Hollister
(Revised to 4/11/57)

OUTLINE FOR OPEN HEARINGS:

"THE NATURE OF RADIOACTIVE FALLOUT AND ITS EFFECTS ON MAN"

May 27 - June 7, 1957

I. Introduction (Oral presentation only, by Dr. Dunham)**

A brief discussion for orientation, covering the following subjects:

A. The general nature of radioactivity and radiation.

B. Why radioactivity and radiation are associated with nuclear energy

C. General aspects of man's relationship to radioactivity and radiation from all sources

D. The general nature of the biological effects of radioactivity and radiation

E. The possible impact of developing and using nuclear energy on the health of individuals and on the health and welfare of the population as a whole

F. Some factors that might be considered in making a decision as to whether or not the hazards associated with radiation and radioactivity are worth risking to try to get the benefits expected from developing and using nuclear energy

** To be preceded by opening statement by Mr. Holifield to orient for the record the purpose and scope of the Hearings

II. Some Background Information on Radioactivity and Radiation (Primarily oral, brief but clear, with possibly some supplementary written discussions and some bibliographical notes) (Probably oral presentation by AEC-designated person, preferably a physicist or equivalent)**

A. The nature of radioactivity and radiation

B. Mass, radiation, and energy

C. Quantum and corpuscular radiation

1. Energy relationships, the radiation field, definition of roentgen

D. Reactions of radiation with matter

1. Ionization and energy transfer (Bibliography)

a. Definitions, quantitative relationships

b. Specific ionization--definition and note on importance

c. Chemical and physical changes

2. Penetration, absorption, attenuation, etc. of radiation

a. Definitions, quantitative relationships

3. Induced radioactivity

4. Secondary radiations

E. The phenomenon of radioactive decay

1. Modes of decay

2. Definitions of half-life, average lift, decay constant, curie, relation between mass, half-life, and curie quantity

JCAE

F. Neutron radiation--special characteristics

** Dr. G. V. Beard, Division of Biology and Medicine, in probably available.

G. Description of neutron fission and neutron chain reaction

1. Fission, number of neutrons released, energy spectrum of neutrons, prompt and delayed neutrons

2. Energy release associated with fission, distribution of released energy by nature (radiation, kinetic, potential, etc.) primary and secondary fission energy

3. Fission products; yield vs. mass number; physical and chemical properties, emphasizing such points as particle size, vapor condensability, and water solubility

   a. Radioactive decay of mixtures of fission products, the simple models used

H. Description of nuclear fusion and thermonuclear processes

1. Contrast fusion and fission, for example in terms of energy and neutron release per unit weight of material consumed

2. Products and energy produced, including neutrons, gamma and alpha particle production

3. Radioactivity of fusion products

J. Particle accelerators and their role in producing radiation and radioactivity

1. The potential radiation hazards associated with accelerators

III. The Production of Controlled Fission and Fusion Reactions and Their Potential as Hazards (Oral, no written supplement, no bibliography)

A fairly brief discussion for orientation, as follows:

A. Controlled fission reactions (Manson Benedict* or Mark Mills)

1. Types and characteristics of neutron chain reactions

a. Slow, resonance, and fast

2. Prompt and delayed neutrons and their role in control

3. Other characteristics of these reactions that lend themselves to application for control

3. Other characteristics of these reactions that lend themselves to application for control

4. Characteristics of reactors

a. Research, test, power, production

b. Liquid and solid fuel

5. Sources of radiation and radioactivity hazards from reactor operation (Bibliography, recent AEC report) and associated chemical processing and waste disposal

B. Controlled fusion reactions (Arthur Ruark* or Dr. Tuck, or Dr. Teller)

1. Contrast control problems with fission reactors

2. Compare as potential source of radiation and radioactivity hazards

a. Time schedules

b. Possible relationship to over-all electric power supply situation

JCAE

* Probable choice

IV. The Natural Occurrence of Radioactivity and Radiation (Oral, written supplements as needed, extensive bibliography) (Dr. Warren Weaver) **

A review and discussion of this topic, citing as appropriate such recent treatments as appear in the National Academy reports, the U.K. Medical Council report, the World Health Organization report (selected by Sievert), the Government of India study, the statement by Warren Weaver (Hearings, Foreign Relations Subcommittee, January 16, 1957), the British Journal of Radiology (29, pp. 409-417, 1956)

A. Naturally occurring radioactive materials and decay products on land and water

B. Cosmic radiation, effect of altitude

C. Spontaneous fission and induced radioactivity

D. Amount of radioactivity present in man before weapon firing began

E. Measurement methods and limitations of the data

JCAE

** Tentative

V. The Production of Radiation and Radioactivity with Nuclear Weapons (Oral, written supplements as needed, bibliography) (Gen. Starbird** or AFSWP)

A. Description of nuclear weapon

1. Differentiation by type from the point of view of fallout effects, both local and delayed (related also, of course, to type of detonation)

a. Fission weapon

b. Fusion weapon

2. Heat, blast, radiation, and neutron production in a bomb--rough models for attenuation and scaling

3. Division of radiation energy into

a. Prompt gamma and X-rays

b. Kinetic energy of neutrons--induce activity and cause direct damage

c. Potential energy which will manifest itself as:

(1) Direct fission product activity

(2) Induced radioactivity (e.g., C^{14})

B. Types of weapon bursts and their effect on the radiation and radioactivity resulting--physical and chemical properties, etc.

1. Air bursts

2. Ground or surface bursts

3. Underground bursts

4. Underwater bursts

C. Measurements and limitations of the data

JCAE

** Probable choice

VI. Atmospheric Transport, Storage, and Removal of Particulate Radio-activity (Oral, written supplement, bibliography)

A. The types of fallout defined and described (Kellogg, RAND)

B. Local fallout (Kellogg, RAND)

1. The observed fallout patterns

a. Patterns of external radiation in Nevada and PPG

b. Physical, chemical, and radiochemical properties

c. Programming of local fallout

2. The predictability of local fallout

a. Theory of prediction

b. Models of radioactivity within the nuclear cloud (Nevada and PPG); dependence on type and yield of weapon and scavenging material

c. Meteorological transport with examples of fallout under different winds and in massive attacks

d. Uncertainties in models and meteorology

e. Weathering and redeposition of particles

f. Decay

C. Intermediate and delayed fallout (Dr. Machta)

1. The production and distribution of fallout in the atmosphere

JCAE

a. Dependence on height of burst, yield, type of explosion, and scavenging material (may duplicate information to be covered in item V)

b. Observed or inferred physical, chemical, and radiochemical properties with special reference to fractionation

c. Measurements and estimates of radioactivity in the stratosphere

2. Observed deposition on the ground

a. Geographical distribution

b. Physical, chemical, and radiochemical properties with special reference to fractionation

c. Measurement techniques and limitations of the data

3. Transport through and removal from the atmosphere

a. The stratosphere; the stratospheric storage time

b. The troposphere; the tropospheric storage time

c. Tropospheric removal processes; precipitation, interception, dry deposition

d. Possible regions or phenomena of unusual removal due to meteorology and topography

(1) Exposure to prevailing winds and the sometimes accompanying effect, orographic rainfall

(2) Effect of large bodies of water on the distribution of fallout on adjoining land areas

4. Quantitative predictions of future fallout

a. Past tests

b. Future tests

JCAE

VI. (PROPOSED REVISION) - Atmospheric Transport and Removal of Particulate Radioactivity

A. Types of fallout defined and described. (Physical characteristics of cloud, formation and characteristics of particles, transport and separation in cloud, etc. Details of outline to be supplied by Kellog? Some of this is covered in B.)

B. Local Fallout

1. The predictability of local fallout

a. Theory of predicting fallout

b. Models of radioactivity within the nuclear cloud (both Nevada and Pacific); dependence on type and yield of weapon and scavenging materials

c. Meteorological transport with examples of fallout under different winds and in massive attacks

d. Uncertainties in model and meteorology

e. Weathering and redeposition of particles

2. Observed local fallout patterns (Dunning?)

a. Patterns of external radiation in Nevada and the Pacific Proving Grounds

b. Radiation levels as function of time. Radiation dose to unprotected persons as function of time of fallout

c. Fractions of fallout observed locally (?)

d. Factors affecting patterns of fallout

C. Intermediate and delayed fallout (Machta)

JCAE

1. The source (some repetition of statements made by Kellog)

a. Division of material between local, tropospheric and stratospheric: determining conditions

2. Transport through and removal from the atmosphere (Machta)

a. The stratosphere (Would it be easier to discuss the troposphere first?)

(1) Transport, mixing, possible methods of removal

(2) Storage time; cumulative world-wide fallout as function of time; predictions of future fallout from single event; from past weapons tests

(3) Sources of information; measurements and estimates of radioactivity in stratosphere

b. The troposphere

(1) Tropospheric removal processes; storage time

(a) Precipitation, interception, dry deposition

(2) Possible regions of unusual removal (unusual fallout?) due to meteorology and topography

(3) Meteorological tracking and other discussion of transport

JCAE

3. Observed deposition on the ground (Eisenbud?)

a. Geographical distribution; dependence upon [illegible] factors

42

b. Physical, chemical and radiochemical properties with special reference to fractionation

c. Measurement techniques and limitations of the data

(1) gummed paper; (2) pots, collection of rain-fall; (3) soil samples

4. Quantitative predictions of future fallout (Eisenbud, [illegible]

a. From past tests

b. From possible future tests

JCAE

VII. Local Fallout: the mechanisms by which it can affect man and the measures he can take to minimize exposure (Oral, written supplement, bibliography) (Dunning, AEC or somebody from AFSWP)

A. The relative importance of external radiation compared with internal radioactive emitters for the local fallout situation

B. Shelter and shielding—what their effects are

C. Internal emitters, radioiodine, inhalation and ingestion

D. External radiation

VIII. The Behavior of Fallout in Geological and Physical Processes and the Mechanisms by which Fallout Enters into the Biological Processes and Reaches Man (Oral, written supplement, bibliography)

A. Deposition on and migration in soil and transport by surface waters (Dr. Alexander, USDA)

   1. Dependence on chemical properties

      a. Strontium, cesium, rare earths

   2. The effect of river basis and ground water flow patterns; the effect of porous substructure such as Idaho lavas; the effect of inland sinks such as a Salton Sea

   3. Effect of soil type and rock structure

   4. Mechanisms for fallout penetration into the soil

   5. Decay

B. The effect of agricultural practices on the distribution of fallout (Dr. Alexander)

C. The effect of fallout on water supplies for human, agricultural, and industrial use (Dr. Alexander)

D. Behavior in oceans: mixing above thermocline (Dr. Revelle, Scripps Institute) (written only?)

E. Entry into biological processes including man's food chain (Dr. Alexander, USDA, except as noted)

   1. Deposition and retention on surfaces of vegetation

   2. Uptake by vegetation from soil--characteristics for various radioactive materials--dependence on soil characteristics--decay--biological and effective half-life

JCAE

a. Strontium

b. Cesium

c. Rare earths

d. Plutonium

3. Uptake by marine life and algae (Dr. Revelle, Scripps)

4. Uptake by animals, animal products, and man

a. Ingestion and inhalation through diet, water, air

F. Retention and decay in animals and man (Forrest Western, AEC or Neuman, Rochester*)

1. Distribution of fallout in body tissues and milk and other body fluids

a. Tendencies for localization

b. Dependence of equilibrium values upon effective half-life

2. Discrimination factors (preferential uptake of particular fallout products by particular species of plants, animals, and man), types and how determined

a. Methods of determining

b. Numerical values for the various factors

c. The relative behavior of calcium and strontium from soil to man

JCAE

* Tentative

IX. A Detailed Discussion of the Occurrence of Strontium^{90} in the Atmosphere, Biosphere and Its Uptake in Man[1/] (Oral, written supplement, and bibliography) (Dudley, MIT; or Neuman; or Western)

A. Distribution, storage time, and fallout rate from atmosphere

B. Deposition on soil and plants

C. Discrimination from soil and plants to man

1. The calcium model as a basis for predicting Sr^{90} behavior

D. Behavior in man

1. The radium model as a basis for predicting Sr^{90} damage

E. Dosage standards

1. Occupational

2. Population

a. Factors for genetics, skeleton age, etc.

F. Amount of Sr^{90} in man

1. Observed

2. Calculated

JCAE

1/ Note: It is recognized that portions of this topic duplicate other portions of the outline; this point will have to be resolved for the presentation.

(PROPOSED REVISION)

IX. A Detailed Discussion of the Occurrence of Strontium^{90} in the Atmosphere, in the Biosphere, and in Man

A. Distribution: combinationg of local and world wide resulting from fractionation; long half-life; stratospheric hold-up and mixing. Perhaps some repetition of topic VI

B. Understanding and predicting the behavior of Sr^{90} in the biosphere

1. The calcium model

a. Similarities and differences in behavior, Sr vs Ca

b. Influence of calcium in soil, diet; dilution and discrimination

(1) Dependence of occurrence in animal and plant life on calcium in soil and diet

(2) Practicability of controlling occurrence of Sr^{90} by adding calcium to soil or diet

c. Removal of Sr^{90} from foods; calcium considerations

d. Factors affecting uniformity of uptake and retention by man

2. Variations of Sr^{90} level in environment and in man as a result of weapons detonated in a relatively short period of time -- from a few months to two or three years

a. Holdup in stratosphere; radioactive decay

(1) Predicted fallout as a function of mixing and time

b. Effects of retention of fallout on surfaces of vegetation

c. Deposition in humans as a function of age and time

C. Observed occurrence of Sr^{90} in soil, food, and man (brief summary with detailed written supplement)

JCAE

D. Predicted occurrence from weapons tests held prior to 1957

1. Relation to accepted concentration standards (the basis of which is to be discussed later)

IX.-A. A Detailed Discussion of the Occurrence of Cesium[137] in the Atmosphere, in the Biosphere, and in Man

A. Distribution in the physical environment

1. Half-life; stratospheric storage, chemical properties, similarities to potassium

B. Occurrence in food supplies; probable sources

1. Application of similarity to potassium in discussion of behavior in biosphere

C. Observed occurrence in humans - relationship to acceptable concentrations, on basis to be discussed later

D. Predicted occurrence in humans as a result of weapons tests prior to 1957

JCAE

#49

X. (Part One) The Effects of Radiation on Man (Oral, written supplement, and bibliography) (Dr. Bruss, Dr. Friedell, Dr. Shields Warren)

A. Briefly review chain of events

1. Physical effects
2. Biochemical and chemical effects
3. Cellular effects
4. Effects on whole organism

B. Process of physical interaction

1. Significance of alpha, beta, gamma rays and neutrons in this process
2. Significance of these rays with regard to penetration and whether introduced within the organism or arising from the outside

C. Chemical and biochemical changes

1. Direct effect of ionization on vital cell molecules
2. Indirect effects as a result of ionization of water in the presence of oxygen
3. Relationship and importance

D. Cellular changes

1. Range of sensitivity of cells
   List most sensitive (gonads) to least sensitive (nerve, muscle, bone)
2. Relate sensitivity of nucleus to cytoplasm

E. Effects on the whole organism

JCAE

1. Range of survival dose on mammals (guinea pigs 200 r, rabbits 800 r)
2. Compare with non-mammalian radiation (virus 1,000,000 r)

50

a. Point out species variation and position of man

3. Clinical syndrome in man (nausea and vomiting, hematopoietic depression, epilation, bleeding, etc.)

   a. Special place of hematopoietic response to radiation

   b. Late effects

      (1) Reduced longevity

      (2) Production of leukemia and neoplasms

4. Genetic effects

   a. Natural mutation rate (2%)

   b. Dose necessary to double mutation rate (50 r)

   c. Apparent linear non-threshhold relationship between dose and genetic effect

   d. Cumulative character of genetic effects

   e. Mechanics of introducing and eliminating mutants in the genetic pool

F. Relationship between acute single radiation dose and chronic prolonged radiation dose

G. Description of effects by fallout from Hiroshima to Castle, etc.

   1. What are the criteria for picking out the harmful radioelements included in fallout

H. General discussion

   1. All low level effects are extrapolations from effects at higher levels. How secure is this extrapolation? Discuss its relationship .. non-threshhold character of genetic effects

5+

2. Are there any distinctions between temporary and permanent (long term) damage, between repairable and irreparable damage?

3. Are there special criteria for small groups of individuals as compared with large populations with regard to radiation. Does the distinction apply only to genetic effects?

JCAE

57

X. (Part Two) The Effects of Radiation on Man (Oral, written supplement, and bibliography) (Dr. Lauriston Taylor, NBS)

A. The definitions and models relating the amount of damage to the body to the amount and kind of radiation causing the damage

1. Externally caused effects

a. Definitions of the units used for dose rate and cumulative dosage; the r, rad, rem, etc.

b. Application of these definitions to calculating total dose rates and cumulative dosage resulting from several kinds of radioactivity acting externally at one time (e.g., gamma and neutrons) and cumulatively

c. Application of these definitions to calculating the total dose rates and cumulative dosages resulting from one or several kinds of radioactivity acting at once or cumulatively on geographically different parts of the body

2. Internally caused effects

a. Definitions of the units used for concentration and body-burden measurements and the models for these definitions

b. Relationships between the internal and external measurement units, and the relationships between both and energy units and radioactivity units (curies)

JCAE

c. Application of these definitions to calculating total body-burdens and dosages resulting from the

53

intake of one or several different radioactive elements separately or simultaneously, these in turn being uniformly distributed or preferentially deposited in the same or different parts of the body; in short the cumulative effect of several elements superimposed upon the cumulative effect of differing body locations

d. Application of these definitions, together with those for external effects, to calculate the cumulative internal-external dosages for one or several kinds of radioactivity affecting one or several parts of the body, simultaneously and cumulatively

B. The assumptions and models behind the establishment of standard limits of exposure and/or dosage and/or body burdens

1. The historical trend of the standards and future trends
2. The validity of the assumptions now used in the light of up-to-date knowledge

3. The probable trend of standards for the future
   a. Will any new standards have to be defined and given a value because certain kinds of damage are not now adequately protected against
   b. Can the various standards now in existence be ranked in such a way that the most severe always covers the next most severe? In other words, is there any ambiguity as among the various standards as to which apply?

4. The U. S., U. K., and U. N. attitude on the standards, the degrees of agreement and disagreement

   a. Are antipathies concerning such matters as weapons testing policy likely to develop between the U. S. and other governments, or between the U. S. and states and municipalities simply because of a difference in tolerance limits (standards) used?

JCAE

[illegible] Outline: Effects of Radiation on Man

Introduction: discussion of general problems of radiation effects; distinction between acute effects of high level radiation and long term effects of radiation

A. Early effects of exposure of animals and man to high levels of radiation from sources external to the body

   1. Gamma and x-radiation - syndrome of radiation sickness

      a. Fallout on Marshallese: Rongelap, Uterik

      b. (Los Alamos incidents?)

   2. Beta radiation - burns

      a. Marshallese

      b. Other examples, human beings and animals

B. Possible early effects of exposure to high levels of radiation from radioactive materials within the body (Examples?)

C. Delayed effects due either to single massive doses or to protracted chronic exposure; enumeration of effects of interest; dose dependence

D. Genetic effects

   1. Summary of the nature of genetic effects (Supplementary material should be included in written statement)

   2. Relationship of radiation effects to natural mutation

      (a) Predicted increase in mutation rate as a result of estimated increase in radiation levels from fallout

   3. Effects on population: as individuals and as a whole

E. Aplastic anemia, leukemia, and cancer as a result of exposure to radiation

   1. Human and animal experience

   2. Doses at which observable damage occurs; relationship of probability of damage to dose and dose rate; latent periods; doubling doses; relationship to tissue irradiated

   3. Relative importance of cancer and leukemia under various conditions: external source; exposure of various critical

JCAE

56

X. (PROPOSED REVISION) (Part One) (contd)

organs to radiation from external and internal sources: lungs, gut, skeleton, thyroid, etc.

F. Reduction in life expectancy; validity of concept at low levels

X. (PROPOSED REVISION) (Part Two)

A. Methods and Standards of Radiation Protection

1. Historical trends and description
2. Basic assumptions and philosophy
3. Description of current standards
   a. Quantitative statements: radiation from external sources
   b. Units of measurement - concepts
   c. Kinds of radiation and conditions of exposure
   d. Simplifying assumptions to obtain practical standards
   e. Radiation from internal sources
   f. Meaning of maximum permissible dose; safety factors
   g. Occupational vs. environmental standards
   h. Probable trends for the future

B. Possibility of hazards due to low level exposure

1. Threshold considerations
   a. Why do we not know whether or not there is a threshold for each of the various radiation effects of interest?
   b. How and when can we improve our knowledge on this point?
   c. A radiologist may believe that the existence of a threshold is probable or improbable... what are the considerations pro and con?

JCAE

2. Acceptability of currently recommended standards under [illegible] assumption (apropos threshold)

57

XI. The Impact of the Present State of Affairs (Oral, written supplement, bibliography) (Libby, Machta, Selove, Neuman, Dunham)[1]

A. What is the over-all state of our knowledge in the following areas and in related areas of information:

1. The amount of radiation and radioactivity released by weapons fired to date
   (a) By the U. S.
   (b) By others
2. The amount of local and delayed fallout created by these weapons
3. Where this fallout is
   (a) How much has decayed
   (b) How much has fallen out and where
   (c) How much is still "up there" and where
4. What has happened to the fallout that has fallen out
   (a) How much got in soil and where
   (b) How much got on plants
   (c) How much got in the ocean
   (d) How much got elsewhere
   (e) How much of all this has decayed after it fell out
   (f) How much has directly affected man as external radiation
   (g) How much as internal radiation
5. The mechanisms by which fallout gets distributed in the atmosphere and on the earth

JCAE

1/ Note: The method of presentation and discussion of this section is not at all settled yet.

6. The mechanisms by which fallout gets into the biological processes and to man—or gets to man directly
7. The mechanisms by which exposure to fallout leads to damage
8. The amount of damage, if any, that man has so far suffered from fallout
9. The mechanisms and measurement of biological damage from radiation

B. Using the knowledge now available, how well can one predict, and how would one—at least in principle—predict the following:

1. The amount of fallout still to fall out from weapons already fired
2. Where this fallout will fall out
3. What will happen to it
   a. How much will decay or otherwise be harmless
   b. How much will directly affect man as external radiation
   c. How much will directly affect man as internal radiation
   d. How much damage, if any, will man suffer from it

JCAE

C. Using the knowledge now available, how much information does one need to postulate concerning the characteristics of future weapon firings (test or war) so that one could predict with a certainty appropriate for policy-making purposes the same sort of information (as discussed above) for future firings?

1. Is the prediction possible even assuming unlimited information concerning the firing characteristics? How would it be made?

2. Is a postulated rate of firing (yield per unit time) meaningful? What does "present rate of firing" mean? Is a postulated rate of firing sufficient information by itself for making the prediction named here?

3. How does one take into account such problems as diverse sites of firing, firing of weapons whose characteristics are not known, differences in weapons type and burst

4. Are the present criteria for biological damage and are the measurements pertaining to biological damage adequate so that one could predict with the certainty named above the future hazard, if any, owing to future weapon firings, even if he could forecast how much fallout there would be and what would happen to it? If they are adequate, what is the pattern for putting them together?

JCAE

5. If one had before himself a working definition of hazard that was satisfactory from a moral or ethical, social, political, and economic point of view, and if this definition was stated in terms of measureable or observable phenomena in nature (including man), does

60

sufficient information exist so that he could determine--with the degree of certainty named above--whether or not a hazardous situation exists now or will exist in the future for various possible circumstances of weapon firings and radioactive fallout? Could he determine the degree of hazard?

6. If not, is it possible to state what information is lacking and how it might be obtained?

JCAE

61

[illegible]. What Should the Research Program in the Physical, Geological, Biological, and Medical Sciences Be? (Oral, written supplement) (Dr. Dunham, Dr. Wexler, Dr. Brues, Dr. Eisenbud, Dr. Crow, AF[illegible], and others)

A. Information sources

1. Must private research groups depend on the government, particularly the AEC, for most of their data? To what extent does the depth and breadth of the research program rest on what the government is willing to turn over to private research organizations?

2. Are scientific information and findings adequately and promptly distributed and available?

3. To what extent are government classification and other information-withholding mechanisms interfering with the distribution of information to the public and to scientific groups?

4. How much and what kind of data on radioactive fallout remains classified? What justification is given by AEC and other government agencies for continued classification of such information?

5. Is information exchange occurring properly between the U.S. and foreign countries and the U.N.? (Shields Warren or Lauriston Taylor) JCAE

6. Is the U.S. adequately represented on international scientific and policy-making groups related to this field? (Shields Warren or Lauriston Taylor)

B. The research program: What is the extent of research on radioactive fallout problems?

1. Is the AEC presented with a conflict of interest when it is required to act on the one hand as an agent in developing nuclear weapons, and on the other hand as an agent in providing safeguards against weapon hazards? If a conflict does exist, what would be effective ways of removing or at least minimizing it?
2. How much of the research is being done by the government and how much by private research groups under government sponsorship and with government funds?
3. Are there serious soft spots in either the experimental or theoretical aspects of the sciences related to fallout; in particular are there any that limit a thorough understanding of the civilian and military policy implications of the fallout problem?
4. How well is the research program in balance?
5. Is the general level of the research program adequate in view of the obvious policy implications of fallout in such areas as weapons testing, nuclear weapons banning, civil defense, the stockpile spectrum and the associated production capability?

JCAE

6. Is the scope of inquiry broad enough so that it is not likely that the U.S. could be surprised by an enemy using the properties of fallout in a manner that we have no notion of how to cope with?

7. Is the atmospheric, biospheric, and medical sampling program adequate?
8. Should the U.S. prepare through cooperative programs to process samples obtained from all parts of the world?
9. Are federal funds made available for research in the field of fallout adequately protected so that what is apparently made available is in fact available?
10. Is cooperation between government and non-government sponsored research adequate?
11. What, if any, data should be sought after urgently on grounds that it may never again be available assuming tests continue; that is, what virgin data or what check points should be established?
12. If the research program is inadequate, should Congress increase appropriations for such research?

C. JCAE information

1. Should the results of research on radioactive fallout be made available to and reviewed by the JCAE as well as the AEC?
2. Would the creation of a special committee of scientists be an effective way of reviewing information and resolving differences of opinion?