforts to quantify uncertainties. He ended his comment at 12:02 pm.

Dr. Vu commented briefly that the Agency has developed a White Paper on Expert Elicitation.

At 12:02 pm, Ms Cindy Folkers, of the Nuclear Information Research Service (NIRS) mentioned the comparison chart of existing EPA risk numbers and BEIR VII, and stating that this chart should be made available to the RAC and the public. Dr. Kooyoomjian, the RAC DFO indicated that he will make this available to the public by posting it on the SAB Web site, and the Committee may also decide to incorporate it into the SAB/RAC advisory. Ms. Folkers discussed the tritium RBE numbers, leaking tritium, the tritium papers in which it was recommended that the RBE should be 3, and noting that as a matter of safety and precaution, that it might be higher. She advised that if the Agency doesn't go with the higher number, the public may not like this result. She made a broad statement that history has been on the side of making regulations more protective. She noted that historically those risk numbers have risen, especially with cancers. She thanked the Committee for the opportunity allowing the public to comment,

and ended her comments at 12:08 pm.

At 12:08 pm, Mr. Joseph Moon of the J.W.Moon Co. offered some comments from the perspective of a radon professional. It was his observation that the issue of tritium has been and will be very much in the public's awareness (e.g., NEI, EPRI). He cited Connecticut Yankee as well as the Yankee Rowe tritium plume. He also cited the tritium problem with nuclear plants with heavy water in Canada, which was relatively unknown in the past. He cited the problems of leaking fuel and that exposed concrete absorbs C14 and poses problems in decommissioning once an entire concrete mass is contaminated. He wondered if there is a consensus opinion to lower RBE on the ground water standard. He ended his comments at 12:12 pm.

Dr. Lipoti thanked Mr. Moon for his comments, and briefly responded that his concern relating to decommissioning is outside the SAB/RAC's charge for this exercise. The ORIA staff offered the follow-up comment that an increase in the tritium risk would not necessarily translate to a higher standard.

At 12:12 pm, Mr. Stuart Walker of the EPA Superfund Program discussed taking slope factors and plugging them into the models, noting that the new science in Federal Guidance 13 (FG-13) is being applied for such things as Superfund site cleanup decisions.

Dr. Lipoti asked if there was anyone else who would like to comment. There being no additional members of the public who wished to speak, the comment period ended at 12:14 pm.

Concluding Remarks and Adjournment:

At 12:14 pm, Dr. Lipoti offered brief concluding remarks. She thanked the EPA Staff for their collegial exchange. She also thanked Dr. Vu and Dr. Kooyoomjian for their hospitality and providing a forum for productive dialogue in the SAB conference facility. There being no further business to discuss, the meeting was adjourned at 12:15 pm.

Respectfully Submitted:

Certified as True:

_____/S/_____
K. Jack Kooyoomjian, Ph.D.
Designated Federal Official
Radiation Advisory Committee (RAC)

_____/S/_____
Dr. Jill Lipoti, Chair
Radiation Advisory Committee (RAC)

LIST OF ATTACHMENTS

<u>Attachment</u>	<u>Description</u>
A	Radiation Advisory Committee (RAC) Roster
B	<u>Federal Register</u> Notice: August 9, 2006, Vol. 71, No. 153, pages 45545-45546
C	Meeting Agenda for September 26, 27 and 28, 2006 (Aug 29, 2006 draft)
D	Mailout Dated August 3, 2006 Containing Memo from K. Jack Kooyoomjian, Ph.D., DFO RAC to RAC Members entitled "Hard Copy of BEIR VII Phase 2," containing the following:
D-1	<u>"Health Risks from Exposures to Low Levels of Ionizing Radiation, BEIR VII Phase 2,"</u> National Research Council of the National Academies, The National Academies Press, Washington, DC, 2006
E	Agency Request for Advisory from Elizabeth A. Cotsworth, Director, Office of Radiation and Indoor Air (ORIA) to Vanessa Vu, Director, SAB Staff Office, dated August 31, 2006 and entitled " <i>Advisory Review of the Draft White Paper: Modifying EPA Radiation Risk Models Based on BEIR VII.</i> "
F	Email Review Information and Review Package dated August 3, 2006 from K. Jack Kooyoomjian, Ph.D., DFO/RAC to RAC Members entitled "Review and Background Materials for Draft White Paper Advisory Entitled "Modifying EPA Radiation Risk Models Based on BEIR VII," and containing the following:
F-1	Charge to the Science Advisory Board's Radiation Advisory Committee on Draft White Paper ((racwhitpaperchargefinal.doc),
F-2	"Modifying EPA Radiation Risk Models Based on BEIR VII, Draft White Paper," Prepared by Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, August 1, 2006 (White Paper8106.doc),
F-3	Draft Federal Register Notice announcing the Sept 6, 2006 public conference call and the September 26,27, & 28, 2006 public meeting (RAC WhitePaper_FRN RevDft072006Jack Rev4.rtf.,
F-4	RAC Roster(RAC 07IntRoster05032006.rtf)

Attachment

Description

- G Email Review Information and Review Package dated August 29, 2006 from K. Jack Kooyoomjian, Ph.D., DFO/RAC to RAC Members, entitled “Pertaining to the Advisory of the Agency’s Draft White Paper Entitled ‘Modifying EPA Radiation Risk Models Based on BEIR VII’ “ Working Review Draft #1 Dated March 9, 2006 & FR Notice,” NOTE: The current package contains the following:
- G-1 The Agenda for the September 6, 2006 Public Conference Call (File Name: RACWhite PaperPubAgenda090606.pdf),
- G-2 The Proposed Agenda for the September 26-28, 2006 Face-to-Face Public Meeting of the RAC (File Name: RACWhite PaperPubAgenda092606.pdf), and
- G-3 The August 3, 2006 Memo containing the Draft White Paper Charge, the Draft White Paper, the *Federal Register* Notice, and the RAC’s Roster
- G-4 The *Federal Register* notice announcing the September 6, 2006 public conference call and the September 26, 27, & 28, 2006 public meeting
- H Radiation Advisory Committee Pre-Meeting Comments on “Beyond the Charge’ for U.S. EPA/SAB/RAC Public Meeting September 26-28, 2006:
- H-1 Brian Dodd Email of 9/6/06 entitled “Beyond the Charge,” and
- H-2 Jonathan Links Email of 9/15/06 entitled “Beyond the Charge Issue.”
- I Biosketches of Radiation Advisory Committee
- J RAC Advisory on White Paper: Modifying EPA Radiation Risk Models Based on BEIR VII, a briefing by J.S. Puskin & D.J. Pawel, ORIA, September 26, 2006,
- K REFERENCES PROVIDED IN MEETING (9/27/06):
- K-1 Email from Ethel Gilbert to J. Puskin, ORIA,
- K-2 Article by R. Doll and R. Wakeford entitled “*Risk of childhood cancer from fetal irradiation,*”*The British Journal of Radiology*, Feb, 1997,
- K-3 Article by Kocher, Apostoaei and Hoffman entitled “*Radiation Effectiveness Factors for Use in Calculating Probability of Causation of Radiogenic Cancers,*” *Health Physics Society*, Vol. 89, No. 1, July 2005
- L RADIATION ADVISORY COMMITTEE (RAC) MATERIALS PREPARED DURING MEETING (9/27 & 9/28/06) IN RESPONSE TO THE CHARGE QUESTIONS:
(See Attached Sequenced by Charge Question Number)

Attachment

Description

- M REQUESTS FOR PUBLIC COMMENT AT U.S. EPA/SAB/RAC PUBLIC MEETING SEPTEMBER 26-28, 2006:
- M-1 Summary of Organizations, Communications, Requests pertaining to EPA/SAB/RAC Advisory on Agency's Draft White Paper Public Meeting
- M-2 Joseph W. Moon Correspondence 9/15/06,
- M-3 Diane D'Arrigo Correspondence 9/19/06,
- M-4 Roger M. Cooke, 9/21/06(and Margaret MacDonell attached correspondence 9/5/06)
- M-5 Lynn Howard Ehrle : DFO Response of 9/25 to Mr. Ehrle's Comments on White Paper (Cover Sheet Only. Refer to Public Comments Attachment N for full data sets)
- N PUBLIC COMMENTS:
- N-1 Written Public Comment Summary Sheet on Agency's Draft White Paper,
- N-2 Public Comments by Lynn Howard Ehrle,
- N-3 Public Comments by Mr. Dan Hirsch, Committee to Bridge the Gap, Ms. Diane D'Arrigo, Nuclear Information & Resource Service, and Ms. Michele Boyd, Public Citizen,
- N-4 Public Comments by Dr. Roger Cooke, Resources for the Future (RFF) and Delft University of Technology, and Ms. Margaret MacDonell, Argonne National Laboratory, and
- N-5 Comments of the Nuclear Information & Resource Service Prepared by Ms. Cindy Folkers
- O PUBLIC CORRESPONDENCE:
(Pre & Post Meeting Correspondence)
- P COMMITTEE CORRESPONDENCE:
(Pre & Post Meeting Correspondence)
- Q MISCELLANEOUS AND ADMINISTRATIVE
CORRESPONDENCE:(Pre & Post Meeting Correspondence)
- R CORRESPONDENCE FROM W.J. BAIR TO K.J. KOOYOOMJIAN RE RAC GAVEL, October 22, 1999
- S DFO's Marked-Up Agenda of 09/26/06 TO 9/28/06 Public Meeting (K. Jack Kooyoomjian)
- T DFO's Notes of 09/26/06 to 9/28/06 Public Meeting

End of Record