RECOMMENDATIONS FROM LS '76
AIBS RADIOBIOL. PANEL REVIEW – APRIL '76

SECTION A

① LONG TERM DELAYED SOMATIC & POSSIBLY TERATOGENIC EFFECTS
{ LIFETIME FOLLOW UP ON ASTRONAUTS
{ ANIMAL STUDIES – LONG TERM HOLDING FACILITIES
– DETERMINATION OF MOLECULAR EFFECTS & TRANSLATION TO EFFECTS ON WHOLE ANIMALS & MAN

UNIQUE – HZE
– MIXTURES OF PROTONS & NEUTRONS (NEAR-UNIQUE)

∴ DELAYED EFFECTS OF EXPOSURE TO 1-100 RAD RANGE OF MIXED NEUTRON, PROTON & SOME HZE PARTICLES.
WHAT ARE THE RISKS? (NEG. & POS. INFO.)

* DELAYED EFFECTS OF EXPOSURES TO PLANNED ENVIRONMENTS!

② LONG TERM, LOW LEVEL PROTON & HZE EXPOSURES OF PRIMARY CONCERN.

③ IMPROVE & REFINE AUTOMATED DOSE MEASUREMENTS TO → INFO ON FLUENCE & DOSE AS RELATED TO DEGREE OF DAMAGE.

④ MORE SOPHISTICATED NEUROANATOMICAL & NEUROPATH. CORRELATIVE RESEARCH TO DETECT MORE SUBTLE EFFECTS OF RADIATION (INCL. HZE) ON BRAIN & NERVOUS SYSTEM IN TERMS OF FUNCTIONAL DECREMENTS.

⑤ LYMPHOCYTE CHROMOSOME EVAL. A POSSIBLE IN FLIGHT PREDICTIVE TECHNIQUE.

⑥ MEDICAL SELECTION FACTORS EXPENSIVE & PROBABLY LOW-YIELD OFFERING ONLY 10 % MAXIMUM IMPROVEMENT.

⑦ COUNTERMEASURES – OTHER AGENCIES DOING. (WHO? WHO TO WATCH?)

⑧ MICROWAVE EFFECTS

SECTION B

* ① LONG TERM BIOLOGICAL EFFECTS OF LOW DOSE AND FRACTIONATED EXPOSURE TO HZE
E EMPHASIS ON POTENTIALLY SERIOUS DEGENERATIVE EFFECTS ON CERTAIN NON-PROLIFERATING (NON-RENEWING) SYSTEMS (RETINA, CNS) —
AND TISSUES LIKELY TO UNDERGO MALIGNANT CHANGES (BONE MARROW)

NOT EXPLOITING IMPORTANT TOOLS AVAILABLE IN MODERN MOLECULAR & CELL BIOLOGY.
* MAY NOT SEE SHORT TERM MISSIONS – 0.[illegible]
LOSS OF VAR[illegible]

(2)

* NEED LAB. STUDIES TO EXAMINE CELLULAR INJURY (MOLECULAR, GENETIC, CHROMOSOMAL ABERRATION, CELL TRANSFORMATION) WHICH COULD → THESE LATE EFFECTS (VISION, TUMORS, CATARACTS, etc.)
* FOCUS ON EXAMINATION SYSTEMS (IN VIVO & IN VITRO) FOR DOSE-RESPONSE RELATIONSHIPS; TEST FOR ADDITIVITY (& DEVIATIONS FROM); DERIVE SENSITIVE METHODS TO DETECT INTERCURRENT HZE DAMAGE – esp. BRAIN STEM
* NEED METHODS OF FUNCTIONAL ANALYSIS & LONGITUDINAL STUDY.

(2) HZE DOSIMETRY EMPHASIZING NEW KIND OF DOSE EXPRESSION FOR CALCULATING DOSE-RESPONSE RELATIONSHIPS & PREDICTIVE EQUATIONS.

ALL PI'S COLLABORATE & INTERACT IN THIS DOSE EXPRESSION ACTIVITY.

(3) PLAN & INITIATE PROSPECTIVE EPIDEMIOLOGICAL STUDIES OF PAST AND FUTURE ASTRONAUTS EXPOSED TO SPACE RADIATIONS. CERTAINLY, BEGIN ≈ TWELVE ASTRONAUTS, AT LEAST. (HAVE HAD AVR. OF 10 REM EXPOSURES)

FOLLOW UP EXAMINATIONS SHOULD INCLUDE ALL VULNERABLE SYSTEMS (EYES, SKIN, BLOOD, DON'T KNOW ABOUT MARROW).

(4) PATIENT DATA ON HZE EFFECTS ON BRAIN STEM DEFY FUNCTIONAL INTERPRETATION. NEED CORRELATIVE MORPHOLOGICAL AND FUNCTIONAL STUDIES.

(5) NEED MORE MEANINGFUL AND EXACT HAZARD PROJECTIONS FOR PLANNED ACTIVITIES IN SPACE (MAPPING, ~~DOSE~~ FLUENCE PROJECTIONS, SHIELDING PRODUCTS, ANTICIPATED EXPOSURE PROFILES, & DOSE-RESPONSE EXPECTATIONS – BOTH IMMEDIATE & DELAYED).

(6) CONSIDER HUMAN BIOASSAY DOSIMETRIC STUDIES, i.e., CYTOGENETIC STUDIES OF LYMPHOCYTE CHROMOSOME CHANGES OR IN VIVO MEASUREMENTS OF RADIATION INDUCED ACTIVITY IN THE WHOLE BODY.

(7) CONSIDER MICROWAVE RESEARCH – re SSPS.

Section E.

(1) COMBINED EFFECTS – ~~[illegible]~~ AMBIENT OR ON-BOARD SOURCE.

(2) LOW DOSE RATE (PROLONGED) EXPOSURE TO PROTON-ELECTRON-HZE USING BESS IN POLAR ORBIT. (POSSIBLY SOLAR FLARES)

PEER REVIEW SYSTEM

MEDICAL SCIENCES PROGRAM/SBR-3

OFFICE OF LIFE SCIENCES

Medical Sciences Peer Reviews are of two types, both carried out under the aegis of the American Institute of Biological Sciences (AIBS).

1. New and resubmitted proposals are reviewed by a standing multidisciplinary panel of 10-12 members, called the Medical Sciences Panel. They meet regularly, three times a year and review for scientific merit only. A grading system of 1-5 is used, one being high. Comments on relevance are also frequently provided. For proposals in subdisciplinary areas where the Panel feels special competence is needed, additional mail reviews are requested, in almost all cases by reviewers who are recommended by the Panel. In these instances, the AIBS consults the Panel by telephone after mail-in reviews are received in order to derive an integrated critique and score. Site visits are carried out from time to time as indicated in the opinion of the Panel.

   At the end of the Panel meetings three NASA people, who are also in attendance, assemble to determine on a preliminary basis the relative desirability of the research tasks proposed for incorporation (or retention) into the program, and which Center would support each most suitably. Tentative priotities are assigned sequentially based on evaluations of such factors as relevance, redundancy, cost effecitveness and consistancy with program needs, in addition to the scientific merit determinations, critiques and comments of the Panel. These three NASA individuals are the Deputy Directors of Life Sciences at ARC and JSC, and the Director (Chief?) of Medical Sciences, NASA Headquarters. The tentative priorities and conclusions derived at this time are later confirmed or modified per telephone after the final AIBS Panel critiques and scores are received in Headquarters and distributed to the individuals concerned.

   Proposals are required to be written to contain the same kinds of information and at the same level of sophistication as proposals addressed to the NIH, since these evaluations are of equivalent quality and use similar criteria. NASA requires no specific format but, generally, proposing investigators stray little from the NIH format.

   Normally, those whose proposals are not accepted are notified through routine NASA channels by form letter. At their request, either by letter or by telephone, however, we supply them with the critique either in its entirety or with some deletions or paraphasing, as appropriate. The sole aim of any editing that is done is to delete negative comments that might be personally directed, or, perhaps, that the investigator clearly could not use constructively. All negatives about the proposal, itself, and the work it proposes are communicated freely,

as are all positive comments. With few exceptions the critiques are in actual practice either read or sent in toto. Both proposals and critiques are handled as privileged information in NASA, and are therefore available only to the investigator and those few Agency people who are directly concerned.

2. The on-going Medical Sciences Program is reviewed by RTOPs, one or two at a time, by ad hoc single disciplinary panels chaired by members of the Medical Sciences Panel. These reviews are also held three times a year and are timed as closely as possible to coincide with the Medical Sciences Panel meetings. Ad hoc panel members are selected by their respective chairmen with recommendations by NASA and the AIBS. Panel members are carefully selected to cover all of the subdisciplinary aspects of the RTOP material. Two closely related RTOPs may be reviewed at the same time. Usually these panels consist of four to eight members and the chairman. By this method all RTOPs are reviewed every three years. If indicated, these reviews may be held on site at a NASA Center. Site visits of outside investigators may also be carried out on recommendation of the chairmen.

   These meetings are attended by the same three NASA personnel noted above, plus the respective RTOP manager from each of the two Centers. At the beginning of each Ad Hoc Panel meeting, the Panel is given a short series of orientation briefings, usually by the Director, Medical Sciences on the relationships organization, objectives, scope and methodology of the program, followed by the Center RTOP managers on the scientific background, research organization and strategy to meet the problems to be resolved. At the end of the meeting the NASA personnel convene to update the research approaches of the RTOP(s) and establish actions to be taken in consequence of the peer review and NASA discussion.

   The proposals prepared for Ad Hoc Panel reviews are written to the same standards of quality and content as new proposals, but they are called Research Descriptions for Peer Review (RDPRs). The only difference is that their proposed budgets carry no implication of legal committment by NASA if they are continued. From NASA's point of view RDPRs need not be signed off by any member of a principal investigator's parent institution except for the PI, himself. The investigator need only be concerned with the regulations of his own institution on this point. Procurement legalities and funding allotments are covered at renewal times through appropriate NASA channels.

   Ad Hoc Panel scoring is the same that of the Medical Sciences Panel. Critiques are similarly treated as privileged but, here, communication of the results of the review to the PIs is carried out routinely by the grant/contract monitors and Center RTOP managers.

All new proposals and on-going research in or relating to the Medical Sciences Program, whether in or out of house, are reviewed in accordance with this peer review system with the following exceptions: straight hardware development efforts,

evaluation of RFP responses, straight support items (laboratory support contracts; in-house laboratory support funds), or any other type of effort either plainly not suitable for scientific review or for which a different review system is established (RFPs). In the aggregate, these exceptions are very few.

The salient features of the system are shown in outline form in the two pages attached.

MEDICAL SCIENCES PROGRAM

-PEER REVIEW FOR SCIENTIFIC MERIT-

2 TYPES

- New and Resubmitted Proposals
  - o AIBS Medical Sciences Panel, Standing Panel, Multidisciplinary
  - o Meet 3 times a year, March, July, and November
  - o Limited NASA attendance from Headquarters, ARC, JSC, & JPL
  - o Meetings followed by NASA attendees meetings for tentative decisions
  - o High quality reviews, full proposals required

- On-going Program
  - o Ad Hoc Panels, single discipline, chaired by members of Standing Medical Science Panel
  - o Three reviews per year; 1 or 2 RTOPs each; March, July, and November
  - o Three year program cycle; each RTOP reviewed every 3 years
  - o Same high quality; full write-ups required
  - o NASA attendance also includes Center RTOP managers
  - o Meetings followed by NASA attendees meetings for tentative decisions

MEDICAL SCIENCES PROGRAM

-PEER REVIEW FOR SCIENTIFIC MERIT-

GENERAL FEATURES

- If good review
  - o If on-going, retained
  - o If new: -Post Hoc NASA meeting determines relevance, duplication, priority, Center, modification
    - -If priority high and $ available, funded

-If bad review

- o If on-going, phase out or recommend resubmit & inform PI of critique
- o If new, reject - if PI asks, inform of critique

-In-house research and out-of-house treated same; same standards

-Not reviewed by Peer Reveiw System:

RFP responses
Engineering tasks
Support tasks
Tasks already reviewed (3 years)

ROUGH DRAFT

April 30, 1976

Mr. Donald R. Beem
Head, Special Science Programs
American Institute of Biological Sciences
1401 Wilson Boulevard
Arlington, VA 22209

Dear Don:

The ad hoc Radiation Biology Review Panel, which convened earlier this month at ARC, was asked to carry out two tasks on behalf of NASA. These were (1) to review the on-going research efforts in the NASA Radiobiology Program and (2) to assist us in assembling an improved, well-directed problem oriented radiobiology program based on soundly considered problem objectives and well-conceived research strategies in light of current knowledge.

It was, therefore, with some dismay and considerable concern that I read the panel report on the second task indicated above. The over-all attitude of the report was that of a program review group, rather than a consultant working group, which was really what the task required. It was precisely because we recognized that the Radiobiology RTOP needed a more focused direction, tighter integration and more efficient problem orientation that we asked for this assistance. The existing program was, after all, about the best we could manage to keep together in the face of severe constraints over which we had minimal control during the past several years. What we needed and still need is a sound, well-planned, updated program which we can confidently justify in the competition for funds and in the accomplishment of our purposes. Instead of assisting us in fulfilling these needs, the panel report criticized us for having them (ref. last paragraph of Section A) and, beyond that, leveled individual criticisms which quite possibly could impair the effectiveness of the very people who are attempting to improve and protect the radiobiology program.

While the primary purpose of this letter is not to present a rebuttal of the criticisms expressed in the report, the fact that a liberal portions of the first 3 of its 6 pages were devoted to such criticism does seem to warrant at least the following two comments. First, I do not believe that the statement that "much previous thought and advice has been overlooked", was at all a fair appraisal. On reviewing the 1972 NAS recommendations, it is our feeling that we have been approximately 90% compliant despite time, money and facilities constraints. With respect to the recommendations made on specific

research efforts as summarized in Appendix II, our compliance has been very close to 100%. The only research task which might appear to be an exception was an excellent price of work on low dose rate effects which ultimately had to be dropped because of low patient loads and reorganization of personnel assignments within that ~~fa~~ facility, but we are still kept apprised of new data as it becomes available. The 1973 NAS recommendations on HZE tended to downplay the urgency of the problem but did recommend quantitative assessment of the potential hazard of this form of irradiation. Our program is clearly so directed, and we have also tasked our remaining NASA counterparts in the physical sciences to obtain more extensive mapping data for us. All of these recommendations, far from being ignored, were very seriously considered and followed wherever and to the extent possible.

Secondly, the array of specific radiobiology problems labeled "A" through "F" which was given to the panel was misconstrued as a NASA position in the report. It was actually a tentative list I, myself, ~~had~~ prepared, which was meant to serve only as an example of the problem oriented format for the panel report. Our intention was that the work of the panel would entail, first, the definition of a similar problem array according to their own views, and then the filling in of the outline down to the next two or three levels. The second level would consist of constituent problem areas, the third would be made up of recommended approaches, and the fourth would point up specific research prospects or lines of approach that appear to be attractive and promising enough on the current horizon to warrent possible investment by NASA. This, together with some indication of relative priorities, is the kind of help and advice we were, and still are ~~screening~~ SEEKING. We know of no better means of finding it than through the deliberations of high quality radiobiological scientists such as those represented on your panel. We purposely refrained from presenting our views of the next levels of detail because of our desire for the independent concepts of this knowledgable body. Somehow or other, the context of the problem list and the anticipated "working group" approach to the task did not come across clearly. Regardless of how or why this happened, I feel that our mutual responsibility is to correct it, and you and I, at least, seem to be in agreement that the best way to do this is by holding a working group meeting of the same panel in the near future.

The positive comments in the panel report are appreciated, and panel assistance in translating and incorporating these into a balanced prospective research program is desired. We would like embellishment of panel recommendations to obtain information on long-term delayed effects of mixed neutron, proton, and HZE exposures in the 1 to 100 RAD dose range; on long-term effects of low level HZE and proton exposures; on the potential efficacy of lymphocyte (or other) chromosome aberrations as a prognostic technique; on possible improvements

CHP.

OMISSION

in dose expression; and on the development and use of in vivo and in vitro examination systems for dose-response relationships and intercurrent damage detection. These are all excellent and very pertinent comments as are the additional recommendations which give support and strength to CERTAIN on-going activities. They are given in varying levels of detail, but in all instances at least some further detail is needed, and further subjective guidance would be helpful. On the whole, the attitude and content of Section B, and the concept of using BESS in polar orbit for low dose rate, long exposure HZE effects were particularly cogent. The recommendations concerning medical selection factors and countermeasures, though negative in content, are also very constructive, but here, too, some further guidance would be helpful.

I will be in touch with you concerning the possibility of setting up another meeting of this panel to attempt to complete this second task in the context originally intended, this time with NASA representation present. In the meantime, you might determine whether the Chairman would be agreeable to such an effort, and mull over the possibility of one or two supplemental members. I will check into the feasibility of the meeting on NASA's part, and will work with the RTOP manager to assemble a more detailed format for the panel to use as a working model. I believe we should target the meeting for the latter part of May.

Sincerely yours,

SPV

Med

NASA HEADQUARTERS

ADMINISTRATOR'S OFFICE BRIEFING MEMORANDUM

Date: JAN 25 1971

From: M/Associate Administrator for Manned Space Flight

Subject: NASA Program Requirements for High Energy, High Atomic Number (HZE) Particle Ground Based Experiments

Discussion:

This letter is in response to directions given by Dr. Low at the conclusion of our presentation on January 14, 1971, relating to high energy, high atomic number (HZE) radiations and the Princeton-Pennsylvania Accelerator.

Dr. Low also directed that letters be prepared and forwarded to Dr. Seaborg, Chairman of the Atomic Energy Commission and to the Office of Management and Budget. These letters have not yet been written because we are working with the AEC to establish the most appropriate time for them to be prepared and forwarded.

Recommended Action:

Signature of the Acting Administrator to the letter to Dr. Edward E. David, Jr.

Background Material:

Tab A: Letter to Dr. Edward E. David, Jr., Scientific Adviser to the President, dated October 23, 1970.

Letter from Dr. David to Dr. Low, dated November 2, 1970.

Tab B: Letters to Dr. S. G. English of the AEC and Dr. Paul Donovan of the NSF, dated October 19, 1970.

Letters from Dr. S. G. English of AEC and Dr. Paul Donovan of NSF to Dr. J. W. Humphreys, dated November 13, 1970 and October 22, 1970, respectively.

Tab C: Memo from AD to M dated October 6, 1970, Subject: NASA's Proposed Program for High-Energy, High Atomic Weight Particle Ground Based Experiments.

Tab D: Memo from M to AD with attachments, dated October 2, 1970, Subject: Princeton-Pennsylvania Accelerator.

Tab E: Memo from AD to M dated June 9, 1970, Subject: Princeton-Pennsylvania Accelerator.

MM
JWHUMPHREYS:srm
1-21-71

FEB 11 1971

Honorable Edward E. David, Jr.
Science Adviser to the President
Executive Office Building
Washington, D. C. 20506

Dear Dr. David:

You will recall that in October 1970, I forwarded a progress report to you covering initial NASA investigations into the need for physiological testing of the effects of high-energy, high atomic number (HZE) particles. In summary, I indicated that NASA had asked both the Atomic Energy Commission and the National Science Foundation to formally comment on the proposed research program we had outlined and to recommend an accelerator facility in this country which, in their opinion, could best be utilized to accomplish the research required. I further stated that after our analysis of the AEC and NSF comments, I would notify you of my decision regarding NASA undertaking support of the Princeton-Pennsylvania Accelerator (PPA).

Comments from the AEC and the NSF have been received and indicate that the Princeton-Pennsylvania Accelerator and the synchrotron modification proposed by the Lawrence Radiation Laboratory, Berkeley (LRL-B), are the only facilities which could reasonably provide an HZE capability. The AEC, although stating PPA would be less costly and available sooner, favored the LRL-B primarily because of the existing biomedical research facilities and expertise located there which are not now available at PPA. The NSF indicated PPA would be unique after necessary modification to meet our research requirements.

After thoroughly analyzing the AEC and the NSF comments and the programmatic information obtained during our investigations, I have decided that NASA support of the Princeton-Pennsylvania Accelerator is not consistent with our resources or time-phased program needs. Financial restrictions imposed on our FY72 budget prohibit initiation of such an extensive research program at this time. Furthermore, our validated requirements for data from such research are far enough in the future that they can be satisfied using the proposed LRL-B forecasted for operation in FY76.

Our study has shown that closing the PPA at this time is unfortunate from a general research standpoint since it will result in the loss of an important national research capability. However, NASA cannot justify assuming the responsibility for a national research facility of this type. If PPA sponsorship was retained by AEC or another agency, NASA would consider using the facility in our ongoing research programs.

We have taken action to maintain a viable AEC-NASA liaison for the purpose of reflecting our interest in future AEC planning for the LRL-B.

Sincerely yours,

Original signed by
George M. Low

George M. Low
Acting Administrator

cc: A
ADA
R
W
S
X/Sedlazek
M/Myers

(A 32115 - Indefinite Suspense Date as of 11-5-70)

(M 70-444 - Indef suspense)

MMS:Capt Hartman:srm:X36323:1-21-71

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CONCURRENCES

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INITIALS ▷								
DATE ▷								

NASA FORM 1267 OCT. 68 PREVIOUS EDITIONS MAY BE USED.

TAB
A

OCT 25 1966

Honorable Edward E. David, Jr.
Science Advisor to the President
Executive Office Building
Washington, D. C. 20506

Dear Dr. David:

In June of this year I received a call from Dr. DuBridge indicating that he understood there was a serious concern in parts of the medical community about the flashes of light that our astronauts have seen during some of the lunar flights. They believe that these flashes were caused by very high-energy atomic (HZE) particles which might destroy nerve cells and other cells in the human body. Further, it was also his understanding that the Princeton-Pennsylvania accelerator was the only accelerator in the country that, with some small modifications, could be used to undertake an adequate investigation of this phenomenon.

In responding to Dr. DuBridge, I made the following points:

1. There is no serious concern about HZE particles for flights that are planned in the near future.

2. Because of the controversy concerning the effect of these particles, some research should be undertaken to better define the problem for long-duration flights.

3. It is not clear which of the accelerator facilities in this country is best suited for this research.

4. NASA will investigate all possible facilities and make a determination as to which of these would be the most economical to carry out the required research, but it would be two to three months before the determination could be made.

Subsequently, the Atomic Energy Commission-supported accelerator facilities were surveyed, and it appears that only two facilities could, with modifications, produce the particles of interest. These are the Princeton-Pennsylvania accelerator, Princeton, New Jersey; and the Synchocyclotron proposed by the Lawrence Radiation Laboratory, University of California, Berkeley. (We are also conducting a survey of the NASA-owned Space Radiation Effects Laboratory (SREL) at Langley Research Center to determine the technical and economical feasibility of modifying it for this purpose.

During this same time, all NASA organizations were surveyed to determine their requirements for (HZE) particle experiments. An outline of a research program which would provide the information needed to plan future long-duration manned missions was prepared based upon this survey and is attached. To preclude an arbitrary selection of a facility by NASA, the Atomic Energy Commission and the National Science Foundation, which support most of the accelerator facilities in this country, have been asked to formally comment on the program outline and indicate which facility, in their opinion, could best be utilized to accomplish the research required.

Upon completion of our analysis of the Atomic Energy Commission and the National Science Foundation comments, I will notify you of our decision.

Sincerely yours,
Original signed by
George M. Low

George M. Low
Acting Administrator

Attachment

cc: S/Maugle M/Myers
R/Hicks W/Smart
L/Farley
M/Sedlazek
MMS/R. Hartman

MMS:RHARTMAN:jgc:10/14/70

REWRITTEN:MFSedlazek:css:10/23/70

Previous concurrences: MM, M, W

A 31955
Ref 31802

ATTACHMENT 1

The potential biological damage which could result from exposure to a broad spectrum of high atomic number - high energy (HZE) galactic particles during manned space flight warrants a thorough and comprehensive program of radiobiological investigation. The program outline presented herein represents the basic long-range effort which NASA will pursue to develop experimental data necessary to define and evaluate this potential biological damage. It is the intent to maintain a degree of flexibility in the conduct of this effort so that specialized interests of all NASA organizations may be accommodated in order to achieve a well-coordinated and coherent program.

OUTLINE OF NASA PROGRAM FOR RADIOBIOLOGICAL INVESTIGATION OF EXPOSURE TO HIGH ATOMIC NUMBER - HIGH ENERGY (HZE) PARTICLES

Brain

Ascertain the effects of heavy particles on nerve cells, glial cells and blood vessels as a function of atomic number (Z), energy per nucleon, total particle exposure, and exposure rate. This would be supplemented by vascular permeability and radionuclide studies to bring out functional disturbances in the blood-brain barrier. Regions of the brain most sensitive to particle radiation from the functional standpoint would be determined. Regeneration of brain elements would be studied. Included would be a study of the effects of single particles having the same characteristics as single heavy cosmic particles. Determine, for a given flux, the particles of lowest atomic (Z) number that will produce a given effect. Ascertain the morphological effects on the brain of body exposure alone.

Eye

Determine minimal particle number conducive to retinal injury and cataract formation. Correlate retinal damage with visual disturbances.

Skin and Testis

Studies in relation to Z number and other parameters would be carried out.

Physiology

Study effects of heavy particles on the electrical activity of the brain, both through direct brain irradiation and through irradiation of other systems, e.g., eye, skin, and body organs. Study alerting reaction, somatic and visceral reflex actions. Emphasis would be given the correlation of brain damage with altered brain function. Included would be a study of the effects on the vestibular system, hearing, olfaction, and body sensory endings.

Behavior and Performance

Study behavior and performance in their many aspects, including judgment, as function of exposure parameters, length of latency period before disturbances develop, and length of time before recovery sets in. The results would be correlated with site and degree of brain damage and altered physiological function.

Lethality

Determine the effectiveness of heavy particles in causing irreversible biological damage in various systems and in animals as a whole, both in monkeys and in smaller animals. Study cellular mechanisms of lethality, e.g., (a) double strand scission in DNA and chromosome breaks, and (b) membrane breaks.

Non-dividing Cells

Answer questions introduced in Summer Study regarding the effect of heavy particles on non-dividing cells.

Somatic and Genetic Mutations

Study somatic mutations in various animal systems, including the brain of the monkey, in which somatic mutations have been shown to occur in response to proton and other forms of irradiation; also in primitive life forms in relation to evolutionary processes. For the study of genetic mutations, use would be made largely of insects and plants.

Neoplasia Induction

Ascertain the capacity of heavy particles to produce cancer, including leukemia.

Reduction in Life Span

Drosophila and mice would largely be used for such studies because of the extensive information available from past radiation studies. Various sublethal dosages would be used.

Study of Biogenesis

Utilize heavy particles for study of organic synthesis and breakdown relative to the problem of the origin of life.

Study of Radiation Modifiers

These studies will determine changes at cellular and molecular levels.

Dosimetry

Develop, test, and evaluate devices and techniques for detection and biological quantification of HZE particles.

THE WHITE HOUSE

WASHINGTON

November 2, 1970

Dear Dr. Low:

This will acknowledge your progress report of October 23, 1970, covering initial NASA investigations into the need for physiological testing of the effects of high-energy atomic particles. Although the original request originated with Dr. DuBridge, I am also interested in progress of planning for this test program and will appreciate further reports as they become available.

I should point out that, because of the lead times required for efficient facilities planning, there is a need for rapid resolution of the prospective test requirements.

Sincerely,

Ed

Edward E. David, Jr.
Science Adviser

Dr. George M. Low
Acting Administrator
National Aeronautics and Space Administration
Washington, D. C. 20546

Action Copy to M
Info Copy to A, AA
R
W
S

A 32115

Rec'd in NASA 11-4-70

Suspense Date 11-18-70
Prepare Reply for
Signature of A

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m

11/5/70
70-444
11-17-70
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A

ITEM

TAB
B

OCT 19 1970

MM

Dr. S. G. English
Assistant General Manager for
Research and Development
Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. English:

Enclosed is an outline of a program for high-energy, high atomic weight (HZE) particle ground base radiobiological experiments which we in NASA feel will provide information vital to us while planning for long-duration manned space flights. At present, there is practically no information available concerning biological effects of long-term exposure to HZE particles. Also, there are indications that research may be needed as to the effect of HZE particles on solid-state electronics. It is therefore imperative that a sound research program be initiated in the near future so that we will have adequate, accurate information available on which to base mission-planning decisions.

Utilization of particle accelerator facilities appears to be the most practical and economical approach to obtain required information. Since the Atomic Energy Commission and the National Science Foundation together support almost all accelerator facilities in this country, we request that you comment on our program outline and identify to us as soon as possible specific facilities, either existing or planned, which can best satisfy our program requirements.

Sincerely yours,
ORIGINAL SIGNED BY
J. W. Humphreys, Jr., M.D.
Director, Space Medicine

J. W. Humphreys, Jr., M.D.
Director, Space Medicine
Manned Space Flight

IDENTICAL LETTER SENT TO:
Dr. Paul Donovan
Head, Physics Section
National Science Foundation
Washington, D.C. 20550

Enclosure

cc: R, S, X RAHartman:tas:10/15/70 x20464

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NASA FORM 1287 OCT. 68 PREVIOUS EDITIONS MAY BE USED.

MM

OCT 19, 1970

Dr. Paul Donovan
Head, Physics Section
National Science Foundation
Washington, D.C. 20550

Dear Dr. Donovan:

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Sincerely yours,

J. W. Humphreys, Jr., M.D.
Director, Space Medicine
Manned Space Flight

Enclosure

cc: R, S, X
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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

1970

Dr. J. W. Humphreys, Jr.
Director, Space Medicine
Manned Space Flight
National Aeronautics and
Space Administration
Washington, D. C. 20546

Dear Dr. Humphreys:

I am pleased to respond to your letter of October 19, 1970. The problem of high atomic weight, high energy (HZE) particles is, we recognize, one of rather urgent concern to NASA. AEC also has a strong interest in these particles for studies in the areas of physics, chemistry, and biomedicine. Currently our chemistry and physics interests are mainly with particles with energies of less than 10 MeV/nucleon. It is possible that these interests might extend in the future to higher energies. Our current biomedical interests and activities complement the program you have outlined and require energies exceeding 100 MeV/nucleon. We agree that such issues of broad, national scientific interest can most responsibly be addressed through examination of our combined national scientific capability.

At present, the AEC supports a number of high energy particle accelerators. None of these now has a capability of accelerating heavy ions to the energies needed for your studies. Except as noted below, these accelerators are being utilized for long-range objectives in our physics research program, and we believe that modification of these facilities to provide an HZE capability, while theoretically possible, would be costly and cause serious disruption of ongoing AEC research programs. As a practical matter, only the two facilities discussed below would be reasonable.

We have received requests from two laboratories, the Princeton-Pennsylvania Accelerator (PPA) and the Lawrence Radiation Laboratory-Berkeley (LRL-B), to support the development of a high energy, heavy ion facility. Either of these proposed facilities could, we believe,

provide capability to meet some, if not all, of the needs you have outlined.

The AEC Division of Research has received from PPA a proposal to modify this high energy accelerator facility to achieve a heavy ion capability. I am enclosing documents prepared by Dr. White, Director of PPA, which describe the proposed modifications in detail. Briefly, Dr. White suggests that construction and installation of a ceramic vacuum system, at an estimated cost of $700,000, would provide the capability shown in the following table:

Particle	Energy (MeV/nucleon)	Intensity (pps)
Ne	1000	10^7
A	540	3×10^6
Kr	250	10^7
Xe	130	10^7

(if higher energy ions are required, note that additional modifications have been proposed for the PPA. These would require additional funds and construction time. See the accompanying proposals.)

The expected time schedule to complete this modification is 16 months after initiation of the work. Since ongoing AEC commitments will not permit initiation of any modification to the machine before late spring of 1971, we would estimate the HZE capability would not be available before the middle of FY 1973. Early authorization to PPA to make the modification could lead to early procurement which would shorten this time period. The estimated annual operating cost of the modified facility, exclusive of any research costs, would be about $1,200,000. The Division of Research believes that the proposed PPA modification is feasible, and although no detailed review of the cost estimates has been made, we believe they are reasonable.

As you may know, we have found it necessary to terminate our support for the operation of the PPA as of July 1, 1971. Therefore, we are not able to accept the PPA heavy ion modification proposal. Unless other funding materializes for PPA, this will mean closing the laboratory. We have requested Dr. White to inform us by November 30, 1970, of any plans he might develop which would permit operation of PPA beyond the

July 1, 1971, date, since early decisions regarding personnel and equipment are required for orderly termination. In fact, we now plan to start moving much of the experimental equipment to other high energy physics sites within the next several weeks.

Development of a high energy, heavy ion capability by modifying the PPA would be less costly and quicker by several years than the alternative LRL-B approach but, as discussed below, the absence of appropriate biomedical research facilities and expertise should be carefully assessed.

The AEC Division of Biology and Medicine has received from the LRL-B a proposal to construct a heavy ion synchrotron. A copy of this proposal is enclosed for your information. Heavy ions would be injected into the synchrotron from the upgraded HILAC at energies of 7.5 MeV/nucleon. The synchrotron would then provide particles with the following characteristics:

Particle	Energy (MeV/nucleon)
Proton	1400
$M < 20$	500
$20 < M < 60$	400
$60 < M < 238$	350 - 100

Beam current $\sim 1 \times 10^{11}$ particles/sec.
Beam will consist of 0.5 μsec pulses at 22.5 pps.

The cost for construction of the heavy ion synchrotron is currently estimated to be $7,200,000. Approximately three years will be required for completion of the facility after initiation of construction. The synchrotron components will follow closely the designs developed earlier for the Omnitron accelerator. These designs had been examined by an earlier ad hoc review committee which considered them to have been of high caliber. On this basis, we expect the estimates associated with the synchrotron facility to be reasonable. Financial restrictions imposed on our FY 1972 budget will not enable initiation of this endeavor during the upcoming fiscal year. However, this will be a matter for very serious consideration during development of our FY 1973 budget. If funding is obtained at that time, we would expect the machine to become operable during FY 1976.

Because of our interest in developing a high energy, heavy ion biomedical research activity, our Division of Biology and Medicine convened a special committee to review in detail the proposed research program prepared by LRL-B. The committee returned the following recommendations:

1. That the heavy ion synchrotron, assuming its engineering feasibility for the stated goals, be authorized and constructed at the earliest opportunity to provide a national facility for biomedical research on high energy heavy particles.

2. That the accelerator be constructed as proposed at Berkeley because of the biomedical research group's experience, its initiative in this area, its excellent record of collaboration with other groups, and the relatively modest cost of the proposal in that environment.

3. That a scientific advisory committee be appointed at that time of authorization to assist in strengthening the research plans for adequate utilization of the accelerator and to assist in assuring a continuing research program of high quality.

In reviewing your program requirements, we were impressed with the breadth of studies which must be conducted and with the depth to which many of these studies must be pursued. Such investigations presumably will require a wide variety of biomedical radiation research experience. While certain of the projects could be successfully conducted by periodic visits to a suitable accelerator facility, many may require a strong biomedical radiation research capability on site. This factor can only be fully assessed upon a detailed examination of the means whereby individual projects are to be carried out.

Because the biomedical research group at LRL-B has a long and well established scientific reputation in the field of heavy ion biomedical research, AEC's biomedical research interests lead us to conclude that they may be served best by establishing an HZE machine capability at LRL-B. Whether your interests can best be served by awaiting the installation of that capability, assuming we are successful in getting the necessary funding, or whether the time advantages associated with

modifying the PPA outweigh the lack of biomedical research capability there, will need to be decided by you in the light of the specific projects to be carried out.

In this connection, you may be aware of the letter of July 8, 1970, to me from Dr. John E. Naugle, Associate Administrator for Space Science and Applications, supporting the proposed heavy ion synchrotron at LRL-B on the basis of an analysis of NASA requirements undertaken by his office. A copy is enclosed for your ready reference.

I hope this information will prove useful to you. If we can provide any further information or if you would like to discuss any aspect of this matter, please do not hesitate to contact me. In fact, we would appreciate knowing what approach you intend to pursue as soon as possible. Additionally, I would like to say that AEC and its contractors' accelerator and biomedical research staff can be made available to you for consulting and other similar services to help you both in deciding what to do and in fulfilling your decision after it is made. You may know that AEC staff and contractors have been working with NASA personnel on the biomedical aspects of this matter for some time. Thank you for giving us an opportunity for providing these comments.

Sincerely,

S. G. English

S. G. English
Assistant General Manager
for Research and Development

Enclosures:
1. Proposals Prepared by Dr. White
2. LRL-B Proposal
3. Cy Ltr Dtd 7/8/70 NASA to AEC

HB 10/28 Capt. Hartman
Dr. Brownstein

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

October 22, 1970

Dr. J. W. Humphreys, Jr.
Director, Space Medicine Manned
Space Flight
National Aeronautics and Space
Administration
Washington, D.C. 20546

Dear Dr. Humphreys:

The program of radiobiological experiments which you describe in your letter of October 19th requires high energy heavy ions with sufficient range to penetrate several centimeters in tissue. To our knowledge there are no facilities in the U.S. capable of providing these particles.

However, it has come to our attention that, at relatively minor cost, modifications to the Princeton-Pennsylvania Accelerator (PPA) would allow it to produce the appropriate particles; such as, for example, krypton at 250 Mev/nucleon with a range of 2 cm. This potential to accelerate heavy ions to the high energies required by your needs is unique to the PPA.

We are aware of the fact that this laboratory will no longer receive AEC support and expects, therefore, to start closing down very soon. The closing of this accelerator would be unfortunate for the NASA mission, since providing the equivalent capabilities for heavy ion research would require funds far in excess of those involved in the PPA modification and operation.

Sincerely yours,

Paul F. Donovan

Paul F. Donovan
Head, Physics Section

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OCT 27 1970
OMSF - MM

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

October 6, 1970

TO: M/Associate Administrator for Manned Space Flight

SUBJECT: NASA's Proposed Program for High-energy, High Atomic Weight Particle Ground Base Experiments

REFERENCE: Your memorandum to Dr. Low, dated October 2, 1970, re Princeton-Pennsylvania Accelerator

Regarding referenced memorandum, Dr. Low would like the following:

A. A letter to AEC and NSF stating NASA's requirements for high-energy, high atomic weight particle ground base experiments, requesting a specific response from them on our program plan.

B. A letter to the Office of Science and Technology (Dr. David) for Dr. Low's signature giving him the status of our activities in this area.

Martin F. Sedlazek
Assistant Executive Secretary

cc: S
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X

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JM
~~MM~~

10/7/70
70-311
10/13/70
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MM OCT 2 1970

TO : AD/Deputy Administrator

FROM : M/Associate Administrator for Manned Space Flight

SUBJECT : Princeton-Pennsylvania Accelerator

In compliance with your June 9, 1970 memorandum, we have conducted a comprehensive review of NASA's total program requirements for high-energy, high atomic weight (HZE) particle ground based experiments. Representatives (named in Attachment #1) from both the bio-science and physical-science sections of OAST, OSSA, and OMSF were consulted to obtain the overall radiation experiment requirements for their organizations and respective Centers. From the information received, we have concluded that:

(1) The majority of requirements for HZE particle ground based experiments are in the field of radiobiology. The physical scientists, although interested in an HZE particle facility, indicated they could satisfy their requirements in other ways, i.e., balloon flights, existing lower energy accelerator facilities, etc.

(2) Although there is no serious concern about HZE particles for manned flights that are planned in the near future, the dearth of information regarding the biological effect of exposure to HZE particles requires a thorough and comprehensive program of radiobiological investigation. The outline for the suggested radiobiological program is shown in Attachment #2.

The AEC Division of Biology and Medicine has indicated that there are two facilities that with modifications could have HZE capability in the near future. These are the Princeton-Pennsylvania Accelerator (PPA) and the cyclotron proposed by Lawrence Radiation Laboratory, Berkeley, California (Berkeley). A third facility, the Space Radiation Effects Laboratory (SREL) at Langley Research Center is currently being studied by OAST to determine the technical and scientific feasibility of providing HZE particles.

OFFICIAL FILE COPY

OFFICE CODE

From the radiobiological standpoint, it was the general concensus that of the two AEC facilities, the Berkeley facility could best satisfy NASA's program requirements. Reasons for this selection are:

(1) PPA does not have an inhouse biological research capability while Berkeley is outstanding in this respect. The Berkeley staff is very interested in and are actively investigating the "light flash" observations of Apollo lunar mission crews. Berkeley is currently receiving funds from OSSA ($200K) and OMSF ($140K) to provide for radiobiological studies including that of investigating radiobiologic effects of heavily ionizing radiations as produced by existing facilities.

(2) A letter from the Director, PPA (see Attachment #4) indicates the present workload requirements for PPA would make it impossible to conduct experiments before April 1971, rather than August 1970 as indicated earlier. Since no PPA funds would be available from AEC to conduct carbon experiments after April 1, 1971, NASA would have to fund the costs of PPA operation (at least $200K) for one experiment lasting 2-3 days. The Berkeley proposal on the other hand requires no NASA funds, however, the AEC must go to the BOB to request the funds necessary to modify this facility. It is doubtful that the required funding ($7M) will be made available without a strong expression of NASA interest.

(3) While at PPA, the MSC and USAF personnel were informed by the Director of the PPA Laboratory that the vacuum chamber required to provide HZE particles in the PPA facility is manufactured exclusively by a company in England. Since this is an item for which there is little demand, the company has no assembly line. The owner of the company must therefore be convinced that this is an item of great national importance before he will consider manufacturing it.

In summary, to satisfy NASA's total program requirements for HZE particle experiments, it is recommended that:

(1) The NASA program outline (Attachment #2) should be furnished to the AEC and the National Science Foundation (NSF), which also has an accelerator support program, with a request for their positions regarding the availability of facilities needed to accomplish stated objectives. NASA interest in a synchrotron with capabilities similar to those of the proposed Berkeley facility has already been forwarded to the AEC in a letter from the Associate Administrator for Space Science and Applications to the Chairman of the AEC. (See Attachment #3)

(2) A well-coordinated NASA program of ground experimentation capable of satisfying the radiobiological requirements outlined in Attachment #2, should be developed representing the total agency needs.

(3) A specific office should be identified as sponsor for radiobiological studies outlined herein, and to be the focal point for all negotiations with the AEC and NSF. I recommend OSSA be assigned the responsibility at this time.

(4) NASA refrain from indicating support for any particular facility pending the results of SRNL study and the AEC and NSF response to the NASA program outline.

Original signed by
D. D. Myers

Dale D. Myers

Attachments (4)

cc: Distribution List

NASA Headquarters

J. Rehnlo	S
G. Duncan	SB
O. Reynolds	SB
A. Opp	SG
O. Hicks	R
W. Jones	RB
L. Fox	RB
K. Coburn	RB
A. Reetz	RF
H. Harrison	RR
N. Brownstein	MSC
R. Hartman	MSS
C. Darnes	MSS/DC7/NASA
J. Pickering	USAF/SAM
R. Siegel	SPSL/NASA
R. Benson	LeRC/NASA

NOTE: OSSA and MSC would not concur with subparagraph (3) as it appears on page 3. They would however, concur with subparagraph (3) as it appears on the attached page 3.

(3) A well-coordinated NASA program of manual experimentation capable of satisfying the radiobiological requirements outlined in Attachment #2, should be developed representing the total agency needs.

(3) A specific office should be identified as sponsor for radiobiological studies outlined herein, and to be the focal point for all negotiations with the AEC and NSF.

(4) NASA refrain from indicating support for any particular facility pending the results of SSIJ study and the AEC and NSF response to the NASA program outline.

Dale D. Myers

Attachments

MMS:Bartman:jgc:Prep 9/21/70 CONCURRENCES Ext. 20464

OFFICE CODE ▷	MS/Murchreys	RE/Reetz	RB/Jones	SB/Reynolds	SG/Opp	S/Naugle	R/Nicks
INITIALS ▷	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DATE ▷	[illegible]		24 Sep 70	21/9/70	21-9-70	2 SEP 197	9-22-70

NASA FORM 1267 OCT. 68 PREVIOUS EDITIONS MAY BE USED.

ATTACHMENT #1

LIST OF PERSONNEL CONTACTED

C. M. Barnes	MSC/DC7/NASA
C. H. Duncan	NASA Hq/SB
T. Sihlman	NASA Hq/SB
A. C. Opp	NASA Hq/SG
L. Fox	NASA Hq/RB
K. R. Coburn	NASA Hq/RB
A. Roetz	NASA Hq/RF
J. E. Pickering	USAF/SAM
R. Siegel	SNEL/NASA
R. Hanzon	LaRC/NASA
H. Harrison	NASA Hq/RR
N. F. Darr	AEC/DBM
H. S. Brownstein	NASA Hq/MAC
R. A. Hartman	NASA Hq/MAS

ATTACHMENT #2

The potential biological damage which could result from exposure to a broad spectrum of high atomic number - high energy (HZE) galactic particles during manned space flight warrants a thorough and comprehensive program of radiobiological investigation. The program outline presented herein represents the basic long-range effort which NASA will pursue to develop experimental data necessary to define and evaluate this potential biological damage. It is the intent to maintain a degree of flexibility in the conduct of this effort so that specialized interests of all NASA organizations may be accommodated in order to achieve a well-coordinated and coherent program.

OUTLINE OF NASA PROGRAM FOR RADIOBIOLOGICAL INVESTIGATION OF EXPOSURE TO HIGH ATOMIC NUMBER - HIGH ENERGY (HZE) PARTICLES

Health

Ascertain the effects of heavy particles on nerve cells, glial cells and blood vessels as a function of atomic number (Z), energy per nucleon, total particle exposure, and exposure rate. This would be supplemented by vascular permeability and radionuclide studies to bring out functional disturbances in the blood-brain barrier. Regions of the brain most sensitive to particle radiation from the functional standpoint would be determined. Regeneration of brain elements would be studied. Included would be a study of the effects of single particles having the same characteristics as single heavy cosmic particles. Determine, for a given flux, the particles of lowest atomic (Z) number that will produce a given effect. Ascertain the morphological effects on the brain of body exposure alone.

Eye

Determine minimal particle number conducive to retinal injury and cataract formation. Correlate retinal damage with visual disturbances.

Skin and Testis

Studies in relation to Z number and other parameters would be carried out.

Physiology

Study effects of heavy particles on the electrical activity of the brain, both through direct brain irradiation and through irradiation of other systems, e.g., eye, skin, and body organs. Study alerting reaction, somatic and visceral reflex actions. Emphasis would be given the correlation of brain damage with altered brain function. Included would be a study of the effects on the vestibular system, hearing, olfaction, and body sensory endings.

Behavior and Performance

Study behavior and performance in their many aspects, including judgment, as function of exposure parameters, length of latency period before disturbances develop, and length of time before recovery sets in. The results would be correlated with site and degree of brain damage and altered physiological function.

Lethality

Determine the effectiveness of heavy particles in causing irreversible biological damage in various systems and in animals as a whole, both in monkeys and in smaller animals. Study cellular mechanisms of lethality, e.g., (a) double strand scission in DNA and chromosome breakes, and (b) membrane breaks.

Non-dividing Cells

Answer questions introduced in Summer Study regarding the effect of heavy particles on non-dividing cells.

Somatic and Genetic Mutations

Study somatic mutations in various animal systems, including the brain of the monkey, in which somatic mutations have been shown to occur in response to proton and other forms of irradiation; also in primitive life forms in relation to evolutionary processes. For the study of genetic mutations, use would be made largely of insects and plants.

Neoplasia Induction

Ascertain the capacity of heavy particles to produce cancer, including leukemia.

Reduction in Life Span

Drosophila and mice would largely be used for such studies because of the extensive information available from past radiation studies. Various sublethal dosages would be used.

Study of Biogenesis

Utilize heavy particles for study of organic synthesis and breakdown relative to the problem of the origin of life.

Study of Radiation Modifiers

These studies will determine changes at cellular and molecular levels.

Dosimetry

Develop, test, and evaluate devices and techniques for detection and quantification of HZE particles.

TABLE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

JUN 9 1970

Action Copy to MM
Info Copy to M

MEMORANDUM

TO: M/Associate Administrator for Manned Space Flight

FROM: AD/Deputy Administrator

SUBJECT: Princeton - Penn Accelerator

Rec'd in Code M 6-11-70
Control Number 70-152
Suspense Date 7-11-70
Prepare Reply for
Signature of M

Last week I received a call from Dr. DuBridge indicating that he had heard that there was serious concern about the flashes of light that our astronauts had seen in some lunar flights. He told me that he had heard that at least part of the medical community believed that these flashes are caused by very high energy particles which might destroy nerve cells and other cells in the human body. Dr. DuBridge went on to say that he understood that the Princeton - Penn accelerator was the only one in this country that, with small modifications, could produce particles of sufficient energy to duplicate these events. The Princeton - Penn accelerator is now funded by the AEC, but will be phased down during Fiscal Year 1971 for budgetary considerations. However, if NASA were willing to fund a modification costing between one-half and three-quarters of a million dollars and then continue to fund the accelerator at an annual rate of approximately $1 million, it might be available to support NASA's work.

In General Humphreys' absence, I discussed this subject directly with Dr. Berry in Houston. Dr. Berry informs me that there exists a great deal of controversy about the effects of these high energy particles in space. He said that some calculations have been made with results that indicate that there should be major concern; others show that there is not much of a problem. His main point was that this is a subject that is little understood and that some research should be undertaken for future, very long duration flights. He also indicated that there should be no serious concern about any flights that are planned within the present decade. Dr. Berry also informed me that he had been in contact with the people at Berkeley who said that their accelerator was the only one that, with small modifications, could be made to duplicate the particles in question.

I also understand from Herb Brownstein that Colonel Barnes of MSC and Colonel Pickering of the Air Force are looking into the facilities that might be available to investigate this problem. Based on all of

AA/MSF ACTION ITEM

this information, I called back Lee DuBridge and made the following points:

a. There is no serious concern about these high energy particles for flights that are planned in the near future.

b. Some research should be undertaken so that the problem can be better defined for very long duration flights.

c. It is not clear which facilities in this country are best suited for this research.

d. We will investigate all possible facilities and then make a determination which of these is most suitable to conduct the research by the most economical means.

After you have completed your survey of facilities and decided what kind of work you will be doing in this area, would you please let me know so that I can inform Dr. DuBridge? Incidentally, if it is decided to use the Princeton - Penn accelerator, this would require a Bureau of the Budget decision because the Bureau had previously decided that this facility should be closed. I indicated to Dr. DuBridge that it will be 2 to 3 months before we have reached any decision in this matter.

George M. Low

George M. Low

cc:
MM/Gen Humphreys
R/Mr. Nicks
S/Dr. Naugle

MMS/Hartman

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: MMS#70-40

TO: ATTENDEES

FROM: MM/Director, Space Medicine

SUBJECT: High-energy particle radiation experiments

REFERENCE: Memo AD to M, dated 9 June 1970
Subj: Princeton-Penn Accelerator

The personnel listed below met on 10 July 1970 to discuss approaches to development of NASA's program requirements for high-energy particle radiation experiments in compliance with the referenced memo.

NAME	CODE
G. H. Duncan	SB
F. Zihlman	SB
A. G. Opp	SG
A. Reetz, Jr.	RV-1
K. R. Coburn	RB
C. M. Barnes	MSC/DC7
J. E. Pickering	USAF/SAM
H. S. Brownstein	MMC
R. A. Hartman	MMS

Attendees agreed to furnish to this office by 1 August 1970 the following information:

1. The radiation experiment program for their program organization.
2. Dates for implementation of their experiment program.
3. List of facilities currently supported and level of funding for each.
4. Recommendations to meet future needs.

It was also agreed that not later than 15 August 1970 another meeting will be held to review the information received and consolidate program requirements. The consolidated program will then be forwarded

70-45

to the AEC with a request for identification of facilities capable of meeting these requirements, and to OART to enable them to initiate a study to determine the feasibility and associate costs of modifying the Space Radiation Effects Laboratory at LRC to meet NASA program requirements.

J. W. Humphreys, Jr.
Major General, USAF, MC

cc: R
S
M

A T T E N D E N C E L I S T

Meeting - 10 July 70

SURVEY OF HIGH ENERGY RADIATION REQUIREMENTS AND FACILITIES

H. S. Brownstein	MMC	962-0418
C. M. Barnes	MSC/DC7	713/483-4251
G. H. Duncan	SB	963-6750
J. E. Pickering	USAF	Brooks AFB, Tex.
A. Reetz, Jr.	RV-1	962-0067
A. G. Opp	SG	962-1987
Fred Zihlman	SB	963-5075
K. R. Coburn	RB	962-0312
R. A. Hartman	MMS	963-6323

MMS#70-37

OF PROJECTED BUDGET OUTLAYS

[In billions of dollars]

	1978	1979	1980	1981	1982
aw:*					
nt	95.7	105.4	115.4	125.8	136.0
	37.9	44.0	50.7	58.2	66.3
	74.2	76.9	80.3	83.7	87.0
	31.2	33.2	34.9	36.6	39.6
revenue					
	6.8	6.9	6.9	6.9	6.9
fixed					
	11.5	10.8	11.3	10.9	10.8
d costs	257.2	277.2	299.5	322.0	346.7
budget					
ograms					
	−19.8	−24.7	−29.8	−36.1	−43.1
ployee					
	−4.7	−5.1	−5.5	−5.8	−6.2
ays*	207.2	218.6	232.3	246.9	261.3
ble and					
	182.8	188.8	197.1	205.0	212.0
	440.0	466.0	496.6	527.0	558.7

outlays from prior-year contracts and obligations, which n the category "New programs and other budget outlays". able 16, in Part 9.

programs and fixed costs, outlays for igations" amount to an additional 15% considered relatively uncontrollable in outlays are not projected beyond the at the relatively uncontrollable portion % to 80% of the total in the short-run. ility in the budget has obvious fiscal changes in legislation or careful control ending in subsequent years, attempts to ll on an increasingly smaller proportion has proposed legislation to change some programs. The effect of these proposals ely controllable and other budget out- d are discussed in detail in part 9 of

BUDGET AUTHORITY BY FUNCTION

[In billions of dollars]

	Estimate		Projection		
	1978	1979	1980	1981	1982
Budget authority:					
National defense	122.9	135.5	145.9	156.9	167.1
International affairs	9.0	9.6	8.7	8.5	8.3
General science, space, and technology	4.9	5.2	5.2	4.9	4.5
Natural resources, environment, and energy	19.1	18.8	18.3	17.7	18.6
Off-budget Federal entities	*(83.0)*	*(0)*	*(0)*	*(8.0)*	*(0)*
Agriculture	2.7	2.5	2.3	1.7	2.1
Commerce and transportation	18.7	19.4	19.9	20.6	20.4
Off-budget Federal entities	*(0.8)*	*(0.8)*	*(0.8)*	*(0.8)*	*(0.8)*
Community and regional development	6.4	6.4	6.4	6.3	6.1
Off-budget Federal entities	*(0.1)*	*(0.1)*	*(0.1)*	*(0.1)*	*(0.1)*
Education, training, employment, and social services	18.0	18.5	18.6	18.8	19.0
Health	47.4	52.1	56.9	65.9	73.2
Income security	170.2	185.9	203.7	219.2	232.2
Off-budget Federal entities	(*)	(*)	(*)	(*)	(*)
Veterans benefits and services	18.2	18.6	18.1	17.6	17.3
Law enforcement and justice	3.7	3.8	3.7	3.7	3.8
General government	3.9	4.0	3.9	3.9	3.8
Off-budget Federal entities	*(10.0)*	*(10.5)*	*(11.0)*	*(11.5)*	*(12.1)*
Revenue sharing and general purpose fiscal assistance	9.1	8.7	9.8	8.9	9.9
Interest	39.7	42.4	44.0	45.1	47.3
Allowances:					
Civilian agency pay raises	1.2	2.3	3.5	4.7	5.9
Contingencies	1.8	2.0	3.5	4.8	5.8
Undistributed offsetting receipts:					
Employer share, employee retirement	−4.7	−5.1	−5.5	−5.8	−6.2
Interest received by trust funds	−8.7	−9.7	−10.6	−11.5	−12.5
Rents and royalties on the Outer Continental Shelf	−3.1	−2.5	−2.5	−2.5	−2.5
Total budget authority	**480.4**	**518.6**	**553.9**	**589.5**	**623.9**
Budget authority, off-budget Federal entities	*93.8*	*11.3*	*11.8*	*20.4*	*13.0*
Budget authority, including off-budget Federal entities	*574.2*	*529.9*	*565.7*	*609.9*	*636.9*

*Less than $50 million.

OUTLAYS BY FUNCTION

[In billions of dollars]

	Estimate		Projection		
	1978	1979	1980	1981	1982
	112.3	123.8	136.3	148.2	159.0
	7.3	7.6	7.7	7.9	8.0
	(−0.1)	(−0.1)	(−0.1)	(−0.1)	(−0.1)
y	4.7	5.2	5.1	4.9	4.6
energy	19.7	20.6	19.3	18.6	18.7
	(−0.1)	(−0.1)	(−0.1)	(−0.1)	(−0.1)
	2.3	1.9	2.2	2.1	2.3
	19.3	18.6	19.6	18.7	18.3
	(2.5)	(3.2)	(3.2)	(3.2)	(3.1)
t	7.9	7.1	6.5	6.5	6.4
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
social services	19.4	18.1	18.3	18.4	18.6
	43.2	46.7	50.4	54.4	58.9
	143.9	152.8	164.4	178.7	192.6
	(*)	(*)	(*)	(*)	(*)
	18.3	18.0	18.1	17.6	17.3
	3.8	3.8	3.8	3.8	3.8
	3.9	4.0	4.0	3.9	3.8
	(5.9)	(6.2)	(6.5)	(6.9)	(7.2)
e fiscal assist-					
	8.1	8.3	8.4	8.5	8.6
	39.7	42.4	44.0	45.1	47.3
	1.2	2.3	3.5	4.7	5.9
	1.5	2.0	3.5	4.8	5.8
t	−4.7	−5.1	−5.4	−5.8	−6.2
	−8.7	−9.7	−10.6	−11.5	−12.5
tinental Shelf	−3.1	−2.5	−2.5	−2.5	−2.5
	440.0	466.0	496.6	527.0	558.7
	9.2	10.9	12.1	13.1	14.3
l entities	449.2	476.9	508.7	540.1	573.0

BUDGET AUTHORITY BY AGENCY

[In billions of dollars]

Department or other unit	Estimates		Projections		
	1978	1979	1980	1981	1982
Budget authority:					
Legislative and judicial branches	1.5	1.7	1.6	1.6	1.7
Executive Office of the President	.1	.1	.1	.1	.1
Funds appropriated to the President	4.1	3.8	3.3	3.2	3.2
Agriculture	12.4	12.9	13.1	13.1	13.8
Food stamps and other nutrition programs	(6.7)	(7.2)	(7.5)	(7.9)	(8.1)
Other Agriculture	(5.7)	(5.7)	(5.6)	(5.2)	(5.7)
Off-budget Federal entities	(.1)	(.1)	(.1)	(.1)	(.1)
Commerce	1.9	1.9	2.1	1.8	1.6
Defense—Military	121.7	134.3	144.7	155.6	165.7
Military personnel	(26.2)	(26.3)	(26.4)	(26.5)	(26.6)
Retired military personnel	(9.0)	(9.7)	(10.5)	(11.2)	(11.8)
Operation and maintenance	(34.2)	(35.6)	(37.3)	(39.2)	(41.2)
Procurement	(35.1)	(39.0)	(43.8)	(48.1)	(52.4)
R.D.T. & E.	(12.0)	(13.0)	(14.6)	(15.2)	(15.7)
Other	(5.2)	(10.7)	(12.1)	(15.4)	(18.0)
Defense—Civil	2.6	2.6	2.6	2.6	2.6
Health, Education, and Welfare	161.1	181.2	202.8	224.3	242.7
Social security	(88.6)	(103.3)	(119.3)	(131.1)	(141.4)
Medicare	(28.6)	(32.6)	(36.7)	(44.8)	(51.2)
Other Health, Education, and Welfare	(44.4)	(45.3)	(46.8)	(48.4)	(50.1)
Housing and Urban Development	29.7	29.6	29.8	29.7	29.6
Off-budget Federal entities	(.8)	(.8)	(.8)	(.8)	(.8)
Interior	3.6	3.9	4.1	4.0	3.8
Justice	2.3	2.4	2.3	2.3	2.3
Labor	20.7	19.2	18.3	19.9	21.0
Unemployment trust fund	(17.2)	(17.4)	(17.5)	(17.9)	(17.9)
Other Labor	(3.5)	(1.8)	(0.8)	(2.0)	(3.1)
Off-budget Federal entities	(*)	(*)	(*)	(*)	(*)
State	1.4	1.4	1.6	1.7	1.8
Transportation	13.0	14.4	14.6	15.7	15.7
Treasury	51.0	53.2	55.9	56.1	59.3
Interest on the public debt	(44.6)	(47.3)	(48.9)	(50.0)	(52.2)
General revenue sharing	(6.8)	(6.9)	(6.9)	(6.9)	(6.9)
Other Treasury	(11.8)	(11.2)	(12.3)	(11.4)	(12.4)
Offsetting receipts	(−12.2)	(−12.2)	(−12.2)	(−12.2)	(−12.2)
Off-budget Federal entities	(9.9)	(10.5)	(11.0)	(11.5)	(12.1)
Civil Service Commission	17.1	18.6	20.1	21.0	21.8
Export-Import Bank	1.6	2.2	1.8	1.5	1.2
National Aeronautics and Space Administration	4.0	4.4	4.3	4.0	3.6
Veterans Administration	18.2	18.6	18.1	17.6	17.3
Other agencies	25.7	25.2	24.3	24.3	24.6
Off-budget Federal entities	(83.0)	(−.1)	(−.1)	(7.9)	(−.1)
Allowances	3.0	4.3	7.0	9.5	11.7
Undistributed offsetting receipts	−16.5	−17.3	−18.6	−19.8	−21.2
Total budget authority	480.4	518.6	553.9	589.5	623.9
Budget authority, off-budget Federal entities	93.8	11.3	11.8	20.4	13.0
Budget authority, including off-budget Federal entities	574.2	529.9	565.7	609.9	636.9

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BY TYPE (in millions of dollars)—Continued

	1976 actual	TQ actual	1977 estimate	1978 estimate
E				
inued				
-----	31	16	47	45
ty:				
ritical				
-----	160	63	124	290
nd)	7,257	2,539	8,800	8,800
-----	20	3	33	7
-----	62	1	-------	-------
-----	13	*	1	1
-----	7,542	2,623	9,005	9,143
erna-				
-----	201	100	283	300
-----	128	71	206	208
-----	95	15	85	85
-----	71	-------	73	74
-----	193	61	227	166
nts	688	247	874	834
-----	113	96	112	112
-----	9	−7	*	*
dis-				
----	11,235	3,960	13,542	14,149
helf:				
----	1,662	1,132	1,900	2,300
----	1,001	179	700	800
ublic				
----	2,662	1,311	2,600	3,100
----	13,898	5,271	16,142	17,249
----	53,321	10,543	59,458	61,092

y and railroad retirement funds place the social been if there were no separate railroad retirement rement funds occur when an employee transfers er system.
employees and military personnel.

e transition quarter arising from interest on public

	1976 actual	*TQ actual*	*1977 estimate*	*1978 estimate*
----------	5,767	2,414	6,427	7,404
----------	8,131	2,857	9,715	9,845

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
050 NATIONAL DEFENSE					
051 Department of Defense—Military:					
Military personnel	25,430	6,585	26,210	26,193	26,254
Retired military personnel	7,326	1,943	8,238	9,036	9,706
Operation and maintenance	28,848	7,638	32,175	34,168	35,573
Procurement	20,991	4,135	27,672	35,143	39,014
Research, development, test, and evaluation	9,451	2,406	10,478	11,980	12,971
Military construction	2,360	76	2,147	1,376	4,210
Other [1]	1,461	302	1,515	1,600	1,825
Allowances	-------	-------	-------	2,384	4,826
Deductions for offsetting receipts	−155	5	−176	−176	−107
Total 051	95,712	23,089	108,260	121,704	134,272
052 Military assistance:					
Funds appropriated to the President [1]	13,997	1,306	7,494	7,892	7,423
Deductions for offsetting receipts	−7,476	−2,653	−9,111	−9,110	−8,615
Total 052	6,521	−1,347	−1,617	−1,218	−1,192
053 Atomic energy defense activities:					
Energy Research and Development Administration	1,682	459	1,935	2,380	2,415
054 Defense-related activities:					
General Services Administration	16	4	17	239	319
Other independent agencies:					
Central Intelligence Agency	-------	-------	28	35	42
Intelligence Community Oversight	-------	-------	10	10	11
Renegotiation Board	6	1	6	6	6
Selective Service System	38	7	8	6	6
Other temporary commissions	1	-------	-------	-------	-------
Deductions for offsetting receipts	−162	−64	−124	−290	−329
Total 054	−101	−52	−55	7	56
Deductions for offsetting receipts [2]	−3	1	−3	−3	−3
Total national defense	103,811	22,149	108,520	122,871	135,548
150 INTERNATIONAL AFFAIRS					
151 Foreign economic and financial assistance:					
Funds appropriated to the President [1]	3,899	543	4,482	5,238	5,041
Department of Agriculture	1,090	146	1,169	923	1,049
Department of State	31	1	33	25	25
Department of Transportation [1]	8	1	6	7	37
Other independent agencies: ACTION [1]	82	24	81	68	65
Deductions for offsetting receipts	−12	−3	−12	−11	−11
Total 151	5,097	713	5,761	6,250	6,207

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
150 INTERNATIONAL AFFAIRS—Con.					
152 Conduct of foreign affairs:					
Funds appropriated to the President	17	-------	21	21	21
Department of State [1]	796	358	1,112	1,213	1,269
Other independent agencies:					
Arms Control and Disarmament Agency	12	3	12	13	14
Foreign Claims Settlement Commission	1	*	1	1	1
International Trade Commission	10	3	12	12	12
Deductions for offsetting receipts	−55	−2	−105	−115	−124
Total 152	782	362	1,053	1,146	1,193
153 Foreign information and exchange activities:					
Department of State [1]	68	12	75	83	90
Other independent agencies:					
Board for International Broadcasting	64	18	53	59	62
Japan-United States Friendship Commission [1]	36	-------	-------	1	1
United States Information Agency [1]	273	73	264	277	303
Deductions for offsetting receipts	−18	−*	−*	−*	−*
Total 153	423	103	392	420	456
155 International financial programs:					
Funds appropriated to the President	-------	-------	300	130	120
Other independent agencies: Export-Import Bank	728	384	1,274	1,622	2,242
Deductions for offsetting receipts	−20	−20	−20	−20	−20
Total 155	708	364	1,554	1,732	2,342
Deductions for offsetting receipts [2]	−446	−160	−512	−527	−579
Total international affairs	6,564	1,382	8,247	9,021	9,619
250 GENERAL SCIENCE, SPACE, AND TECHNOLOGY					
251 General science and basic research:					
Energy Research and Development Administration	320	76	372	429	410
Other independent agencies:					
National Science Foundation [1]	717	169	779	889	937
Smithsonian Institution [1]	2	1	2	2	2
Total 251	1,039	246	1,153	1,320	1,349
253 Space flight:					
National Aeronautics and Space Administration	1,957	506	2,039	2,182	2,222
254 Space science, applications, and technology:					
National Aeronautics and Space Administration	944	255	949	1,024	1,241

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY F

(In million

Function and department or other unit
250 GENERAL SCIENCE, SPACE, AND TECHNOLOGY—Continued
255 Supporting space activities:
National Aeronautics and Space Administration [1]
Deductions for offsetting receipts
Total 255
Deductions for offsetting receipts [2]
Total general science, space, and technology
300 NATURAL RESOURCES, ENVIRONMENT, AND ENERGY
301 Water resources and power:
Department of Agriculture [1]
Department of Defense—Civil [1]
Department of the Interior [1]
Department of State
Other independent agencies:
Delaware River Basin Commission
Susquehanna River Basin Commission
Tennessee Valley Authority
Water Resources Council [1]
Deductions for offsetting receipts
Total 301
302 Conservation and land management:
Department of Agriculture [1]
Department of Commerce
Department of the Interior [1]
Department of State
Other independent agencies: Marine Mam mal Commission
Deductions for offsetting receipts
Total 302
303 Recreational resources:
Department of Agriculture
Department of Defense—Civil
Department of the Interior [1]
Other independent agencies:
Advisory Council on Historic Preservatio
Other temporary commissions
Deductions for offsetting receipts
Total 303

See footnotes at end of table.

UNCTION AND AGENCY—Continued
of dollars)

1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
17	-------	21	21	21
796	358	1,112	1,213	1,269
12	3	12	13	14
1	*	1	1	1
10	3	12	12	12
−55	−2	−105	−115	−124
782	362	1,053	1,146	1,193
68	12	75	83	90
64	18	53	59	62
36	-------	-------	1	1
273	73	264	277	303
−18	−*	−*	−*	−*
423	103	392	420	456
------	-------	300	130	120
728	384	1,274	1,622	2,242
−20	−20	−20	−20	−20
708	364	1,554	1,732	2,342
−446	−160	−512	−527	−579
6,564	1,382	8,247	9,021	9,619
320	76	372	429	410
717	169	779	889	937
2	1	2	2	2
1,039	246	1,153	1,320	1,349
1,957	506	2,039	2,182	2,222
944	255	949	1,024	1,241

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
250 GENERAL SCIENCE, SPACE, AND TECHNOLOGY—Continued					
255 Supporting space activities:					
National Aeronautics and Space Administration [1]	327	88	357	391	437
Deductions for offsetting receipts	−1	−*	-------	-------	-------
Total 255	326	88	357	391	437
Deductions for offsetting receipts [2]	−3	−1	−2	−2	−2
Total general science, space, and technology	4,262	1,095	4,496	4,915	5,248
300 NATURAL RESOURCES, ENVIRONMENT, AND ENERGY					
301 Water resources and power:					
Department of Agriculture [1]	239	45	188	166	162
Department of Defense—Civil [1]	2,216	671	2,519	2,667	2,669
Department of the Interior [1]	674	397	1,004	905	909
Department of State	15	3	12	26	23
Other independent agencies:					
Delaware River Basin Commission	*	*	*	*	*
Susquehanna River Basin Commission	*	*	*	*	*
Tennessee Valley Authority	10,100	31	126	132	132
Water Resources Council [1]	15	4	19	-------	-------
Deductions for offsetting receipts	−293	−80	−340	−338	−338
Total 301	12,966	1,070	3,528	3,558	3,558
302 Conservation and land management:					
Department of Agriculture [1]	1,275	362	1,542	1,458	1,466
Department of Commerce	18	5	35	45	56
Department of the Interior [1]	289	111	338	374	414
Department of State	5	2	6	6	6
Other independent agencies: Marine Mammal Commission	1	*	1	1	1
Deductions for offsetting receipts	−385	−58	−527	−495	−494
Total 302	1,202	422	1,396	1,388	1,448
303 Recreational resources:					
Department of Agriculture	3	2	2	4	4
Department of Defense—Civil	2	*	3	7	5
Department of the Interior [1]	872	192	2,075	1,386	1,565
Other independent agencies:					
Advisory Council on Historic Preservation	-------	-------	1	1	2
Other temporary commissions	*	*	-------	-------	-------
Deductions for offsetting receipts	−2	−1	−2	−2	−2
Total 303	875	194	2,079	1,396	1,573

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
300 NATURAL RESOURCES, ENVIRONMENT, AND ENERGY—Continued					
304 Pollution control and abatement:					
Department of the Interior	*	*	-------	-------	-------
Department of Transportation	13	1	18	8	9
Environmental Protection Agency [1]	671	168	1,764	5,206	5,207
Other independent agencies:					
Interstate Commission on the Potomac River Basin	*	*	*	*	*
Other temporary commissions	*	-------	-------	-------	-------
Deductions for offsetting receipts	—*	—*	—*	—*	—*
Total 304	684	168	1,782	5,215	5,215
305 Energy:					
Funds appropriated to the President	24	15	806	561	694
Department of Agriculture	21	5	22	23	23
Department of the Interior	62	15	66	63	63
Energy Research and Development Administration [1]	2,514	729	4,083	5,031	5,496
Environmental Protection Agency	101	21	96	96	96
Other independent agencies:					
Energy Independence Authority	-------	-------	-------	42	55
Federal Energy Administration	466	33	275	1,802	809
Federal Power Commission	37	9	43	43	43
Nuclear Regulatory Commission	217	52	249	292	336
Deductions for offsetting receipts	—*	—12	—401	—561	—695
Total 305	3,441	867	5,240	7,392	6,922
306 Other natural resources:					
Department of Commerce [1]	516	145	593	606	597
Department of the Interior [1]	415	103	472	551	573
Deductions for offsetting receipts	—10	—4	—11	—11	—11
Total 306	921	245	1,055	1,146	1,159
Deductions for offsetting receipts [2]	—807	—359	—800	—997	—1,045
Total natural resources, environment, and energy	19,283	2,607	14,279	19,098	18,830
350 AGRICULTURE					
351 Farm income stabilization:					
Department of Agriculture [1]	3,158	63	591	1,588	1,338
352 Agricultural research and services:					
Department of Agriculture [1]	1,039	258	1,128	1,193	1,216
Deductions for offsetting receipts	—48	—13	—49	—49	—49
Total 352	991	245	1,079	1,144	1,167
Deductions for offsetting receipts [2]	7	1	—2	—3	—3
Total agriculture	4,157	309	1,668	2,729	2,502

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FU

(In millions

Function and department or other unit
400 COMMERCE AND TRANSPORTATION
401 Mortgage credit and thrift insurance:
Department of Agriculture
Department of Housing and Urban Development
Total 401
402 Postal Service:
Other independent agencies: Postal Service
403 Other advancement and regulation of commerce:
Legislative branch
Department of Commerce [1]
Department of Housing and Urban Development
General Services Administration
Other independent agencies:
Commodity Futures Trading Commission
Federal Communications Commission
Federal Trade Commission
National Center for Productivity and Quality of Working Life
Securities and Exchange Commission
Small Business Administration
Other temporary commissions
Deductions for offsetting receipts
Total 403
404 Ground transportation:
Department of Transportation [1]
Other independent agencies:
Washington Area Metropolitan Tran Authority
Interstate Commerce Commission
U.S. Railway Association
Total 404
405 Air transportation:
Department of Transportation [1]
National Aeronautics and Space Administ tion
Other independent agencies: Civil Aeron tics Board
Total 405
406 Water transportation:
Department of Commerce [1]
Department of Transportation [1]
Other independent agencies: Federal M time Commission
Deductions for offsetting receipts
Total 406

See footnotes at end of table.

FUNCTION AND AGENCY—Continued

ıs of dollars)

1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
*	*	-------	-------	-------
13	1	18	8	9
671	168	1,764	5,206	5,207
*	*	*	*	*
*	-------	-------	-------	-------
—*	—*	—*	—*	—*
684	168	1,782	5,215	5,215
24	15	806	561	694
21	5	22	23	23
62	15	66	63	63
2,514	729	4,083	5,031	5,496
101	21	96	96	96
-------	-------	-------	42	55
466	33	275	1,802	809
37	9	43	43	43
217	52	249	292	336
—*	—12	—401	—561	—695
3,441	867	5,240	7,392	6,922
516	145	593	606	597
415	103	472	551	573
—10	—4	—11	—11	—11
921	245	1,055	1,146	1,159
—807	—359	—800	—997	—1,045
19,283	2,607	14,279	19,098	18,830
3,158	63	591	1,588	1,338
1,039	258	1,128	1,193	1,216
—48	—13	—49	—49	—49
991	245	1,079	1,144	1,167
7	1	—2	—3	—3
4,157	309	1,668	2,729	2,502

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
400 COMMERCE AND TRANSPORTATION					
401 Mortgage credit and thrift insurance:					
Department of Agriculture	138	5	192	328	362
Department of Housing and Urban Development	6,275	211	1,027	1,125	735
Total 401	6,413	216	1,219	1,453	1,096
402 Postal Service:					
Other independent agencies: Postal Service	1,708	934	2,272	1,472	1,435
403 Other advancement and regulation of commerce:					
Legislative branch	7	2	11	12	13
Department of Commerce [1]	408	106	448	476	595
Department of Housing and Urban Development	6	1	8	7	7
General Services Administration	1	*	1	1	1
Other independent agencies:					
Commodity Futures Trading Commission	11	3	13	13	13
Federal Communications Commission	51	13	57	60	60
Federal Trade Commission	47	13	55	60	60
National Center for Productivity and Quality of Working Life	2	*	3	5	-------
Securities and Exchange Commission	49	13	57	58	57
Small Business Administration	318	10	632	603	698
Other temporary commissions	1	*	2	*	-------
Deductions for offsetting receipts	—23	—7	—24	—25	—25
Total 403	879	154	1,262	1,270	1,479
404 Ground transportation:					
Department of Transportation [1]	7,209	3,731	5,224	8,976	10,091
Other independent agencies:					
Washington Area Metropolitan Transit Authority	100	27	116	37	19
Interstate Commerce Commission	67	14	62	62	60
U.S. Railway Association	522	965	12	435	143
Total 404	7,898	4,736	5,414	9,511	10,314
405 Air transportation:					
Department of Transportation [1]	1,928	951	2,565	2,710	2,860
National Aeronautics and Space Administration	325	83	379	423	488
Other independent agencies: Civil Aeronautics Board	84	23	99	93	96
Total 405	2,337	1,056	3,043	3,226	3,444
406 Water transportation:					
Department of Commerce [1]	531	110	430	396	266
Department of Transportation [1]	1,093	280	1,286	1,336	1,382
Other independent agencies: Federal Maritime Commission	8	2	9	9	9
Deductions for offsetting receipts	—*	—*	—1	—*	—*
Total 406	1,631	392	1,724	1,740	1,656

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
400 COMMERCE AND TRANSPORTATION—Continued					
407 Other transportation:					
Department of Transportation	63	16	67	74	75
Other independent agencies:					
National Transportation Safety Board	11	3	14	15	15
Other temporary commissions	-------	-------	1	1	-------
Total 407	74	19	81	90	89
Deductions for offsetting receipts [2]	−52	−12	−43	−67	−65
Total commerce and transportation	20,890	7,496	14,974	18,694	19,447
450 COMMUNITY AND REGIONAL DEVELOPMENT					
451 Community development:					
Department of Agriculture	250	38	200	50	50
Department of Commerce	9	2	17	14	15
Department of Housing and Urban Development	2,746	68	3,860	3,812	3,707
Other independent agencies:					
ACTION	103	21	109	95	87
Commission on Fine Arts	*	*	*	*	*
Community Services Administration [1]	520	130	512	398	398
District of Columbia	211	-------	102	161	127
National Capital Planning Commission	2	*	2	2	2
Pennsylvania Avenue Development Corporation	1	*	30	21	46
Total 451	3,842	259	4,833	4,554	4,432
452 Area and regional development:					
Funds appropriated to the President	311	12	118	298	308
Department of Agriculture	318	136	365	352	347
Department of Commerce [1]	514	128	2,600	463	480
Department of the Interior [1]	637	165	736	778	794
Other independent agencies:					
Appalachian Regional Commission [1]	5	1	6	6	6
Joint Federal-State Land Use Planning Commission for Alaska [1]	1	*	1	1	1
Deductions for offsetting receipts	−239	−91	−277	−277	−312
Total 452	1,546	352	3,548	1,622	1,623
453 Disaster relief and insurance:					
Funds appropriated to the President	150	38	200	150	150
Department of Agriculture	10	2	10	10	10
Department of Housing and Urban Development	75	19	82	118	149
Other independent agencies: Small Business Administration	100	1	90	20	96
Total 453	335	60	383	298	405
Deductions for offsetting receipts [2]	−15	−19	−33	−39	−42
Total community and regional development	5,708	653	8,731	6,434	6,418

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FU

(In millions

Function and department or other unit
500 EDUCATION, TRAINING, EMPLOYMENT, AND SOCIAL SERVICES
501 Elementary, secondary, and vocational education:
Department of Health, Education, and Welfare
Department of the Interior
Total 501
502 Higher education:
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Treasury
Other independent agencies: Harry S. Truman Scholarship Foundation [1]
Total 502
503 Research and general education aids:
Legislative branch [1]
Department of Health, Education, and Welfare [1]
Department of the Treasury
Other independent agencies:
Corporation for Public Broadcasting
National Commission on Libraries and Information Science
National Foundation on the Arts and the Humanities [1]
Smithsonian Institution
Deductions for offsetting receipts
Total 503
504 Training and employment:
Department of Commerce
Department of Health, Education, and Welfare
Department of Labor [1]
Deductions for offsetting receipts
Total 504
505 Other labor services:
Department of Labor [1]
Other independent agencies:
Committee for Purchase from the Blind and Other Severely Handicapped
Federal Mediation and Conciliation Service
National Labor Relations Board
National Mediation Board
Total 505

See footnotes at end of table.

NCTION AND AGENCY—Continued
of dollars)

1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
63	16	67	74	75
11	3	14	15	15
------	-------	1	1	-------
74	19	81	90	89
−52	−12	−43	−67	−65
20,890	7,496	14,974	18,694	19,447
250	38	200	50	50
9	2	17	14	15
2,746	68	3,860	3,812	3,707
103	21	109	95	87
*	*	*	*	*
520	130	512	398	398
211	-------	102	161	127
2	*	2	2	2
1	*	30	21	46
3,842	259	4,833	4,554	4,432
311	12	118	298	308
318	136	365	352	347
514	128	2,600	463	480
637	165	736	778	794
5	1	6	6	6
1	*	1	1	1
−239	−91	−277	−277	−312
1,546	352	3,548	1,622	1,623
150	38	200	150	150
10	2	10	10	10
75	19	82	118	149
100	1	90	20	96
335	60	383	298	405
−15	−19	−33	−39	−42
,708	653	8,731	6,434	6,418

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
500 EDUCATION, TRAINING, EMPLOYMENT, AND SOCIAL SERVICES					
501 Elementary, secondary, and vocational education:					
Department of Health, Education, and Welfare	4,846	2,868	5,953	5,177	5,374
Department of the Interior	243	79	256	266	280
Total 501	5,089	2,947	6,209	5,443	5,654
502 Higher education:					
Department of Health, Education, and Welfare	3,688	185	2,950	2,816	3,019
Department of Housing and Urban Development	−19	−5	15	-------	-------
Department of the Treasury	1	-------	-------	-------	-------
Other independent agencies: Harry S. Truman Scholarship Foundation [1]	10	-------	20	-------	-------
Total 502	3,680	180	2,985	2,816	3,019
503 Research and general education aids:					
Legislative branch [1]	100	24	116	144	146
Department of Health, Education, and Welfare [1]	310	211	548	417	416
Department of the Treasury	7	-------	-------	-------	-------
Other independent agencies:					
Corporation for Public Broadcasting	78	18	103	107	120
National Commission on Libraries and Information Science	*	*	4	1	1
National Foundation on the Arts and the Humanities [1]	180	60	253	294	300
Smithsonian Institution	100	27	112	121	121
Deductions for offsetting receipts	−10	−2	−10	−10	−10
Total 503	765	338	1,125	1,074	1,095
504 Training and employment:					
Department of Commerce	374	-------	-------	-------	-------
Department of Health, Education, and Welfare	400	80	370	344	344
Department of Labor [1]	6,490	759	6,494	3,931	3,924
Deductions for offsetting receipts	−*	*	-------	-------	-------
Total 504	7,264	839	6,864	4,275	4,268
505 Other labor services:					
Department of Labor [1]	237	59	277	305	309
Other independent agencies:					
Committee for Purchase from the Blind and Other Severely Handicapped	*	*	*	*	*
Federal Mediation and Conciliation Service	18	5	21	22	22
National Labor Relations Board	70	18	81	89	92
National Mediation Board	3	1	4	4	4
Total 505	329	82	383	420	427

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
500 EDUCATION, TRAINING, EMPLOYMENT, AND SOCIAL SERVICES—Continued					
506 Social services:					
Department of Health, Education, and Welfare	4,095	935	4,197	3,940	4,008
Department of Housing and Urban Development	-------	-------	3	5	5
Total 506	4,095	935	4,200	3,945	4,013
Deductions for offsetting receipts [2]	−5	−1	−5	−6	−5
Total education, training, employment, and social services	21,217	5,321	21,762	17,967	18,471
550 HEALTH					
551 Health care services:					
Department of Health, Education, and Welfare [1]	32,463	8,448	41,257	36,303	40,688
Other independent agencies: Civil Service Commission [1]	348	99	452	506	596
Deductions for offsetting receipts	−3,598	−878	−5,997	−7,077	−7,500
Total 551	29,214	7,669	35,712	29,733	33,784
552 Health research and education:					
Department of Health, Education, and Welfare	2,981	555	3,188	2,439	2,400
553 Prevention and control of health problems:					
Department of Agriculture	228	65	241	242	242
Department of Health, Education, and Welfare	612	103	553	341	341
Department of the Interior	84	21	98	106	111
Department of Labor	117	29	130	135	135
Other independent agencies:					
Consumer Product Safety Commission	40	10	40	40	40
Occupational Safety and Health Review Commission	6	1	6	7	7
Total 553	1,087	231	1,069	871	876
554 Health planning and construction:					
Department of Health, Education, and Welfare [1]	378	53	394	1,210	1,236
Deductions for offsetting receipts	−2	−1	−1	−1	−1
Total 554	376	52	393	1,208	1,235
555 General health financing assistance:					
Department of Health, Education, and Welfare	-------	-------	-------	13,172	13,830
Deductions for offsetting receipts [2]	−8	−1	−8	−8	−8
Total health	33,649	8,505	40,354	47,416	52,118

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY

(In millio

Function and department or other unit
600 INCOME SECURITY
601 General retirement and disability in surance:
Department of Health, Education, an Welfare [1]
Department of Labor [1]
Other independent agencies: Railroad R tirement Board [1]
Deductions for offsetting receipts
Total 601
602 Federal employee retirement and di ability:
Legislative branch
The Judiciary [1]
Department of Labor
Department of State
Other independent agencies: Civil Servi Commission
Deductions for offsetting receipts
Total 602
603 Unemployment insurance:
Department of Labor [1]
Deductions for offsetting receipts
Total 603
604 Public assistance and other inco supplements:
Department of Agriculture
Department of Health, Education, Welfare [1]
Department of Housing and Urban velopment
Department of the Treasury
Other independent agencies: Railroad tirement Board
Total 604
Deductions for offsetting receipts [2]
Total income security
700 VETERANS BENEFITS AND SERVI
701 Income security for veterans:
Veterans Administration [1]
Deductions for offsetting receipts
Total 701

See footnotes at end of table.

FUNCTION AND AGENCY—Continued

s of dollars)

1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
4,095	935	4,197	3,940	4,008
-------	-------	3	5	5
4,095	935	4,200	3,945	4,013
−5	−1	−5	−6	−5
21,217	5,321	21,762	17,967	18,471
32,463	8,448	41,257	36,303	40,688
348	99	452	506	596
−3,598	−878	−5,997	−7,077	−7,500
29,214	7,669	35,712	29,733	33,784
2,981	555	3,188	2,439	2,400
228	65	241	242	242
612	103	553	341	341
84	21	98	106	111
117	29	130	135	135
40	10	40	40	40
6	1	6	7	7
1,087	231	1,069	871	876
378	53	394	1,210	1,236
−2	−1	−1	−1	−1
376	52	393	1,208	1,235
-----	-------	-------	13,172	13,830
−8	−1	−8	−8	−8
3,649	8,505	40,354	47,416	52,118

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
600 INCOME SECURITY					
601 General retirement and disability insurance:					
Department of Health, Education, and Welfare [1]	72,197	18,592	82,684	91,881	106,426
Department of Labor [1]	26	6	33	31	32
Other independent agencies: Railroad Retirement Board [1]	3,485	374	3,914	4,169	4,004
Deductions for offsetting receipts	−2,004	−*	−2,286	−2,568	−2,435
Total 601	73,705	18,972	84,345	93,513	108,027
602 Federal employee retirement and disability:					
Legislative branch	*	*	*	*	*
The Judiciary [1]	2	1	64	2	2
Department of Labor	276	75	307	292	330
Department of State	97	11	159	161	171
Other independent agencies: Civil Service Commission	13,099	1,480	16,472	16,482	17,903
Deductions for offsetting receipts	−4	−1	−87	−50	−50
Total 602	13,470	1,565	16,916	16,888	18,357
603 Unemployment insurance:					
Department of Labor [1]	21,111	3,350	21,013	17,761	17,477
Deductions for offsetting receipts	−7,878	−625	−3,851	−1,800	−3,000
Total 603	13,233	2,725	17,162	15,961	14,477
604 Public assistance and other income supplements:					
Department of Agriculture	7,737	1,966	8,160	6,700	7,241
Department of Health, Education, and Welfare [1]	11,626	3,131	12,449	12,476	12,843
Department of Housing and Urban Development	19,405	107	15,512	24,598	24,954
Department of the Treasury	808	86	856	-------	-------
Other independent agencies: Railroad Retirement Board	38	10	40	50	30
Total 604	39,613	5,300	37,017	43,825	45,069
Deductions for offsetting receipts [2]	−1	−*	−*	−*	−*
Total income security	140,019	28,562	155,440	170,186	185,930
700 VETERANS BENEFITS AND SERVICES					
701 Income security for veterans:					
Veterans Administration [1]	9,145	2,299	9,954	10,071	9,932
Deductions for offsetting receipts	−460	−149	−500	−523	−512
Total 701	8,685	2,150	9,454	9,548	9,420

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
700 VETERANS BENEFITS AND SERVICES—Continued					
702 Veterans education, training, and rehabilitation:					
Veterans Administration [1]	6,015	1,159	3,990	2,751	3,111
Deductions for offsetting receipts	-------	-------	−6	−31	−54
Total 702	6,015	1,159	3,984	2,720	3,057
703 Hospital and medical care for veterans:					
Veterans Administration	4,436	1,092	5,077	5,319	5,489
705 Other veterans benefits and services:					
Department of Defense—Civil [1]	21	5	22	22	22
Department of the Treasury	*	*	*	*	*
Veterans Administration [1]	517	122	534	587	589
Other independent agencies: American Battle Monuments Commission [1]	5	2	6	6	6
Deductions for offsetting receipts	−*	−*	−1	−2	−2
Total 705	544	129	561	614	615
Deductions for offsetting receipts [2]	−2	−1	−2	−2	−2
Total veterans benefits and services	19,678	4,529	19,073	18,199	18,580
750 LAW ENFORCEMENT AND JUSTICE					
751 Federal law enforcement and prosecution:					
The Judiciary [1]	21	5	23	27	28
Department of Health, Education, and Welfare	25	7	30	33	33
Department of Housing and Urban Development	12	3	12	15	15
Department of Justice	1,129	297	1,246	1,300	1,302
Department of the Treasury	569	151	609	660	664
Other independent agencies:					
Administrative Conference of the United States	1	*	1	1	1
Commission on Civil Rights	8	2	10	11	10
Equal Employment Opportunity Commission	64	19	71	74	74
Legal Services Corporation	92	25	125	90	90
Other temporary commissions	1	*	*	-------	-------
Deductions for offsetting receipts	−2	−1	−2	−2	−2
Total 751	1,920	508	2,125	2,209	2,215
752 Federal judicial activities:					
Legislative branch	7	2	7	8	8
The Judiciary	322	82	368	414	438
Other independent agencies: Indian Claims Commission	1	*	2	2	-------
Total 752	331	84	377	423	446

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY

(In milli

Function and department or other unit
750 LAW ENFORCEMENT AND JU TICE—Continued
753 Federal correctional and rehabilitati activities:
Department of Justice [1]
754 Law enforcement assistance:
Department of Justice
Deductions for offsetting receipts [2]
Total law enforcement and justice
800 GENERAL GOVERNMENT
801 Legislative functions:
Legislative branch [1]
Deductions for offsetting receipts
Total 801
802 Executive direction and management:
Executive Office of the President
Funds appropriated to the President
General Services Administration
Total 802
803 Central fiscal operations:
Department of the Treasury [1]
Deductions for offsetting receipts
Total 803
804 General property and records man ment:
General Services Administration [1]
Other temporary commissions
Deductions for offsetting receipts
Total 804
805 Central personnel management:
Other independent agencies:
Advisory Committee on Federal Pay
Civil Service Commission
Other temporary commissions
Deductions for offsetting receipts
Total 805

See footnotes at end of table.

NCTION AND AGENCY—Continued

dollars)

1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
6,015	1,159	3,990	2,751	3,111
-----	-------	−6	−31	−54
6,015	1,159	3,984	2,720	3,057
4,436	1,092	5,077	5,319	5,489
21	5	22	22	22
*	*	*	*	*
517	122	534	587	589
5	2	6	6	6
−*	−*	−1	−2	−2
544	129	561	614	615
−2	−1	−2	−2	−2
,678	4,529	19,073	18,199	18,580
21	5	23	27	28
25	7	30	33	33
12	3	12	15	15
129	297	1,246	1,300	1,302
569	151	609	660	664
1	*	1	1	1
8	2	10	11	10
64	19	71	74	74
92	25	125	90	90
1	*	*	-------	-------
−2	−1	−2	−2	−2
920	508	2,125	2,209	2,215
7	2	7	8	8
322	82	368	414	438
1	*	2	2	-------
331	84	377	423	446

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
750 LAW ENFORCEMENT AND JUSTICE—Continued					
753 Federal correctional and rehabilitative activities:					
Department of Justice [1]	240	63	329	336	393
754 Law enforcement assistance:					
Department of Justice	810	205	759	714	715
Deductions for offsetting receipts [2]	−4	−31	−6	−6	−6
Total law enforcement and justice	3,297	829	3,584	3,677	3,762
800 GENERAL GOVERNMENT					
801 Legislative functions:					
Legislative branch [1]	780	188	806	838	847
Deductions for offsetting receipts	−1	−*	−1	−1	−1
Total 801	779	188	805	837	846
802 Executive direction and management:					
Executive Office of the President	69	18	75	72	72
Funds appropriated to the President	1	*	1	1	1
General Services Administration	*	*	3	1	1
Total 802	71	18	79	74	74
803 Central fiscal operations:					
Department of the Treasury [1]	2,006	507	2,160	2,320	2,329
Deductions for offsetting receipts	−193	−34	−170	−190	−190
Total 803	1,813	473	1,990	2,130	2,139
804 General property and records management:					
General Services Administration [1]	347	78	350	339	340
Other temporary commissions	4	2	5	-------	-------
Deductions for offsetting receipts	*	-------	-------	-------	-------
Total 804	352	80	355	339	340
805 Central personnel management:					
Other independent agencies:					
Advisory Committee on Federal Pay	*	*	*	*	*
Civil Service Commission	4,849	25	7,396	7,034	8,055
Other temporary commissions	-------	-------	*	-------	-------
Deductions for offsetting receipts	−4,750	−*	−7,287	−6,921	−7,943
Total 805	99	25	109	113	113

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
800 GENERAL GOVERNMENT—Continued					
806 Other general government:					
Legislative branch	45	11	47	65	214
The Judiciary	2	-------	-------	-------	-------
Department of Defense—Civil	62	17	69	74	74
Department of the Interior [1]	210	128	200	274	260
Department of the Treasury [1]	171	11	254	258	209
General Services Administration	3	1	3	3	3
Other independent agencies:					
Civil Service Commission	15	4	15	-------	-------
Federal Election Commission	5	1	6	7	-------
American Revolution Bicentennial Administration [1]	28	10	4	-------	-------
Other historical and memorial agencies [1]	-------	*	*	*	30
Advisory Commission on Intergovernmental Relations [1]	1	*	1	2	2
Other temporary commissions	13	1	1	25	*
National Commission on the Observance of International Women's Year [1]	5	*	*	*	-------
Deductions for offsetting receipts	−28	−6	−52	−145	−152
Total 806	532	177	549	563	638
Deductions for offsetting receipts [2]	−272	−69	−184	−152	−152
Total general government	3,372	892	3,705	3,904	3,997
850 REVENUE SHARING AND GENERAL PURPOSE FISCAL ASSISTANCE					
851 General revenue sharing:					
Department of the Treasury [1]	12,713	3,328	13,315	13,715	13,715
Deductions for offsetting receipts	−6,360	−1,664	−6,655	−6,855	−6,855
Total 851	6,353	1,664	6,661	6,860	6,860
852 Other general purpose fiscal assistance:					
Department of Agriculture	89	110	50	191	208
Department of Defense—Civil	4	-------	5	4	5
Department of the Interior	198	147	266	392	426
Department of the Treasury	2,638	398	1,269	1,328	922
Other independent agencies:					
District of Columbia	295	83	323	318	300
Federal Energy Administration	5	-------	-------	-------	-------
Federal Power Commission	*	-------	*	*	*
Deductions for offsetting receipts	−40	-------	−78	−20	-------
Total 852	3,189	737	1,835	2,214	1,862
Total revenue sharing and general purpose fiscal assistance	9,542	2,402	8,496	9,074	8,722
900 INTEREST					
901 Interest on the public debt:					
Department of the Treasury	37,063	8,102	42,000	44,600	47,300

See footnotes at end of table.

Table 14. BUDGET AUTHORITY BY F

(In million

Function and department or other unit
900 INTEREST—Continued
902 Other interest:
Department of the Treasury
General Services Administration
Deductions for offsetting receipts
Total 902
Total interest
Allowances for:
Civilian agency pay raises
Contingencies for:
Relatively uncontrollable programs
Other requirements
Undistributed offsetting receipts:
Employer share, employee retirement:
Interfund transactions
Receipts from off-budget Federal entities
Interest received by trust funds
Rents and royalties on the Outer Continent Shelf
Total budget authority [3]
Budget authority for off-budget Federal entities:
300 NATURAL RESOURCES, ENVIRO MENT AND ENERGY
305 Energy:
Department of Agriculture
Energy Independence Authority
Total natural resources, environment, energy
400 COMMERCE AND TRANSPORTATI
401 Mortgage credit and thrift insurance:
Department of Housing and Urban Deve ment
404 Ground transportation:
Other independent agencies: United S Railway Association
Total commerce and transportation

See footnotes at end of table

JNCTION AND AGENCY—Continued

of dollars)

1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
45	11	47	65	214
2	-------	-------	-------	-------
62	17	69	74	74
210	128	200	274	260
171	11	254	258	209
3	1	3	3	3
15	4	15	-------	-------
5	1	6	7	-------
28	10	4	-------	-------
------	*	*	*	30
1	*	1	2	2
13	1	1	25	*
5	*	*	*	-------
−28	−6	−52	−145	−152
532	177	549	563	638
−272	−69	−184	−152	−152
3,372	892	3,705	3,904	3,997
2,713	3,328	13,315	13,715	13,715
6,360	−1,664	−6,655	−6,855	−6,855
6,353	1,664	6,661	6,860	6,860
89	110	50	191	208
4	-------	5	4	5
198	147	266	392	426
2,638	398	1,269	1,328	922
295	83	323	318	300
5	-------	-------	-------	-------
*	-------	*	*	*
−40	-------	−78	−20	-------
3,189	737	1,835	2,214	1,862
9,542	2,402	8,496	9,074	8,722
1,063	8,102	42,000	44,600	47,300

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
900 INTEREST—Continued					
902 Other interest:					
Department of the Treasury	303	103	288	308	308
General Services Administration	1	-------	1	-------	-------
Deductions for offsetting receipts	−2,776	−960	−4,302	−5,173	−5,189
Total 902	−2,472	−857	−4,013	−4,866	−4,881
Total interest	34,591	7,244	37,987	39,734	42,419
Allowances for:					
Civilian agency pay raises	-------	-------	-------	1,199	2,311
Contingencies for:					
Relatively uncontrollable programs	-------	-------	-------	0	0
Other requirements	-------	-------	-------	1,750	2,000
Undistributed offsetting receipts:					
Employer share, employee retirement:					
Interfund transactions	−3,233	−890	−3,407	−3,557	−3,924
Receipts from off-budget Federal entities	−1,009	−95	−1,185	−1,113	−1,183
Interest received by trust funds	−7,800	−270	−8,201	−8,659	−9,700
Rents and royalties on the Outer Continental Shelf	−2,662	−1,311	−2,600	−3,100	−2,500
Total budget authority [3]	**415,336**	**91,409**	**435,925**	**480,440**	**518,615**
Budget authority for off-budget Federal entities:					
300 NATURAL RESOURCES, ENVIRONMENT AND ENERGY					
305 Energy:					
Department of Agriculture	*1,000*	-------	*25*	-------	-------
Energy Independence Authority	-------	-------	-------	*83,000*	-------
Total natural resources, environment, and energy	*1,000*	-------	*25*	*83,000*	-------
400 COMMERCE AND TRANSPORTATION					
401 Mortgage credit and thrift insurance:					
Department of Housing and Urban Development	*750*	-------	*750*	*750*	*750*
404 Ground transportation:					
Other independent agencies: United States Railway Association	*−1,225*	-------	*120*	-------	-------
Total commerce and transportation	*−475*	-------	*870*	*750*	*750*

See footnotes at end of table

Table 14. BUDGET AUTHORITY BY FUNCTION AND AGENCY—Continued

(In millions of dollars)

Function and department or other unit	1976 act.	TQ act.	1977 est.	1978 est.	1979 est.
Budget authority for off-budget entities—Continued					
450 COMMUNITY AND REGIONAL DEVELOPMENT					
452 Area and regional development:					
Department of Agriculture	*89*	*17*	*136*	*125*	*116*
800 GENERAL GOVERNMENT					
807 Federal Financing Bank:					
Department of the Treasury	*8,946*	*3,471*	*12,154*	*9,963*	*10,461*
Budget authority, off-budget Federal entities	*9,561*	*3,488*	*13,186*	*93,838*	*11,327*
Budget authority including off-budget Federal entities	*424,896*	*94,897*	*449,111*	*574,278*	*529,942*

* $500 thousand or less.
[1] Includes both Federal and trust funds.
[2] Excludes offsetting receipts which have been distributed by subfunction above.
[3] Consists of:

	1976 act.	*TQ act.*	*1977 est.*	*1978 est.*
Federal funds	312,693	63,012	325,560	349,065
Trust funds	137,432	32,780	147,282	167,800
Interfund transactions	−34,789	−4,383	−36,918	−36,425

Table 15. OUTLAYS BY FUNCTION

Function and department or other unit
050 NATIONAL DEFENSE
051 Department of Defense—Military:
Military personnel
Retired military personnel
Operation and maintenance
Procurement
Research, development, test, and evaluation
Military construction
Other [1]
Allowances
Deductions for offsetting receipts
Total 051
052 Military assistance:
Funds appropriated to the President [1]
Deductions for offsetting receipts
Total 052
053 Atomic energy defense activities:
Energy Research and Development Administration
054 Defense-related activities:
Funds appropriated to the President
Department of Health, Education, and Welfare
General Services Administration
Other independent agencies:
Central Intelligence Agency
Intelligence Community Oversight
Renegotiation Board
Selective Service System
Other temporary commissions
Deductions for offsetting receipts
Total 054
Deductions for offsetting receipts [2]
Total national defense
150 INTERNATIONAL AFFAIRS
151 Foreign economic and financial assistance:
Funds appropriated to the President [1]
Department of Agriculture
Department of State
Department of Transportation [1]
Other independent agencies: ACTION [1]
Deductions for offsetting receipts
Total 151

See footnotes at end of table.

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