APPENDIX C
Funding Allocation in Six Federal Research Agencies'

National Institutes of Health

The primary review bodies for grant applications at the National Institutes of Health (NIH) are the study sections, of which there are over 90. Initially, all proposals go to the Division of Research Grants (DRG), which assigns each to a study section for an initial review and an institute for second level review. A grantee can request, but not designate, an institute; an institute can request that a grant be directed its way, but DRG has the right to overrule that request. Grant applications are classified according to type, such as new, competing continuation (renewal), and supplemental applications, and according to activities, such as regular research projects, conferences, centers, and fellowships. Last year DRG received over 30,000 applications.

Biennially each institute provides DRG with referral guidelines. The referral guidelines for all institutes are circulated and overlaps noted and negotiated through memoranda of understanding. Overlaps can usually be resolved in this manner. Most often, the issue then goes to the institute directors involved for a final decision. Grants in the areas of dispute can be assigned primarily and secondarily to the participating institutes or there may be a decision to send the grant to more than one institute for dual finding.

Study sections meet several times a year to review applications. Each proposal is discussed individually and recommendations are determined by majority vote of the members. If the application is recommended for approval, each member votes privately, assigning a priority rating from one for outstanding to five for acceptable. A priority score for an application is determined by averaging the individual ratings and multiplying by 100. To deal with the diversity of rating behavior among study sections and because of priority score ''creep' (a tendency for scores to get better as reviewers realize that only the very best scores will allow a proposal to be funded), a percentile rank is now calculated for each score. The percentile represents the relative position or rank of each priority score among the scores assigned by the study section at its last three meetings. The lower the numerical value of the priority score or percentile, the better the application. Funding units designate an approximate percentile ''payline," a priority score below which applications will not be funded.

After a grant has been through review by the study section, it enters a second level of review by the statutorily mandated National Advisory Council or Board of the institute. The councils and boards are comprised of scientists and lay representatives. They consider the percentiles assigned by the study sections and review grants for their relevancy to the institute's programs and priorities. Councils can choose not to concur with a study section approval based on program or policy considerations. However, they cannot reverse a disapproval action when their decision is based on scientific and technical merit only.

The award rate is the proportion of applications recommended for approval that are actually funded. In 1989, the overall award rate at NIH was 29.4 percent. The success rate is the proportion of reviewed applications that are actually awarded. In 1989, the overall success rate was 27.5 percent. In 1990, the award rate was 33 percent for competing renewals at the National Institute of General Medical Sciences (NIGMS), 14 percent for new applications, and between 12 and 15 percent for first-time applications. NIGMS budgets minority and training programs separately, thereby removing them from the same level of competition for limited resources (although each program is competitive in its own right).

At NIGMS, nearly 3,000 grant proposals are received each year. DRG study sections review the grants for scientific merit and amount requested. They then send their recommendations to the council for concurrence. Most often the council will approve blocks of grants. If rejected applicants wish to appeal they can submit rebuttals. In this case, NIGMS staff then submit their reply with the rebuttal to council. They can either support the study section decision or the rebuttal. More often than not, the council will concur with staff.

There has been a perception that the workload requirements associated with membership on study sections are an impediment for recruiting members. A 1989 review of study section workload showed that the average workload had actually gone down between 1980 and 1988, in part, because more study sections had been formed. In 1980, there were about 70 study sections. In 1988, there were 90. Still, the average study section member spends 45 days each year preparing for and attending meetings. This does not include site visits or mail reviews. The average tenure of service is 4 years. The NIH peer review system has been criticized for repeatedly using the same individuals on study sections. In fact, only 13 percent of reviewers are reappointed.

Some managers feel the payline has become inflexible and creates too much of a focal point for micromanage-

[1]This appendix is based on OTA interviews, spring-summer 1990.

ment. For example, if a program chooses to go below the payline and fund an exceptional grant, rejected applicants who came in above the payline have been known to request intervention by their representatives in Congress. The program and the institute must then respond to congressional inquiries and justify their decision. Some managers feel that this creates a disincentive for program managers to ignore the payline occasionally when considering innovative research. Some policies have been created to allow flexibility around the payline to fund young investigators and other groups.

However, every institute has an exception process for funding. Generally about 10 percent of the research budget can be used for exceptions or for applications below the payline that are cutting edge and, in the eyes of staff, deserve to be funded because of high program relevance. At the National Cancer Institute, for example, each division takes its exceptions to the director, where they are put in priority order and then compete for institute resources with the executive committee as final arbiter.

Department of Defense

The Department of Defense (DOD) solicits proposals through Broad Agency Announcements, which detail the interests of the services, the Defense Advanced Research Projects Agency (DARPA), or the Strategic Defense Initiative Organization (SDIO) research program. Program managers are allowed much latitude in funding decisions, and their performance is judged by the impact of the research program on issues of defense interest. External peer review may be used, but only in an advisory capacity. In general, inhouse review will suffice and laboratory personnel are often integral to this review process.

Army

Of the 6.1,6.2, and 6.3A budget categories, the Army distributed 15 percent to basic research (6.1), 46 percent to applied research (6.2), and 39 percent in the early stages of development (6.3A). Within the 6.1 budget (fiscal year 1989), the Army laboratories received 68 percent, extramural single principal investigator grants accounted for 21 percent,[2] Centers of Excellence encompassed 6 percent, and inhouse laboratory independent research received the final 5 percent.

Within the Army, the 6.1 budget is disbursed by the Army Research Office (ARO), Medical Commands, and institutes such as the Army Research Institute for the Behavioral and Social Sciences. In addition, each laboratory, institute, or center has its own 6.1 monies. Through the tri-service University Research Initiative program, the Army also sponsors 12 centers in 10 research areas. In addition, the Army sponsors seven of its own Centers of Excellence.

Army Research Office-Until 1985, ARO did not solicit proposals directly. ARO has a tradition of supporting single investigators over long periods of time. ARO feels that this stable funding environment produces highly creative research, both because the investigator has more time to devote to research and because stable funds are sought by the scientific community, and so competition is fierce.

Medical Research and Development Command (MR&DC)--Medical research needs are addressed by the nine laboratories of MR&DC and monies are allocated between them. The largest, with 90 percent of the technology base funds, is the Walter Reed Medical Center. Walter Reed employs 1,100 scientists of which 600 are in the Institute for Research. About one-half are uniformed and the other one-half are civilian.

Army Research Institute for the Behavioral and Social Sciences—Research proposals are reviewed by the Basic Research Office (BRO), the laboratories, and often external reviewers. They are rated on five factors: 1) scientific significance, 2) potential Army relevance, 3) technical merit, 4) quality of executing personnel, and 5) cost realism. Contracts and grants are awarded on the basis of this inhouse, and partially external, review. Also, an inhouse review committee will examine annually all of the contracts and grants awarded in each program area. Universities receive 80 to 90 percent of the available grant and contract funds from BRO. Profitmaking corporations receive another 10 to 15 percent and nonprofits receive the remaining 2 to 5 percent.

Laboratories-Research laboratories operate primarily on 6.2 and 6.3 funds, but 6.1 monies makeup a small proportion of the funding. Funds are distributed to research groups through inhouse budgeting. Contracts are awarded at program manager discretion after substantial scientific review by inhouse personnel.[3]

Navy

Almost all Navy basic research money is disbursed by the Office of Naval Research (ONR), although many of the larger laboratories also have small 6.1 budgets to support basic research. As part of the Navy's investment strategy for research, ONR stresses that, while spending 60 percent of their funds on ''evolutionary' research and 25 percent on research that is "closely associated with

[2]Note that the University Research Initiative (URI) funds are not included in these figures since URI is now funded by the Office Of the Secretary of Defense.

[3]For details, see U.S. Congress, Office of Technology Assessment, *Holding the Edge: Maintaining the Defense Technology Base*, OTA-ISC-420 (Washington DC: U.S. Government Printing Office, April 1989), especially chs. 1 and 3.

transition to the fleet, ” 15 percent of the funds are allocated to high-risk, but potentially high-payoff research. ONR also seeks to leverage funds from other departments and industry to boost research in its programs in civilian laboratory settings.

ONR divides its efforts into ‘core’ and “accelerated’ research initiatives. Core initiatives build on previous efforts with slight modifications in levels of funding from year to year. Two percent of the research program is set aside for core enhancements. Each directorate will compete annually for enhancement funds and will often solicit external reviewers. Accelerated Research Initiatives (ARIs) provide increased levels of support over 3 to 7 years. The average funding is about $1 to $2 million per year, and about 6 percent of the current research program is set aside for new ARIs. Directorates also compete annually for funding for their proposed ARIs and, as with core enhancements, will solicit both inhouse and external reviews. The core program represents about 70 percent of the total Navy research program and ARIs total about 30 percent.

Air Force

Before 1974, inhouse laboratories controlled the 6.1 monies for the Air Force. However, in 1974, the Air Force consolidated the direction of the 6.1 monies into one unit, the Air Force Office of Scientific Research (AFOSR). Each laboratory still has a portion of 6.1 monies, but the bulk are distributed by AFOSR. The laboratories compete for these funds along with universities and other performers.

New initiatives are usually begun with funds designated for new starts ($10 million in fiscal year 1990). Eighteen months before the start of a fiscal year, the program managers propose new initiatives. The seven directorates then compete for the funds. Each directorate is asked to bid for twice their ‘‘fair share” (or one-seventh) of the funds set aside. An extensive inhouse review process determines the awarding of funds. Eight to 10 projects are awarded at about $1 million each. AFOSR requires that at least 15 percent of the research portfolio for a directorate changes composition every year.

AFOSR had about 1,200 grants and contracts in fiscal year 1990 (about 900 grants and 300 contracts). Roughly 500 projects are initiated in a year, with an average duration of 2 to 3 years. AFOSR works with close to 220 universities, which receive over one-half of AFOSR funding. Laboratories receive 30 percent of AFOSR funds.[4]

DARPA and SDIO

Project managers are primarily responsible for the selection of contract and grant awards, and usually conduct inhouse reviews of proposals. DARPA does very little contracting itself. ONR, AFOSR, ARO, or other parts of DOD will administer the grant, often because the service is the ‘customer’ for the project and will benefit from its results. This close working relationship of DARPA and SDIO with other parts of DOD facilitates the technology transfer of the project findings.

Although program managers determine the specific goals of a project, the development of these goals through the letting of contracts and grants is left to the agent in ONR, AFOSR, ARO, or some other part of DOD. (Examples of specific goals include development of a particular kind of focusing mirror or more efficient laser using a particular kind of technology.) Managers use whatever selection mechanism they normally use for grants and contracts.

National Aeronautics and Space Administration

Office of Space Science and Applications

The Office of Space Science and Applications has two primary means of soliciting research/contract proposals. *Announcements of Opportunity (AOs) are* solicited and awarded over the associate administrator’s signature. They usually call for hardware and experiments for an upcoming flight mission, and are funded via contracts. They represent one-of-a-kind opportunities with substantial monetary commitment. The AO is also the primary means of selecting the team of scientists for a mission. These scientists will not necessarily work together, but their combined efforts will set the schedule for the mission.

An AO will state the criteria and the procedure for selecting successful candidates. Usually, each proposal will be reviewed by panels of peers to judge scientific merit. Further review by National Aeronautics and Space Administration (NASA) staff will weigh feasibility, management issues, and relevance to the mission. NASA also keeps the prerogative of splitting up a proposal to fund only part of it and of joining two or more investigative teams together. The division will then rank the proposals. The final decision is left to the associate administrator, as advised by the division. An oversight committee, chaired by the assistant associate administratrator, checks the selection criteria for adherence to proper procedures and adequacy of documentation of the review process. In descending order of importance, NASA

[4]One cannot compare directly funding allocation between universities and laboratories, because university funds reflect roughly full costs including investigator salaries whereas laboratory scientist salaries are funded through another budget line.

acknowledges the following criteria to rank proposals: 1) scientific merit, 2) relevance to the goals of the mission, 3) adequacy of the research methods, 4) feasibility within logistical constraints, 5) competence and experience of the investigators, and 6) fiscal and other support by the investigator's institution.

Research Announcements (RAs) are released under the signature of the associate administrator with the division director as the selecting official. They are more modest in scope than an AO, and more specific in focus. Taken together, however, the RAs cover a broader range of topics. In some divisions, RAs solicit "guest' observers, who will use an apparatus after the original investigator's share of the time is up. Theory, archival research, and other disciplinary areas are also supported with RAs. Like an AO, RAs state what selection criteria and which procedure will be used to make awards. Funding is primarily through grants. This procedure is usually very similar to the one described for an AO.

In addition to AOs and RAs, NASA employs other funding mechanisms. For example, unsolicited proposals are encouraged. They are submitted to a peer review process that is very similar to the procedure outlined above for AOs. Also, discretionary money is available to the division director, which represents a small portion (often nearly 10 percent) of the research monies and is disbursed by a less formal procedure (sometimes with only internal review) for projects of higher risk or for specific needs not addressed through other selection methods. Discretionary money is also available to the program manager. It is often allocated for the use of old equipment and flight time on NASA planes, and for technology development in preparation for new mission proposals.

Each division has its own method of proposal review. In general, however, for every proposal for funds, the program managers select the peer reviewers. (Life Sciences contracts with the American Institute for Biological Sciences (AIBS) to provide all peer review panels for their solicited and unsolicited proposals. AIBS has similar contracts with other agencies and it provides a ''back room" check on duplication of funding.) For a small ($100,000 to $200,000) grant, four to five reviews are solicited. For larger proposals, as many as eight may be requested. The reviews judge scientific merit and technical feasibility. Program relevance and all other factors are judged by the program manager. It is generally recognized that university reviewers give the most conservative reviews and this type of factor is taken into account.

Each proposal is graded from A to E. (At AIBS, each reviewer also gives a rating of how competent he or she is to judge the science contained in the proposal.) If a proposal receives four reviews with ratings equivalent to four As, or two Bs and two As, it will generally get funded. Anything below four Cs would have to be defended forcefully within the division. However, among the group of high scoring proposals, it is up to the program manager to pick and choose to best satisfy his or her programmatic goals. Occasionally, there is concern over what proportion of the money should go to universities and the rest to NASA laboratories and private think tanks.

Office of Aeronautics, Exploration and Technology (OAET)

In OAET headquarters and in its laboratories, there is less reliance on AOs and RAs and more use of Requests for Proposals (RFPs). All proposal review for OAET is done inhouse. Most of the small aeronautics research grants that do not involve 'cutting metal" are performed by the three laboratories (Ames, Langley, and Lewis) that operate with primarily OAET aeronautical research funds; space technology research is performed throughout the centers. If the contract is large, it will be farmed out (primarily) to industry and a laboratory will oversee the contract. The laboratories produce specifications, ask for bidders, and then negotiate procurement. Roughly 50 percent of the total research and development funds in OAET stays in the laboratories, 30 percent goes to industry, and 20 percent to universities.

Department of Energy

The Department of Energy's (DOE) Office of Energy Research uses many of the same proposal review techniques as NASA and the offices of scientific research within DOD, with peer or inhouse review for scientific merit and final judgment by the program manager. However, all individual investigator proposals are solicited through Broad Agency Announcements.

The majority of basic "research funds at DOE (two-thirds of the Office of Energy Research budget, for instance) are given to the laboratories. These expenditures are estimated for the budget request for DOE and are derived through an iterative process with DOE headquarters. In the defense portion of DOE, almost all of the research is done in intramural laboratories. The money is competed among them, using mostly inhouse review.

In the Conservation and Renewable Office and in many of the other applied research offices, research money is often allocated with an industrial cosponsor. Contracts, grants, and cooperative agreements are all used. The evaluation of industry contracts is regulated by Federal law and is similar to that used by DOD and NASA. For individual investigator and university grants, peer review for scientific merit generally occurs. Inhouse review is used, at the very least, to allocate monies.

National Science Foundation

Proposals are received by the Division of Administrative Services and are assigned to the appropriate National Science Foundation (NSF) program for evaluation. Most proposals are unsolicited, though a few are in response to specific Announcements or RFPs. The applications are then reviewed by the relevant program officer and sent out for peer review. Proposers and reviewers are invited to suggest reviewers. The program officer may convene a panel (ad hoc or standing) to review proposals or can rely on mail reviews, or both.[5] The program officer can solicit advice from advisory committees, review panels, or site visits before recommending final action. Recommendations are then sent to division directors for review and approval.

Proposals are funded on the basis of demonstrated research performer competence, intrinsic merit of the research, utility or relevance of the research, and the effect of the research on the infrastructure of science and engineering. The success rate for the agency, overall, is about 30 percent, but is as low as 14 percent in some areas, such as decision, risk and management sciences.

The program officer has a fair amount of discretion in making awards recommendations. Typically, after receiving the reviews on all proposals (some programs process grants on a continuous basis, relying on mail review rather than panels), the manager will sit down with the reviews and the program budget, evaluate the area of science each proposal encompasses, consider how much money the investigator is getting from other sources, and then make the difficult allocation decisions.

Many program officers said they tend to give new investigators a break. Others said they like to help out smaller colleges. There is a specific program announcement called "Research in Undergraduate Institutions" that encourages proposals from nondoctoral departments at institutions that produced 20 or fewer Ph.D.s in science and engineering in the 2 years preceding the proposal. Targets are set for the amounts NSF funds each year in this area, and divisions must ensure that minimums are met. In some cases, a proposal might be consistent with areas deemed of high priority, but would not fare well in disciplinary program competitions.

This is a point in the process where the program officer can also participate in the agency goal of increasing awards to women and minorities. Most program managers interviewed consider this an important goal and make their best effort to fulfill it. However, it has created a new dilemma. Money given to young investigators, women, or minorities comes out of a pool that would normally be given to the highest scoring proposals, which may come from older, established scientists with lofty track records. Program managers have to make the difficult decision of denying grants to, or cutting the budgets of, known performers in order to create a more equitable allocation of funds. The increasing number of applications, stable funding, and the process of reviewing grants have strained the system, say some managers. The safeguards built into peer review consume a great deal of staff time.[6]

Forty percent of the scientific and technical staff of NSF is comprised of rotators on temporary assignment, normally of 1 to 3 years duration.[7] They bring direct knowledge of forefront research to the grants process. Many interviewees feel that this prevents NSF from becoming an entrenched, out-of-touch bureaucracy. Rotating staff, however, can disrupt continuity in certain research areas, as new grants managers have the potential influence to shift the focus of research every few years.

Department of Agriculture

Agricultural Research Service (ARS)

The proposal process at ARS is unique. It is essentially a negotiation process between National Program Staff (NPS) and ARS scientists. ARS scientists work with their regional directors to send ideas up to NPS program leaders. Meanwhile, NPS sets out its budget priorities. Once the administrator approves the plan for the upcoming year, proposals are sent forward to NPS staff. If NPS staff want to fund a project, they send the proposal out for external review. Proposals are only sent out for review after the decision has been made to fund them. The reviewers are not asked whether the project should be funded, but how to improve the technical quality of the research. This places an enormous amount of power in the hands of NPS.

Obviously, there is mom for criticism of this system of ex post peer review. In 1986, the ARS administrator asked the Board on Agriculture of the National Research Council (NRC) to examine the project peer review system, assess its effectiveness, and recommend possible improvements. NRC found a lack of agreement and understanding among ARS staff regarding the purpose, use, and effect of the system. There also seemed to be inadequate understanding within ARS as to how the administrator balances and optimizes the dual objectives

[5] The National Science Foundation has recently instituted electronic proposal review panels. See National Science Foundation, *Electronic Proposal Review Panels: An Option for NSF Program Officers* (Washington DC: forthcoming 1991).

[6] A forthcoming General Accounting Office report on peer review procedures found no evidence of sloppy practices at the National Science Foundation. Concerns were raised, however, about review processes at other agencies, especially the Department of Energy and the National Oceanic and Atmospheric Administration. See David P. Hamilton, "NSF Off the Hook," *Science,* vol. 251, Feb. 15, 1991, p. 733.

[7] National Science Foundation, *Report of the Merit Review Task Force,* NSF 90-113 (Washington, DC: Aug. 23, 1990), p. 9.

of scientific excellence and mission relevance, and how project peer review is used in the context of these objectives.

Recently, NSF changed its rules to allow ARS principal investigators to apply to NSF for grants. This can be done only when ARS investigators are affiliated with a university that becomes the primary recipient of the grant. ARS scientists also apply directly for other sources of outside funding support to supplement ongoing research. Most ARS scientists will apply for other grants to support postdoctorates or graduate students.

One might ask what motivates the ARS scientist. A government salary and the system of getting project money is noncompetitive. The annual performance evaluation motivates the ARS scientist to propose good projects and perform well. In ARS, it is the scientist that is peer reviewed, not the research. ARS uses a system comparable to tenure review whereby a scientist is scored by peers on the level and quality of his or her research. The scores determine GS level. If an individual is found to be slipping, that is, not contributing to the advancement of the field in a manner demonstrated in the past, he or she can be demoted.

Cooperative State Research Service (CSRS)

Special Grants—**The** scientific agenda and budget for special grants are often specified in the agriculture appropriation bill. When given discretion over the awards process, CSRS often institutes open competition with peer review for scientific merit. Otherwise the research agenda is negotiated with the participating institution. Within these institutions, there may be competition for money (run by the institution itself), but it is often decided informally.

Competitive Research Grants—The Competitive Research Grants Office (CRGO) allocates funds with peer review mechanisms that are very similar to those at NIH and NSF. Review panels, chosen by the program manager and associate program manager, judge the scientific merit of proposals and their relevance to the purpose of the grant program to rank order them. Proposals are funded in order until the program runs out of money, and proposals are rarely pulled out of rank.

A new, congressionally mandated experiment at CRGO limited indirect costs in research grants to 25 percent in fiscal year 1990 and 14 percent in fiscal year 1991. The U.S. Department of Agriculture implemented this policy in fiscal year 1990 and proposals are now negotiated under the new terms. Program managers projected that this ceiling would be useful in fiscal year 1990 (optimistic estimates said that it would save $3.5 million to be disbursed to other researchers). After the first few years, universities and other organizations are expected to bill directly for laboratory space and other items usually claimed under indirect costs, thereby recouping the funds.

Forest Service

Research Work Unit Descriptions (RWUDs), written by research groups within Forest Service research centers, charter work in a particular problem area. They usually prescribe a plan for a 5-year duration and often will build directly on previous work. Staffing needs are directly related to the RWUD. The station director has a large amount of discretion to choose projects at the RWU level, but the RWUDs are reviewed inhouse in the Washington office to provide balance in a nationally coordinated program.