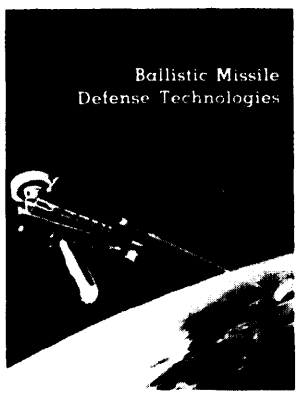
Section II.-Year in Review

The assessments carried out by OTA cover a wide spectrum of major issues that Congress and the country are facing, A brief summary of each report published by the Office during the year* is presented in this section. The reader is cautioned that these are synopses of reports. They do not cover the full range of options considered or all of the findings presented in any individual report.

Ballistic Missile Defense Technologies

President Reagan's Strategic Defense Initiative (SDI) proposes intensive research on technologies such as lasers, particle beams, electromagnetic railguns, and new types of sensors—some of which might lead to highly effective space-based defenses.



This report describes the controversies over what requirements such technologies would have to meet, describes the present state and future potential of the most relevant technologies, and offers policy options both for current research and future deployment.

Several general findings carry implications for the choices Congress faces in approving BMD research:

1. If the Soviets are determined to maintain the ability to destroy many U.S. cities, BMD cannot assure the survival of all or nearly all the U.S. population in an all-out nuclear attack, But BMD combined with agreed strict limitations on the quantity and quality of offensive forces might lead to a high level of assured survival.
2. A BMD system that could protect a substantial fraction of U.S. land-based intercontinental ballistic missiles (ICBMS) and possibly of the strategic command and control system against a Soviet first strike could be built with available technology.
3. How effective an affordable BMD system could be is impossible to say at this time.
4. The decision whether to push ahead vigorously with the SDI or to scale back the Administration proposal involves a balancing of opportunities against risks, in the face of considerable uncertainty.

*Fiscal year 1985 (October 1984 through September 1985).

The SDI offers an opportunity to substantially increase our nation's safety if we obtain great technical success ***and*** a substantial degree of Soviet cooperation.

The SDI carries a risk that a vigorous BMD research program could bring on an offensive and defensive arms race, and a further risk that BMD deployment, if it took place without Soviet cooperation, could create severe strategic instabilities. At issue is how a vigorous U.S. program to develop BMD will affect Soviet willingness to agree to deep reductions of strategic offensive forces on terms acceptable to the United States.

5. It would be prudent to organize any U.S. BMD research program so as to minimize Soviet incentives to break out of the ABM Treaty before the United States is ready to make its own decision about BMD deployment.

OTA has identified a range of approaches to BMD research. These are:

1. SDI approach: Vigorously investigate advanced BMD technologies with the intent to decide in the 1990s on whether or not to enter full-scale engineering development and subsequent deployment.
2. Early or intermediate deployment approaches:
   a. emphasize early and incremental deployment of currently available BMD technology; or
   b. emphasize research on BMD technologies advanced beyond those available today but which, unlike many SD I technologies, might be applicable to deployments in the early to mid-1990s,
3. Research approaches with no commitment to a deployment decision in the foreseeable future:
   a. investigate advanced BMD technologies at a funding level well below that requested for the SDI and with a much reduced sense of urgency, though with similar long-run technological goals; or
   b. balance research in advanced BMD technologies with the development of near-term deployment options which would include "traditional" BMD technologies (ground-based, nuclear-armed, radar-guided interceptors).

The report examines technologies and ideas which suggest possibilities for a variety of sensors and destructive mechanisms for tracking and attacking ballistic missiles throughout their trajectories: in the boost phase when the missile is gathering speed; in the post-boost phase when the warhead-bearing reentry vehicles (RVs) are separating from the upper stage of the rocket; in the midcourse as the RVs coast through space; and in the reentry phase as the RVs come into the atmosphere. The report discusses the current state of these technologies and ideas and what further developments will be needed if they are to be incorporated into workable, affordable weapon systems.

The subject of anti-satellite weapons is dealt with in a companion report, ***Anti-Satellite Weapons, Countermeasures, and Arms Control.***

Anti-Satellite Weapons, Countermeasures, and Arms Control

A combination of arms control and technical improvements in satellite survivability may make the greatest contribution to safeguarding valuable U.S. satellites, However, anti-satellite (ASAT) arms control provisions could reduce the ability of the United States to respond to threatening Soviet satellites and could slow the pace of the current Strategic Defense Initiative program.

Current U.S. policy towards ASAT arms control is the product of three concerns:

1. ***The Desire to Protect U.S. Satellites,*** The United States is becoming more dependent on military satellites. New technologies will soon enable satellites to supply more types of information, more rapidly, to more diverse locations, and to operate as components of weapon systems.

The U.S. ASAT weapon program is intended, in part, to deter Soviet attack on valuable U.S. satellites by threatening retaliation in kind. However, the United States, with its global security commitments and force deployments, depends more on satellites to perform important military functions than does the Soviet Union. Therefore, the Soviets may be willing to accept the loss of some of their satellites in exchange for the destruction of more valuable U.S. satellites.

Whether or not advanced ASAT weapons are developed, the United States could take a variety of unilateral defensive measures to protect its satellites. Passive countermeasures—such as evasion, hardening, and proliferation—all offer significant protection against the current and some future Soviet ASAT weapons. Active countermeasures such as electronic jamming could also be effective.

2. ***The Threat Posed by Soviet Satellites.*** Although current Soviet military satellites pose only a limited threat to U.S. military capabilities, future Soviet satellites capable of carrying out advanced target acquisition and tracking functions will pose a greater threat. The U.S. ASAT weapon, when operational, would be able to destroy many of the satellites that the Soviets might rely on in a terrestrial conflict.

The United States would not always have to destroy Soviet satellites to neutralize the threat they pose. Countermeasures such as “jamming” (overloading enemy receivers) or “spoofing” (sending deceptive signals) could be effective in some instances.

3. ***The Relationship Between ASATArms Control and BMD.*** ASAT and ballistic missile defense (BMD) technologies overlap, but BMD plays a potentially more important role in the U. S./Soviet strategic relationship. If the United States wishes to maintain a rapid pace of BMD re-

search, it should avoid most types of negotiated ASAT limitations. Conversely, if the United States wishes to slow the pace of Soviet BMD research and is willing to defer the testing of space-based or space-directed weapons, an ASAT treaty could contribute to that result. In either case, it is the U.S. position on space-based BMD that will determine its position on ASAT, not vice versa.

The Balance Between Arms Control and Technology Development

OTA considered the pros and cons of seven different combinations of arms control and ASAT weapon development. In addition to the developments described, the United States would likely pursue some of the passive or active countermeasures allowed in each regime:

1. Existing Constraints. Existing treaties prohibit attacks on satellites except in self-defense, testing or deploying space-based weapons with BMD capabilities, and detonating or deploying nuclear weapons in space. All other ASAT weapon development and deployment activities are allowed.

z. ***Comprehensive ASAT and Space-Based Weapon Ban.*** The United States and the Soviet Union would forgo the possession of specialized ASAT weapons, the testing–on Earth or in space—of specialized ASAT capabilities, the testing in the "ASAT mode" of systems with inherent ASAT capabilities, and the deployment—in space—of any weapon,

3. ***ASAT Test Ban and Space-Based Weapon Deployment Ban.*** The United States and the Soviet Union would agree to forgo all testing in an "ASAT mode" (i.e., the testing of ground-, air-, sea-, or space-based systems against targets in space or against points in space) and the deployment of any weapon in space.

4. ***One Each/No New Types.*** The United States and the Soviet Union would retain their current ASATs but halt the testing and deployment of more advanced systems.

5. ***Rules of the Road for Space.*** Rules would either serve the general purpose of reducing suspicion and encouraging the orderly use of space, or specifically aid in the defense of space assets. General rules might include new, more stringent requirements for advance notice of launch activity. Specific rules might include agreed upon and possibly defended "keep-out" zones around important space assets.

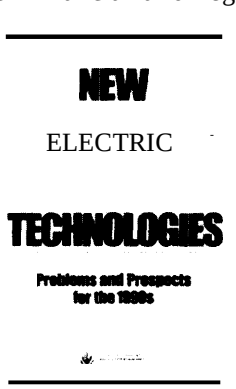
6. ***Space Sanctuary.*** Altitude limits would be set above which military satellites could operate, but testing or deploying weapons would be forbidden.

7. Space-Based BMD. Since a modest BMD system would make a very capable ASAT weapon, in a "space-based BMD" regime there would be no attempt to restrain ASAT development. Moreover, each side would probably want the freedom to develop new "ASAT-type" weapons capable of destroying the opponent's space-based BMD systems,

The subject of ballistic missile defense is dealt with in a companion report, ***Ballistic Missile Defense Technologies,***

New Electric Power Technologies

In the face of highly uncertain demand growth, and increasingly complex financial and regulatory considerations, electric utilities are now taking steps to increase their flexibility in planning for adequate electricity supply, The steps include environmental and efficiency improvements to conventional power generation, life extension of existing powerplants, and purchase of power from other sources.



In addition, there is growing interest in a number of technologies that have not traditionally been used by utilities or other power producers. These technologies can offer increased flexibility to meet a significant fraction of demand growth beyond the year 2000. They can be constructed in modular units that permit capacity additions to be made in small increments, with less concentration of financial assets and shorter lead-times between commitment and coming "on-line." In addition, many can increase the clean and efficient use of abundant domestic energy resources. These technologies include: atmospheric fluidized-bed combustion (AFBC), integrated coal gasification/combined-cycle (IGCC), fuel cells, geothermal, wind, photovoltaics, solar thermal, compressed air energy storage (CAES), battery storage, and load management.

At the current rate of development, however, these technologies are not likely to be able to contribute significantly to U.S. electricity supply in the 1990s. For the AFBC, IGCC, and CAES, initial commercial plants are now likely to require longer planning, permitting, and construction lead-times than technically is possible. For the other technologies, resolution of cost and performance uncertainties and cost reduction is not taking place at a rate sufficient to satisfy utility and nonutility investors before the late 1990s.

If electricity demand growth should accelerate by the early 1990s, the first choice of utilities is likely to be to expand conventional central station generation capacity. Utilities, however, may not be able to invest adequately in this choice, and could encounter serious problems in meeting increased demand should it occur. Accelerating the availability of new, smaller scale, more flexible technologies could be a prudent way to give utilities more choices.

Utilities are more cautious than they were a decade ago about investing in new technology, and they impose rigorous performance tests on investment alternatives. Advanced commercial demonstration projects are especially important in accelerating development and deployment of new technologies, as has been shown by several efforts, sponsored by industry and government, and managed by the utilities. Also, by working closely with regulators and carefully managing construction, demonstrations and initial commercial plants are less likely to require long lead-times.

Where cost and performance improvement is of greatest concern—primarily for photovoltaics, solar thermal, geothermal, and batteries—one approach to accelerating development would be to increase or concentrate Federal research and development efforts on those technologies. For load management as well as certain generating technologies—specifically fuel cells, photovoltaics, solar thermal technologies, and batteries—economies of scale in manufacturing could reduce cost substantially.

There are other approaches that can complement Federal efforts in technology development, The reemergence of nonutility power production is and can continue to be an important test bed for some of these new generating technologies. For nonutility power producers, the Renewable Energy Tax Credit (RTC) and the recovery of full avoided costs under the Public Utility Regulatory Policies Act (PURPA) have been crucial in the initial commercial development and deployment of wind and solar power generating technologies,

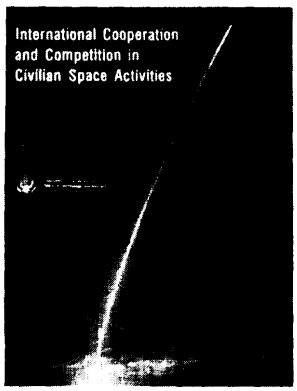
Without some form of favorable tax treatment and high avoided costs, continued development of much of the domestic renewable power technology industry may be slowed significantly. Even for those technologies for which development would continue if the RTC were withdrawn, principally geothermal and wind, that development would be accelerated with favorable tax treatment.

Cooperative agreements among utilities, public utility commissions, and government can provide another mechanism for supporting advanced commercial demonstration projects of new technologies. Utility involvement would likely increase if commissions were to encourage greater R&D expenditures by electric utilities. Projects also could be financed with an equity contribution from the utility and the remainder through a “ratepayer loan” granted by the commission, possibly federally guaranteed.

Finally, the contribution of new generating technologies is likely to increase if utilities are allowed full benefits under PURPA; if the restrictions on the use of natural gas in power generation are removed; and if steps are taken to streamline the mechanisms for wheeling of power through utility service territories.

International Cooperation and Competition in Space Activities

The United States faces the difficult challenge of adapting rapidly to the increasing volume and complexity of international civilian space activities. Recent changes in the political, economic, and technical aspects of outer space raise five important issues for Congress:



1) How to define the Federal and private sector roles: High technological and economic risks and uncertainties continue to hinder private investment in space. Future technology, trade, and regulatory policies, designed to lower these risks, could aid in developing a wide array of internationally competitive commercial space applications by the 1990s. However, substantial commercialization will also depend strongly on favorable market developments.

As the U.S. private sector becomes more involved in space activities, several government agencies in addition to the National Aeronautics and Space Administration (NASA) will have to play a broader role if the United States is to have an effective and competitive space policy. NASA, by itself, is not well-equipped either to promote or to regulate growth in the commercial exploitation of space, Government attempts to stimulate commercial space activities must be based on realistic analysis of domestic and international markets and on information provided by the private sector. Such efforts should be the responsibility of agencies versed in domestic commerce and regulation, international trade, and foreign affairs. Moreover, the regulation of "space industries" should be integrated with the regulation of their terrestrial counterparts.

2) How to maintain international competitiveness in space technologies: Although the United States is dominant in most space research, technology development, and commercial systems, Western Europe and Japan are now marketing space-related goods and services in direct competition with the United States. Western Europe has developed the successful Ariane launch vehicle and the SPOT land remote sensing system. Japan offers strong commercial competition in satellite Earth stations and is developing ocean and land remote sensing systems. Continued U.S. leadership in space will require thoughtful congressional articulation of national space goals, and well-designed Administration strategies.

3) How to help U.S. firms maintain access to international markets: Large parts of the international market for satellite communications equipment and services are closed to international competition. Where open competition exists, U.S. firms continue to dominate the market for communication satellites and to be competitive in satellite network

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services and equipment. Greater access to international markets in services and equipment will require continued efforts by the U.S. Government to secure increased opportunities for U.S. firms.

4) Ways to get the most out of U.S. participation in international cooperative space projects: Cooperative space projects continue to help maintain U.S. prestige and influence, support global economic growth, and increase access to information across national borders. Such cooperation should continue to involve developing countries, especially because they are becoming a significant market for space-related goods and services.

5) What should be the future of U.S. space activities: The United States has not achieved wide agreement on a long-term agenda for the civilian space program, The recently appointed National Commission on Space, authorized in Public Law 98-361,[1] could help develop a national consensus on U.S. space goals and objectives, but only if it seeks wide input from both private and government sources outside the traditional "space community. "

OTA assessed space science and several space technologies which are at different stages of development:

. Space science: International cooperation in space science continues to be a major source of cultural, economic, political, and social benefits for the United States. The major driving force behind such cooperation is the prospect of reducing U.S. expenditures by sharing costs and knowledge. For example, the United States has chosen a secondary, supportive but low-cost, role in the international study of Halley's Comet, Although the United States still leads in space science, it faces increased competition. Cooperation has contributed to the overall favorable competitive posture of the United States. Therefore, the United States must remain cooperative in space science in order to remain competitive.

- Satellite communications: Because commercial investment dominates this sector, policies on economic regulation, international trade, and intergovernmental agreements have a greater effect than "space policies. " Congress can help decide how much competition U.S. telecommunications firms will be allowed to give to INTELSAT,[2] how vigorously to support the entrance of U.S. firms into overseas service and equipment markets, and how best to further U.S. economic and foreign policy objectives at the International Telecommunication Union's upcoming ORB-85 meeting on the geostationary orbit. Finally, it must determine how many Federal dollars to spend on research and development to keep U.S. industry competitive.
- Remote sensing from space: By 1990, Canada, ESA, France, Japan, and the Soviet Union expect to deploy ocean or land remote sens-

1 Passed by Congress on June 28, 1984, and signed by the President on July 16, 1984. Commission members were announced on Mar. 29, 1985.

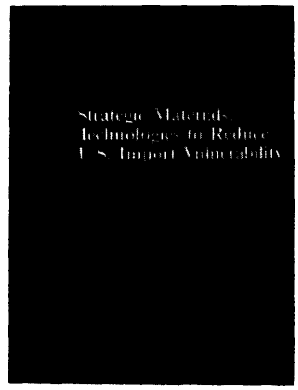
2 International Telecommunications Satellite Organization.

ing systems. The transfer of the Landsat system to private ownership may increase U.S. competitiveness in land remote sensing. Unless a sufficient market for data emerges, to be successful such transfer will require continuing subsidy. The United States could also preserve its leadership in remote sensing technology by continuing to press for the joint construction of an international polar-orbiting meteorological satellite system, close coordination of future international ocean remote sensing activities, and a central role in the worldwide distribution of ocean remote sensing data.

- Space transportation: The entry of ESA's Ariane booster into the international launch vehicle market, and a continuing U.S. private sector interest in selling launch services, require the U.S. Government to reassess its traditional role as sole provider of launch services. Debate has focused on the price charged for Shuttle launch services and competition with Ariane. Leaving Shuttle prices low will continue to hinder the development of a U.S. private launch industry and entail greater cost to the taxpayer. Raising Shuttle launch prices closer to their real costs would slow private investment in other space sectors. Neither course of action is likely to change significantly the market share captured by Ariane.
- Materials processing in space: The economic feasibility of manufacturing commercial products in space remains highly uncertain. More basic and applied research is needed to establish whether such products can compete with products manufactured on Earth. The U.S. Shuttle is an important research tool for materials processing. Because they have strong programs in materials processing, Europe and Japan should be viewed as valuable partners for international cooperation in the basic research phase. If further research is successful in developing commercially important processes, such cooperation could result in undesirable technology transfer.

Strategic Materials: Technologies to Reduce U.S. Import Vulnerability

The nations of southern Africa are the United States' major suppliers of chromium, cobalt, manganese, and platinum group metals (PGMs], all essential to defense and the civilian economy. The principal alternative supplier to the United States is the Soviet Union. Reliance on the Soviet Union is an obvious concern, but there is also uncertainty about the continuity of supplies from southern Africa.



There is almost no domestic production of any of these metals. The United States maintains a stockpile of strategic materials, but it can only be used for defense applications. The non-defense economy remains vulnerable to disruptions of supply.

No single technical approach to reduce U.S. reliance on imports of strategic materials will work by itself. A combination of actions, specific to each metal, must be undertaken. An overall strategy would encompass three technical approaches:

1. ***Diversify the supply of strategic metals by developing known deposits, both foreign and domestic, and by exploring for new deposits.***

The production of cobalt and manganese can be diversified through expansion or development of known deposits in Australia, Indonesia, the Philippines, Canada, Brazil, Mexico, and Peru. Opportunities to diversify chromium and PGM production are more limited. The PGM deposit in Stillwater, Montana, is one of the few deposits under active consideration for exploitation,

Exploration for deposits of strategic materials is difficult, expensive, and often unsuccessful. Improvements of geologic understanding and the tools of exploration would increase the likelihood of success.

2. ***Decrease the demand for strategic metals by improving manufacturing processes and recycling of strategic metals from waste and scrap.***

Improved casting and forging technologies are already reducing cobalt requirements for the manufacture of superalloy components for jet engines, the largest and one of the most critical uses of cobalt in the United States. Similarly, improved steelmaking technologies and operating practices and the increased use of electric arc furnaces may reduce by about 50 percent the imported manganese needed to produce each ton of domestic steel.

Recycling of PGMs from automobile catalytic converters is increasing, and will become a major source in the future, Technologies for the recovery of chromium and cobalt from obsolete products have been developed and appear promising. However, low metal prices and the

cost of testing new processes discourage the investments needed for commercialization.

3. Identify and test substitute materials for current applications and develop new materials with reduced strategic material content for current and future applications.

Potential substitutes for stainless steel have been developed that could reduce chromium requirements in many applications by one-third, and laboratory tests indicate that it is possible to reduce cobalt content of many superalloys by about 50 percent. In the longer term, improved ceramic and composite materials may become important alternatives to chromium and cobalt alloys.

Although substitute alloys may have lower requirements for strategic materials, they offer consumers only limited economic advantages, which are often offset by the cost of testing and certification of the materials and modification of manufacturing processes.

Advanced casting and forging techniques, improved steelmaking systems, and recycling processes for automotive catalytic converters are economically advantageous and are being implemented by private industry without government intervention.

However, other technological approaches will achieve only limited application, unless the government takes a larger role in promoting the development and use of strategic materials technology.

Policy Options

The government could take a number of actions, spanning a range of cost and degree of involvement, to promote the technical alternatives to strategic materials vulnerability:

- Emphasize the collection and dissemination of mineral and material data to improve planning for mineral exploration and exploitation and for conservation technologies and substitution.

Government already plays a key role in providing essential information about strategic materials. An expanded role could include more emphasis on identification of foreign investment opportunities in strategic material development, sponsorship of a substitution information "bank," development of better data about domestic mineral occurrences, and periodic reexamination of trends in strategic materials recycling and conservation.

- Support mineral exploration and materials research and development (R&D) in order to move promising mineral and material technologies closer to practical application.

Implementation of any technical approach to reduce import vulnerability will require a continuing R&D effort, most of which would need government support. Decentralized R&D programs need better coordination if common objectives, goals, and purposes are to be met.

Federal funding of strategic materials R&Din the areas of recycling, substitution, and advanced materials appears adequate to keep pace with the changing industrial mix in the economy. Prospects for a major domestic discovery of one or more of these minerals are not promising, but could possibly be enhanced through greater support for public and private exploration research, including basic research on geological theories of mineral occurrence, improved geophysical, geochemical, and drilling equipment, and more intense study of the resource potential of Federal lands.

c Encourage the adoption of new materials technologies by providing assistance for education and training related to advanced materials, manufacturing technology, and metal processing and recycling systems.

Advanced materials, now in their infancy, hold promise of altering the mix of basic materials used in many applications now dependent on strategic materials. International competition for supremacy in these emerging markets is strong. Other countries, including Japan, emphasize the technical education and training of workers in these fields more than the United States. Increased government support to U.S. educational institutions working in conjunction with the advanced materials industry may be needed to ensure competitiveness in these fields.

- Develop, test, and certify alternative technologies and materials for use in defense and commercial applications.

In cases where the principal barrier to commercialization of a technology is the cost of demonstration and pre-commercial development, or where benefits arise from having the technology or material "on-the-shelf," the government could support the construction and operation of demonstration plants or the testing and evaluation of substitute materials.

- Encourage investment in domestic mineral development, metal processing facilities, and new technologies for recycling scrap.

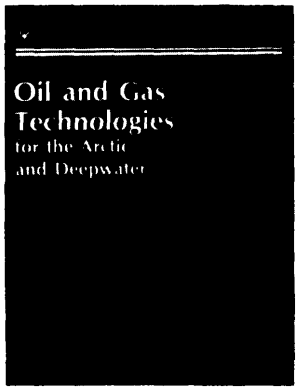
The economics of nearly all opportunities for domestic mineral development are discouraging to potential investors. If the benefits of domestic mineral production are desirable from the public's perspective, however, assistance could be provided in the form of subsidies, purchase commitments, loan guarantees, tax incentives, or other government financial aid. Such programs need not be limited to mineral production; processing of ores and metals, production of substitute materials, and operation of recycling facilities could be similarly encouraged. Such financial assistance programs could be expensive, however, so that their cost and effectiveness, compared to other alternatives, need to be carefully considered.

The basic legislative framework to implement any of these options is largely in place. In recent years, however, the potential for supply interruptions has been overshadowed by more immediate problems. If materials import vulnerability is to be reduced through technical alter-

natives, Congress would have to continue to emphasize the importance of implementing these alternatives.

Oil and Gas Technologies for the Arctic and Deepwater

Most of the undiscovered oil and gas in the United States is expected to be in offshore Arctic areas, in deepwater, or onshore in Alaska; but exploratory drilling in the OCS frontier since 1978 has been discouraging. As a result, the Department of the Interior recently lowered its estimates of economically recoverable offshore oil by 55 percent and natural gas by 44 percent.



The extent of our offshore oil and gas resources will be confirmed only by actual drilling, In the 30 years since the Federal offshore leasing program began, about 2 percent of the U.S. Outer Continental Shelf (OCS) has been leased; less has been explored.

OTA warns that reliance on speculative estimates of offshore oil and gas resources in national energy planning could jeopardize the future strategic and economic position of the United States, As economic recovery and potentially lower oil prices stimulate consumption, the United States will again face rising petroleum imports unless substantial new domestic reserves are discovered,

Despite recent discoveries in the Gulf of Mexico and offshore California, additions to proven reserves of oil continue to fall. Although more will be known about U.S. offshore petroleum resources after additional exploration, the Department of the Interior's lowered expectations for OCS oil and gas indicate that the Federal Government should develop strategic plans now if we are to meet our future energy needs. Part of the plan should include determining as soon as possible the extent of oil and gas resources in the OCS.

New technologies are now being used for exploration in the harsh environments of the Arctic and deepwater frontiers, but production technologies are still in the development and testing phase. New approaches may be needed to reduce the environmental and safety risks which could accompany expanded oil and gas activities in the harsh operating conditions of the Arctic and deepwater regions.

Because of severe conditions in these areas, large investments are needed to operate and only very large discoveries will be profitable to develop. If ."giant" discoveries are not made in industry's first round of exploration, which is now underway in the most promising areas of the frontier regions, the government may need to consider a "second-round" leasing policy, which shifts more of the economic risks to the government, to induce the industry to drill second-level prospec-

tive structures, which could lead to the development of smaller oil and gas discoveries, now considered economically marginal.

OTA found that the OCS Lands Act appears to provide Congress and the executive branch with enough room to guide the leasing program in any direction that public policy may dictate. In general, the Act allows the administrative flexibility needed to adjust leasing terms and conditions to deepwater and Arctic frontier areas.

Several problems continue to influence the pace of exploration for new resources in the Nation's offshore frontiers:

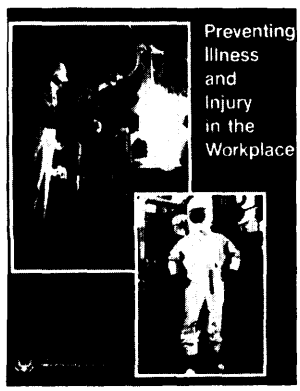
- ***Area- Wide Leasing.***—Efforts to offer larger offshore areas for tract selection by industry continue to meet with opposition from State and environmental interests. The area-wide leasing system, substantially modified since its implementation in 1982, allows the early identification and exploration of prospective areas by the industry. It maybe the most efficient and cost-effective leasing approach for Arctic and deepwater frontier regions, but it requires that the Secretary of the Interior adequately balance environmental considerations and the concerns of the coastal States with industry tract preferences.
- ***Military Operations,***—As offshore petroleum activities have expanded to the frontier areas, conflicts with military uses have become more obvious. An estimated 40 million acres are excluded from offshore leasing in the entire OCS, and as much as 75 million additional acres have military restrictions on the density of drilling operations. While the Departments of the Interior and Defense now negotiate military limitations on offshore acreage, a legal conflict exists as to who has final authority for withdrawing offshore lands from energy development.
- ***Disputed international*** Boundaries.—Disputes over ownership of offshore areas with Canada, the Soviet Union, Mexico, and perhaps Cuba could constrain exploration in some highly prospective offshore areas. There is also uncertainty concerning the legal definition of the boundaries of the Outer Continental Shelf. Unless the disputes are resolved or joint exploration agreements are negotiated, these boundary regions may not be evaluated for oil and gas potential.
- ***Alaskan Oil Export Ban.***—Export restrictions on Alaskan offshore oil adversely affect the profitability of Arctic operations and the attractiveness of exploration and development in this area, However, removing these restrictions could also have adverse economic effects on the U.S. maritime industry, which now carries oil on American flag vessels, and could perhaps affect future oil supplies in times of emergency. Japan would be the most likely importer of Alaskan oil, but it is not certain that markets there could be established.
- ***Oil*** Spills.—While the offshore industry has a good record of preventing oil spills, it has little experience in cleaning up oil spills in Arctic and deepwater areas. Most cleanup technology was de-

veloped for temperate, nearshore regions. Arctic conditions especially may present extensive cleanup problems, including extreme cold and ice, darkness, remoteness, and lack of facilities. Standardized testing of oil spill countermeasures under Arctic conditions could help evaluate the capabilities of available equipment and indicate the need for new strategies.

- ***Offshore Safety.***—At present, government collection and analysis of offshore safety and injury data is inadequate for evaluating the extent of risks and the effectiveness of safety programs in frontier areas. Given the severe conditions of frontier operations, government inspection programs and evacuation drills need to be evaluated carefully and may need to be increased.

Preventing Illness and Injury in the Workplace

The Occupational Safety and Health Act of 1970 sought "to assure so far as possible . . . safe and healthful working conditions" for the U.S. work force. But the toll of work-related disease and injury remains significant. Each year about 6,000 American workers, about 25 every working day, die from workplace injuries. Depending on what kinds of injuries are counted, nonfatal injuries total between 2.5 and 11.3 million annually—l0,000 to 45,000 cases per working day. Although information about work-related illnesses is too poor to generate reliable estimates of the number of deaths and diseases, there is general agreement that exposures to hazardous working conditions threaten the health of particular groups of workers. OTA has examined occupational health and safety and presents options for congressional action that could facilitate hazard identification, enhance the development of control technologies, and change the incentives that affect employer decisions to control workplace hazards.



Identification of safety hazards and collection of injury data is facilitated by the usually close connection between injury-producing events and injuries. Identifying health hazards, however, is impeded by the often long period of time between exposure and illness, similarities between diseases caused by occupational and nonoccupational factors, and failures to recognize occupational causes of disease. More concerted effort and better use of existing methods would enhance hazard identification.

Controls for safety hazards include machine guarding, process redesign, work practices, and personal protective equipment, Design and selection of these controls has largely been based on personal experience, common sense, and recommended "good practice, " with little

systematic data collection, epidemiologic analysis, and experimental research. Controls for health hazards include substitution of less dangerous substances, enclosure and ventilation of processes, changes in work practices, and personal protective equipment, These controls have often been developed plant by plant, substance by substance, with much trial and error. Including controls in the initial design of workplaces and equipment is more protective and less expensive than adding them later. But frequently, health and safety controls have not been incorporated into workplace design and operation.

"Engineering controls," e.g., machine guards and ventilation systems, function continuously and reliably to prevent workers' coming in contact with hazards. Although personal protective equipment is sometimes suggested as equal to engineering controls, it seldom works as well and is best restricted to situations where engineering controls are not available. Research on engineering controls, personal protective equipment, and attention to the health and safety problems that may be posed by new technologies could pay off in improved controls and reduced costs. A pressing need is information for evaluation and certification of personal protective equipment.

OTA examined incentives and imperatives that influence decisions by employers to control workplace hazards. The important incentive of employer concern for workers' health and safety produces many voluntary actions to control hazards, but it is often limited by competitive pressures. Providing information to workers and employers is necessary, but not sufficient to guarantee effective hazard identification and control. Government-provided financial incentives, such as changes in business taxes or provision of financial assistance or loans, might encourage installation of controls, but any new program would generate costs, Employers' efforts to reduce costs associated with workers' compensation and lawsuits can lead to the installation of controls, but these incentives are limited, especially for occupational illness. Collective bargaining and workers' rights concerning health and safety can also lead to installation of controls, although collective bargaining is restricted to the small fraction of the work force that belongs to labor unions,

The Occupational Safety and Health Administration (OSHA), charged with ensuring safe and healthful workplaces, has issued only a handful of new or revised regulatory standards. The standards and regulations it enforces are still predominantly those that were adopted in 1971. Furthermore, the incentive provided by OSHA's enforcement activities is limited because of generally infrequent inspections and comparatively low penalty levels. While there have been a few successful OSHA regulations, especially for health hazards, most studies on injury rates have found that OSHA has had either no effect or only a limited effect. According to OTA's analysis, the decline in injury and fatality rates between 1979 and 1983 resulted from the effects of the economic slow down.

The National Institute for Occupational Safety and Health (NIOSH) conducts research on hazard identification and control technologies,

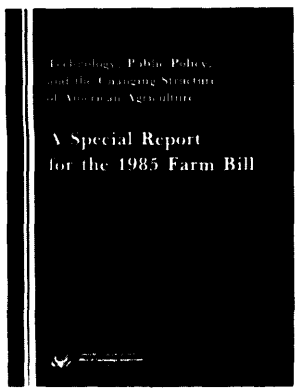
disseminates information, and educates health and safety professionals. The largest share of its budget is for hazard identification; research on controls receives a relatively small portion. OSHA and NIOSH have probably increased awareness about occupational hazards and spurred efforts to control, but evaluation of many of their specific programs is needed.

Safety and health in small businesses can be aided by increasing OSHA and NIOSH consultation; providing loans for compliance with regulations; testing the safety of products used by small businesses; and providing industrial hygiene, safety engineering, worker training, and occupational medical services in places currently lacking these services.

Periods of modernization and replacement of plant and equipment offer opportunities to improve health and safety, Compliance with OSHA's vinyl chloride and cotton dust standards demonstrate that simultaneous improvements in productivity and worker health and safety are possible.

A Special Report for the 1985 Farm Bill

Rapid advances in biotechnology and information technology are revolutionizing agricultural production and dramatically altering the structure of the U.S. agricultural sector. The potential impacts of adopting these technologies also have important policy implications for Congress as it begins debate on the reauthorization of the 1981 farm bill.



One impact will be technology's role, under current policy, in creating a surplus of certain commodities in the immediate future. Overall, the balance of agricultural supply and demand is expected to fluctuate in unpredictable ways. However, for certain commodities, notably dairy products, further U.S surpluses are likely. The adoption of new technologies coupled with current farm policy will exacerbate that problem. The implication for policy makers is the need for a farm program that more easily allows for adjustments in periods of shortages and surpluses, rather than remaining fixed.

New technologies also are contributing to a shift from an agricultural system dominated by moderate-size farms—the traditional backbone of American agriculture—to one dominated by large and very large industrialized farms. New technologies have allowed farmers to operate larger farms while reducing operating costs. Public policy has provided further incentives for expansion, such as price supports and tax incentives.

The farmers who are most aggressive in the early adoption and application of new technologies generally are benefiting the most. But

the technologies that can keep farmers competitive are costly and complex. Farmers who lack the capital or expertise to adopt new technology early enough to maintain a competitive edge must seek supplementary off-farm income, find some special niche for their products, or give up farming altogether.

This last alternative has become a frequent choice—the moderate-size farms are rapidly disappearing. Moderate farms, those with gross sales ranging from $100,000 to $199,000 each year, are failing to compete for their historical share of farm income. Their net income has decreased from 21 to 15 percent of total farm income between 1974 and 1982. In contrast, the net farm income of those farmers with sales in excess of $200,000 grew from 35 to 84 percent of the total in the same period. As a group, these large and very-large farmers are relatively well-off.

By comparison, part-time farms, with sales in the range of $20,000 to $99,000, have declined from 39 to 5 percent of net farm income and farmers with sales of less than $20,000 had a negative net farm income in 1982, However, in contrast to larger farms, these farms rely on off-farm employment as a primary source of income.

If we disregard or discourage technological advances, as some have suggested, American farmers would not remain competitive in international markets, A general retreat from traditional R&D support in agriculture would harm the whole American farm system, not just some of the farmers.

If a decision is made to slow the decline of the moderate-size farm, policy makers' first step could be to provide ways to make new technologies more available to these farms and to provide training in their use. Targeting income support to these farms also would be effective, although even this measure may not help dairy farmers in some regions.

Second, despite the apparent advantages of very large farms, their operators may need a loan safety net to help them weather price instabilities and the rigors of the world marketplace, Unlike most of their moderate-size counterparts, large farms are more likely to survive without income supports.

Third, agriculture policy makers could help particular groups and regions make the transition to different endeavors, for example, programs to retrain agricultural workers for jobs in other sectors or to change to alternative kinds of farming. Farmers in the Great Lakes States region, for instance, could gain some comparative advantages by switching from dairy production to corn.

Finally, and perhaps most significantly, farm programs must be considered in the context of these strong technological, economic and institutional forces. Farm programs can merely speed up or slow down these forces of change—they cannot reverse the trends.

Superfund Strategy

EPA has made progress in the Federal Superfund program for cleaning up toxic waste sites, and much can be learned from the initial efforts to improve protection of public health and the environment.

The Environmental Protection Agency's (EPA) low estimate of Superfund costs can be traced to a lack of detailed planning for the program and optimism about both the number of toxic waste sites that will require cleanup and the effectiveness of cleanup technologies. While EPA estimates that about 2,000 sites will reach the National Priorities List (NPL), on which sites must be placed to qualify for a permanent cleanup, OTA estimates that 10,000 sites (or more) may require cleanup. With Superfund's existing resources, it is not technically or economically possible to permanently clean up even 2,000 sites in less than several decades. OTA defines permanent cleanups to be those where the likelihood of recurring problems with the same site or wastes have been minimized through the use of treatment rather than containment technologies.

Only 30 percent of the 538 sites now on the NPL are receiving remedial cleanup attention even though about $1 billion (two-thirds of the initial 5-year program's funding) have been committed. Initial actions and cleanups now emphasize the removal of wastes to land disposal facilities, which themselves may become Superfund sites, or wastes are left on site. Current "remedial cleanups" tend to be impermanent. Some sites get worse, and repeated costs are almost inevitable. Environmentally, risks are often transferred from one place to another, and to future generations.

Underestimating national cleanup needs could result in environmental crisis years or decades from now. The issue now is not so much about whether or not to have a continued, expanded Superfund program as it is to choose between continuing with the current approach or, based on experience, to restructure the program.

OTA finds that a two-part strategy (see below) could offer cost and time advantages over the current program. Even so, costs to Superfund could easily be $100 billion—out of total costs to the nation of several hundred billion dollars–and a sensibly paced effort could take up to 50 years to clean 10,000 sites. This two-part strategy could be advantageous regardless of the size of the Superfund program.

(I) In the near term, for perhaps up to 15 years, the strategy would focus on: a) early identification and assessment of potential NPL sites,

b) initial response to reduce near-term threats at all NPL sites and prevent sites from getting worse, c) permanent remedial cleanups for some especially threatening sites, and d) developing institutional capabilities for a long-term program. A substantially larger Superfund program would be needed to carry out these efforts. Case studies by OTA and others reveal that both immediate removals and remedial cleanups have been largely ineffective for their intended purposes. Under the two-part strategy, initial responses would emphasize covering sites and temporarily storing wastes and contaminated materials to reduce groundwater contamination and, where technically and economically feasible, excavating wastes to minimize releases into the environment.

(II) Over the longer term, the strategy would call for more extensive site studies and focus on permanent cleanups, when they are technically feasible, at all sites that pose significant threats to human health and the environment (unless privately or State-funded cleanups offering comparable protection have taken place). These cleanups would draw on the institution building that occurred during the first phase.

Federal support could contribute in five areas:

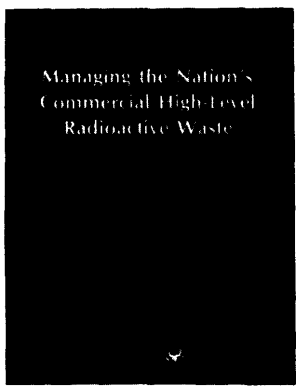
1, Obtain more information on health and environmental effects and develop specific national cleanups goals. Without this effort, selecting technologies, estimating costs, and evaluating public and private cleanups will be difficult and contentious.
2. Provide substantially more support for developing and demonstrating innovative, permanent cleanup technologies. Permanent remedies, which destroy, detoxify, or otherwise treat wastes will be necessary to any cost-effective, long-term Superfund program; many innovative approaches exist, but they face substantial barriers to demonstration and use, such as the absence of protocols to evaluate their effectiveness.
3. Provide increased support for EPA so it can improve technical oversight of contractors.
4. Increase support for training and education: expanded national cleanup effort could increase the need for certain technical specialists fivefold by 1995; shortages of experienced technical personnel such as hydrogeologists have already been noticed.
5. Support public participation in decisionmaking and provide technical assistance to communities.

OTA considered only one use of Superfund, the remedial cleanup of hazardous waste sites that are “uncontrolled’ ’-that is, because actual or potential releases of hazardous substances into the environment must be managed. A number of other applications exist and could increase in the future. OTA’s estimate of additional waste sites include: 5,000 sites from the more than 600,000 open and closed solid waste facilities, such as sanitary and municipal landfills; 2,000 from an improved site identification and selection process; and 1,000 from hazardous waste management facilities operating with ineffective groundwater protection standards.

A much larger Superfund program would likely mean that more reliance would have to be placed on general tax revenues or some other broadly based tax. Along with continued use of the tax on chemical and petroleum feedstocks, a tax on hazardous wastes could raise significant sums, but this latter tax would generate significant revenue only in the near term, if less hazardous waste is generated over time. If such "waste-end" taxes, already adopted by 20 States, were made simple to administer, they would aid in reducing the generation of hazardous waste and use of land disposal and, hence, the creation of still more Superfund sites.

Managing the Nation% Commercial High-Level Radioactive Waste

The Nuclear Waste Policy Act of 1982 (NWPA) establishes in law a comprehensive Federal policy for commercial high-level radioactive waste management. NWPA provides sufficient authority for developing and operating a waste management system based on disposal in mined geologic repositories.



The Act requires the Department of Energy (DOE) to submit to Congress three key documents:

1. a Mission Plan, containing both a waste management plan with a schedule for transferring waste to Federal facilities and an implementation program for choosing sites and developing technologies to carry out that plan;
2. a monitored retrievable storage (MRS) proposal, including a design for long-term Federal storage facility, an evaluation of whether such an MRS is needed and feasible, and an analysis of how an MRS would be integrated with the repository program if authorized by Congress; and
3. a study of alternative institutional mechanisms for financing and managing the radioactive waste program, including the option of establishing an independent waste management organization outside of DOE.

As part of its analysis of NWPA, OTA identified the elements of a Mission Plan that can meet the requirements of the Act using only the authority it provides.

The major difference between this "OTA Mission Plan" and DOE's Mission Plan, delivered to Congress in June 1985, lies in the measures they use to provide confidence that spent fuel will be removed from reactor sites within a reasonable period. DOE's Mission Plan uses a

repository development strategy that assumes that major problems are unlikely and can be dealt with adequately when and if they occur. For example, backup technologies and sites would be developed only if and when problems are encountered. To give confidence that waste can be accepted by 1998, even if there are significant delays in the repository program, DOE would ask Congress for early authorization to site and license an MRS facility.

The OTA Mission Plan relies on geologic repositories alone, and contains features to increase confidence that they will be available without major delays. MRS facilities would be needed only in the unlikely event that there are major unanticipated difficulties with geologic disposal. The key to confidence in this Plan is early development of backup repository technologies and potential sites so that they will be available quickly if problems arise. This anticipatory approach might cost more at the start, but the long-term financial and political costs could be less than those of a plan that reacts to problems after they are encountered.

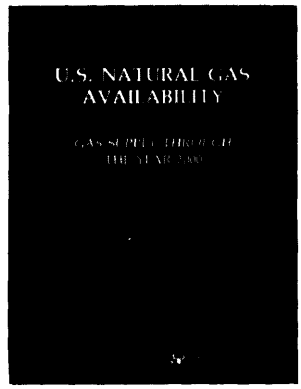
The major issues to be addressed in the MRS proposal are when and whether DOE should be authorized to construct a centralized MRS facility. It now appears that MRS facilities will not be necessary for safe waste management unless major unanticipated difficulties are encountered with geologic disposal. OTA's analysis suggests that, to aid congressional deliberations, the MRS proposal submitted by DOE should evaluate at least three alternatives:

1. Early siting, licensing, and construction of an MRS facility.
2. Federal at-reactor storage beginning in 1998.
3. Deferral of the decision on whether to build an MRS until at least 1990, when the first repository site is to be recommended to Congress.

NWPA also requires DOE to submit a study of alternative institutional mechanisms for financing and managing the radioactive waste system. A public advisory committee established by DOE to address this subject recommended consideration of an independent federally chartered public corporation. OTA's study concludes that creating an independent waste management agency could enhance the credibility of the Act's commitment to developing a complex technological system on a firm schedule. Balancing independence and accountability is a key challenge in designing such an agency. A Mission Plan approved by Congress could play a major role in achieving that balance, Since approval of the Mission Plan is not now required by NWPA, consideration of mechanisms for such approval might be included in any congressional deliberations on establishing an independent waste management agency.

U.S. Natural Gas Availability: Gas Supply Through the Year 2000

Despite current optimism, the uncertainty of both the future production and recoverable resources of natural gas in the United States is still high. For exam-pie, production from traditional domestic sources of natural gas could range from slightly higher than today's rate to a sharp reduction within 10 to 20 years. Thus, complacency about U.S. natural gas availability over the next few decades would be an error.



If a downturn in production from its traditional sources were to occur, the United States could turn to several supplemental sources of natural gas, including "unconventional" gas sources, especially tight gas, Devonian shale gas, and coalbed methane; Alaskan natural gas; increased pipeline gas imports from Canada and Mexico; and liquified gas imports. Each of these supplemental sources is promising, but also uncertain because of possible technical roadblocks, geological unknowns, and sociopolitical difficulties. Given these uncertainties, reliance on only one or two of the supplemental sources may still leave the United States vulnerable to future gas supply shortages. In OTA's opinion, however, the probability of the United States obtaining adequate gas supplies for the next two decades is high if access to all sources of natural gas is ***vigorously*** pursued.

Lower 48 States "conventional" natural gas, gas that can be produced domestically with current technologies (or their simple extensions) at prices not much higher than today's, is the mainstay of the present gas supply of the United States (well over 90 percent). OTA projects the range of plausible year 2000 production rates for conventional gas to be 9 to 19 trillion cubic feet per year (TCF/yr), compared to today's rate of about 17 TCF/yr. A plausible range for the remaining recoverable resources in the Lower 48 is 430 to 900 TCF. The critical areas of uncertainty include: the role of small gasfields, and gas in hard-to-locate geological settings; the potential of the "frontier" areas, including very deep gasfields; the potential for improving gas recovery from older gasfields; and the proper interpretation of past discovery trends.

Tight gas, in extremely low-permeability rock formations, is found in basins throughout the United States and is produced by fracturing the rock around the wellbore to stimulate gas flow. OTA projects that incremental tight gas production in 2000 could range from 1 to 4 TCF/yr

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or perhaps even higher. A plausible range for the recoverable resource is 100 to 400 TCF, with some potential for a few hundred TCF more. Critical areas of uncertainty include: the volume of recoverable gas in the Northern Great Plains and in the many less explored basins; the ability of new fracturing techniques to produce gas from small reservoirs ("lenses") not directly drilled; and the ability to create very long fractures at low costs.

Devonian shale gas is natural gas found in low-permeability shales of the Devonian geologic period, primarily in the Appalachian Basin. The year 2000 production of Devonian shale gas, over and above current production, could range from negligible amounts to about 1.0 to 1.5 TCF/yr. The resource base ranges from 20 to 100 TCF, with additional potential if gas can be produced from shales without a well-developed natural fracture system.

Coalbed methane is natural gas created as part of the coal formation process and trapped in the coal seams. Although there is considerable new drilling aimed at recovering this resource, a projection of future production rates is too speculative at this time. A likely range for the recoverable resource is 20 TCF to a few hundred TCF.

Imports and Alaskan natural gas currently provide about 1 TCF/yr to the Lower 48, and could range from 1 to about 6 TCF/yr by 2000 depending on price, delivery costs, and demand growth in the exporting nations as well as a variety of sociopolitical considerations.

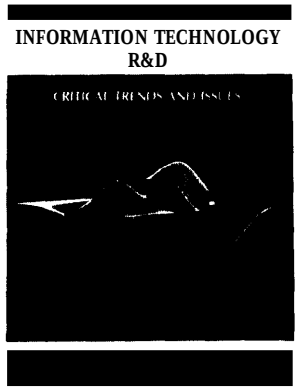
Aside from technical uncertainties, all projections of future gas supplies from the various sources are vulnerable to uncertainties about fuel prices, economic activity, energy demand, and other unpredictable variables.

Natural gas policy. One implication of OTA's projections of future gas production and recoverable resources is that any policy that would tend to restrict U.S. gas availability to its traditional domestic sources would increase the likelihood of gas shortfalls by the 1990s. A diversified development strategy, including a willingness to let gas prices seek a market clearing level and an active encouragement of technology development and exploitation of new gas sources, would greatly increase the likelihood that a shortfall could be made up by alternative gas sources.

Given the high risks and long leadtimes necessary to establish new sources of supply, the United States should place a premium on providing an early warning of any impending shifts in gas supply. High priority should be placed on maintaining the Government's data collection and forecasting capability and keeping these functions independent of the Federal policymaking apparatus.

Information Technology R&D: Critical Trends and Issues

By all historical measures, U.S. research and development (R&D) in information technology—communications, computer technology—is not only robust, but is adapting rapidly to changing regulatory structures and increasing world-wide economic competition. Federal and private investments are increasing, universities and industry are forming new institutional arrangements, new technical advances continue to be made, and increasing numbers of students are entering information technology programs.



Despite this adaptation, continued congressional concern is warranted: patterns for the conduct of R&D in the United States that have been successful in the past may be undercut by government-coordinated programs in other nations. The changes taking place in funding and institutional structure for information technology R&D may create issues such as:

1. Whether current levels of Federal R&D support for information technology (including research on the social impacts of these technologies) are adequate both overall and in the balance of civilian/military priorities, and whether further coordination of research programs within and among agencies is needed.

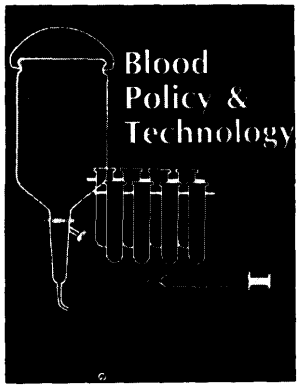
   The Federal Government is a major supporter of information technology R&D, with the Department of Defense providing over 80 percent of the Federal funding, and civilian funding agencies such as NASA and NIH providing the balance. Private computer and communications firms also have made major contributions, but reduced regulation of telecommunications and divestiture of AT&T have changed the environment for R&D in industrial laboratories. For example, the funding mechanism and, to some extent, the goals of AT&T's Bell Laboratories have changed significantly. Although serious harm to Bell Labs' R&D activities is unlikely in the short term and other R&D institutions may be positively affected by these changes, the changing overall patterns of industrial research need to be watched to see whether the anticipated surge in innovation occurs and whether an increased focus on short-term development will detract from basic research.

z. Unintended barriers to R&D. Federal policy not directly related to science and technology (e.g., antitrust, taxation, immigration, and intellectual property) can inhibit investments in and the conduct of R&D, Congress may wish to remove these barriers in cases where other important policy objectives are not compromised. The passage in 1984 of the Semiconductor Protection Act and the National Cooperative Research Act are examples of congressional action in this area.

3. Access. Computers (including supercomputers), on-line electronic data bases, and communication networks have become major research tools in a variety of science and engineering disciplines. Improved access to these facilities by researchers is vitally important to the U.S. R&D effort, For example, Congress may wish to take steps to encourage the executive branch to improve coordination and management among supercomputer research centers, to encourage access to them through high-speed data communication networks, and to support research on software problems involved with advanced computer architectures.
4. Technical manpower. Federal programs have traditionally encouraged a steady supply of technical manpower and provided equality of access to technological careers. To achieve their purpose, these programs need to be long term and stable. Attempts to make short-term corrections to narrowly defined temporary shortages have generally failed because of the long lead-time required for a program to have an effect, and the errors of predictions.
5. Information policy. Innovation in information technology both influences and is shaped by many Federal policies regarding information and its use—including privacy, computer crime, trade in information and intellectual property. Many foreign nations incorporate their R&13 programs in broader comprehensive national information policies that are based on their concepts of the economic and social role of information and information technologies. A more integrated approach to U.S. information policy would help Congress establish priorities and appropriate funding levels for R&D in the technology.

Blood Policy and Technology

The U.S. blood supply today is safer and more types of blood products are available than 10 years ago. But several recent developments are affecting our blood supply: transfusion-related cases of acquired immunodeficiency syndrome (AIDS); efforts to contain health care costs and the related issue of the costs of blood products; and the development of blood substitutes using new recombinant-DNA technologies.



A decade ago, hepatitis B was the primary disease that was transmitted through blood. Hepatitis continues to be the primary blood-transmitted disease, with a relatively new type of hepatitis (non-A, non-B) replacing hepatitis B as the most prevalent, However, the discovery of AIDS in transfused patients and hemophiliacs has become the 'focal safety issue.

Measures to prevent the spread of disease through blood products include: 1) screening of donors, 2) testing of collected units, and 3) inactivation of micro-organisms that may be in the blood. Donor screening remains the primary line of defense although some laboratory tests, such as that for detecting carriers of the hepatitis B virus, are available. Inactivation procedures depend on the particular blood product in question and cannot be used on the cellular elements of blood without destroying them.

With the discovery of a probable agent for AIDS (human T-cell lymphotropic virus, type III, or HTLV-III), a blood test to detect exposure to the HTLV-III virus may be available soon and used to screen blood donors. Other than indicating that the person has been exposed to the HTLV-III virus, however, the meaning of a positive blood test is uncertain. What to tell these persons and who should have access to their identities have been difficult issues to resolve.

Another current problem for blood suppliers is the prospective payment system Medicare is now implementing. Limits were set on hospital payment rates to provide incentives for hospitals to be cost conscious about the services they provide and the purchases they make. Hospital management is now taking a close look at the prices that they are charged by blood banks. Regional blood centers are concerned that the distribution networks that have been developed could be disrupted, and that they may be unable to support their research and education activities.

Recent advances in biotechnology, particularly in the field of recombinant DNA technology, have raised the prospect of their competing with human donors as the source for some blood products by the end of the 1980s. In the relatively near future, recombinant DNA sources of some plasma proteins will be available and could cause additional problems for organizations that collect blood or plasma.

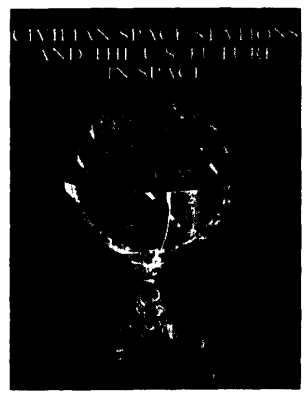
Overall, the U.S. blood supply system is organized in basically the same way as it was 10 years ago, but the products, services, and technologies offered today are very different. The system consists of two different sectors: 1) a voluntary whole blood and blood components sector, and 2) a largely commercial plasma and plasma derivatives sector.

The report also describes Federal and private involvement in developing and maintaining a safe blood supply; the current structure of the industry; technologies for whole blood collection and processing and for plasma fractionation; the impact of future technologies; current issues in blood policy; and future directions for blood collection organizations.

Given the overall success of the past decade and the transitional nature of present circumstances, the prudent course would be to continue with the cooperative arrangements that have been established over the past years and to monitor key developments to anticipate when particular adjustments need to be made.

Civilian Space Stations and the U.S. Future in Space

After 25 years of experience, the United States has the capability to succeed in virtually any civilian space venture it chooses. The Nation is now poised to make a major decision on the future direction of its publicly funded civilian space program: whether or not— and how—to proceed with the acquisition of a "space station." Such a decision can be made only in the context of nationally agreed upon long-term goals. Although there are important reasons for acquiring advanced space infrastructure elements, the lack of clearly defined goals argues against committing at this time to the specific "space station" concept proposed by NASA, the related time-scale, or the currently suggested method of funding.



Without a clear consensus on goals, the "space station" program could become an end in itself, rather than a means to achieve objectively important program goals. The National Commission on Space, created by the 98th Congress, could initiate and sponsor the broad national debate necessary for gaining acceptance of clearly formulated, long-range goals and specific objectives designed to address them.

OTA suggests some broad goals as a starting place for discussion, for example: reduction of the unit cost of space activities, direct involvement of the public, increased international cooperation and collaboration, and broad exploration of the solar system and the universe.

Specific objectives to address these larger goals might include a global natural hazard warning service; a lunar settlement; medical studies of potential direct benefit to the public; direct investigation of asteroids; large numbers of the public visiting space each year; and a global direct audio broadcasting service. All could be attained within the next decade or two, and within currently anticipated appropriations.

There is no such thing as "the" space station, and NASA's proposal is only one alternative in a wide range of options. These range from modest, low-cost extensions of current capabilities to ensembles of space station elements more sophisticated, capable, and costly than NASA is now suggesting,

NASA's "space station" would be of a broadly general-purpose nature, to be used to support over 100 conceptual uses. Few of the proposed activities have been sharply defined or have gained wide acceptance as important objectives of the space program. The best defended are the conduct of life and materials sciences experiments and satellite servicing.

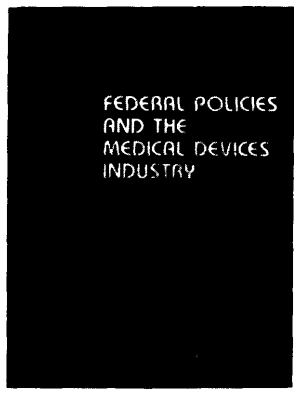
OTA also examined opportunities for reducing the unit cost of space assets and activities, the importance and opportunities involved in greatly enlarging the role of the private sector, and the possibility of different roles for foreign nations in cooperative work. All these issues require attention if the commitment of dollars, technology, and professional manpower likely to be requested for a "space station" is to be fully justified. However, traditional NASA management practices, internal needs, and historical roles inhibit such a thorough reexamination of these issues.

NASA should place relatively less emphasis on accomplishing itself those things that the private sector or other friendly nations can do, including production of much of the technology and facilities envisioned for the "space station, " Rather, NASA should pursue cutting-edge technology and undertake exploration and discovery that only it can do.

Some policy options for congressional consideration include:

1. agree, in principle, with NASA's proposal, accepting its $8 billion and 7- to 8-year estimate;
2. ask NASA to present estimates of costs, schedules, and procurement strategies for providing specific major space services, and select elements and strategies from these;
3, decide that obtaining any large amount of new long-term, in-space infrastructure is premature; or
4. simply approve an average annual expenditure rate for acquisition of any in-space infrastructure and let NASA select the elements, acquisition schedules, and procurement strategies based on relative cost and value.

Federal Policies and the Medical Devices Industry



The Food and Drug Administration's (FDA) regulation of marketing and the Medicare program's payment policies have had the most influence of all Federal health policies on the development and use of medical devices. Such products range from simple, inexpensive items, such as bandages and stethoscopes, to sophisticated, expensive equipment, such as computed tomography (CT) scanners.

The Medical Device Amendments of 1976 significantly expanded FDA's authority to regulate medical devices for safety and efficacy. Evidence indicates that, despite regulation, medical device companies have continued to be profitable and innovative, and new companies are entering the field. But major portions of the Medical Device Amendments have not been implemented by FDA and some may not be workable. As implemented so far, the regulatory process has posed the greatest problem for small manufacturers of contact lenses.

The purpose of the Medical Device Amendments is to protect the public from unsafe and ineffective devices. However, information from FDA's voluntary reporting system has been inadequate for assessing the hazards associated with devices and the law's effectiveness in consumer protection.

The medical devices industry has grown from less than $1 billion in 1958 to more than $17 billion in 1983. Medicare and other health insurance programs have stimulated growth in the medical devices industry by providing a secure and growing market for health care products. Between 1960 and 1982, the share of total medical expenditures paid by third parties rose from 45 to almost 70 percent.

As a result of payment policies, the market has rewarded technological sophistication but not cost consciousness and has fostered devices used in acute care rather than in prevention and rehabilitation.

Medicare's new method of paying hospitals prospectively on the basis of diagnosis-related groups (DRGs) has the potential to make hospitals, and hence device manufacturers, more cost conscious. Medicare's DRG hospital payment method also raises some concerns: assurance of quality when providers have financial incentives to minimize the use of devices and possible inefficiencies if device use shifts to locations less financially constrained than hospitals.

Congress has several options to improve regulation of medical devices. One option is to retain the basic framework and intent of the 1976 law and provide guidance to FDA on priorities in its implementation. A second option is to narrow the scope of the law to reflect FDA's current priorities in implementation. A third approach is to exclude

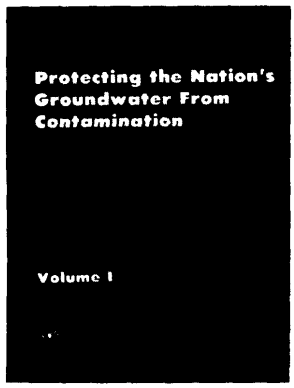
certain types of devices from regulation on the basis of their potential risk.

Congressional options in the payment area include encouraging Medicare to develop payment methods that are more neutral with respect to providers' decisions to use devices and that encourage physicians to select the least costly setting of use. A broader approach would be to encourage Medicare to set overall limits on the amount to be paid for care and to permit providers and patients to determine the use of specific devices and other technologies within that limit.

In addition to policies pertaining to payment for health care and regulation of marketing, OTA's report examines Federal policies pertaining to support for research and development, regulation of medical providers, and the development and procurement of devices for veterans. Policy options are provided in each of these areas.

Projecting the Nation's Groundwater From Contamination

Contaminants are being found in the groundwater of every State and are being detected with increasing frequency. Although the quality of only a small-portion of the 'Nation's total groundwater resource may now be impaired, the potential risks of this contamination are significant.



Many substances being found in groundwater are linked to human health hazards including cancers and damage to the liver, kidney, and central nervous system. These substances can also have serious environmental, social, and economic impacts. Adverse effects can be expected to increase because demands for groundwater and the likelihood of exposure to contaminants are growing. Groundwater is now used for drinking by about one-half of the Nation's population; supplies many industrial, agricultural, and domestic requirements; and recharges streams and lakes.

Despite increased Federal and State efforts in recent years, our ability to protect groundwater against contamination is limited. For example, there is no explicit national legislative mandate to protect groundwater quality. In addition, laws and programs vary in the ways they address groundwater; responsible institutions are not coordinated; and programs to protect groundwater and surface water are not integrated.

If groundwater quality is to be better protected, laws and programs must be broadened to include sources of contamination, contaminants, and users of groundwater not now covered. Most programs now focus

on contamination from "point" sources, especially landfills and other activities with hazardous wastes (as defined by Federal law). Not generally covered are non-point sources (e.g., pesticide and fertilizer applications) and sources associated with nonhazardous wastes (e.g., residential disposal) and nonwaste products (e.g., leaks and spills from storage tanks). Also, over 200 individual substances have been detected in groundwater, but mandatory Federal water quality standards have been established for only 18 of them. And existing programs are primarily concerned with protecting public drinking water supplies; at least 11 million rural households–as much as 20 percent of the Nation's population—rely on private drinking water wells.

Adequate and sustained Federal support to the States is also required to protect groundwater quality and will involve a balancing among activities to detect, correct, and prevent contamination. This support must be flexible enough to respond both to the site-specific nature of contamination problems and to variations among the States' priorities and capabilities. Federal support could include funding, technical assistance, and research and development.

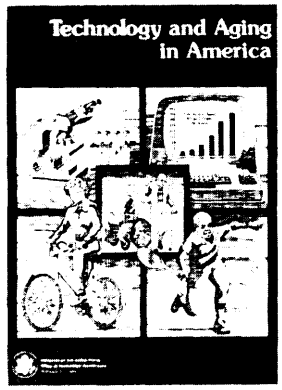
At present, no Federal program earmarks funds for groundwater. As a result, all water quality programs are competing for State grants, some of which have recently been reduced or eliminated, And because groundwater protection activities are expensive, funds are needed by the States for both program development and implementation.

The kinds of technical assistance that Congress may want to consider include: 1] Federal support for training programs to provide an adequate supply of technical personnel; 2) development of criteria and/or guidelines to ensure that detection, correction, and prevention activities are technically sound; and 3) efficient information exchange both to provide the States with information that they require (e.g., about health impacts) and to enable the States to benefit from each other's experiences with protection programs.

Key areas for research and development include the toxicology of individual contaminants and of their mixtures; hydrogeologic investigations in fractured rock; the systematic and efficient analysis of water quality samples; chemical and biological transformations of substances in the subsurface; the prospects for treating contaminated groundwater; and options for prevention.

Technology and Aging in America

A major challenge stretching well into the 21st century will be to maintain the health and functional ability of America's rapidly growing older population, particularly as the proportions in the oldest age groups rise to unprecedented levels. Technology has been the major factor in the growth and increased longevity of the population, and can enhance the ability of older persons (those over 65) to remain vital and active for many years.



Almost four-fifths of all babies born in the United States this year can expect to live to age 65; only two-fifths of those born in 1900 could expect to do so. More than half of the improvement in life expectancy at age 65 that has occurred since 1950 has been gained in the last 12 years.

For the first time older persons outnumber teenagers in the United States, and by 2025 will outnumber them more than 2 to 1. If expected demographic trends continue, the aging of the U.S. population will accelerate and the older population itself will have notably larger proportions in the highest age groups—75 to 84 and over 85.

Technologies that have increased life expectancy include advances in public hygiene and sanitation, reductions in infectious diseases, and continued improvement and accessibility of general health care. The OTA study broadly defines technology to include the development of knowledge and its application in solving societal problems. Technology thus ranges from biomedical research in the clinic to stair safety treads in the home.

Although the societal effects of technological change and the aging of the population are only partly foreseeable, likely possibilities are:

- Increasing prevalence of chronic diseases that can impair the older person's ability to function independently, especially as the proportions of those in the oldest subgroups increase.
- Growing need for social and health care services (i.e., long-term care) for chronic conditions and demand for medical care for treatment of acute illness.
- Significant changes in family structure, living arrangements, and housing, with more older persons living alone, and those over 55 more likely to have a very old living parent.
- A particular vulnerability of older workers to the impact of new production methods and workplace technologies, and changes in required work skills.

Recent advances have sharply reduced death rates among the elderly from heart disease and stroke, yet these remain the two leading killers. Today's most common disorders affecting elderly persons—chronic diseases—are those about which much less is known. OTA reviews five chronic conditions that have major impacts on the lives of older Americans: dementia, osteoarthritis, osteoporosis, hearing impairments, and urinary incontinence. Without greater efforts in biomedical research to discern causes, treatments, and preventive technologies for these conditions, the demand and costs for long-term care and supportive services will be greatly compounded.

Medication is effective in managing chronic conditions. Yet much remains unknown about the effects of individual drugs and, more importantly, combinations of drugs on the mental and physical health of older persons.

Behaviors that promote health and may prevent or delay the onset of various chronic diseases should be encouraged at even the oldest ages because their positive effects can be realized in relatively short time periods.

There is a need for a coordinated approach to long-term care and for improved technologies to assess the health and functional status of older persons. A wide range of options for supportive services and settings would more appropriately respond to the different needs of the elderly, Because Federal and State cost reimbursement policies influence the availability of health and long-term care services, changes in reimbursement criteria could promote such options.

Elderly persons have special housing needs. Federal policy has concentrated on construction and subsidies for elderly rental housing, but more attention is needed to coordinate community-based services with such housing programs. New technologies more easily allow single family units to be renovated for the elderly. Federal policies could encourage shared housing, accessory units, and other types of housing to expand the choices available.

Changes in workplace technologies may threaten job security in some industries, but in others they may improve performance, efficiency, and safety for many older workers, particularly the impaired. Telecommunications may enable older persons to take advantage of new home-based work arrangements. The retraining of older workers would encourage continued employment or provide new employment possibilities.

The development and application of technologies in all spheres of life will promote the independence of the elderly and enhance their ability to remain active and vital. American society will greatly benefit from the contributions that a healthy older population can contribute,

TECHNICAL MEMORANDA

Energy Technology Transfer to China

This technical memorandum presents preliminary findings on energy technologies from a major study which will examine the long-term commercial, political and security implications of technology transfer to China. The transfer of U.S. energy technology to China is of considerable benefit to both countries.

U.S.-Soviet Cooperation in Space

This technical memorandum concludes that valuable gains in science and space applications are possible through renewed cooperation between the countries; but obtaining these benefits calls for care and understanding in addressing other foreign policy and security concerns as well. Space cooperation can lead to substantive gains in some areas of space research and applications, and can provide the United States with improved insight into the Soviet space program and Soviet society as a whole.

Medical Devices and the Veterans Administration

This technical memorandum was prepared as part of OTA's assessment on ***Federal Policies and the Medical Devices Industry*** (released in October 1984).

OTA provides three different perspectives of the medical devices industry: that of the veteran as a consumer, that of the device industry as a supplier, and that of the VA as both a consumer and supplier. Topics addressed include the VA's programs in research and development, testing and evaluation, procurement and supply, and adoption and use of medical devices.

Review of the Public Health Services' Response to AIDS

By the end of 1984, approximately 7,000 cases of AIDS were reported in the United States; 40,000 new cases can be expected in the next 2 years, according to this technical memorandum. The main populations affected so far, in the United States, have been gay or bisexual men, intravenous drug abusers, recent immigrants from Haiti, and hemophilia patients. AIDS is also found in the rest of the Americas, in Europe, and in Africa.

Africa Tommorrow: Issues in Technology, Agriculture, and U.S. Foreign Aid

OTA concludes that the greatest potential for significantly expanding Africa's food production lies in increasing the productivity of small, subsistence-level farmers and herders, who raise most of Africa's food and yet have been largely ignored. The challenge is to devise research, extension, and aid programs that involve local people and integrate on-farm work into the larger framework of national and international efforts.

BACKGROUND PAPERS

Alternative Approaches to Cargo Policy

Because U.S. interests and negotiating strategies have not been defined, the United States has not generally accepted cargo policy. Foreign governments have adopted such policies, thus increasing the disadvantage of U.S. shipping interests and increasing the intensity of the debate over U.S. cargo policy.

R&D in the Maritime industry

Problems identified with existing Federal maritime R&D include: difficulty with government contracting procedures, limited dissemination of R&D results, and restricted involvement of some sectors of the industry.

Human Gene Therapy

The main reason for attempting human gene therapy is that many severe genetic diseases are currently untreatable. There are 2,000 to 3,000 genetic diseases, and only a few can be treated using present medical technologies, according to OTA. Some of these might be aided by gene therapy.

CASE STUDIES

The Effectivenoss and Costs of Continuous Ambulatory Peritoneal Dialysis [CAPD)

Continuous ambulatory peritoneal dialysis appears to be an acceptable alternative to hemodialysis for selected persons with end-stage renal disease, Analyzes the incentives that Medicare's reimbursement provides, and determines the cost differences between patients who remain on one system and those who change.

Tecnologies for Managing Urinary Incontinence

Describes the problems of urinary incontinence and its costs to the medical care system and society as a whole. The impact of Federal policies, particularly Medicare and Medicaid payment policy, on the kinds of technologies used and their effect on the quality of patients' lives is also discussed,

The Cost Effectiveness of Digital Subtractionion Angiography in the Diagnosis of Cerebrovascular Diseases

DSA is a major technological advance in the field of diagnostic imaging radiography. Refinements in the basic technology are expected to increase its use in the diagnosis of cerebrovascular disease.

The Hemodialysis Equipment and Disposables Industry

In response to Medicare cost-containment pressures, the prices of hemodialysis equipment and disposable have decreased substantially in the past 5 years, The market for hemodialysis equipment grew rapidly when Medicare coverage was extended to ESRD patients. To save on costs, dialyzers labeled for single use are frequently reprocessed and reused. To protect ESRD patients, the Federal Government should ensure that dialyzers are adequately reprocessed and that quality control procedures are followed,

The Contact Lens Industry: Structure, Competition, and Public Policy

About 120 million people in the United States wear corrective eyeglasses and another 16 to 18 million use contact lenses, either exclusively or interchangeably with eyeglasses. Under the Medical Device Amendments of 1976, evidence of the safety and effectiveness of contact lenses must be presented to the U.S. Food and Drug Administration before lenses can be marketed. Small manufacturers have had difficulty in meeting these requirements because of the costs of such testing,

The Market for Wheelchairs: Innovations and Federal Policy

Although wheelchairs are essential to many disabled persons, the amount of money spent by the government for research and development on wheelchairs appears modest in relation to the number of users. The wheelchair market is dominated by third-party payers, such as Medicare, the Veterans Administration, and insurance companies.

The Boston Elbow

The Boston Elbow is an artificial arm that can be controlled by signals from an amputee's stump muscles, The adoption and use of the Boston Elbow has not been substantially impeded by the policies of the Veterans Administration, Medicare, or Workers' Compensation.

Intensive Care Units: Clinical Outcomes, Costs, and Decision making

A number of steps concerning the provision of ICU care are outlined: modification of DRG payment for ICU, recognition by the legal system, research on the feasibility of developing predictors of short- and long-term survival to aid in treatment decisions, and encouraging health professionals to learn more about medical ethics and relevant legal obligations.

WORKSHOP PROCEEDINGS

Innovative Biological Technologies for Lessor Developed Countries

The participants of the workshop agreed that a range of promising, innovative technologies could help LDCs sustain soil fertility with reduced imputs but that these technologies are underused and many important ones are ignored. The technologies discussed include: underexploited plant resources, multiple cropping, agroforestry, azolla/algae symbiosis, underexploited animal species, zeolites, biological nitrogen fixation, and mycorrhizal fungi.

Technologies to Benefit Agriculture and Wildlife

Examines the opportunities and constraints to the application of technologies that benefit both agricultural production and wildlife conservation. It also identifies how the Farm Bill and other legislation can be changed to foster the integration of agriculture and wildlife interests.

SPECIAL REPORT

First Report on the Prospective Payment Assessment Commission

OTA's report covers the commission's first year of operation, focusing on ProPAC's procedures and functions. It discusses the commission's progress and contains questions that Congress may wish to analyze in the coming year.