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POLITICAL AND LEGAL IMPLICATIONS

OF DEVELOPING AND OPERATING A

SATELLITE POWER SYSTEM

FINAL REPORT

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POLITICAL AND LEGAL IMPLICATIONS OF DEVELOPING AND OPERATING A SATELLITE POWER SYSTEM

FINAL REPORT

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by

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ABSTRACT

A number of political and legal implications o· developing and operating a satellite power system (SPS) are identified and studied in this report. These include the vulnerability of SPS to actions of adversaries, communications impacts, the legality of an SPS in orbit including on-orbit military protection, alleviation of political concerns about deployment and operation of SPS, programmatic planning for SPS and the interaction of SPS with federal regulatory agencies and major departments. In comparing SPS to terrestrial power stations, it is seen that the political problems are neither clearly larger nor clearly smaller--they are clearly different and they are international in nature. If SPS is to become a reality, these problems must be dealt with, sooner rather than later. Five major issues are identified. These must be resolved in order to obtain international acceptance of SPS. However, this study has found no insurmountable obstacles that would clearly prohibit the deployment, operation and protection of an SPS fleet.

NOTE OF TRANSMITTAL

This report is submitted by ECON, Inc. in fulfillment of the requirements of JPL Contract No. 954652. The ECON study manager for this effort was Dr. George A. Hazelrigg, Jr. Much of the work presented herein was performed by a study team including Dr. David Kay and Dr. John Logsdon of the School of Political Science and Public Affairs at George Washington University, Dr. Delbert Smith of the University of Wisconsin, and Dr. Klaus P. Heiss and Mr. Hans Wynholds of ECON. The study was reviewed for ECON by Mr. Lewis Bass, Esquire and by Ambassador Harlan Cleveland. The JPL Technical Manager for the study was Mr. Irv Stein.

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1. INTRODUCTION AND SUMMARY

The embargo on the export of petroleum products to certain oil-consuming countries (OPEC) in October 1973 and subsequent events have elevated issues relating to the management of energy resources to a high priority in national and international policy making. Energy shortages and sharply increasing costs, with their economic, social and foreign policy implications, have given increased urgency to the search for alternative energy sources. As a result, scientific research relating to the development of nuclear, geothermal, solar, wind and other energy sources has received public support and at attention.

One of the most promising alternative sources is solar energy, both because the supply is for all practical purposes inexhaustible, and because the use of solar energy does not necessarily involve significant environmental hazards as does the use of fossil fuels. Consequently, large- and small-scale applications are being examined.[1] However, solar power generators located on the Earth's surface are subject to a number of limitations, including inoperability due to nightfall and low or variable output due to adverse weather conditions such as cloud cover. Thus, consideration has been given to the establishment and operation of solar generators in outer space.

As presently conceived, a satellite solar power system would incorporate two main components. First, a large-scale solar energy conversion system would be assembled, perhaps in low-earth orbit, and placed in geostationary orbit at a distance of approximately 35,900 km from the surface of the Earth.

In that position, the solar power satellite would occupy a relatively fixed position with respect to the Earth's surface. The second system component would encompass an Earth station capable of receiving the energy product generated in orbit and converting it to electricity through the use of receiving antennae. The space and ground segments are to be connected by means of a microwave or, possibly, laser transmission beam.[2]

Planning for the implementation of a satellite power system raises, in addition to complex technical questions, issues of system security and economic viability and impact. However, it is apparent that some of the major barriers to the development may lie in the areas of international law, the law of outer space, and international policy formulation. The purpose of this study is to examine those aspects of satellite power systems (SPS). The following issues have been considered:

1. Vulnerability of SPS to actions of adversaries
2. Use of microwave power transmission by SPS and its potential impact on others
3. Status of SPS in international law, including the legality of on-orbit military protection
4. Political concerns about risks imposed by the construction and operation of an SPS
5. Benefits of SPS in international trade
6. Programmatic planning for SPS in the context of the federal budget cycle
7. The interaction of SPS with federal regulatory agencies and major departments.

A brief discussion of the major study findings follows.

1.1 Vulnerability of SPS to Actions of Adversaries

The SPS, with its major power conversion and delivery components located in space, presents a different type of target to the potential actions of adversaries than do conventional, ground-based power plants. On the one hand, the space-based components of the SPS offer a significant target that would not involve a direct attack within the national boundaries of the owning state and might not endanger human lives. On the other hand, however, the economic significance of an SPS would likely mean that direct attacks on the system by major powers would be interpreted as unambiguous acts of war. But it must be observed that a range of adversary actions could conceivably occur, some of which are not recognizable as actions against which physical reactions would be appropriate. For example, actions that do not impose a physical threat against SPS hardware, such as legal proceedings, are not likely to be met with physical force against the imposing state.

In comparing SPS to terrestrial power plants, three key differences exist: First, the SPS, in operation, uses an energy source that is not dependent on foreign supplies, finite terrestrial resources, or the vagaries of resource extraction, processing and transportation as are hydrocarbon and nuclear fuels. Second, the technology needed to disrupt the operation of an SPS is generally well above that for terrestrial plants and the hardware for such an attack is not readily available. Third, the scale of an SPS satellite could make it a desirable target and one which does not require attack on the territory of the owning state. It would be desirable to enhance the security of the SPS fleet by any of a number of potential actions. These include enforcement of national strategic deterrence, that is, the ability to strike back at a threatening state, defensive devices maintained possibly in orbit near the satellite to protect against physical actions that might be taken by lesser powers, and by proper design and management of the SPS to make it more difficult to impose real threats. In addition, SPS security could be significantly enhanced by providing the appropriate economic incentives. Basically, this means internationalization of the system at some level.

1.2 Microwave Power Transmission

The SPS has a planned fundamental frequency for the microwave power transmission beam of 2450 MHz. Clearly, allocation of this frequency for SPS use will be necessary if it is to be used by SPS. In addition, however, it is unlikely that suppression of the higher harmonics of the fundamental frequency will be physically possible to the extent that these frequencies will be available to other users. Thus, along with the fundamental frequency, it will also be necessary to allocate the higher harmonic frequencies to SPS use. Besides the problem of harmonics, there is also the issue of actual transmitted bandwidth, which could result in interference (sum and difference frequencies) between pairs of SPSs.

Potential impacts of the SPS power beam on other frequency spectrum users could result from nonlinear interactions between pairs of SPS power beams, between an SPS power beam and other signals and between the SPS power beam and the ionosphere. Nonlinear interactions between radio beams can occur when a conductor, such as an ungrounded wire or free electrons in space, are irradiated by two sources. The conductor than has a potential for detecting and emitting a signal at the sum and difference frequencies of the impinging beams. Because of the extremely high power level in the SPS power beam compared to communications signal levels, the potential for problems of this sort should be of concern. The other area of concern lies in the potential effects that the SPS power beam could have on the ionosphere, thus impacting users that rely on existing properties of the ionosphere. A number of systems might be affected. These include both line-of-sight and over-the-horizon communications and navigation systems.

A further area of interaction between SPS and other frequency spectrum users lies in the use of orbital positions by the existing systems. By the time SPS will be ready for implementation, well in excess of $1 billion will be invested in hardware for space-based communications and navigation systems. Much more will be invested in ground-based systems that could also be impacted and the total number of individuals involved with these systems will be very large. Thus, the viability of the SPS concept may well rest in the ability to find equitable alternatives for the communications and other orbital arc users.

1.3 The Status of SPS in International Law

A number of issues exist relevant to the status of SPS in international law. Four issues are addressed in this study:

1. The legal aspects of the use of the geostationary orbit by SPS
2. The impact of the 1967 Outer Space Treaty on the use of space for power generation
3. The legal status of deployment and operation of SPSs by private sector entitiesd
4. The permissibility under existing international space law of providing on-orbit military protection for SPS.

The conclusions resulting are as follows. Nonpermanent use of the geostationary orbit for SPS is permitted under present space law; however, it will be necessary to obtain appropriate frequency allocations and to register the use of the orbit with the International Frequency Registration Board. Permanent allocation of an orbital location is specifically not permitted unless such allocation is by an international organization duly representing a broad spectrum of states. It is felt that use of an orbital location for 30 years does not constitute appropriation but that periods much longer than this may. The 1967 Outer Space Treaty provides that the resources of space are for the benefit of all mankind. This clause prevents nationalization of various space resources; however, it does not exclude the use of sunlight to provide energy for an SPS. The deployment and operation of an SPS by private sector entities is permitted within existing international law but the private sector then acts as an arm of the government and the government assumes the responsibility for regulation of the activity and is liable for any damages caused by the operating entity. Last, it is felt that on-orbit military protection of SPS can be provided legally within present international law so long as the military systems stationed in orbit are not nuclear weapons or weapons of mass destruction.

1.4 Political Concerns About Risks Imposed by SPS

The construction and use of a fleet of SPSs imposes a number of potential hazards on the peoples and properties of foreign states. These hazards include potential launch vehicle failures, reentry of various materials associated with the SPS and potential hazards of the microwave beam. Alleviation of the concerns regarding launch vehicle failures and reentry debris is not likely to be a major problem, but the problems are reduced if the SPS is constructed and operated by an international organization. The microwave beam poses a somewhat different problem. Clearly, microwave radiation at very high power densities is hazardous and at very low power densities is not in any way dangerous. SPS must operate in the region between these limits, where little is presently known. Thus, it will be necessary to conduct research on the effects of microwaves on biological materials and the ionosphere in order to determine the acceptable, safe limits on power density. There is a basis in international law requiring that this research be conducted and for providing assurances that the states engaged in an SPS program are not imposing undue risks on others.

1.5 Economic Benefits of SPS in International Trade

The present dependence of the United States on bulky hydrocarbon fuels places many conditions on economic growth and stability. For one thing, dependence on foreign oil infers dependence on the security of the transportation of such oil. This implies at least guaranteed access to, if not control of, the seaways over which the oil is moved. Furthermore, the expenditure of some $30-$40 billion on oil imports adversely impacts the domestic economy. This money, properly placed in the United States, would create some 2 million new jobs. At the very least, it is clear that an energy source such as SPS, independent of hydrocarbon fuels, would significantly alter economic growth both foreign and domestic and would drastically alter international economic dependencies.

1.6 Programmatic Planning for SPS

A number of programmatic issues related to obtaining and maintaining support for an SPS development program are identified and discussed. At this point in time, the program should be economically justifiable as a necessary condition for federal support. Although this condition appears to be met, a debate continues to exist over the discount rate that should apply to the economic evaluation. The Office of Management and the Budget dictates a 10 percent rate to apply to the evaluation of federal programs. Economic theory and data indicate 2 to 4 percent is more reasonable. The latter rates more strongly favor proceeding with the SPS development program. In addition, four conditions are identified as necessary for a positive decision on a major program such as SPS:

1. The objective sought must be known to be technologically feasible, with a high degree of probability, at the time the decision to seek it is made.

2. The objective must have been the subject of sufficient political debate so that the groups interested in it and opposed to it can be identified, their positions and relative strengths evaluated, and potential sources of support have time to develop.

3. Some dramatic "occasion for decision," such as a crisis resulting from an external or domestic challenge, must occur to create an environment in which the objective and the policies to achieve it become politically feasible.

4. There must be in leadership positions in the political system individuals whose personalities and political philosophies support the initiation of new large-scale government activities aimed at long-term payoffs and who have the political skill to choose the situations in which such activities can be initiated successfully.

Once a federal program has been initiated, evidence indicates that it is harder to terminate the program then to let it continue. Thus, the focus should be on meeting the necessary conditions to achieve a program start.

1.7 Interactions of SPS with Federal Regulatory Agencies and Departments

As soon as an SPS development program is approved by Congress, it will be appropriate to involve a number of federal regulatory agencies and departments in the SPS program. Regulation of the SPS during development, construction and operation will involve a broad spectrum of agencies, for example, to assure proper environmental protection, safety for both workers and the rest of the world, and to regulate the capital formation and return on investment for the system. The government must be involved in research to determine safe levels of microwave radiation and in international bargaining to obtain frequency allocation and orbit locations for the SPS. Finally, provision must be made to perform the technology developments necessary to make SPS an economic reality.

1.8 Major Issues

This study has identified a number of key legal, political, institutional and environmental issues that are potential "show stoppers" with respect to SPS and outlines the bases, institutionally and with regard to international law, which underlie them. The major issues, which must be resolved prior to implementation of SPS, are:

1. The potential effect of microwave energy on biological materials and on the ionosphere
2. Frequency allocation for SPS, including the center frequency and harmonics
3. The potential problems of radio frequency interference
4. Assignment of geosynchronous orbit locations for SPS
5. Problems associated with potential liability for damage caused by SPS.

1.9 Conclusions and Recommendations

Despite the range of potential problems noted above, institutional, legal and engineering solutions can be expected and this study has found no insurmountable obstacles, politically, institutionally or in international law, that would clearly prohibit the deployment, operation and protection of an SPS fleet.

To the extent that an SPS fleet can be economically deployed and operated, it offers a potential key to "free access" to energy by all nations and could, within limits, place a "once-and-for-all" upper bound on the cost of energy.

Throughout this study there has been one major recurring theme. This is that many of the legal, political and institutional issues are clearly international in character and will demand resolution on an international basis. Additionally, if the SPS concept is successfully developed and exploited, its energy products will be demanded by many nations, especially the less developed countries. Thus, if the SPS concept proves to be economic, it will ultimately be implemented on an international basis. Consequently, we believe that it is best to begin by planning for a fully international system right from the start.

As a result of this study, four major recommendations have been derived:

1. Establish research programs on key impact areas, especially the effects of microwaves on biological materials and on the ionosphere, leading to internationally accepted standards.

2. Prepare a policy statement for presentation at the 1979 World Administrative Radio Conference on orbit and frequency allocation providing for SPS.

3. Establish an international forum for the open discussion of the international implications of SPS and the clarification of international law vis-a-vis SPS.

4. Establish a plan for involvement of federal regulatory agencies and departments in an SPS program.

Because of the extensive reference made in this report to (1) The Convention on International Liability for Damage Caused by Sapce Objects, (2) The Convention on Registration of Objects Launched in Outer Space, and (3) the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, a full text of these articles is given in Appendicies A, B and C respectively. In addition, a bibliography of relevant literature is provided.

2. VULNERABILITY OF SPS TO ACTIONS OF ADVERSARIES

This section identifies and discusses a number of threats that could be posed against an SPS and then postulates mechanisms for risk alleviation. It is shown that a number of generic categories of threats could be imposed against an SPS. These span the range from open military attack down to actions of environmentalists or labor unions. Protection against some of these threats can be of a military nature; however, military forces would not be effective against threats imposed through national or international legal mechanisms. The likelihood of threats occurring is qualitatively assessed in terms of the technologies necessary to impose the threat, who has or will have access to such technologies, and what is to be gained by imposing the threat. Four avenues of risk alleviation are identified: national strategic deterrence, active defense of the system, internationalization of the system, and through international agreement.

2.1 Potential Adverse Actions Against an SPS

A number of potential adverse actions could be posed against a space power system. These can be classified in two ways: first, according to the part of the energy conversion/transmission system to which they apply, and second, according to whether they represent an "active" or a "passive" threat to the system. In order to identify and classify adverse actions against an SPS, it is helpful to depict the overall system in terms of its energy transmission and energy conversion components as shown in Figure 2.1. The energy source is the sun. The energy is transmitted as sunlight to the satellite, collected and converted there to microwave energy, received and converted on the earth to dc power, transmitted as dc power to the rectenna busbar,

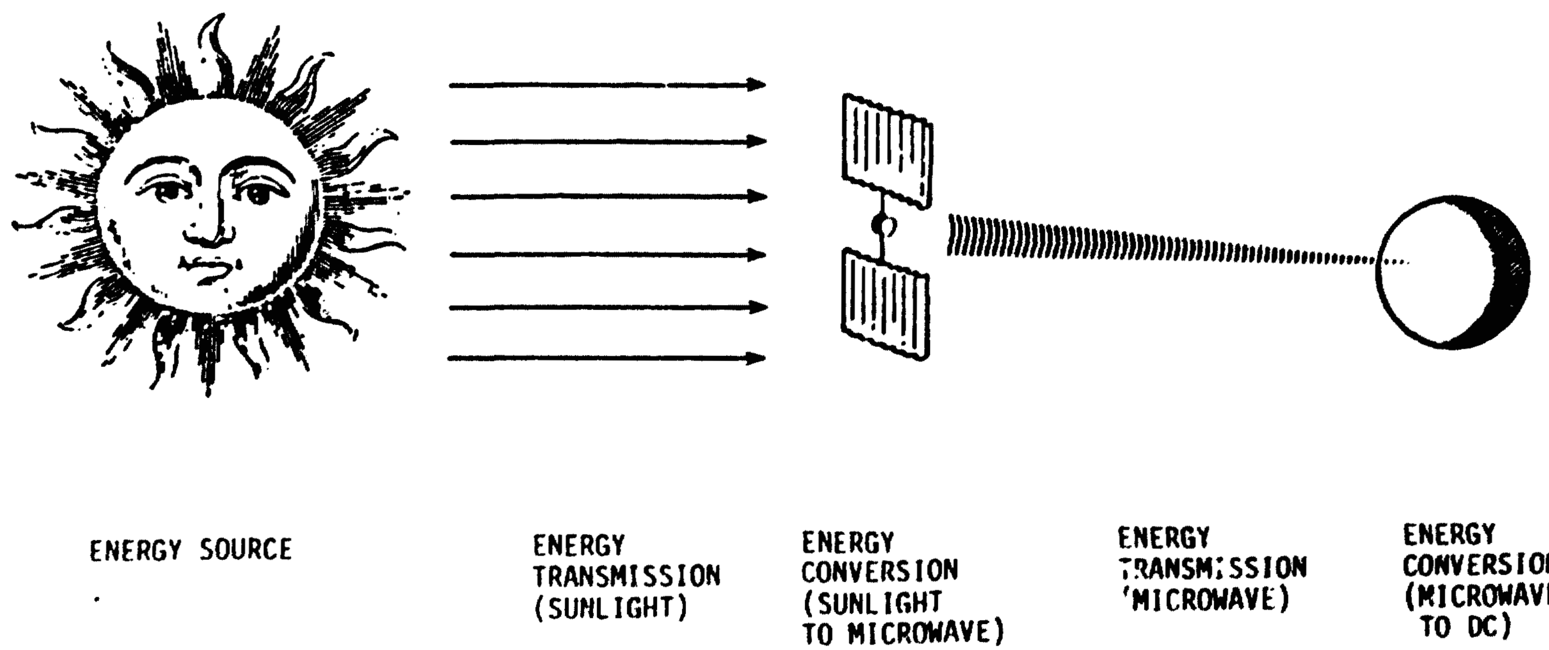


Figure 2.1 The SPS Energy Conversion/Transmission System

and converted there to ac power at a voltage compatible with the utility grid. An adverse action against an SPS is anything that could willfully or accidentally disrupt any of the above processes. In addition, adverse actions against an SPS could exist during its construction and, during its operation, by efforts directed against control or safety systems. It is worth pointing out that no damage whatever need be done to the system itself to constitute a threat. If the operators or regulators of the system could be convinced that it was unsafe to operate, the system would be shut down as effectively as if it were destroyed. For example, a bomb threat against an airplane can cause cancellation of a flight despite the fact that no physical threat ever exists.

Figure 2.2 presents an hierarchical classification of potential adverse actions against an SPS. The major categories include:

1. System construction
2. Physical processes
3. System operation and control.

Within these major categories and their corresponding subcategories, adverse actions are identified and classified according to whether they are "active" or "passive". No clear definition between active or passive actions exists; however, the characteristics of each are generally as follows:

Active actions

- There is a definite intent
- It is easy to show intent
- More likely to deal with the energy transformation process
- More likely to operate on hardware
- Difficult to recover operation after threat passes

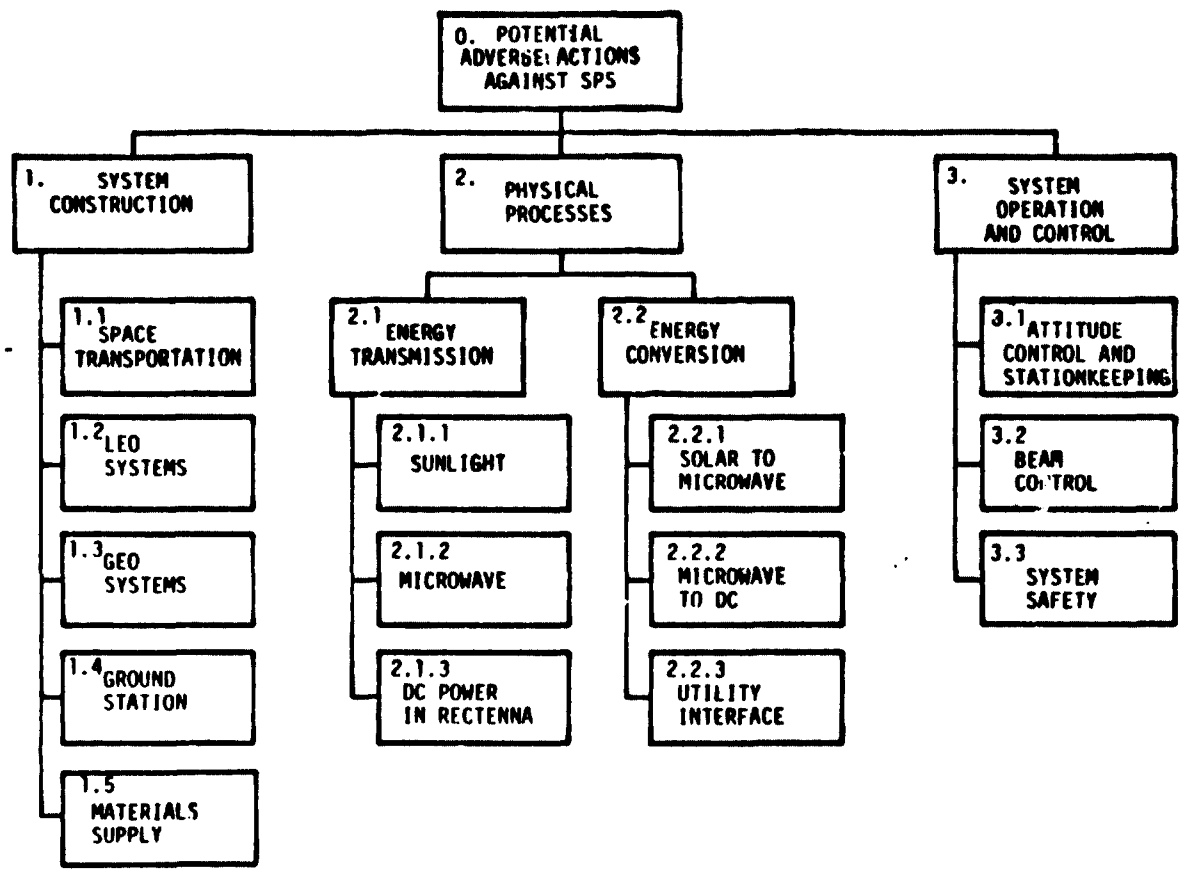


Figure 2.2 Hierarchy of Adverse Actions Against an SPS

Passive actions

- There may be no intent
- It is difficult to show intent if it exists
- More likely to operate on the energy transmission process
- Easy to recover operation after threat passes.

According to the above scheme, generic classes of adverse actions against an SPS are identified in Table 2.1. This is not an all-inclusive list, but serves to identify and classify the various types of actions that could be imposed.

As indicated, a number of potential adversary actions are worthy of consideration. These range from outright attack on the system which, if imposed by a major power, would be perceived as a clear act of war, to legal actions which may be equally effective under the right circumstances and would clearly not represent a belligerent act either toward the system or the operating state. Both extremes and the range of actions between need to be dealt with before they become real actions. In between these extremes are acts such as sabotage, threats against SPS workers, both in space and on the ground, any intervention or mismanagement of supplies, or intervention or deflection of the SPS power beam. Blackmail against SPS system managers is also a possibility.

The actions cited above are active in nature and seek to destroy or obtain control of the system. There exist also a number of potential actions which could be generally classified as passive but which would also result in disruption of system development, construction or services. These actions would include actions that environmentalists or unions might take against the system. They would include national and international legal, political

Table 2.1 Generic Categories of Potential Adverse Actions Against an SPS
Active: • Attack on system elements or construction facilities • Sabotage • Threats against safety of SPS workers • Intervention of supplies • Intervention of power transmission--sunlight or microwave • Obtain physical control of the system • Blackmail
Passive: • Loss of system elements or construction facilities due to accident • Loss of construction capability due to recurring malfunction • Environmental restrictions • Legal or political barriers • Improper critical path management • Union actions • Perceived threats

and institutional barriers that might be erected against the system. They also could include a variety of accidental occurrances involving, for example, a loss of construction facilities or launch vehicles. The measures taken to protect against these "passive" actions are necessarily quite different from the measures that could be taken to protect against "active" actions of adversaries.

2.2 Qualitative Comparison with Terrestrial Systems

Terrestrial power systems are vulnerable to military action at three points:

1. The supply system of raw material for energy production
2. The actual physical system for energy production
3. The distribution network for energy.

The last 40 years provide numerous examples of attempts to interfere with terrestrial power systems at all three points. The Second World War, Korea and Vietnam saw major efforts made to reduce the opponent's industrial capacity through action against its energy generating systems. Various terrestrial energy systems differ considerably as to their vulnerability at these three stages. For example, hydroelectric power stages (that is water, as compared to oil-fired steam generating systems that depend upon a steady input of oil transported from distant sites) have proven to be relatively immune to attempts to disrupt their source of raw material. While it is difficult to generalize across a highly technologically diverse universe of terrestrial power systems, ranging from small coal-fired plants to 1,000 megawatt LWRs, a few generalizations do seem possible.

First, an increasing number of terrestrial power systems are dependent upon foreign-controlled sources of raw material. These include not only the obvious oil and coal-fired systems but also a large number of the nuclear power plants now being built or projected, which will be dependent upon uranium enrichment and fuel fabrication services performed by other countries. This dependence on foreign sources for raw materials opens up a whole range of military/political vulnerability that spans the application of an embargo all the way up to the application of traditional interdiction techniques of using sea and air power to disrupt supply lines. Depending upon where in this spectrum the action is applied, varying levels and sophistication of force will be required. For example, an Arab oil embargo on exports, unless opposed by force, can be applied without any significant application of military force and against countries that may have a large quantitative and qualitative military superiority. In comparison to potential military threats to an SPS system, disruption of the raw material supply of terrestrial systems appears open to far more states and at lower levels of military force and sophistication. In an SPS, the technology necessary to disrupt the sunlight or microwave beam is at least an order of magnitude above that needed for analogous action on a terrestrial system and not likely to be available to most states in the short term.

Second, the actual energy conversion system of terrestrial power plants is subject to a large range of military actions, ranging from covert penetration and sabotage to direct attack with highly sophisticated air- or missile-delivered ordnance. While these systems are relatively vulnerable to such military action, the scale of energy production at any single site is such that the pay-off of such an attack is not high. With interconnected power grids, the removal of a single power-generating facility would usually not be critical or seriously disruptive. Additionally, any such military action involves a direct attack on the national territory and sovereignty of a state and is not likely to be undertaken in a situation short of war or open combat. In comparison, any military attempt to interfere with the energy production phase of an SPS system would appear to require a higher order of technical sophistication than similar efforts directed at terrestrial systems. On the other hand, larger scaling of SPS systems would mean that such efforts, if successful, would offer considerably higher pay-offs in terms of their disruptive impact. Also, the nonterritorial base of the energy production segment of an SPS system would mean that any attack on it would not directly attack the national territory of the state owning the system, and this might lower the restraints against such an attack.

Third, both SPS and terrestrial systems seem to share the same degree of vulnerability to military action with regard to their distribution systems. While the utility interface, and particularly the rectenna of the SPS, would present a larger target than normally associated with a terrestrial system, the relative vulnerability of the systems is probably not altered by this.

Fourth, the two types of systems differ significantly in their vulnerability to nonconventional military action (that is, terrorist and similar action). The terrestrial system, such as an LWR, presents a traditional target profile with very conventional types of barriers to be overcome (that is, physical barriers, detection systems and security forces). These barriers may be considerable, but in any case, they are conventional in the sense that traditional techniques can, if adequate, breech, neutralize and defeat them.

Given the spread of military training and sophisticated military and quasi-military hardware (for example, helicopters, shaped explosive charges, heat-seeking missiles and anti-tank weapons), any number of groups can be expected to be capable of launching terrorist-type attacks on terrestrial power systems. With regard to SPS, another order of sophistication beyond that normally found in terrorist-type groups would be required to creditably pose a military threat to the system. The technology that this study has identified as necessary, for example, to destroy the satellites through active or passive means, is unlikely to be available to terrorists in the time frame of concern. While it is possible to imagine slightly more credible threats to the SPS operation and control system from terrorist groups, these are at the outer limits of plausibility and the system is still significantly less vulnerable than terrestrial systems.

2.3 Relative Likelihood of Threats Occurring

With regard to the energy conversion stage of an SPS, the most serious active threat would involve an attempt to destroy the satellite itself. Such an effort might involve ground-based laser, airborne laser, space-based attack or a ground-based missile attack using a nuclear warhead. All such threats would involve a high order of technical sophistication in the launch vehicle or specific attack mechanism. Laser developments are apparently moving ahead rapidly, and a full assessment would require access to classified data not available for this study, but it still appears probable that, at least during the early years of SPS implementation, only the United States and the Soviet Union, and maybe one or two Western European states, will have laser devices with the appropriate characteristics for such a satellite-destroying mission. Research into high-enegy lasers is apparently being actively pursued with progress being made along the following fronts:

- For in-space use, the open literature in the United States already reports useful efficiencies with small-scale chemical lasers using hydrogen fluoride radiating at a wavelength of 2.7 microns. Research is apparently now concentrated on scaling the size of the device upward to useful power levels.

- For ground-based use against space targets, the United States has reported progress with electrically excited Excimer-type lasers using noble gases, that emit in the visible and ultraviolet part of the spectrum. It is reported that single-pulse energy levels of 350 joules have already been achieved with such devices.

In both of these approaches, formidable problems remain, including major advances in the laser devices themselves, precise locating and tracking and large, high power optic systems. Without access to classified material, it is impossible to assess with a high degree of confidence the pace at which more traditional satellite-destroying technology has developed. However, the impression from the public record is that only the Soviet Union and the United States have made any real attempts to develop such capability.

A passive threat to the satellite itself that deserves serious consideration is the threat posed by collision with another satellite or debris from the breakup of a satellite or associated launch vehicle. While direct space-based attack on the satellite through an active satellite-killer system could be easily identified through ground tracking, it would be much more difficult to establish intent if an effort was made to disguise the search-and-close profile of such a satellite-killer system. Because the SPS would be in geosynchronous orbit, such a deception should be easier to execute. The possible deceptions are many, including a "failed" control system on a launched satellite, an on-board "accident" on a large satellite or its launch vehicle resulting in a large amount of debris crossing the orbit of the SPS or a "miscalculation" by one of the many states that will have satellite launch capabilities by the end of the century.

A third area of threats that deserves serious attention concerns active and passive threats to the SPS operation and control system. These could include, inter alia, attempts to affect the attitude, control and station-keeping capabilities of the system by jamming ground commands, by using superior commands to reposition or change altitudes, or attempt to destabilize the satellite through ordering it to assume unstable attitudes. The beam control could also be similarly misdirected in an attempt to deflect or to direct the power beam in ways likely to cause physical damage to earth-based interests. It is not clear that such threats can be easily or creditably posed. In large part, the answer to whether they can depends upon the design of the command and control system. If the issue of security and access are handled in as haphazard a fashion as they have been in many existing computer systems, then the threat could be quite real. If, on the other hand, attention is paid to such issues, it should be possible to design dependable, secure, control systems.

A threat assessment requires knowing not only the vulnerability of the SPS to military action, but also assessing the creditable motivation that might lead to such action, the objectives that could be gained and identifying states with both the capability and motivations.

Because of its cost, size and contribution to the operating country's national economic system, an attack on an SPS, especially by a major power, is likely to be perceived as a clear and unambiguous act of war. This means that the motivations for attacking an SPS should be sought not in the SPS itself but in the full context of the relations between states. In other words, the motivations for an attack on an SPS are relatively unambiguous. If the SPS has a ground output optimized in the 5 to 10 GW range, the sudden and unexpected destruction of one or more SPSs could cause immediate economic disruption ranging from disruption of the ground-based power distribution system to the slowdown and stoppage of economic activity relying on power derived from SPS. The output of an SPS fleet would be so large compared to present conventional ground-based power generating networks or power pools that it is unlikely that the national energy system could (or should) be designed to absorb the unexpected loss of several SPSs without severe economic disruption. Thus, an attack on the SPS fleet would have as its objective large-scale economic disruption. As with the ability to interrupt the importation of foreign-produced petrochemicals into a state, the destruction of an SPS offers the attraction of being able to disrupt an economy without physically attacking assets within the state's geographic territory.

2.4 Methods of Risk Alleviation

As argued above, the SPS, because of its cost, size and contribution to the operating country's national economic system, presents a high value target, the destruction of which would likely be perceived as a fairly unambiguous act of war. If this is in fact the case, then an SPS would not be attacked unless central national interest, reaching far beyond the mere vulnerability of the SPS, of the involved states were at stake. As with other valued national assets, the real defense for SPS would be the national strategic deterrence system. If strategic deterrence is effective, SPS will be protected from the attack of hostile nations. On the other hand, if strategic deterrence should fail, SPSs would probably share a high target priority with a lot of other high-value, hard-to-defend targets.

Four principal avenues of risk alleviation for an SPS system offer themselves. The first, and perhaps the most effective, risk-alleviation technique is that of national strategic deterrence. That is, afterall, the technique used by the United States and U.S.S.R. to defend other hard-to-defend targets such as large urban-industrial regions. The techniques of mutual vulnerability, while psychologically and militarily disturbing, likely outweigh very expensive and dubiously effective defensive measures that might be undertaken.

A second risk-alleviation technique, which could be compatible with the first, is to adopt minimal defensive devices sufficient to ward off small-scale, not highly sophisticated attacks. This would give some protection against terrorist or irrational Amin-type attacks while not seriously degrading the mutual vulnerability that the United States and Soviets share. The difficulty of this technique, as demonstrated in the ABM debate, is that a third state defensive capability may appear to be more than that and upset the mutual deterrence relationship among major protagonists. In the ABM debate, the United States anti-Chinese system was claimed by the Soviets to be directed at providing a defense against Soviet missiles and thus upsetting strategic deterrence. The United State, for its part, had great difficulty in assessing whether a Soviet defense system was designed against bomber attack, Chinese missiles or was the start of an ABM defense against the United States.

A third risk-alleviation technique would involve internationalizing the system at its research, production and/or operation stages. The simplest example of this would involve an SPS that produces power for several states. In such a case, an attack on an SPS would be an attack on more than one nation and hence, presumably, be harder to justify. This technique could be illustrated, for example, by an SPS that fed the national grids of Israel, Syria, Jordan, Egypt and Iraq; or one that fed the FRG, DDR, Poland, Czechoslovakia and Austria, or one that fed both China and the Soviet Union.

A final risk-alleviation technique that might be followed would involve seeking an international agreement in which the signatories would specifically agree to declare that the SPS would not be subject to military action. This strategy by itself would seem to offer little real security but if coupled with other techniques might offer some added security, particularly against any attempt to attack an SPS in a less than all-out war situation.

3. LEGAL AND POLITICAL QUESTIONS ON COMMUNICATIONS IMPACTS

This section identifies a number of issues related to frequency allocation for SPS and the potential impact of SPS on other frequency spectrum users. First, the problem areas are identified as they impact and are impacted by the present frequency allocations. Then, the present frequency, allocation and potential SPS impacts are identified. Next, the frequency allocation procedure and the 1977 and 1979 meetings of the World Administrative Radio Conference are reviewed. Finally a survey of existing and projected satellites and equipments potentially impacted by SPS are reviewed.

SPS could possibly impact many frequency spectrum users, including communications, navigation and radiolocation systems. The potential mechanisms involved include nonlinear interactions between the SPS power beam and other radio signals, higher harmonics of the SPS power beam and the actual transmitted bandwidth, and effects due to power beam heating of the ionosphere. To provide for SPS, it is necessary to obtain appropriate frequency allocation and orbital slot allocation. These issues will be addressed in the 1979 World Administrative Radio Conference and it is key that SPS be provided for as one outcome of that session. With the wide range of impacts that SPS could potentially have, and the large number of systems, groups and individuals potentially involved, it will be necessary to design the SPS for minimum impact, to assure that the impact of SPS is adequately controlled, and to find equitable alternatives for those that must be impacted.

3.1 Frequency Allocations and Potential SPS Impacts

Before delving into the frequency allocation problem and potential SPS impacts it is important to understand the frequencies that can be impacted by SPS and the mechanisms which would cause these impacts. As shown in Table 3.1, the proposed center frequency for SPS is 2450 MHz. Table 3.1 also shows the frequencies of the first five harmonics of this center frequency. The center frequency, 2450 MHz, has been proposed for SPS due to a number of reasons. First, this frequency is presently allocated to industrial users and is in use today for such things as microwave ovens.[1,2] Second, this is a frequency which has relatively good characteristics with respect to transmissions through the atmosphere and through areas of precipitation. Third, it is a frequency at which considerable work has already been accomplished on the development of high power transmitting devices such as klystrons and Amplitrons and on rf-to-dc converters.

Table 3.1 Problem Areas
• Center Frequency of SPS: 2450 MHz
• Harmonics:
2nd - 4900 MHz
3rd - 7350 MHz
4th - 9800 MHz
5th - 12250 MHz
• Actual Transmitted Bandwidth
• Sum and Difference Frequencies with Other Signals
• Power Flux Density Limits in Side Lobe Areas

Clearly, problem areas in the frequency spectrum associated with SPS will include the center frequency and at least the first several harmonics of the center frequency. In addition, however, there are a number of other problems as depicted in Figure 3.1. The first of these deals with the actual transmitted bandwidth of the SPS system. Because of the large amount of power being handled, there is a strong requirement for maintaining very precise frequency control. Despite the fact that the center frequency is protected to 50 MHz on either side, one effect which can occur when two or more SPS satellites radiate the same point on the ground is the reradiation of sum and difference frequencies due to nonlinear effects such as might be caused by the radiation of ungrounded pieces of metal. Another potential effect involving charged particles trapped either in the ionosphere or in the Van Allen belts is referred to as the Luxembourg effect. In the Luxembourg effect, charged particles excited by the power beam are modulated by other rf signals. The result, due to the nonlinearities of the process, is the radiation of rf power at the sum and difference frequencies between the power beam and the interferring rf signal. These nonlinear effects have the potential for creating radio frequency interferrence over a broad frequency spectrum, thereby impacting a wide range of users. In addition, radio frequency users can be impacted in yet another way. It is known that the SPS power beam will cause heating of the ionosphere. The exact extent and effect of this phenomenon is not presently understood, however it could potentially impact radio frequency users that make use of the ionosphere to

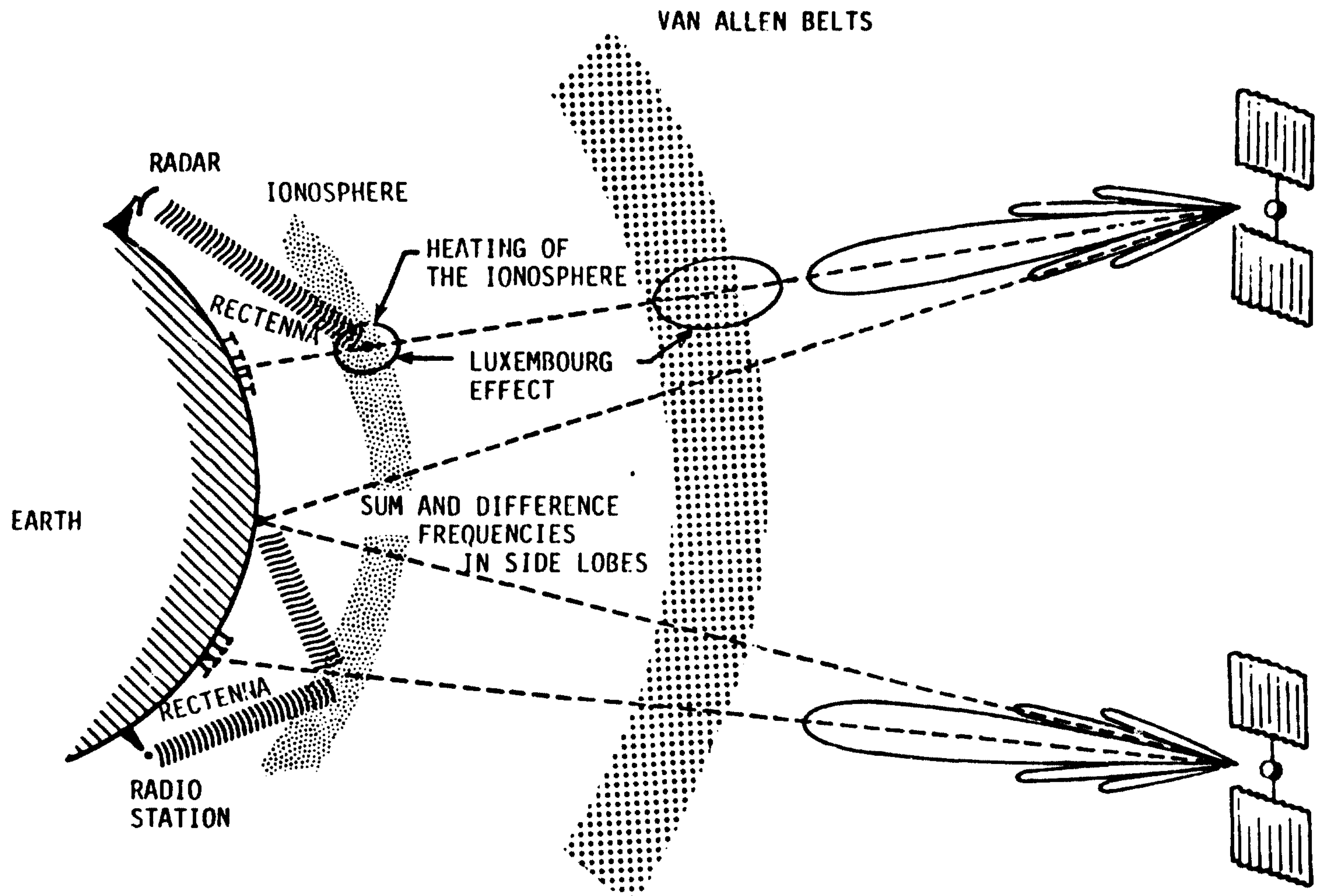


Figure 3.1 Potential Effects of the SPS Power Beam

obtain long-range radio transmission. Finally, it should be emphasized that the effects that could be caused by a fleet of SPS satellites in orbit can be significantly different and more extensive than the effects caused by a single SPS satellite.

Tables 3.2 and 3.3 detail a number of potential power beam effects on existing and proposed communications and navigation systems.[3] The effects detailed in these tables are due strictly to heating of the ionosphere by the SPS power beam and are representative, but not all inclusive, of the problems that could occur due to this phenomenon. Basically, all HF communication systems operating in the 3-30 MHz range make use of the ionosphere as a reflector to propagate the signal over substantial distances. Alteration of the ionosphere could result in propagation outages with subsequent loss of communication links. Many users, both civilian and military, could be affected. In addition, a number of satellite communication systems could be impacted due to scintillations. The results would be fading of the communication signal. Both LF (low frequency) and VLF (very low frequency) navigation systems rely on the ionosphere for signal propagation; for example, the Omega navigation system which is presently being implemented on a worldwide scale. This system will serve both military and civilian users, primarily ships and submarines at sea and aircraft flying out of the range of VHF navigation systems. To date, the Omega system has been widely praised for its accuracy. It is possible however that sudden phase anomalies (SPAs) could increase the Omega location error by a factor of five. Similar degradations in performance may also occur for LORAN C which is presently being

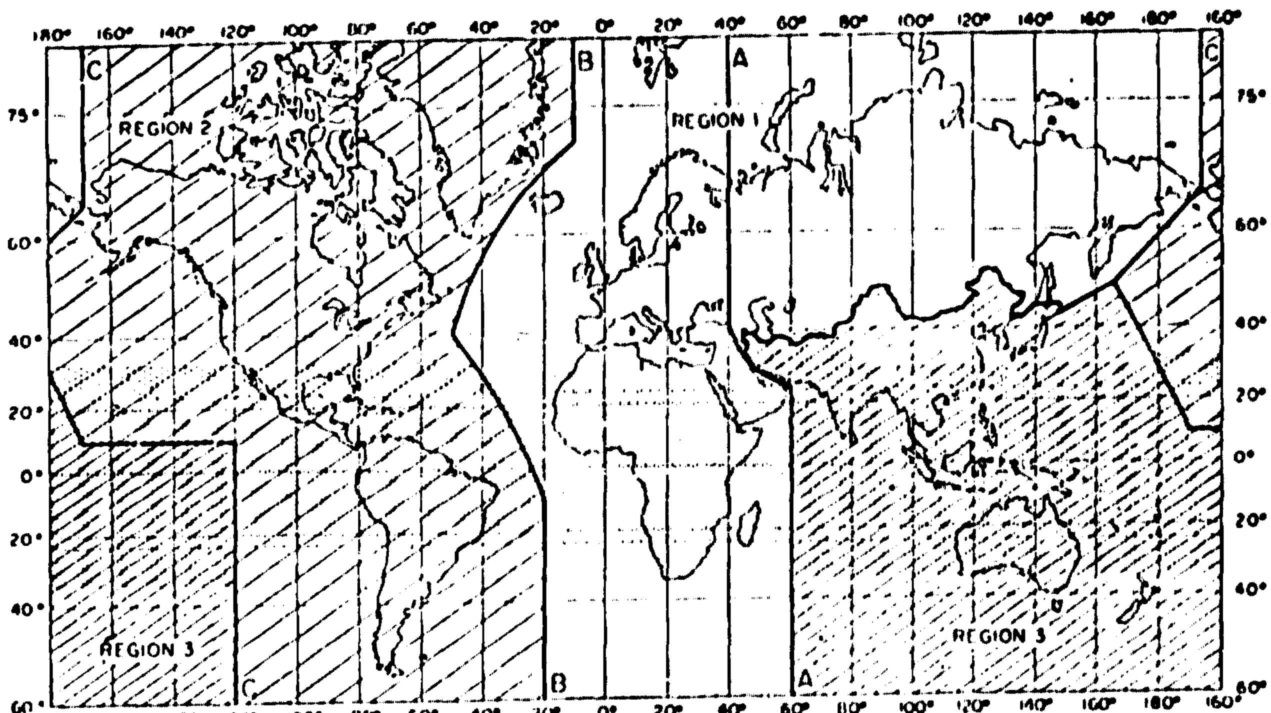
Table 3.2 Possible Effect of SPS on Communication Systems		
System	System Characteristics	Power Beam Effects
HF	• 3-30 MHz • Uses ionosphere as reflector to propagate	• Propagation outages • Loss of comm. links • Many users affected - Ham - Military - Civilian
AFSATCOM	• ~260 MHz ~340 MHz • Satellite-to-aircraft communication system	• Fading due to scintillations • Aspect scatter could cause multipath degradation
INTELSAT/ MARISAT/ DOMSAT	1200 MHz 1600 MHz 6000 MHz 4000 MHz	• Fading, if severe could be significant.

implemented in the United States as a supplement to the VOR system. Again, due to scintillations, performance of the Navstar Global Positioning Satellite could also be impacted by the SPS power beam.

Table 3.3 Possible Effect of SPS on Navigation Systems		
System	System Characteristics	Power Beam Effects
OMEGA	• 10.2 to 13.8 KHz, CW • 8 stations, TDMA • Single frequency hyperbolic system (phase comparisons)	• Low altitude effect could cause sudden phase anomaly (SPA) • SPAs could increase location error by a factor of 5 (1 to 5 miles)
LORAN C	• 100 KHz, pulse • Ground wave (2000 km) and sky wave (8000 km) • Hyperbolic system	• For sky wave users, power beam could degrade performance although sky wave users far removed from disturbed regions
NAVSTAR GPS (Global Positioning Satellite) First Satellite in May 1977	• Three-D location using 4 satellites • 1200 and 1600 MHz (two frequencies eliminate range error of ionosphere) • Use of ionospheric model for a single-frequency user • Designed for low gain omni-receive antenna	• Electron density changes will not affect two-frequency users • Electron density changes increase error budget for single-frequency users • Irregularities could cause scintillations which could prevent sync. acq. by unsophisticated user

As a result of the broad range of possible effects cited above, it is not possible to consider all of them at this point in time. Furthermore, it is likely that many of these effects will not actually materialize and, thus, need not be dealt with--more work is necessary before it will be possible to know which of the effects must be dealt with. Thus, the remainder of this section deals with the frequency allocation problem in general, focusing on the center frequency and harmonics of the planned 2450 MHz power beam frequency.

Frequency allocations are assigned by region as indicated in Figure 3.2. The United States with North and South America, Greenland and Hawaii



THE SHADED PART REPRESENTS THE TROPICAL ZONE

Figure 3.2 Frequency Allocation Regions

is located in Region 2.[4] Frequency allocations are made with the concensus of states within the allocation region. The frequency allocation procedure is reviewed in Table 3.4. First, recommendations are made to the Federal Communication Commission by the Joint Industry Government Committee, by public common carriers, and by others. These recommendations are then forwarded to the Department of State along with recommendations from the Office of Telecommunications Policy and the U.S. study groups of the International Radio Consultative Committee. Frequency allocations are then negotiated by the Department of State in the form of a treaty at a meeting of the International Telecommunication Union (ITU). These meetings of the ITU are referred to as World Administrative Radio Conferences (WARC).

The present frequency allocations for Region 2 are shown in Figure 3.3.[5] It is interesting to note that essentially the entire frequency spectrum to

Table 3.4 The Frequency Allocation Procedure

- Recommendations made to Federal Communications Commission (FCC) by
  - JIGC (Joint Industry-Government Committee)--Established by the Federal Advisory Committee Act (5 U.S.C. §§1-15)--composed of six working groups

    WG-A: Definitions and Terminology
    WG-B: Sharing Principles
    WG-C: Sharing Criteria
    WG-D: Evolution and Requirements
    WG-E: Nontechnical Implications
    WG-F: Procedures

  - Public-Common Carriers and others.

- Recommendations made to the Department of State by
  - FCC
  - OTP (Office of Telecommunications Policy)
  - CC.R (U.S. Study Groups of International Radio Consultative Committee)

- Frequency allocations are made in the form of a treaty, negotiated by the Department of State, at a meeting of the International Telecommunication Union (ITU). Such a meeting of the ITU is referred to as a World Administrative Radio Conference (WARC).

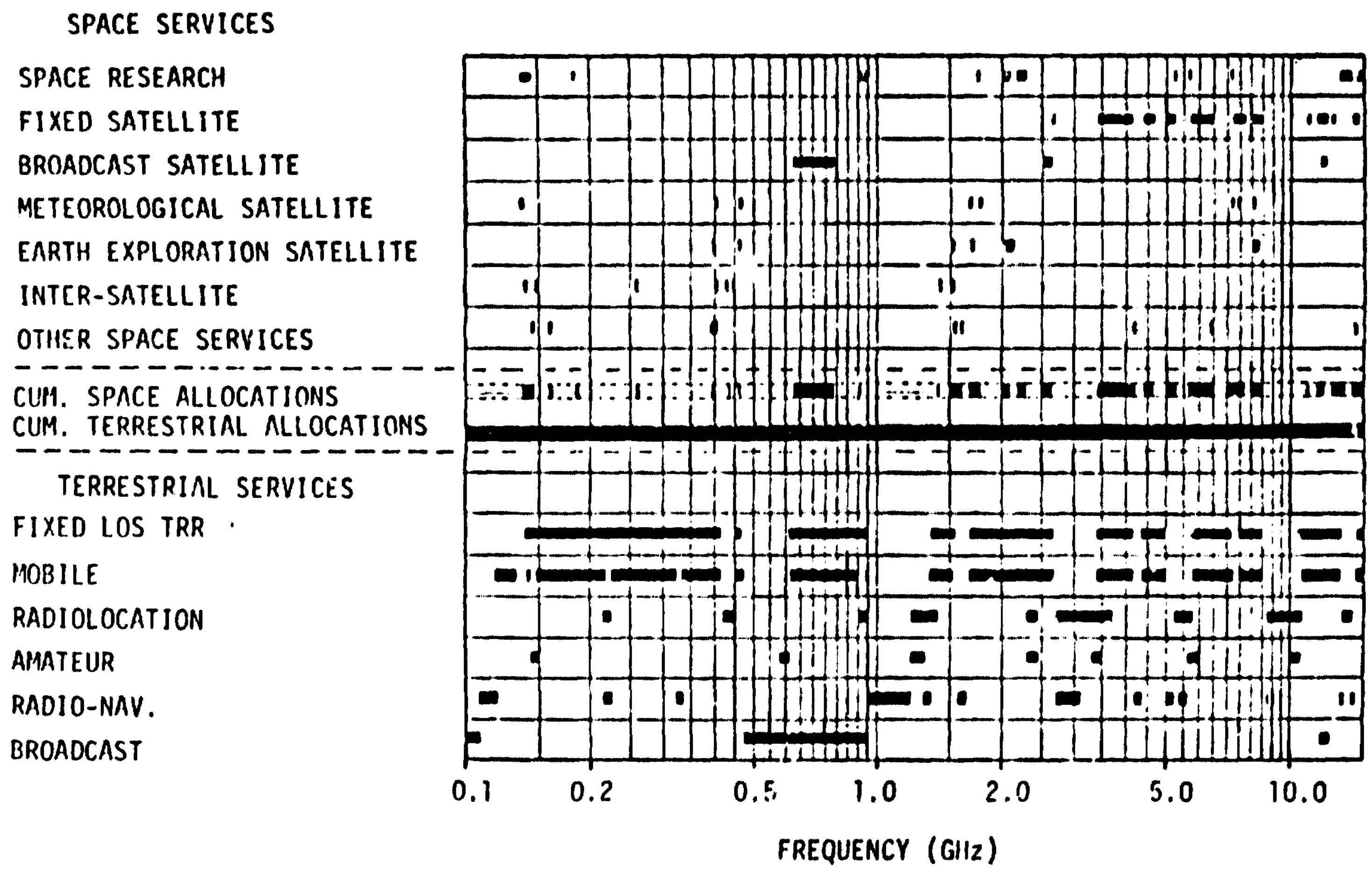


Figure 3.3 Present Frequency Allocations in Region 2

well above 10 GHz is presently allocated for various terrestrial purposes and that a number of slots are presently allocated for various space purposes. Figure 3.4 details the frequency allocation around the SPS center frequency.[6] As noted above, the center frequency, 2450 MHz, is designated for industrial, scientific and medical purposes in Regions 2 and 3 with a band of 50 MHz to either side of the center frequency being protected. These frequencies are also allocated to, and used extensively by, the fixed service which includes the terrestrial microwave network. This network is already very extensive and is placing constraints on present communication satellites with the result that ground station antennae are required to be located well outside the center city areas. The total investment in the microwave network could not be determined within the scope of this study; however, it is expected to be at least as large as the total investment in satellite communication equipment and it is quite possible that SPS could impact much of this system.

The present frequency allocation around the second harmonic of the SPS center frequency is shown in Figure 3.5.[7] Again this frequency is allocated to the fixed service. The spectrum slightly above the second harmonic is allocated to radio astronomy purposes. This could be significant if radio astronomers believe that the second harmonic of the SPS center frequency will interfere with their work.

3.2 WARC 1977 and 1979

In any discussion of frequency allocation for SPS, it is important to recognize two important meetings of the WARC. The first of these, WARC 1977, convened on January 10, 1977. The agenda for this meeting was:

1. To establish sharing criteria for the bands 11.7 to 12.2 (Regions 2 and 3) and 11.7 to 12.5 GHz (Region 1) between broadcast satellite service and other service including the fixed service, broadcasting service, mobile service and the fixed satellite (space-to-earth) in Region 2;

ALLOCATION TO SERVICES		
REGION 1	REGION 2	REGION 3
2300-2450 FIXED AMATEUR MOBILE RADIOLOCATION	2300-2450 RADIOLOCATION AMATEUR FIXED MOBILE (SEE NOTE)	
2450-2500 FIXED MOBILE RADIOLOCATION	2450-2500 FIXED MOBILE RADIOLOCATION	
2500-2550 FIXED MOBILE EXCEPT AERONAUTICAL MOBILE BROADCASTING-SATELLITE	2500-2535 FIXED FIXED-SATELLITE (SPACE-TO-EARTH) BROADCASTING-SATELLITE	
	2535-2550 FIXED MOBILE EXCEPT AERONAUTICAL MOBILE BROADCASTING-SATELLITE	

SPS CENTER FREQUENCY 2450 MHz

NOTE: 2450 MHz IS DESIGNATED FOR INDUSTRIAL, SCIENTIFIC AND MEDICAL PURPOSES EXCEPT IN ALBANIA, BULGARIA, HUNGARY, POLAND, ROUMANIA, CZECHOSLOVAKIA AND USSR WHERE 2375 MHz IS USED. EMISSIONS CONFINED TO ± 50 MHz OF CENTER FREQUENCY.

Figure 3.4 Present Frequency Allocation--2300 to 2550 MHz

ALLOCATION TO SERVICES		
REGION 1	REGION 2	REGION 3
4700-4990 FIXED MOBILE		
4990-5000 FIXED MOBILE RADIO ASTRONOMY	4990-5000 RADIO ASTRONOMY	4990-5000 FIXED MOBILE RADIO ASTRONOMY
5000-5250 AERONAUTICAL RADIONAVIGATION		

← SPS SECOND HARMONIC 4900 MHz

Figure 3.5 Present Frequency Allocation--4700 to 5250 MHz

2. To plan for broadcasting satellite service

3. To establish procedures to govern use of these bands by the broadcasting satellite service and other services.

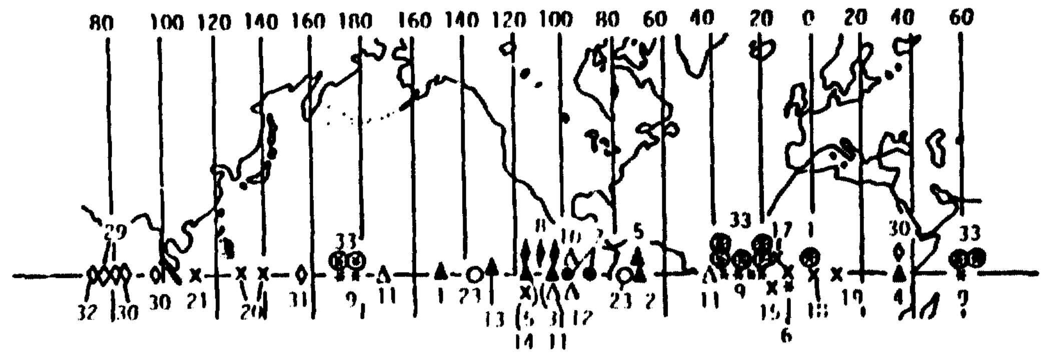
During this meeting, principles to govern the management of the geostationary orbit were discussed. These are discussed in more detail in Section 4.1.2.

A second important meeting of the WARC convenes on September 24, 1979 and will remain in session for about 10 weeks. Two important debates are scheduled for this meeting: (1) regarding allocation of the geostationary orbit and (2) allocation of the center frequency 2450 MHz and all of its harmonics for industrial, scientific and medical purposes. Both of these debates are key to the future of SPS. This meeting is also discussed further in Section 4.1.2.

3.3 Survey of Existing and Projected Satellites and Equipments

The geostationary orbital arc occupancy present and planned is summarized in Figure 3.6.[9] It has been estimated by COMSAT that by the end of the century some 50 satellites will be on orbit in the geostationary orbital arc. The services which they will provide will be both extensive and vital to the countries which they serve. In addition to communications, there will be weather service satellites, earth observation satellites, tracking and data relay satellites, storm and disaster warning satellites and navigation satellites to name a few. Clearly, the industrialization of space has begun with the exploitation of this important orbit.

The Intelsat system alone, as of December 31, 1975, is shown in Figure 3.7. It consists of satellites over the Atlantic, Pacific and Indian Oceans and, as of the end of 1975, tied together 71 countries, territories and possessions with 123 Earth stations in 97 locations.[10] Investment in



EXISTING

EXPERIMENTAL	OPERATIONAL
▲ NASA	● U.S.
1 ATS-1	7 WESTAR (2)
2 ATS-3	
3 ATS-5	⧫ OTHER
4 ATS-6	
5 SMS (2)	8 ANIKS (3)
	*9 INTELSATS (7)
* OTHER	
6 SYMPHONIE (2)	

PLANNED

EXPERIMENTAL		OPERATIONAL	
Λ NASA	x OTHER	o U.S.	◊ OTHER
10 SEOS (2)	14 CTS (NASA/CANADA)	23 GOES (3) (WMSC)	28 BRAZIL (2)*
11 TDRS (3)	15 SIRIO		29 INDONESIA (2)
12 STORMSAT	16 AEROSAT (2)*	24 COMSTAR (4)*	30 STATSIONAR (11)
13 ATS-6 9/76	17 MAROTS	25 RCA*	31 JAPAN GMS (WMSC)
	18 METEOSAT-WMSC	26 WESTAR (2)*	32 USSR (WMSC)
	19 OTS	27 CML*	⊕ 33 INTELSATS (>10) INMARSAT*
	20 JAPAN CS (2)		
	21 JAPAN BSE		
	22 MARISAT (3)*		

NOTES: ( ) INDICATES NUMBER OF SATELLITES
* POSITIONS TO BE DETERMINED
WMSC WORLDWIDE METEOROLOGICAL SATELLITE COVERAGE

DOD, NATO, FOREIGN MILITARY SATELLITES AND NASA SCIENCE AND MSF MISSIONS ARE NOT SHOWN.

Figure 3.6 Geostationary Orbital Arc Occupancy

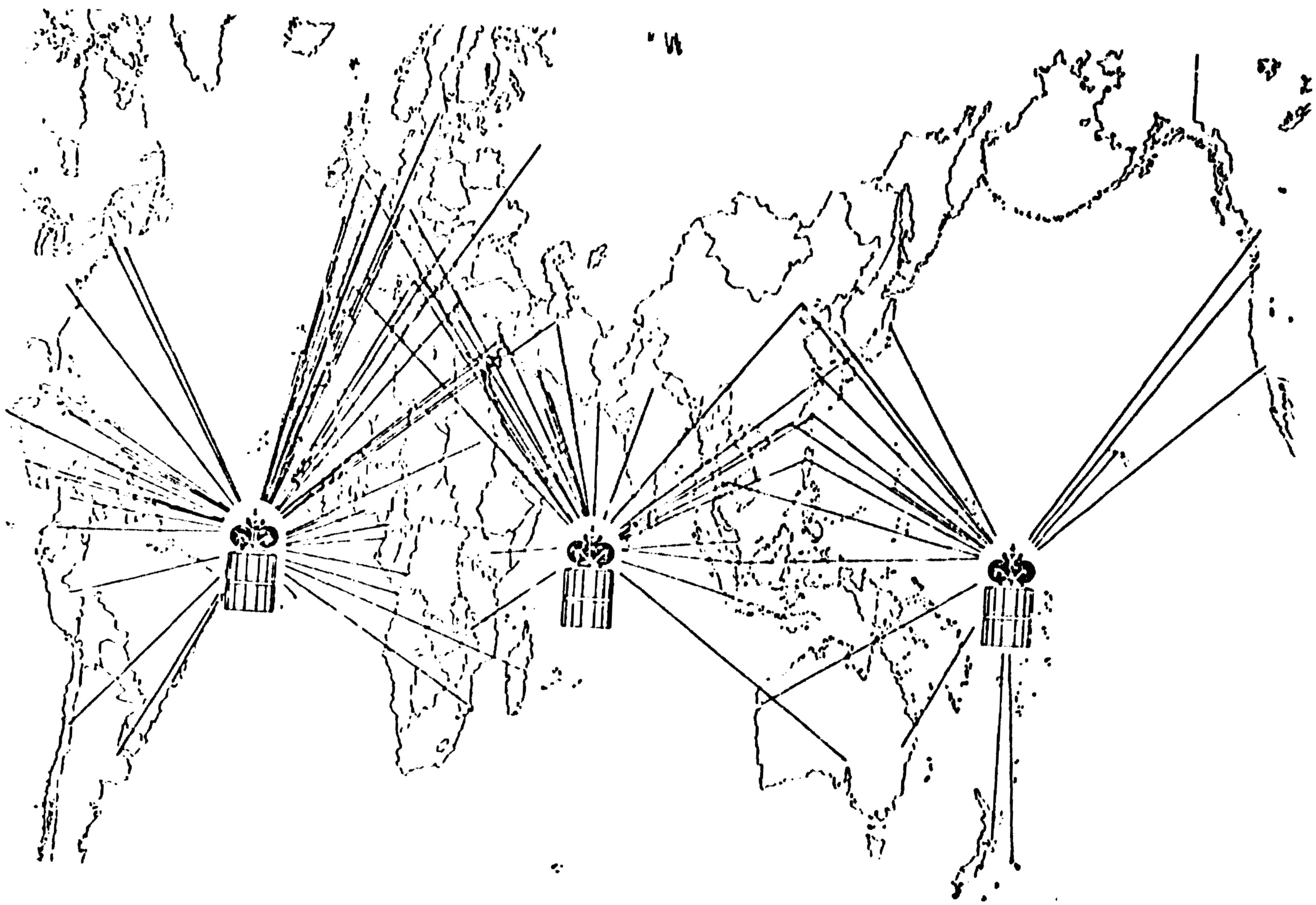


Figure 3.7 The Intelsat System

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the Intelsat system is shown in Figure 3.8 as a function time. It is expected that the present Intelsat IV-A satellite system will be saturated by 1979.[11] To obtain more channel capacity, Intelsat has embarked on a program for developing and constructing its next generation of communication satellites, the Intelsat V. These satellites will have a capacity of about 12,500 two-way circuits each and will incorporate not only the dual beam concept of Intelsat IV-A but will also include repeaters in the new frequency bands at 11 and 14 GHz, in addition to those in the present 4 and 6 GHz bands. It will also incorporate the techniques of dual polarization. Seven Intelsat V satellites are scheduled to be manufactured by Ford Aerospace and Communications Corp., four to be launched on the Atlas Centaur and three on the Space Shuttle. The total cost of the Intelsat V program is estimated to be approximately $450 million. The Intelsat ground station costs should not be neglected as a part of the total system costs. In 1976 the cost of a ground station ranged from about $3.5 to $7.5 million.

Other communication satellite systems scheduled for implementation in Region 2 are shown in Table 3.5. These include the Anik system which is the Canadian Domestic System, the Westar System of Western Union, the RCA Satcom, the COMSAT General/ATT System and the ATS Satellites. No doubt, these systems will be augmented by a number of other systems in the future.

3.4 Conclusions

It is clear from the above analysis that SPS will have to compete both for its required frequency spectrum and for orbital arc space. Assurance will have to be obtained that SPS will not produce intolerable amounts of radio frequency interference nor unduly disrupt other services such as communications, navigation, radiolocation and others. The requirements for

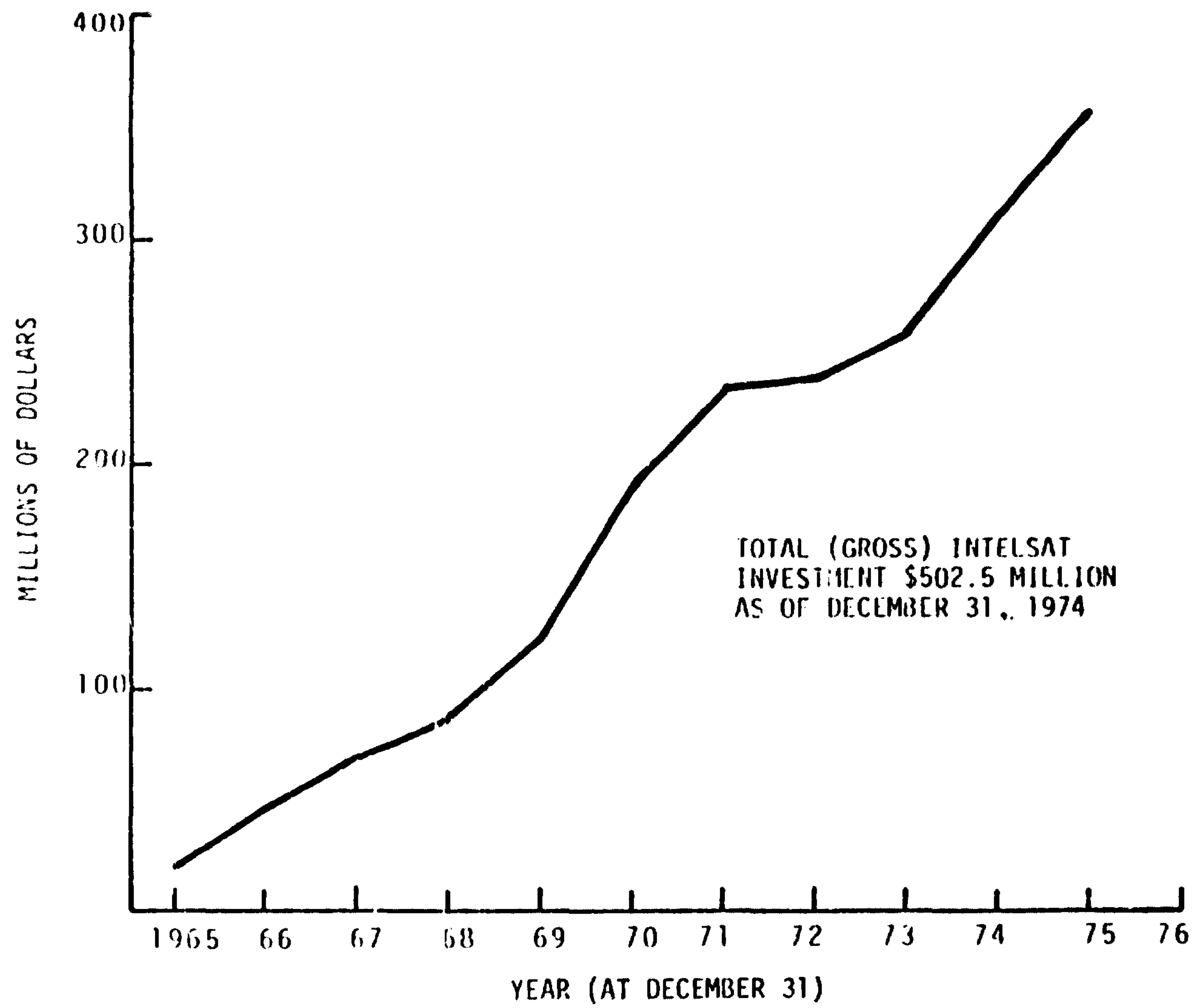

Figure 3.8 Net Intelsat Investment in Global Satellite System
(Net Capital Contributions by Signatories)

Table 3.5 Other Communications Satellite Systems (In Region 2)

System	Remarks
• ANIK	Canadian domestic system, 3 satellites in orbit. Net value $91.9 million as of December 31, 1975.
• WESTAR	Western Union system, 2 satellites in orbit. Initial system, including seven ground stations, estimated at $68.8 million less incentives.
• RCA SATCOM	RCA domestic system serving 48 states plus Alaska and Hawaii, 2 satellites in orbit. Approximate investment in systems is $180 million.
• COMSAT GENERAL/ATT	Serves ATT. ATT has 4 earth stations and shares capacity with GTE. GTE owns 3 earth stations, 2 satellites in orbit. Now entering commercial service. Total investment about $105 million.
• ATS	NASA Application Technology Satellite. ATS-1 used for communications in Alaska. ATS-6 used for direct broadcast at 2.25 GHz band for community reception (education, health).

SPS to co-exist with other users in an rf environment that has been established over the past 70 or so years are likely to place engineering demands upon the system. It appears, for example, that it will be necessary to maintain the center frequency with very high precision and to minimize the radiated power both in the center frequency harmonics and in the frequencies to either side of the SPS center frequency. This could possibly mean control of the SPS frequency to an accuracy of as much as one part in a million. There might also be a need for a number of compromises between SPS and other orbital arc users. One such type of compromise might be found in the use of SPS platforms by other users. In fact, the viability of the SPS concept may well rest in the ability to find equitable alternatives for the communications and other orbital arc users.

As indicated in this section and reiterated in Section 4, the meetings of the ITU are key in obtaining the frequency allocation necessary for SPS. As such it will be necessary to begin planning now the U.S. position for the 1979 WARC. By that time, the U.S. should have established a position relative to SPS and should negotiate for frequency allocations accordingly.

Finally, it should be observed that investment in various satellite systems that will make use of the geosynchronous orbit are already extensive and growing rapidly at an increasing rate. It will be necessary to regulate the growth of these systems in such a way that implementation of the SPS is not precluded due to the space activities to take place over the next 20 years.

Section 3: Footnotes

1. Final Acts of the World Administrative Radio Conference for Space Telecommunications, The International Telecommunication Union, Geneva, 1971, pp. 88,92.

2. Radio Regulations, Additional Radio Regulations Resolutions and Recommendations, General Secretariat of the International Telecommunications Union, Geneva, 1968, p. 80.

3. Space-Based Solar Power Conversion and Delivery Systems Study, Final Report, Volume III, Microwave Power Transmission Studies, Prepared by Raytheon Co., Wayland, Mass. for ECON, Inc., March 1, 1977, pp. 2-60, 2-61.

4. Radio Regulations, op. cit., p. AP24-1.

5. Freibaum, Jerome, Effects of Propagation Phenomena and Frequency Allocation on the Growth of Satellite Communications, Proceedings of the 1976 International Conference on Communications, Philadelphia, June 14-16, 1976, pp. 12-23.

6. Final Acts of the World Administrative Radio Conference for Space Telecommunications, The International Telecommunication Union, Geneva, 1971, pp. 88. Radio Regulations, Additional Radio Regulations Resolutions and Recommendations, General Secretariat of the International Telecommunications Union, Geneva, 1968, p. 80.

7. Final Acts of the World Administrative Radio Conference for Space Telecommunications, The International Telecommunication Union, Geneva, 1971, p. 92.

8. Federal Communications Commission, Docket 20468, Released August 6, 1976.

9. Freibaum, Jerome, op. cit., pp. 12-24.

10. COMSAT, Report to the President and the Congress, Communications Satellite Corporation, 1976.

11. Charyk, Joseph V., Communications Satellites, AIAA Paper No. 77-323, presented at AIAA 13th Annual Meeting and Technical Display, Washington, D.C., January 10-13, 1977. Also, to be published in the Journal of Spacecraft and Rockets.

4. SPACE RIGHTS

Some of the potential barriers to SPS development lie in areas of international law, the law of outer space, and international policy formulation. This section examines four main issues:

1. Legal aspects of use of the geostationary orbit by satellite power systems
2. Impact of the 1967 Outer Space Treaty on the use of outer space for orbital power generation
3. Legal status of establishment and operation of satellite power systems by private sector entities
4. Permissibility under existing international space law of establishing weapons systems in orbit to protect solar power satellites from attack.

The basic conclusion of this section is that the existing principles of space law present no fundamental impediments to the development and implementation of a satellite power system; however, clarification of many ambiguities could create a more favorable environment for SPS. It is also true that these principles favor the SPS more if it is developed, constructed and operated within the context of an international organization rather than by one nation alone. No obstacle to the use of geosynchronous orbit by SPS was found, but the limited space available in this orbit and possible crowding for other uses could pose a problem. In the assignment of orbital positions for SPS, consideration must be given to the rights and demands of nations not presently active in space, particularly as these rights are protected by the 1967 Outer Space Treaty. It was concluded that construction and operation of SPS by private sector entities is legal under existing space law. However, in so doing, these entities are acting as an arm of the government of the people they serve and that government assumes all responsibility and liability with respect to the system. Finally, existing space law appears to permit on-orbit military protection of SPS satellites so long as the military systems used do not include nuclear weapons or weapons of mass destruction. Beyond this analysis of existing space law, a number of identifiable trends can be observed. It should be cautioned that the legal environment for SPS could change significantly over the next 20 years.

4.1 Legal Aspects of Use of the Geostationary Orbit by Satellite Power Systems

Nearly all conceptual designs for satellite power systems are based on use of the geostationary orbit.[1] The reasons for selection of that approach are threefold. First, the use of geostationary satellites would minimize the cost and complexity of ground receiving stations by eliminating the need for a steering mechanism to track satellites moving along nongeostationary orbital paths. In light of the projected large size of the receiving antennas, systems based on the use of polar orbiting satellites may be infeasible.[2] Second, the continuous use of a limited set of ground stations would minimize both the total system cost and the danger that the microwave or laser beam conveying to Earth the power products generated in orbit would spill over into areas surrounding the reception sites, potentially causing physical harm.[3] Third, a geostationary satellite would be capable of supplying an essentially continuous supply of energy. Solar arrays operating either on the Earth's surface or in polar orbit would be cut off from the sun during a significant portion of each time segment. In contrast, a satellite in geostationary orbit would be continuously irradiated by the sun, except for a short period near each vernal and autumnal equinox.[4] Consequently, both experimental and operational satellite power systems are likely to utilize the geostationary orbit.

Both the present state of the international law of outer space and the character of the geostationary orbit as a limited natural resource subject to a wide range of potentially conflicting uses raise issues relating to the utilization of the orbit. Relevant international law is embodied primarily in the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies.[5] To date, international discussions relating to the management of the geostationary orbit have occurred primarily under the auspices of the International Telecommunication Union (ITU).

4.1.1 The Outer Space Treaty and Utilization of the Geostationary Orbit by Satellite Power Systems

1. Article I

The 1967 Outer Space Treaty contains three main provisions which will affect utilization of the geostationary orbit by satellite power systems. First, Article I, which establishes the most basic principles governing activities in outer space, provides:

> The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.
>
> Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.
>
> There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.

a. Article I(1): The "Common Interests" Clause. Paragraph 1 raises two main issues: first, whether this provision constitutes a binding contractual obligation or is merely a declaratory of general objectives, and second, the meaning of the phrase "for the benefit and in the interests of all countries." Related to the former is the question of whether the provision is self-executing. Some authorities argue that although the so-called "common interests" clause of Paragraph 1 embodies one of the broadest and most fundamental principles upon which the outer space regime is founded, its breadth precludes direct application. Consequently, other, more limited, expressions of international consensus are required to give this provision enforceable form. Hence, pending agreement on specific operative principles elaborating the fundamental policy of Article I(1), the use of outer space--and therefore of the geostationary orbit--is permitted under Article I(2), provided it is peaceful in nature.[6]

A contrary conclusion is reached by a number of other authorities who take the position that the language of Article I(1) is as binding as any other provision of the treaty. Two main reasons are advanced to support this proposition. First, during consideration of the text of the provision in the fifth session of the Legal Sub-Committee of the Committee on the Peaceful Uses of Outer Space (CPUOS), a proposal to delete the phrase "for the benefit and in the interests of all countries" from Article I and place it in the preamble was rejected.[7] Similarly, the draft of Article I(1) was modified when the words "irrespective of their degree of economic or scientific development" were moved on the basis of a consensus from initial position in the preamble to their present position following the "common interests" clause, because the developing countries advocated inclusion of the latter phrase as part of the binding treaty commitment.[8] Thus, it may be inferred that the drafters intended Article I(1) to be binding. Second, even if the provision is considered non-self-executing and the effectiveness of the limitation is thereby somewhat diminished, its binding character is not impaired and the legislative or executive acts necessary to implement the binding provision are nonetheless mandatory for all parties to the treaty.[9]

The content of the phrase "for the benefit and in the interests of all countries" in Article I(1) is also open to dispute. Some authorities take the position that the treaty's admonition to use outer space for the benefit of all members of the international community constitutes no more than a duty upon each member not to misuse outer space in a way which could diminish the value of space activities to other members.[10] Under that construction, unilateral use of an orbital slot would not violate Article I(1), since space shuttle technology and the potential ability to remove inoperative satellites from orbit emphasizes the character of the geostationary orbit as a renewable resource which is nondepletable in any permanent sense.

Others have taken the closely related position that the phrase means that the use of space objects should not be detrimental to the interests of other countries, including national security, public order and sovereignty over natural resources which are protected under international law.[11] However, in contrast to other potential uses of the geostationary orbit, the use of space for solar power generation does not affect any of those essentially terrestrial interests.[12] The third possible interpretation would impose on space powers the obligation either to permit other countries to use the former's space vehicles or to share the financial benefits of its space activities. Arguments supporting this position have been raised in the discussions of the CPUOS Legal Sub-Committee relating to the direct broadcast and earth resources satellites.[13] To date, that approach has received little direct international support.[14] Nonetheless, a similar approach relating to the exploitation of resources in another area located beyond the limits of national jurisdiction, the deep seabed, has received substantial support during the present series of United Nations Conferences on the Law of the Sea.[15] Although a scheme for licensing exploitation of the orbit and distributing the proceeds equitably among the members of the international community has been proposed, current developments in space law and the law of the sea suggest that final agreement on such an arrangement is not likely to occur in the near future.

An analysis of trends in the interpretation of Article I(1) as it applies to the utilization of the geostationary orbit indicates a number of conclusions. First, as an operative element of a treaty, Article I(1) is binding upon all states which are parties to the treaty. Second, the content of the "common interests" clause is unclear and therefore requires further elaboration. As a result, the clause may be considered non-self-executing for purposes of developing a satellite power system. Third, although the clause's content is unclear, at a minimum it imposes a duty upon states not to use outer space in such a way that either the earth-bound interests of other states, including national security, are jeopardized or the potential interests of the latter in the exploration or use of outer space are diminished by depletion or complete use of space resources, including the geostationary orbit. Finally, although the upper limit of the "common interests" requirement is unclear under existing space law, Article I(1) does not require space powers to share either their space vehicles or the profits derived from space activities with nonspace powers. From these conclusions, it appears to us that Article I(1) and its requirement that outer space be used "for the benefit and in the interests of all countries" would not inhibit plans to use a segment of the geostationary orbit for the purpose of satellite power generation.

b. Article I(2): The "Free Use" Clause. The second paragraph of Article I, which embodies the principle of the free exploration and use of outer space, also bears upon the utilization of the geostationary orbit. Because of its policy of promoting space activity, Article I(2) has played an important role in the protection of space initiatives against unnecessary restrictions. In particular, the "free use" principle has provided the conceptual basis for resisting arguments that activity in outer space is unlawful in the absence of clear and convincing evidence that it is being conducted "for the benefit and in the interest of all countries."[16]

Although the "free use" is one of the key principles of the Outer Space Treaty, and is sufficiently broad to sustain the right of states to conduct activities in outer space free from claims of sovereignty of subjacent states, it is not unlimited. In addition to the prohibitions of Article II relating to nonappropriation and Article IV dealing with the stationing of nuclear weapons in outer space, the "free use" principle is subject to the limitations imposed by Article IX on activities likely to contaminate either outer space or Earth.[17]

Similarly, Article I(2) must be read in the context of the "common interests" clause of Article I(1) with the result that the advantages to be derived from rapid development of the geostationary orbit must be balanced against the requirement that the development be carried out in a manner beneficial to all members of the international community. In that combinaion, the "free use" clause creates a tendency to limit the potential inhibiting effect of a restrictive construction of Article I(1). As applied to the use of the geostationary orbit, Article I(2) tends to shift construction of Article I(1) toward the minimal duty to avoid conducting space activities in a manner detrimental to the interests of nonparticipating states as described above.

2. Article II

The provision of the Outer Space Treaty which affects utilization of the geostationary orbit most directly is Article II, which provides:

> Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

The language of Article II raises three main issues with respect to the use of the orbit:

1. The subject matter to which the prohibition applies
2. The meaning of the term "appropriation"
3. The validity of "appropriation" by entities other than national governments.[18]

In theory, a satellite power system could "appropriate" both the sun's energy and a segment of the geostationary orbit. With respect to solar energy, the prohibition should not apply. One of the primary purposes of Article II is to implement the "free use" policy of Article I(2).[19] Article II must therefore be construed to promote rather than inhibit the exploration and use of outer space. Nearly all satellites presently in service or planned for the near future will depend on conversion of the sun's energy to electrical power for use in the operation of their respective payloads. Large-scale use of alternative energy sources by satellites may be impractical. As a result, application of the Article II prohibition to the use of the sun's energy would sharply limit the scale, duration, and, hence, the economic viability of space development projects. Further, in the absence of special circumstances, enforcement of Article II against the "appropriation" of essentially inexhaustible space resourc s would serve little purpose,[20] and should be avoided in favor of the "free use" principle. Since the same policy considerations apply to conversion of solar energy for use on Earth as well as for use by satellites in orbit, Article II probably does not limit the use of solar energy by satellite power systems.

In contrast, use of a particular segment of the geostationary orbit is undoubtedly subject to the terms of Article II, especially in light of its function of providing support to the "free use" principle. A satellite power system would occupy a particular slot in the geostationary orbit. Because of the projected dimensions of a solar power satellite[21] and other considerations, the size of the orbital slot required for safe operation may be greater than that required for existing communications or meteorological satellites. In addition, other factors suggest the need for safety zones similar in concept to those established for installations engaged in exploitation of the resources of submarine areas.[22] Although the Article II prohibition clearly applies to the appropriation of a particular orbital slot, the determination of the validity of placing a solar power satellite in geostationary orbit is dependent on the meaning of the term "appropriation" as used in Article II.

Professor Gorove's analysis of the concept of "appropriation" suggests the existence of two subsidiary elements:

1. Exclusive use
2. Relatively permanent use, including consumption.[23]

It has been argued that since use of a particular orbital slot by a geostationary satellite is temporary, the requirement of permanence is absent and the use of the orbital slot cannot be considered an "appropriation" within the meaning of Article II.[24] Other authorities conclude that national use of particular segments of the orbital arc deprives other states of the opportunity to use the same area and therefore constitutes appropriation through occupation.[25] The key issue is the permanence of the use. Evaluation of the economic viability of a satellite power system is based on the assumption that the system would operate for up to thirty years.[26] Although that period is lengthy, it does not indicate the permanence necessary to invoke the prohibitions of Article II. However, longer periods could exceed the nit and come within the purview of Article II.

The third issue relates to the identity of the system operator. Article II prohibits only national appropriation, suggesting that even permanent use of an orbital slot by international organizations or commercial entities would not constitute a violation of that provision.[27] Consequently, a commercial consortium would not be prohibited under Article II from maintaining a solar power satellite in a particular orbital slot for an indefinite period. Similarly, subject to establishment of a clear distinction from other types of organizations, an "international" organization would not be prohibited either from operating a similar system or allocating orbital slots among its members. For that reason, the activities of the International Telecommunication Union described in Section 4.1.2 relating to the management of the geostationary orbit do not violate Article II.

Two potential limitations on these conclusions should be noted. First, if an entity were established which, although commercial in form, was essentially under the control of the government of the country in which it is organized, permanent use would constitute national, as distinguished from nonnational, appropriation.[28] Second, dispute has arisen regarding the minimum standard for an international organization which would be implicitly exempted from the rule of nonappropriation. Professor Jenks has argued that only the United Nations as a representative of the whole international community should be exempt.[29] Presumably any intergovernmental organization of relatively universal membership satisfies the minimum standard. However, some question remains regarding the exemption of an organization composed of a limited number of governments.[30]

Thus, the Article II prohibition against the appropriation of outer space applies to exclusive use of a segment of the geostationary orbit. However, the prohibition does not apply to the activities of either nongovernmental entities or relatively comprehensive international organizations. The implications of the nonappropriation provision for satellite power systems are further limited by the conclusion that since the use contemplated is not permanent, exclusive use for a limited period of time would not constitute "appropriation" as that term is used in Article II. Hence, we believe that regardless of the operating entity's institutional structure, it can expect to conduct power generation activities in goestationary orbit without concern that its action violates Article II.

3. Article IX

Article IX, the third provision of the Outer Space Treaty which is likely to affect the utilization of the geostationary orbit, provides in part:

In the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty....If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon other celestial bodies, may request consultation concerning the [illegible] or experiment.

Like Article II, Article IX operates as a limit on the "free use" p[illegible] of Article I(2). Under the terms of Article IX, national space activities may not be carried out without taking into account the interests of other states.[31] That limitation is particularly relevant to the use of the geostationary orbit, where the problem of conflicting uses is complicated, first, by potential interference among satellites which are located in proximity to one another, and second, by disputes between countries which intend to use a particular orbital slot in the present or near future and countries which plan to use the same slot in the more distant future and which are therefore concerned about preserving their future interests. In an effort to promote resolution of these potential conflicts, Article IX provides the basis for consultation among the concerned parties.[32] The general policies of Article IX are applied to the utilization of the geostationary orbit by the International Telecommunication Convention and the Radio Regulations periodically revised by ITU conferences.

4.1.2 Activities of the International Telecommunications Union Affecting the Utilization of the Geostationary Orbit

International debate regarding the practical application of Articles I, II and IX of the Outer Space Treaty to the task of managing the geostationary orbit have occurred primarily at the World Administrative Radio Conferences convened by the International Telecommunication Union (ITU) for the purpose of regulating global telecommunications activity and accommodating conflicting uses of the electromagnetic spectrum. During the past fifteen years, the ITU has also developed an interest in the management of the geostationary orbit.

That interest is based both on the special characteristics of the orbit which make it particularly valuable for communications satellite applications and on the character of the geostationary orbit as a limited natural resource. Some experts argue that if mutual interference is to be avoided, the number of satellites in geostationary orbit must be limited to 180.[33] Others contend that the spacing of satellites could be diminished, leaving only the necessary safety margin to ensure avoidance of collision, with the result that the capacity of the orbit could be increased to nearly 1800 satellites.[34] However, in order to ensure avoidance of mutual interference under the present state of communications satellite technology, the spacing must be increased beyond the minimum necessary to prevent collision, satellite-satellite occultations, radio interference, etc. Thus, although the maximum capacity is dependent on a number of technical variables, including frequency staggering, signal polarization, signal format, location of earth stations and transmission power, and, hence, cannot be precisely calculated, the geostationary orbit must be considered a limited resource.[35]

The 1959 ITU Radio Regulations which govern the use of the electromagnetic spectrum have been periodically revised to respond to developments in satellite communications. In 1963, the ITU convened the Extraordinary Administrative Radio Conference in Geneva to allocate frequencies for use by satellites. Although the Radio Regulations were partially revised,[36] the conference did not alter the historical practice of permitting individual states to assign transmission frequencies unilaterally.[37] Thus, the traditional "first come, first served" approach was extended into the realm of satellite communication, where it applies both to the allocation of frequencies and to occupation of orbital "parking slots" by communications satellites.[38] Since that approach gives an obvious advantage to those technologically advanced states which are presently capable of establishing geostationary satellite systems, less developed states began to exert pressure to preserve future interests in use of the orbit against saturation by more developed countries.[39]

During the following eight years, utilization of the orbit grew dramatically, causing increased concern among nonspace powers. Against this background, the ITU convened the 1971 World Administrative Radio Conference for Space Telecommunications (WARC-ST) in Geneva. In opposition to proposals that the ITU should allocate not only frequencies but orbital slots as well, the United States argued that regulation of the orbit would inhibit its development as a natural resource.[40] The strength of the opposition and other complications resulted in the general preservation of the status quo.[41] Nonetheless, some progress was made toward the accommodation of the conflicting interests of states at various stages of economic and technological development. Article 9A of the Radio Regulations was revised to establish a mechanism for coordinating use of the geostationary orbit.[42] Section I requires a government which intends to establish a satellite system to convey to the International Frequency Registration Board (IFRB), the entity responsible for management of the international use of the electromagnetic spectrum,[43] within five years prior to commencement of service, information defined in Appendix 1B of the Radio Regulations relating to the characteristics of the system's satellites and earth stations, including orbital information. In particular with respect to geostationary satellites, Section II requires any government considering the use of the orbit to coordinate the planned use--prior to notification of the IFRB under Section I on commencement of service--with any other government which has registered an assignment in the same band with the IFRB or which is engaged in or has completed coordination procedures under this section. To facilitate coordination, the former is to supply the information defined in Appendix 1A of the Regulations. The purpose of this coordination procedure is to promote resolution of potential conflicts prior to commencement of system construction.

Another element of the effort of delegates to the WARC-ST conference to resolve conflicts regarding management of the orbit is embodied in Resolution Spa 2-1, which reflected the concern of nonspace powers regarding the management of the orbit. In part the resolution provides:

> The World Administrative Radio Conference for Space Telecommunications (Geneva, 1971),
> <u>considering</u>
> that all countries have equal rights in the use of both the radio frequencies allocated to various space radiocommunication services and the geostationary satellite orbit for these services;
> <u>taking into account</u>

that the radio frequency spectrum and the geostationary satellite orbit are limited natural resources and should be most effectively and economically used;

having in mind

that the use of the allocated frequency bands and fixed positions in the geostationary satellite orbit by individual countries or groups of countries can start at various dates depending on requirements and readiness of technical facilities of countries;

resolves

1. that the registration with the ITU of frequency assignments for space radiocommunication services and their use should not provide any permanent priority for any individual country or groups of countries and should not create an obstacle to the establishment of space systems by other countries....

The linkage between the revised version of Article 9A and Resolution Spa 2-1 is embodied in Resolution Spa 2-2 which reiterated the importance of achieving the best possible use of the geostationary orbit and the frequency bands assigned to the broadcasting satellite service, and which called upon participating governments to establish and operate satellite broadcasting systems in accordance with plans established by general and regional conferences in which affected states are entitled to participate.[44] Although not binding on the parties to the International Telecommunication Convention,[45] the resolutions expressed a broadening consensus among participating delegations and emphasized the fact that the Radio Regulation does not provide permanent protection to spectrum and orbital assignments for space broadcasting services.[46] However, the resolutions did not allay the concern of nonspace powers that present space activities will saturate the most desirable segments of the orbital arc.

The third phase of the ITU's consideration of the problem of allocating the geostationary orbit among potentially conflicting uses occurred at the Plenipotentiary Conference of the ITU which was held in September and October 1973 in Torremolinos. The basic purpose of the conference was to evaluate and, if necessary, revise the ITU's fundamental structure and functions. In addition, the question of orbital slot allocation was included in the agenda.[47] In that context, the Israeli delegation proposed to modify the International Telecommunication Convention[48] to authorize ITU allocation of both the frequency spectrum and geostationary orbital slots as a means of ensuring equitable access by all parties.[49] Although the Israeli proposal did not receive the support required for adoption, the Plenipotentiary Conference amended the listing of the duties to be performed by the IFRB contained in Article 10 of the Convention to add relatively undefined responsibilities relating to the geostationary orbit. In revised form, Article 10(3) provides:

> The essential duties of the International Frequency Registration Board shall be:
>
> a) to effect an orderly recording of frequency assignments made by the different countries so as to establish, in accordance with the procedure provided for in the Radio Regulations and in accordance with any decision which may be taken by competent conferences of the Union, the date, purpose and technical characteristics of each of these assignments, with a view to ensuring formal international recognition thereof.
>
> aa) to effect, in the same conditions and for the same purpose, an orderly recording of the positions assigned by countries to geostationary satellites;
>
> b) to furnish advice to Members with a view to the operation of the maximum practicable number of radio channels in those portions of the spectrum where harmful interference may occur, and with a view to the equitable, effective and economical use of the geostationary satellite orbit;
>
> c) to perform any additional duties, concerned with the assignment and utilization of frequencies and with the utilization of the geostationary satellite orbit, in accordance with the procedures provided for in the Radio Regulations, and as prescribed by a competent conference of the Union, or by the Administrative Council with the consent of a majority of the Members of the Union, in preparation for or in pursuance of the decisions of such a conference....(emphasis added)

In essence, the IFRB was instructed to record use of orbital slots on the same basis as frequencies for space services.

Although the revised version of Article 10 authorized recording of orbital use, the basic "first come, first served" approach was not altered. However, in order to preserve the interests of nonspace powers, the Plenipotentiary Conference also revised Article 33 to provide:

> Rational Use of the Radio Frequency Spectrum and of the Geostationary Satellite Orbit
>
> In using frequency bands for radio space services, Members shall bear in mind that radio frequencies and the geostationary satellite orbit are limited natural resources, that they must be used efficiently and economically so that countries or groups of countries may have equitable access to both in conformity with the provisions of the Radio Regulations according to their needs and the technical facilities at their disposal.[50]

Read in combination, the revised version of Articles 10 and 33, which became effective January 1, 1975, lead to a series of conclusions regarding the status of management of the geostationary orbit:

1. Countries are entitled to utilize the geostationary orbit and obligated to record such use with the IFRB.

2. At least during the period of active use of an orbital slot, the system operator is protected against harmful interference from subsequently established systems by the coordination requirements of Article 9A.

3. The system operator is not entitled to permanent utilization of any particular orbital slot.

4. Governments operating geostationary satellites are required to conduct their operations in such a way as to permit equitable areas to orbital slots by other governments subsequently establishing communications systems based on the use of geostationary satellites.

At the 1977 World Administrative Radio Conference for the planning of the broadcasting-satellite service in the 12 GHz band (WARC-BS), principles to govern the management of the geostationary orbit were discussed. During the debates,[51] Colombia and other equatorial states raised the question of national sovereignty over the geostationary orbit. At the 1975 session of the First Committee of the General Assembly, Colombia had asserted that the geostationary orbit is a natural resource over which equatorial states are entitled to exercise sovereign rights in relation to the segments of the arc located over their respective territories.[52] Similar contentions had been incorporated in the Bogota Declaration of December 3, 1976.[53] The states which supported that document raised the question at WARC-BS and stated their opposition to allocation of orbital slots in an effort to promote international recognition of national jurisdictional control. Recognition of that approach would permit the equatorial states to control access to the orbit, most likely on a licensing basis. Conflicts with the "free use" principle of Article I(2) and the Article II prohibition against appropriation as well as the low level of support from nonequatorial states suggest that the establishment of an international consensus on this approach is unlikely. But the likely result in the long run is not reinforcement of traditional sovereignty claims (albeit temporary) by nonequatorial states, but a trend towards internationalization of decision making.

The remaining delegations divided their support between development of an a priori plan and evolutionary planning for orbital slot and frequency allocation. Under the first approach, a comprehensive plan covering all aspects of the allocation question would be developed in an attempt to accommodate to the maximum possible extent the whole set of needs foreseen by the period covered by the plan.[54] In contrast, under evolutionary planning, system design and deployment would be undertaken within limits imposed by a series of general sharing principles and would be based on prior consultations with other governments whose existing systems could be affected by the establishment of new systems.

Under that approach, no advance assignments of orbital slots, frequencies and signal polarizations are made, permitting actual use to benefit from advancing technology.[55]

The _a priori_ approach enjoyed substantial support from a significant number of nonequatorial states in Regions I and III. The United States led another bloc of states, including Canada and Brazil, which opposed _a priori_ planning, supporting instead various forms of evolutionary allocation for Region II. When the WARC-BS ended, no _a priori_ plan was approved for Region II, but a conference of Region II countries, including North and South America and the Caribbean states, was scheduled for 1982, at which a "detailed plan" is to be considered.[56] Thus, the conference did not significantly alter the existing regime with respect to the use of the geostationary orbit by the United States, Canada and Latin America. However, technological advances are likely to result in increased pressure to preserve rights of access for states which do not yet possess the capability to operate satellite systems.

In June and July 1976, the Administrative Council of the ITU met in Geneva to determine, among other things, the agenda for the 1979 World Administrative Radio Conference. In its present form,[57] the agenda calls for the review and, if necessary, revision of Articles 9 and 9A relating to the coordination, notification and recording of frequency assignments.[58] As noted above, Article 9A establishes procedures for coordinating use of the geostationary orbit.[59]

In the context of discussions of Article 9A, the issue of allocating orbital slots is likely to be raised. Participating delegations are expected to align themselves along the lines drawn at the WARC-BS. Thus, we would expect that equatorial states will continue to press their claims that the geostationary orbit is a natural resource subject to the sovereign control of individual countries which lie along the equator. The nonequatorial developing countries and those which are considered developed but which do not yet possess the capability to operate sophisticated satellite systems could be expected to press for adoption of a comprehensive frequency and orbital slot allocation plan which would ensure future access to segments of the geostationary orbit suitable for national or regional use. The United States and other space powers are likely to continue their support of evolutionary planning in order both to ensure maximum use of the orbit and to incorporate technological advances into the allocation scheme as rapidly as they occur.

The debate will be given a sense of urgency by intervening communications satellite experimentation and the evolution of planning for operational domestic, regional and global satellite networks. Canadian and American experimentation using the ATS-6 and CTS systems will focus on applications of geostationary, high-power broadband satellite transmissions in conjunction with small terrestrial receiving terminals.[60] In addition, experimental activities by the European Space Agency (ESA) and the Japanese National Space Development Agency (NSDA) are expected to demonstrate the utility of new applications.[61]

These experimental activities will provide the basis for expanded operational use of geostationary communications satellites. Significant expansion of the Intelsat network and deployment of new Intelsat V satellites are projected.[62] On the regional level, the Arab League's Telecommunications Union is considering establishing a system based on geostationary satellites for the provision of broadcast and telephone services to each member country.[63] Expanded Domestic Systems are either under development or in the planning phase in the United States, Canada, Indonesia, Iran and Japan. In addition, a number of countries, including Algeria, Zaire, Brazil, Nigeria and Norway, have leased or are considering leasing transponders from Intelsat for dedicated use in domestic systems.[64]

Increases in existing and planned use of the geostationary orbit for communications and other purposes will provide impetus for the 1979 WARC debate regarding allocation of the geostationary orbit. Because of the key role played in the existing law of outer space by the "free use" principle of Article I(2) and the nonappropriation principle of Article II, and in light of the potential economic and social value of the proposed satellite applications based on the use of the geostationary orbit, the claims of equatorial states to sovereign control over large segments of the orbit will not easily receive broad international recognition. A struggle is likely to take place between comprehensive advance allocation of frequency and orbital slots and allocation according to actual use, taking into account existing systems and advancing technology.

Current positions and trends of discussion indicate that although substantial discussion of the problem will occur at the 1979 WARC, no definitive solution will be reached, because of the strength of the competing interests involved. Proposals for both a priori and evolutionary planning are likely to be referred for consideration to regional conferences. After consideration there, the resulting recommendations will probably be reexamined at a general WARC in the mid-1980s. Debates at the 1970 WARC and subsequent conferences are likely to reveal a trend toward the assignment within each region of orbital segments dedicated to individual communications services. Within each segment, each country would be assured equitable access to orbital slots, but no specific frequency or orbital slot allocations would be made in advance of actual use. Despite a trend toward that approach, complicating factors including noncommunications applications such as satellite power generation are likely to delay establishment of an effective compromise among competing interests.

Thus, the impact of the 1979 WARC on the development and establishment of satellite power systems is expected to center on identification, first, of the problems of coordinating potential uses of the geostationary orbit to avoid mutual harmful interference, and second, of the competing interests of equatorial, developing and developed countries in the use of the orbit. In particular, since satellite power systems are not likely to be operational prior to 1995 and therefore are dependent on long-term orbital management activities, it is anticipated that the 1979 WARC will emphasize the importance of preliminary planning and evaluation of future orbital requirements for satellite power systems in order to ensure that future conferences take into account both the need to establish such systems and, if established, their projected orbital requirements.

4.2 Satellite Power Systems and the 1967 Outer Space Treaty

The second major set of issues affecting the legal status of satellite power systems centers around the basic principles of international space law as embodied in the 1967 Outer Space Treaty. Closely related to the discussion in Section 4.1 of international legal principles governing the utilization of the geostationary orbit for all peaceful purposes, the present section focuses on the norms as they affect the use of outer space for the specific purpose of power generation.

4.2.1 Article I

As noted in Section 4.1.1, Article I presents two main issues:

1. The existence of a binding obligation to explore and use outer space "for the benefit and in the interests of all countries...;"

2. The content of the declaration that outer space "shall be free for exploration and use by all States without discrimination of any kind...."

Assessing the impact of Article I on the use of the geostationary orbit, Section 4.1.1 concluded that it imposes on states engaged in space activities a duty not to use outer space in a manner which would jeopardize either the earth-oriented or space-oriented interests of other states. Further, space powers are not required under the existing law of outer space to share either their space initiatives or the profits of such ventures with other states. The same principles apply to the use of outer space for the purpose of power generation.

As presently conceived, a satellite power system would not adversely affect a state's sovereignty over its natural resources, its political, social, cultural and economic self-determination or domestic order among its citizens. Those interests would not inhibit establishment and operation of a satellite power system. A second potential concern could arise among energy-producing countries that the establishment of such systems by energy-consuming countries could undermine the economies of the former. However, as suggested below in Section 4.2.3, international law does not protect countries against either economic competition or economic pressure.

More substantial concerns could arise in other areas. A system based on the use of a laser transmission beam could jeopardize the national security of other countries, because of the potential military applications.[65]

However, use of power satellites as weapons would probably contravene the Article IV ban on the stationing of weapons of mass destruction. Protection against that eventuality would therefore not be dependent on the more general provision of Article I. The transmission beam could also traverse the airspace and therefore encroach upon the territorial integrity of non-participating states. That possibility could be avoided, first, through careful system design, and second, through consultation with potentially affected states as provided in Article IX. Similarly, the possibility of environmental degradation affecting air, water and land areas, as well as associated human and wildlife must be avoided through the same procedures.[66] The potential for interference of the transmission beam with the radio communications of other countries could be avoided either under procedures established in the International Telecommunication Convention and the Radio Regulations or under the consultation procedures of Article IX.[67]

In addition to the questions relating to the interpretation of Article I discussed in Section 4.1.1 above, an assessment of that provision's impact on the use of outer space for the specific purpose of satellite power generation raises a set of issues centering around the argument that Article I(1) requires states to use outer space "for exclusively peaceful purposes."[68] Assuming for the purposes of this subsection that the Article I(1) requirement that outer space be used "for the benefit and in the interests of all countries" contains within it the requirement that outer space be used "exclusively for peaceful purposes,"[69] the main point of contention is the meaning of the latter phrase. Regardless of their respective positions on the question of content, authorities agree that the main interpretational alternatives are limited to two: "peaceful uses" can be defined either as "nonaggressive uses," leaving open the possibility of th e of outer space for defensive military purposes, or as "nonmilitary uses," excluding both aggressive and defensive activities.[70] However, satellite power generation, as distinguished from the use to which the resultant power is put, is neither aggressive nor defensive as those terms are used in a military context. Consequently, the act of producing power in orbit complies with the proposed interpretation of Article I(1) that requires outer space to be used exclusively for peaceful purposes.

4.2.2 Article II

The implications of Article II for satellite power generation activities are limited to the potential appropriation both of a segment of outer space corresponding to the orbital slot and of solar energy. As indicated in Section 4.1.1 above, the Article II prohibition should not be applied to use of solar energy because of its essentially inexhaustible character. In addition, Article II is not likely to inhibit use of a particular orbital slot for the lifetime of any projected system, regardless of the institutional configuration of the system operator. An argument could be raised that the use of a transmission beam which could necessitate the establishment of safety zones around the beam constitutes appropriation of outer space in violation of Article II. However, the considerations discussed above which appear to exempt use of the geostationary orbit by satellite power systems from the Article II prohibition against appropriation would also permit use of microwave or laser power beams to connect the space and ground segments.

4.2.3 Article III

Another fundamental principle affecting the utilization of outer space is the general applicability of international law as embodied in Article III, which provides:

> States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.

As suggested in Subsections 4.2.1 and 4.2.2, Article III, through its reference to the United Nations Charter, affects the use of satellite power systems, first, because it prohibits the aggressive use of military force, and second, because it does not prohibit the use of economic pressure. In both cases, the key is Article 2(4) of the United Nations Charter which provides:

> All Members [of the United Nations] shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any manner inconsistent with the purposes of the United Nations.

Interpretation of this provision in light of the remainder of the Charter suggests that the use of armed force is prohibited, except under certain specified circumstances when the use of force in self-defense is authorized.[71] Consequently, aggressive military activities in space are not permitted, but the use of space for defensive purposes is not inhibited.

In connection with the analysis of Article I(1) in Section 4.2.1 above, it was suggested that international law would not prohibit the operator of a satellite power system from engaging in economic competition with other energy-producing countries or from using the availability of power from the system to exert economic pressure on energy-consuming countries as a means of political persuasion. Construction of Article 2(4) of the Charter limiting its prohibition to the use of armed force is a significant part of the underpinnings of that proposition. The conclusion that economic pressure is not prohibited under Article 2(4) is supported by significant authority.[72] In addition, that conclusion is consistent with prevailing general international law.[73] As a result, the system operator need not be concerned that any selection of the consumers of the system's products contravenes existing international law.

4.2.4 Article IV

Article IV of the Outer Space Treaty provides in part:

> States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.
>
> ...The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited....

The language of Article IV raises two main issues:

1. The implications for satellite power systems of the Article IV prohibition against the stationing of weapons of mass destruction in orbit
2. The impact of Article IV on plans to establish military facilities in orbit for the protection of a satellite power system from attack.

The latter issue forms the primary subject matter of Section 4.4 below and will be examined in detail there.

In Section 4.2.1 above, analysis of Article IV in the context of the concept of the exclusive use of outer space for peaceful purposes suggested, among others, the conclusion that Article I(1) and IV(1) implicitly authorize the establishment of military installations and weapons system in outer space--but not on the celestial bodies--which are exclusively defensive in nature, provided they do not contain nuclear weapons or other weapons of mass destruction. Because of the nature of the transmission beam, the argument may be made that the establishment of a satellite power system potentially constitutes the stationing of a weapon of mass destruction in outer space in violation of Article IV. The system operator can correctly respond that the system is designed not as a weapon but as a utilitarian device for the efficient use of solar resources. All the present designs incorporate a series of safety devices to terminate transmission of power when the transmission beam moves outside the intended reception area.[74] Although the selection of a laser transmission beam could constitute a safety hazard, the tendency among designers is toward the use of a microwave beam, which is considered less dangerous.[75] Nonetheless, the potential harm from a microwave beam should not be underestimated.[76]

4.2.5 Article VI[77]

Article VI, which establishes the foundations for international responsibility for activities in outer space, provides:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the State concerned. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Thus, each state which is a party to the treaty is charged with the obligation, first, to ensure that the activities of its nationals comply with the provisions of the treaty, and second, to accept responsibility of those activities which contravene applicable provisions. In this manner, states are unable to avoid the duty of compliance through the use of institutional configurations which do not involve elements of the national government.[78] Consequently, the responsibility of each state's government is not affected by the juridical character of the entity actually operating the satellite power system.

A state's duty to supervise the activities of its nationals for practical purposes probably prohibits unregulated, purely private undertakings.[79] Article VIII of the Outer Space Treaty reinforces the obligation by requiring the state under whose registry an object is launched into outer space to retain control and jurisdiction. In light of the potentially hazardous character of satellite power generation, the policy considerations underlying Article VI suggests the need for relatively strict supervision.[80] The provisions of Article VII and the Convention on International Liability for Damage Caused by Space Objects,[81] which impose liability on the launching state for damage resulting from space activity, are likely to give rise to practical and foreign policy considerations which create pressure upon national governments to exercise the supervision necessary to ensure protection against the potential hazards of orbital power generation.

Although governments are required to ensure compliance of their respective nationals with appropriate provisions of the treaty, Article VI does not have the effect of subjecting nongovernmental entities to provisions which would otherwise not apply to them. For example, as suggested above in Section 4.1.1, Article II does not apply either to private sector entities or to international organizations. Although terms of Article VI require states parties to the treaty to ensure compliance of their nationals with its provisions, Article VI does not extend the prohibition against appropriation to entities which are not covered by the terms of Article II.

4.2.6 Article VII

Article VII, which embodies the fundamental principles governing liability for danger arising from space activities, provides:

> Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies.

Because of the wide range of potential environmental and other injuries which could result from the operation of a satellite power system, the question of liability is particularly significant. Potential injuries include:

1. Damage to body tissue of humans and wildlife exposed to the transmission beam
2. Radio frequency interference
3. Interference with electronic instrumentation, especially for medical, navigation and explosives detonation purposes
4. Environmental modification, including weather and climate alteration, resulting from increased heat generation and interaction of the transmission beam and launch vehicle exhausts with the upper atmosphere and ionosphere.[82]

If injury results from the operation of a satellite power system, the injured party is entitled to redress under Article VII. Under its terms, the state which procured the launch of the vehicle causing the injury and the state which launched the space object are internationally liable to the entity actually injured, or to its national government. The language of Article VII raises two main issues:

1. The meaning of the word "damage"
2. The meaning of the phrase "internationally liable."[83]

The broad principles of Article VII were implemented in the Convention for Liability for Damage Caused by Space Objects. The term "damage" is defined in Article I(a) of the Convention to mean

> loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international inter-governmental organizations....

The language of that provision leaves open to question whether it covers consequential or nonphysical damage.[84] Since three of the four damage categories listed above are either consequential or nonphysical in nature, the ambiguity is significant for potential operators of satellite power system.

If the injury incurred falls within the definition of "damage," the type of liability imposed is based on the location at which the injury occurred. If a space object caused damage on the surface of the Earth or to an aircraft in flight, Article II provides that the "launching State shall be absolutely liable to pay compensation" for the damage. In that case no proof of negligence is required and the launching state is liable even though it is able to demonstrate that it complied with all applicable standards of care.[85] Thus, if a solar power satellite transmission beam injures a person on the Earth's surface or while traveling in an aircraft, the launching state would be liable to pay compensation upon demonstration

1. That the injury occurred

2. That it resulted from the operation of the satellite power system.

However, liability may be avoided by establishing that "the damage has resulted either wholly or partially from gross negligence or from an act of omission done with intent to cause damage on the part of the claimant State or of natural or juridical persons it represents," as provided in Article VI(1). In contrast, if damage is suffered in outer space, the launching state is liable to compensate the injured party under the terms of Article III only upon a demonstration of fault of the launching state or of persons for whom it is liable.[86] In both bases, the measure of damages is determined under Article XII, which provides that when compensation is granted under the convention, the amount shall be determined in accordance with international law and the principles of justice and equity in order to provide such reparation...as will restore the person, natural or juridical, State or international organization on whose behalf the claim is presented to the condition which could have existed if the damage had not occurred.

The provisions of Article VII of the Outer Space Treaty and of the Convention on Liability for Damage Caused by Space Objects are likely to affect the interests of the operator of a satellite power system in two ways. First, if the system is damaged through the acts of the nationals of a foreign government, the foundation is laid for the indemnification of all losses falling within the definition of "damages." However, since the extent of coverage is in question, effective means for preventing damage to the system should be found. Second, if the system causes damage, the state of registry would be liable for those injuries which occur within the jurisdiction of or to the nationals of other governments. Nationals of the state of registry would be entitled to pursue remedies in the courts of that state. Consequently, the exercise of all due care in operations in outer space, and design and operation in a manner likely to minimize any risk of damage, are considered essential if only from this point of view.

4.2.7 Article VIII

Article VIII of the Outer Space Treaty, pertaining to the ownership and control of objects in outer space provides:

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel therefor, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State, which shall, upon request, furnish identifying data prior to their return.

The first sentence assists implementation of the provisions of Articles VI and VII relating to international responsibility and liability for activities in outer space, particularly over nationals operating in nongovernmental capacities.

The second sentence is considered extremely important to operational implementation of solar power satellite technology. By protecting the rights of ownership as established in accordance with traditional international law, Article VIII provides the basis for industrialization of outer space under both commercial and national governmental organizational structures. As suggested below in Section 4.3, the capital investment necessary to develop, establish and operate a satellite power system would be deterred or completely prevented if rights of ownership are not protected.

4.2.8 Article IX

As noted in Section 4.1.1(3) above, Article IX plays an important role in the management of the geostationary orbit.[87] The same provision has equal impact on the use of outer space for the purpose of satellite power generation. The key provision of Article IX requires states to "conduct all their activities in outer space..., with due regard to the corresponding interests of all other States Parties to the Treaty." The remaining three sentences implement the "due regard" requirement.[88]

The second sentence, which requires states parties to the treaty to conduct activities in outer space so as to avoid both harmful contamination of outer space and adverse changes in the earth's environment resulting from the introduction of extraterrestrial matter, could limit operation of satellite power systems if liberally construed. On its face, the second sentence is limited to environmental hazards potentially created by extraterrestrial matter brought within the Earth's biosphere. Although the distinction between matter and energy is not yet precisely defined for these purposes, the passage of the satellite power system transmission beam through the Earth's atmosphere may be judged to fall outside the category of matter. If so, the second sentence appears not to limit the operation of such a system.

However, the combination of the first two sentences may have the effect of extending the prohibition to the introduction of any physical phenomenon which could adversely affect the Earth's environment. The first sentence implicitly incorporates, at least conceptually, the requirement of Article I(1) that outer space be used "for the benefit and in the interest of all countries."[89] To the extent the two provisions are coextensive, the first sentence would require space powers to conduct their space activities in a manner which does not prejudice the "corresponding" interests of nonparticipants. The definition of the term "corresponding" is not clarified, but presumably encompasses both space and terrestrial interests likely to be affected by space activities, in a manner comparable to the "common interests" clause of Article I(1).[90] Consequently, Article IX requires that consideration be given to the elimination of the adverse effects listed above,[91] especially to the extent they affect the interests of states other than the state conducting the activity in question.

The third and fourth sentences establish a minimum standard for "due consideration." If the state undertaking the activity has reason to believe that activities planned by its nationals are likely to cause harmful interference with the activities of other states parties to the treaty, it is obligated to "undertake appropriate international consultations" with the affected states prior to implementation of its plans. Similarly, if one party has reason to believe that the activities of another party would cause potentially harmful interference with activities relating to the exploration and use of outer space, the former may request such consultations, even if its own activities would not be adversely affected.[92] The consultation provisions raise three key issues:

1. When does a party have sufficient "reason to believe" that harmful interference would result from the planned activities?

2. What constitutes harmful interference?

3. What are the characteristics of "appropriate international consultations"?

Under the language of the third sentence of Article IX, the obligation of a state planning to engage in space activity becomes operative when it has "reason to believe" that execution of plans would cause harmful interference with the activities of other states in outer space. Thus, the determination that the obligation has become operative is solely within the discretion of the launching state. If it lacks sufficient information relating either to interference factors or to the plans of existing space activities of other states, the launching state is authorized to proceed without consultation.[93] The scope of this discretion may be limited, however, by communications from states whose space activities would be adversely affected or from third states to the launching states informing the latter of potential interference and requesting consultations as provided in the fourth sentence of Article IX.

Article IX does not provide a clear standard for determining when the activities of one state "could cause potentially harmful interference" with the activities of another. The language of the third sentence suggests that only interference with the space activities, as distinguished from the earth-bound activities, of another state are relevant; however, since a large proportion of space activity necessarily involves support activities on the Earth's surface, interference with those also gives rise to the consultative obligation of Article IX.[94] Further, interference can only occur with respect to activities which constitute "peaceful uses of outer space."[95] Presumably, the term "interference" is used in its ordinary meaning to signify conflicting uses resulting in obstruction, creation of significant hazards or significantly diminishing the efficiency of space activities.

The characteristics of "appropriate international consultations" are left undefined. From the context, the term "consultation" refers to the joint examination--including the exchange of relevant information--of the proposed activities and the probable consequences for each consulting party's interests.[96] Since the term "consultation" was selected by the drafters of Article IX, the parties are obliged only to make a good faith effort to conduct the joint examination with a view to reaching satisfactory resolution of conflicts among the consulting states. However, Article IX imposes no obligation to achieve reconciliation.[97] Although the form or forum of consultation is not significant, the consultation must involve either diplomatic or scientific elements of the affected governments. As emphasized by the use of the word "international," the duty to consult is primarily bilateral in nature although consultation under the auspices of an intergovernmental organization is not precluded.[98] The suggestion that Article IX consultation must include all parties to the Outer Space Treaty cannot be supported.[99]

Thus, Article IX would require satellite power system operators to conduct power generation activities with due regard at least to the space activities of other states. Although that requirement is likely to affect most directly the use of the geostationary orbit, it imposes a duty to remain alert to the possibility of adversely affecting the space interests of other states. In those cases where adverse consequences are likely, the operator is required to consult in good faith with the affected parties, with a view to the elimination of those consequences. However, Article IX does not impose an obligation to accept unnecessary restrictions on the operation of a satellite power system.

4.3 Legal Status of Private Sector Operation of Satellite Power Systems

One of the key questions raised by the development of innovative applications of satellite technology is the allocation of responsibility for operational implementation, first, between national and international entities, and second, between public and private sector entities. Policy debates regarding organizational configurations have had a significant impact on the pace and direction of the development of operational space capabilities, particularly in the area of communications satellites.[100] At present, the question of institutional arrangements for the development and use of an operational earth resources satellite system are proceeding in parallel paths in the federal government[101] and in the United Nations.[102]

In both areas, the possibility that the private sector should be encouraged to assume primary responsibility was discussed. The same possibility exists for the implementation of solar power satellite technology. Two main organizational options for establishment of a United States private sector system could be considered:

1. Regulated private enterprise based on traditional corporate structures
2. Federal corporation chartered by Congress, similar to the Communications Satellite Corporation.[103]

Since financial, fiscal, efficiency and foreign policy considerations may lead to selection of one of these private sector options for operation of a satellite power system, the status of private sector initiatives under existing space law could materially affect the extent to which such systems are utilized to satisfy national and international energy requirements.

The discussions of international space law principles governing both the use of the geostationary orbit and the use of outer space for the specific purpose of solar power generation, set forth in Sections 4.1 and 4.2 above, expressly or implicitly establish a series of four principles relating to private sector initiatives in outer space:

1. Private sector activity in outer space is permitted under existing international law
2. Private sector activity in outer space is subject to the provisions of the Outer Space Treaty
3. Private sector activity is subject to the exercise of jurisdiction by certain national governments
4. Each state party to the Outer Space Treaty is responsible for the acts of its nationals.

Each of these conclusions is discussed more fully below.

4.3.1 <u>Permissibility of Private Sector Activity in Outer Space</u>

Under existing international law, private sector undertakings in outer space are implicitly authorized under the terms of both the Outer Space Treaty and the Convention in Liability for Damage Caused by Space Objects. As noted in Section 4.2.5, Article VI of the former imposed international responsibility on states party to the treaty for the activities of its nationals in outer space "whether such activities are carried on by government agencies or by non-governmental entities...." Similarly, Article VII imposes international liability on any state party for injuries caused by its space objects to the natural or juridical persons of another party not only on Earth but in outer space as well. Both provisions clearly contemplate the possibility that non-governmental--including private sector--entities may conduct activities in outer space. In addition, Articles IV(1), VIII(1) and XI, among others of the Convention on Liability, refer to injury to "national or juridical persons" of a state. In legal literature, the term "juridical person" is often used to refer to corporations and other lawfully constituted commercial organizations.

Further evidence supporting the proposition that private sector activity in outer space is permitted under existing international law may be found in the debates of the United Nations Committee on the Peaceful Uses of Outer Space relating to international principles to govern the use of direct broadcast and earth resources satellites. During the direct broadcast debates, the Soviet Union led an effort to incorporate into the appropriate international policy structures a provision limiting direct broadcast either to government agencies or to entities under the direct supervision of the government.[104] The character of the supporting arguments suggests that the proposed limitation would be more restrictive than required by the terms of Article VI of the Outer Space Treaty.

Argentina and Brazil have advocated the restriction of private sector activities in the area of satellite remote sensing. In a draft treaty, those governments proposed to prohibit states parties from both conveying to and receiving from private entities information obtained through remote sensing relating to the natural resources of another state party in the absence of the latter's express consent.[105] The direct purpose is to apply the proposed prior consent regime to all potential actors, thus implicitly recognizing that under existing international space law private entities may be involved in the acquisition, reception, processing and distribution of remote-sensing data. Attempts in both the direct broadcasting and satellite remote-sensing debates to limit private sector activities, without referring to existing principles allegedly dictating such limitations, makes clear that existing space law implicitly permits private sector activity in outer space.

4.3.2 Applicability of the Provisions of the Outer Space Treaty to Private Sector Activities

As suggested in Section 4.2.5 above, Article VI expressly imposes on parties to the treaty the duty to ensure compliance of national, nongovernmental entities with the provisions of the treaty. Consequently, private sector entities are both entitled to the "free use of outer space" and subject to the limitations imposed by the treaty, for example, the Article IX duty to avoid introducing extraterrestrial matter into the Earth's biosphere if that is likely to cause adverse changes in the Earth's environment. However, those provisions which by their terms apply only to states, including the Article II prohibition against the appropriation of outer space, are not extended to the private sector through Article VI.

4.3.3 National Jurisdiction Over Private Sector Activities

National governments are likely to exercise relatively strict control over private sector activities in outer space, first, because they are required to do so by provisions of the Outer Space Treaty, and second, because the Convention on Liability for Damage Caused by Space Objects imposes liability on states for certain private sector activities in outer space.

Article VI of the Outer Space Treaty requires states parties to exercise control over the activities of their respective nationals for the purpose of ensuring compliance with the treaty's provisions. In addition, Article VIII requires a state party to retain jurisdiction and control over any space object launched under its registry and its crew, regardless of the crew's nationality. Thus, the activities of a space vehicle launched and registered in one state, chartered by a corporation of a second state and manned by a crew from a third state could conceivably be subject to the control of all three governments.

As noted in Section 4.2.6 above, under Article VII of the Outer Space Treaty and the provisions of the Convention on Liability for Damage Caused by Space Objects, the states which launch or procure the launching of a space vehicle are subject to international liability for damage caused by the space vehicle. Since no limit is imposed on the measure of damages awarded under the convention, creating the possibility of substantial liability on the part of the launching states as well as the resultant domestic and foreign political consequences, those states are likely to establish relatively strict regulations relating the structural, safety and operating procedures as a means of preventing the occurrence of damage covered by the terms of the convention.

In addition to regulation for the purposes of ensuring compliance with the requirements of the Outer Space Treaty and avoiding international liability for damage resulting from space activities, states are likely to extend their respective legal regimes into outer space for the purpose of taxation, enforcing national laws relating to patents, copyrights, antitrust and unfair trade practices. In light of the likelihood that outer space will be developed through the establishment of satellite power systems and space manufacturing facilities, and the common interests of states in regulating such operations, appropriate multilateral agreements pertaining to private sector operations in outer space should be anticipated.

4.3.4 Liability of States for the National Private Sector Activities

Article VII of the Outer Space Treaty and the provisions of the Convention on Liability impose liability on states for damage caused by their respective nationals. Since claims for compensation for damage sustained by the nationals of one country as the result of the commercial activities of the nationals of another country are likely to be pursued using the diplomatic procedures established in the Convention on Liability, the launching state rather than the private sector entity would be directly liable. However, this protection from liability is likely to be limited in three ways. First, the government is likely to establish procedures for recovering amounts paid to foreign claimant from the entity actually responsible for the damage. The main options are incorporation of appropriate procedures either into the regulatory framework or into the jurisdictional statutes of national courts. Second, although nationals of the launching state are excluded from coverage by the convention by Article VII(a), they would be entitled to pursue appropriate remedies directly against the operating entity in national courts of competent jurisdiction. Finally, the right of nationals of other states to seek relief in the courts of the launching state is expressly preserved in Article XI(2) of the Convention on Liability. All three circumstances suggest that commercial satellite power systems are likely to be subject to normal liability for damage caused by their operation.

The four principles discussed above indicate that existing international space law does not present any unusual impediments to the establishment of a commercial satellite power system. In particular, under existing legal principles, private sector initiatives are not prohibited by the Outer Space

Treaty, but would be subject to its provisions. Both the launching state and the states in which the organization establishing the system is chartered would be entitled to exercise control over it. The level of regulation is likely to be relatively high due both to the obligation of those states to ensure compliance with the provisions of the Outer Space Treaty and to the provisions for liability for damage resulting from the operation of a satellite power system by their respective nationals. Finally, although the provisions of the Convention on Liability would shield commercial enterprises from direct international liability, the option of national governments to seek indemnification from the operating entity for damages paid in compensation for injuries resulting from operation of the system, as well as the option for injured parties to seek relief from the system operator through the courts of the launching state, indicate that standard concepts of liability apply. These conclusions indicate the need for national and international policy analyses to parallel technical and economic studies as a means of ensuring that as technical and economic viability is achieved, the capability is also developed to create conditions for optimum combinations of incentives and regulatory safeguards are brought into existence. The importance of formulating appropriate policies on the national and international levels must be emphasized.

4.4 Legal Status of Orbital Weapons Systems for the Protection of Satellite Power Systems

Once established, a satellite power system in geostationary orbit could present a desirable target for military or terrorist action. The importance of a high-capacity power system to a nation's economic, political and military potential suggests that destruction of the system would be assigned a high priority in time of military or political conflict. An attack on the system could create significant social and political impact.

In theory, Article VII of the Outer Space Treaty and the procedure established in the Convention on Liability for Damage Caused by Space Objects would provide remedies for any damage except that caused by actions taken against the system not involving a space object. A laser attack originating from a terrestrial installation is a possible example. However, the procedures established by treaty are not likely to be effective, especially in cases of deliberate destruction. First, extensive delays must be anticipated prior to resumption of service, with obvious consequences for the launching state's economic stability. Second, since diplomatic claims settlement procedures are involved, full recovery of damages specified in Article XII of the Convention on Liability is not likely, first, because damage claims are often discounted, and second, because few countries have the economic capacity to repay the cost of establishing a satellite power system. Third, a successful attack could create potential hazards from debris in space and from transmission beam spillover on the Earth's surface.

In light of the foregoing considerations, some means of military protection may be desirable. Terrestrial weapons systems are likely to be limited in their ability to defend solar power satellites against attack either from outer space or from the Earth. Hence, some form of defensive weapons system stationed in space in a position to protect the satellite power system may appear appropriate.

In Section 4.2.1, an analysis of Article I(1) and IV and the concept that outer space should be used exclusively for peaceful purposes led to two main conclusions:

1. The stationing of nuclear and other weapons of mass destruction in outer space is prohibited.
2. Military activity in outer space is not prohibited if it is defensive or nonaggressive in nature.[106]

The same principles apply to the establishment of an orbital weapons system for the protection of the space segment of a satellite power system. In principle, Articles I(1), III and IV do not prohibit the establishment of such a weapons system, provided it does not incorporate weapons of mass destruction or require the use of installations on the moon or other celestial bodies.

Some difficulties could arise, however, if a protective system were incorporated which purported to be defensive in nature but which could be trained on Earth or other celestial bodies, or upon large space objects and used for aggressive as well as defensive purposes. Although it could be argued that in the era of modern warfare, such flexibility is necessary to ensure national security, the dual purpose approach would undermine the rationale for omitting defensive weapons system from the prohibitions of Article IV. As a result, such systems must be considered unlawful to the extent that they are capable of inflicting mass destruction.

4.5 Conclusions on Existing Space Rights

The foregoing analyses suggest that while the existing principles of international space law do not on their face represent significant impediments to the establishment and operation of satellite power systems in geostationary orbit, in many cases clarification of ambiguities of existing law could promote creation of conditions favorable to such initiatives.

4.5.1 Legal Aspects of the Use of the Geostationary Orbit

Articles I, II and IX of the Outer Space Treaty pose no obstacle to the use of the geostationary orbit by satellite power systems. The most significant potential problem in this area is based on the trend toward crowding in segments of the orbit which would be useful for satellite power systems. The most significant activity relating to the management of the orbit is occurring under the auspices of the ITU. To date, the ITU has not examined the potential frequency and orbital requirements of satellite power systems. However, in light of their projected contribution to the satisfaction of global energy needs, such systems should be included in the ITU planning process.

Although the ITU is presently the primary forum for consideration of orbital management issues, the range of potential noncommunications applications requiring utilization of the geostationary orbit indicates, that the problem of orbital management could be shifted to another forum with a broader mandate. In that manner, a more comprehensive approach, potentially leading to the conclusion of an international agreement, could be undertaken as a means of ensuring availability of orbital slots for all potential uses compatible with the purposes of the Outer Space Treaty. This broader approach could be particularly valuable when use of the orbit increases sharply enough that the establishment of priorities among potential uses becomes unavoidable.

4.5.2 Impact of the Outer Space Treaty on Satellite Power Systems

The provisions of the 1967 Outer Space Treaty provide the general framework for all activity in outer space, including the conversion of solar energy into electrical power. In its present form, the treaty would not interfere with the establishment and operation of a satellite power system. However, the foregoing conclusion is tempered by two considerations. First, although the Outer Space Treaty would not inhibit satellite power initiatives, it does not take any affirmative steps to create conditions favorable to such initiatives. Because of the extremely large investment in research, development and demonstration of the technology, as well as construction of operational solar power satellites and appropriate ground terminals, effective incentives are likely to be essential to full realization of the benefits of satellite power systems. The optimum combinations of incentives should be given careful national and international consideration as energy demand increases and the technology evolves.

The second limiting consideration is the fact that the conclusion stated above is based on constructions of Article I which would avoid restrictive impact on space initiatives. In this regard interpretation of the "common interests" clause in a manner which would not require a system operator either to permit foreign participation in the system or require the system operator to distribute a portion of its earnings among the less developed countries is particularly important. Although that interpretation is favored under existing international space law, trends in the debates of the Committee on the Peaceful Uses of Outer Space and its subcommittees, as well as the controversy regarding interpretation of Article I, suggest that pressure from nonspace powers could alter the existing balance of international legal opinion. This possibility suggests the existence of an international political basis for initiatives in the United Nations and elsewhere to impose restrictive limits on the use of solar power satellites. To the extent that public and private sector planners are compelled to base the decision to construct a satellite power system on the provisions of the Outer Space Treaty, the uncertainty of interpretation may exert an inhibiting influence.

For those reasons, the decision of the Committee on the Peaceful Uses of Outer Space (CPUOS) to add orbital power generation to the agenda of the fourteenth session of its Scientific and Technical Sub-Committee must be considered a significant development. After initial considerations there, the probability that the subject will be added to the agenda of the Legal Sub-Committee for the 1978 session is increased. Consequently, CPUOS is likely to give extensive consideration to the technical and legal aspects of satellite power generation. This development will result in timely consideration. In specific subject areas, especially direct broadcast and earth resources satellite regulations, CPUOS has--as a result of substantial deliberations--made some progress in relatively uncontroversial areas, but has not yet taken significant steps toward the resolution of the key issue of prior consent in either area. Parallel developments with respect to solar power satellites could mean protracted debates. In light of these potential consequences, consideration should be given to the possibility that the international aspects of satellite power generation could be considered more advantageously in another forum.

4.5.3 Legal Status of Private Sector Satellite Power Systems

The provisions of the Outer Space Treaty provide a foundation for private sector initiatives with respect to satellite power generation. In particular, the treaty implicitly authorizes commercial space activities, subject to compliance with applicable provisions of the treaty under the supervision of the national governments specified in Article VI. Once a private sector system is established, the supervising governments are liable for any damage caused, as provided in the Convention on Liability for Damage Caused by Space Objects. The imposition of international liability on supervising governments is likely to result in the imposition of relatively strict national controls.

Although this foundation has been established, a number of questions remain unresolved. First, the status of attempts to preclude private sector participation in the operational implementation of space technology should be monitored, and the desirability of such participation as a matter of national and international policy should be carefully considered. Second, a number of practical aspects regarding application of the Convention on Liability should be clarified. Particularly important is the need to develop effective means of national regulatory control over activities carried out by space vehicles. Even more difficult is the problem of providing the launching state with the means to control the activities carried out by a spacecraft which it has launched but which is registered in another state. Problems potentially arising from conflicts in jurisdiction and control should be examined. Further, the impact of the liability framework established by the convention should be tested to ascertain whether realization of tangible benefits is promoted or impeded. Finally, the regulatory and other policy implications of commercial satellite power generation initiatives by multinational corporations should be assessed in order to permit formulation of appropriate national and international regulatory response. As solar power satellite technology progresses through experimental and demonstration phases, the need for further elaboration of existing space law to create optimum conditions for the establishment of commercial solar power systems should be fully examined.

4.5.4 Legality of Orbital Weapons Systems for the Protection of Satellite Power Systems

Interpretation of Articles I and IV leads to the conclusion that the establishment of orbital weapons systems for the purpose of protecting satellite power systems against attack is permitted, provided they do not incorporate weapons capable of aggressive use on a massive scale. However, in light of the possibility that launching states may establish orbital military installations as a means of protecting large-scale structures in space, including solar power satellites, alternative means of balancing the need for protection against the desire to minimize militarization of outer space should be assessed.

Thus, although international space provides a substantial basis for the establishment and operation of satellite power systems, a number of shortcomings represent potential obstacles. Consequently, in order to ensure that legal and policy development on both the national and international levels keeps pace with the technical program, a series of examinations of various legal and policy aspects of satellite power systems should be undertaken in the near future. Increasing demand and increasing cost of energy from traditional sources emphasize the need for careful examination of innovative applications of technology to meet global energy requirements. The history of the utilization of outer space for the benefit of mankind has clearly indicated the need for careful planning on both the technical and policy levels to ensure optimum development of technology and maximum realization of benefits. As satellite power systems come closer to reality, these lessons ought not to be forgotten.

4.6 Trends in Space Rights

SPS is a system which would not be operational for quite a while, perhaps two to three decades, and with its major period of implementation occurring perhaps over the period 2000 to 2050. What should be of concern, therefore, is not so much the current interpretations of existing texts, but the trends in doctrine and interpretation--as clues to what "international law" on this subject might look like 20 years from now. We are interested as much in the World Administrative Radio Conference of 1989, and 19c , as we are in the WARC that is just around the corner, in 1979.

The need to peer farther into the future is reinforced by the observation that the existing doctrine, and the treaties and resolutions that reflect it, are essentially the work of lawyers for the industrially advanced countries, especially the two major space powers. The latecomers to the game of international politics have already shown that they do not feel bound by laws and concepts which they did not participate in creating. In international business, contracts are obviously not as sacred as they were once thought to be.

The sluggish progress of the "North-South dialogue" does not suggest that revolutionary change is in the wind. But compared to 20 years ago, some very large doctrinal changes have come about in international law and the practice of international institutions. Twenty years from now, much of the detailed argumentation presented above will seem arcane and academic.

At least seven trends are currently visible to the naked analytical eye. Together they suggest the political and legal climate in which Space Power Systems would have to be born, and survive infancy.

4.6.1 Fairness and Equity

Until recently, the measure of success in national development was growth, as measured by a rising GNP. Now a global fairness revolution has brought equity considerations up alongside growth as a factor in development strategy and international economic relations. In international institutions as disparate as the International Monetary Fund and the proposed seabed-mining enterprise, the doctrine is that international operations should, in effect, make disproportionate profits for the poorer nations. The same is true of discussions about a "common fund" for commodity stabilization, of negotiations for changes in the rules of trade, and of proposals for diverting to developing nations the savings from arms reduction.

The fairness revolution has also begun to relate international economic cooperation and development assistance to the meeting of basic human needs inside countries. In other words, the earlier notion that poor countries should be helped because they are poor is already being elbowed aside by the doctrine that the object of national development strategies and supportive international action should be poor people.

Space rights, as they affect an SPS, are likely to rest not so much on past treaties as on future bargains that create obligations to act more positively "for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development" (Outer Space Treaty, Article I).

4.6.2 "Freedom"

Traditional "freedoms"--of the seas, of communications, of travel, of investment, of trade, of scientific research--have been eroded by nonobservance of previously accepted norms of behavior by newcomers to the behavior pattern. The older members of the international community have been gradually accommodating to the complaints of the newcomers: the oldtimers have swallowed a great deal of expropriation, an oil cartel, the principle that trade discrimination is good if it favors the poor, the creation of economic zones far out into "international waters" (on that, the United States followed the charismatic leadership of Peru and Ecuador), and sterner regulation of multinational corporations based in the industrial nations. From the point of view of the newcomers--and they are increasingly making their point of view effective--the earlier "freedoms" were grants of rights without obligations to nations with the technological competence to exploit the freedom. The market was always rigged; the newcomers are not objecting to a rigged market, but merely insisting that it be rerigged in their favor to achieve a more equitable balance.

The present regime in outer space was created by analogy to "freedom of the seas." But the oceans will sooner or later be organized and regulated by international institutions--and so will earth-based activities in outer space.

4.6.3 "Common Heritage"

By the same token, the doctrine of international responsibility for international "commons" has taken hold very fast, and will probably be an important feature of the legal/political landscape 20 years from now. So far, the "commons" idea has been applied to environments where national claims to sovereign jurisdiction had not been strongly pressed--the high seas, Antarctica, outer space and celestial bodies. But it is quite conceivable that over a 20-year span, many of the leaders of the less well endowed countries could rationally conclude that all natural resources are "gifts from God" to mankind, not to the people who happen as of 1977 to have conquered or inherited them.

"Sovereignty over natural resources" has been the developing nation's backward-looking battle-cry in the rhetoric of the New International Economic Order. But "the forward-looking interest of most geographically smaller countries would clearly be to maximize the international jurisdiction over (and therefore their own participation in decisions about) the key world resources they will need, but do not own, for their own development--oil, coal, iron, copper, uranium, manganese, nickel, and the rest."[107]

In such a climate, the pressure from the world's majorities in every international institution will be to make space power systems profitable for all the "stockholders" in the international commons.

4.6.4 Transnational Enterprise

Two distinctions important in our inherited concepts of international law are becoming blurred in the practice of intergovernmental institutions and nongovernmental actors in transnational relations. One is the distinction between "private" and "public." The term "multinational corporation" is used to imply some identifiable degree of privateness. But there now exists a good many multinational enterprises which are, by intent or in effect, socialized companies: this is obviously true of enterprises sponsored by communist and other totalitarian governments; but the heavy government investment in a Lockheed Corporation, and the Congressional parentage of a COMSAT, are also blurring the line between "public" and "private". What is already developing is a community of transnational enterprises which operate beyond the reach of any one government and are not yet effectively the object of international governance.

It seems likely that multinational enterprises will be important, perhaps even central, in the development of operational Satellite Power

Systems. But it also seems likely that by the time they are operational, the enterprises that are big enough and efficient enough to take on the tasks involved will be so "affected with the public interest" that most of our current law and practice, based on concepts of private ownership and control, will have given way to a pattern of international enterprise regulated by intergovernmental agreements and institutions.

4.6.5 Internationalization of Internal Affairs, and Vice Versa

The second distinction which is blurring fast is that between "domestic" and "foreign" policies, or between "internal" and "international" affairs. President Carter's new emphasis on human rights ("...no member of the United Nations can claim that mistreatment of its citizens is solely its own business," he said at the U.N. on March 18, 1977) is only the most dramatic case in a crowd of current precedents. A nation's policies and practices on such subjects as internal economic and monetary management, export promotion and tariffs, population, environmental protection, public health, experimental organisms, weather modification, nuclear energy, narcotics, and the meeting of s own people's human needs are already the subject of international agreements and in some cases of international regulatory bodies.

Paralleling the internationalization of internal affairs is the tendency to fashion "domestic" policies in the perspective of their international impacts. Every major institution in our society--corporations and their associations, organized labor, farm organizations, foundations and nonprofit enterprise, school systems, colleges and universities, educational associations, and governments, municipal and state as well as federal--is currently engaged in pervasive shifts of policy and practice in the effort to "cope with interdependence."[108]

In these circumstances the bargaining about access to and benefits from outer space is not likely to remain the province of experts in a comparatively few governments and corporations.

4.6.6 Decision Making About "Limits"

Somewhere near the center of contemporary international relations is an emerging ethic of ecology which will produce during the next generation new negotiated and administered limits to the behavior of nations and the people subject to their jurisdiction. International agreements, and institutions to match, will likely be created, or adapted, to make sure mankind as a whole stays well inside seven kinds of "limits" on which there is already the beginning of a consensus.

1. A system for establishing and reviewing international standards for individual entitlement to food, health, education and any other agreed components of "minimum human needs"; and for relating international economic cooperation, including "aid," to progress toward those standards.

2. A system for international review and monitoring of national decisions about growth, affluence and waste in the more developed countries.

3. A system that negotiates and monitors agreed standards of air and water quality, and reviews national actions that pollute beyond national frontiers.

4. A system that keeps under review the damage and potential damage from man-made processes, and blows the whistle on those that may affect people beyond national frontiers.

5. A system that promotes exploration for, and keeps a world inventory of, nonrenewable resources that may be needed by people outside the nations where the resources happen to be found.

6. A system that monitors world production of food and fibers; seeks international agreements to limit overcropping, overgrazing, overcutting and overfishing; and provides for the exchange of timely information on national harvests and food requirements.

7. A system that limits armed conflict by international conciliation and mediation, the deployment of peacekeeping forces, and (through arms control) the institutionalization of military uncertainty (that is, deterrence) at the lowest possible cost.

None of these trends will run in a straight line; all of the resulting institutions will be messy, pluralistic, capricious, political--in other words, expressions of governance in a world where nobody is in charge. Space systems will play a part in this growing web of international information gathering, international monitoring and international regulation. Already the geostationary orbit has come to be regarded as a limited natural resource. Long before a satellite power system is ready to launch, there is likely to be a widespread assumption that so important a development, depending so crucially on occupancy of a limited area of outerspace "commons," should be effectively international from the start.

4.6.7 Participation and Openness

The trend in modern large-scale management is to flatten out the traditional pyramids, with their recommendations-up-and-orders-down processes, into horizontal "systems" in which more and more of the key relationships are lateral, and more and more of the key decisions are collegial and consensual. A similar trend is already strong in international decision making.

In a horizontal system so many people are somehow involved, and the complexity becomes so great, that certain modes of operation are imperative. Secrecy in a small in-group simply doesn't work; information about goals and processes has to be widely shared. Voting arrangements, which divide people on issues of principle, inhibit getting on with the job, so consensus systems develop which bring people to take "next steps" together even if they go on arguing about ideology; this trend is now very clear in many units of the UN system. In economic arrangements, producers find they cannot retain essentially exclusive jurisdiction over decisions about the price and supply of what they offer for sale; consumers assert the right to help make those decisions. (The United States is asserting this doctrine of international consumerism in current discussions with OPEC on oil; one of these days, the major consumers of food may take our doctrine seriously and ask us to open up to their participation U.S. decisions on farm subsidies and agricultural production quotas.)

This cannot mean that everybody has to be in on every decision. In practice, the global institutions already work by caucus, and through small-group negotiating teams: the bargaining about the final resolution from the Seventh Special Session of the U.N. General Assembly (which converted the North-South confrontation into a North-South dialogue) took place among seven people in a group which never had a name. What will probably tend to develop will be two-tier systems--the operations (and most of the investment) in the hands of a community of the concerned, who in turn perceive an obligation to report to, consult with, and on some matters even seek the ratification of, larger bodies representing the rest of what Article I of the Outer Space Treaty calls "all mankind." It would be wise to plan from the start for a fully international system to develop the generation of power in space, and avoid the INTELSAT experience of starting on a too-American basis and being pushed to internationalize the system by the other participants in what was always bound to be an international system to govern an inherently global technology.

Section 4 Footnotes

1. See, e.g., Dr. Peter E. Glaser, Perspectives on Satellite Solar Power, American Institute of Astronautics and Aeronautics Paper No. 72-352 (1977), at 1-2 (hereinafter cited as Glaser, Perspectives); Testimony of Dr. Peter E. Glaser, Hearings Before the Subcommittee on Aerospace Technology and National Needs of the Senate Committee on Aeronautical and Space Sciences, 94th Congress, Second Session, at 9-11 (1976) (hereinafter cited as Glaser, Testimony); G. F. von Thiesenhausen, Photovoltaic and Thermal Energy Conversion for Solar Powered Satellites, International Astronautical Federation Paper No. IAF-76-117 (1976), at 1; J. R. Williams, Solar Energy: Technology and Applications 93-97 (1974).

2. See AIAA Technical Committee on Electric Power Systems, Solar Energy for Earth: An AIAA Assessment 62, 64 (1975); von Thiesenhausen, supra note 1, at 3. For alternative orbital configurations suggested for a satellite power system, see Glaser, Perspectives, supra note 1, at 2 n. 2 and authority cited there.

3. On the potential for harm of various types resulting from contact with the transmission beam, see Glaser, Testimony, supra note 1, at 26-28; AIAA, Technical Committee on Electric Power Systems, supra note 2, at 68-69. The question of liability for such harm is discussed below in Section III G.

4. Glaser, Perspectives, supra note 1, at 93; J. R. Williams, supra note 1, at 93.

5. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, January 27, 1967, (1967) 18 U.S.T. 2410, T.I.A.S. 634, 610 U.N.T.S. 205, entered into force for the United States on October 10, 1967 (hereinafter referred to as the Outer Space Treaty).

6. See Section 4.1.1 (1.b) below.

7. H. Markoff, Disarmament and "Peaceful Purposes" Provisions in the 1967 Outer Space Treaty, 4 Journal of Space Law 3, 12 (1976).

8. P. Dembling and D. Arons, The Evolution of the Outer Space Treaty, 33 Journal of Air Law and Commerce 419, 429-30 (1967), and authority cited there.

9. Markoff, supra note 7, at 13-14; M. Markov, Implementing the Contractual Obligation of Art. I, Par. 1 of the Outer Space Treaty of 1967, in Proceedings of the Seventeenth Colloquium on the Law of Outer Space 136, 137 (1976); M. Dauses, The Relative Autonomy of Space Law, in Proceedings of the Eighteenth Colloquium on the Law of Outer Space 75, 79 (1976).

10. See E. Fasan, Utilization of Energy From Space--Some Legal Questions, in Proceedings of the Eighteenth Colloquium on the Law of Outer Space 2,3 (1976).

11. M. Markov, Implementing the Contractual Obligation of Art. I, Par. 1 of the Outer Space Treaty of 1967, in Proceedings of the Seventeenth Colloquium on the Law of Outer Space 136, 137-138 (1975).

12. The assertion by Colombia and other countries that the segment of the geostationary orbit which is situated vertically above equatorial states constitutes a natural resource over which the subjacent state is authorized to exercise sovereign control (see, e.g., U.N. Doc. A/C.1/PV. 2049, October 13, 1975, at 43-46) must be rejected as violating both the "free use" principle of Article I(2) and the nonappropriation principle of Article II of the Outer Space Treaty.

13. See, e.g., Treaty on Remote Sensing of Natural Resources by Means of Space Technology: Draft Basic Articles, Submitted jointly by Argentina and Brazil, U.N. Doc. A/C.1/1047 (1974), Arts. VII, VIII, XI and XII; Working Paper Submitted by France to the Second Session of the Working Group on Direct Broadcast Satellites, U.N. Doc. A/AC.105/62, June 30, 1969.

14. See, e.g. Markov, supra note 11, at 137-38.

15. See Revised Single Negotiating Text, Third United Nations Conference on the Law of the Sea, (1976), Part I.

16. See, e.g., B. Dudakov, International Legal Problems in the Use of the Geostationary Orbit, in Proceedings of the Fifteenth Colloquium on the Law of Outer Space 71 (1973).

17. G. Reintanz, Some Remarks on Space Activities Which May Have Harmful Effects on the Environment, in Proceedings of the Fifteenth Colloquium on the Law of Outer Space 277, 278 (1973); B. Dudakov, International Legal Problems in the Use of the Geostationary Orbit, in id., at 71-72.

18. S. Gorove, Interpreting Article II of the Outer Space Treaty, 37 Fordham Law Review 349 (1969). Professor Gorove adds a fourth issue relevant to general interpretation, namely whether any exercise of sovereign authority, use or occupation is permissible despite the prohibition of Article II. Id.

19. Dembling and Arons, supra note 8, at 431; E. Galloway, the Future of Space Law, in Proceedings of the Nineteenth Colloquium on the Law of Outer Space 2, 3 (1977).

20. Gorove, supra note 18, at 350.

21. Projected dimensions range from 11.73 kilometers in length and 4.33 kilometers in width, AIAA, supra note 2, at 61, to 18.41 kilometers by 7.01 kilometers, von Thiesenhausen, supra note 1, at 3.

22. See, e.g., Convention on the Continental Shelf, 499 U.N.T.S. 311 (1964), Art. 5(3).

23. Gorove, supra note 18, at 352.

24. E.g., W. von Kries, Legal Status of the Geostationary Orbit, in Proceedings of the Eighteenth Colloquium on the Law of Outer Space 27, 30 (1976).

25. Dudakov, supra note 17, at 71; Comment, Utilization of the Geostationary Orbit--A Need for Orbital Allocation, 13 Columbia Journal of Transnational Law 98, 100-101 (1974).

26. E.g., G. Hazelrigg, The Economic Viability of Pursuing a Space Power System Concept, American Institute of Aeronautics and Astronautics Paper No. 77-353 (1977) at 1; Glaser, Perspectives, supra note 1, at 11.

27. Gorove, supra note 18, at 351.

28. Gorove, The Outer Space Treaty, 23 Bulletin of Atomic Scientists 44, 45 (1967).

29. W. Jenks, Space Law 201 (1965).

30. Gorove, supra note 18, at 351-52.

31. Dudakov, supra note 17, at 71-72.

32. For a discussion of the scope and content of the consultation sions, see, e.g., J. Sztucki, International Consultations and Space Treaties, in Proceedings of the Eighteenth Colloquium on the Law of Outer Space 166-200 (1976); I. Herczeg, Provisions of the Space Treaties on Consultation, in Proceedings of the Seventeenth Colloquium on the Law of Outer Space 141-146 (1975). See also the discussion of Article IX in Section III N. below.

33. J. Busak, Geostationary Satellites and the Law, 39 Telecommunications Journal, 487 (1972) and authority cited there.

34. See, e.g., Comment, supra note 25, at 103 n. 30.

35. For an excellent discussion of the characteristics, capacity and technical considerations affecting the use of the geostationary orbit, see J. Gehrig Geostatonary Orbit--Technology and Law, in Proceedings of the Nineteenth Colloquium on the Law of Outer Space 267, 268-272 (1977).

36. See Partial Revision of the Radio Regulations, Geneva, 1959, November 8, 1963 (1964) 1 U.S.T. 887, T.I.A.S. No. 5603.

37. Comment, supra note 20, at 101; and Partial Revision of the Radio Regulations, supra note 36, Arts. 5, 9A.

38. E. Valters, Perspectives in the Emerging Law of Satellite Communications, 5 Stanford Journal of International Studies 53, 76-77 (1970).

39. Comment, supra note 25, at 102.

40. Id., at 104.

41. Id., at 107. For a summary record of the 1971 WARC-ST, see "The World Administrative Radio Conference for Space Telecommunications," 38 Telecommunications Journal 673-82 (1971).

42. In its revised form, Article 9A provided:

> Section I. Procedure for the Advance Publication of Information on Planned Satellites Systems.
>
> (1) An administration (or one acting on behalf of a group of named administrations) which intends to establish a satellite system shall, prior to the coordination procedure in accordance with No. 639 AJ where applicable, send to the International Frequency Registration Board not earlier than five years before the date of bringing into service each satellite network of the planned system, the information listed in Appendix 1B.
>
> Section II. Coordination Procedures to be Applied in Appropriate Cases.
>
> (1) Before an administration notifies to the Board or brings into use any frequency assignment to a space station on a geostationary satellite or to an earth station that is to communicate with a space station on a geostationary satellite, it shall effect coordination of the assignment with any other administration whose assignment in the same band for a space station on a geostationary satellite or for an earth station that communicates with a space station on a geostationary satellite is recorded in the Master Register, or has been coordinated or is being coordinated under the provisions of this paragraph. For this purpose, the administration requesting coordination shall send to any other such administration the information listed in Appendix 1A.

Final Acts of the World Administrative Radio Conference for Space Telecommunications, Geneva, 1971.

43. Regarding the role of the ITU and the IFRB in the management of the radio spectrum, see Comment, The Role of the International Telecommunications Union in the Settlement of Harmful Interference Disputes, 13 Columbia Journal of Transnational Law 82-97 (1974); D. Smith, International Telecommunication Control 29-35 (1969); D. Leive, Regulating the Use of the Radio Spectrum, 5 Stanford Journal of International Studies 21, 26-39 (1970).

44. Busak, supra note 33, at 480.

45. Gehrig, supra note 35, at 273.

46. See Busak, supra note 33, at 489.

47. Comment, supra note 25, at 107.

48. International Telecommunication Convention (Malaga-Torremolinos 1973).

49. Comment, supra note 25, at 103 n. 33.

50. von Kries, supra note 24, at 33.

51. The agenda for the WARC-BS is reported in "Broadcasting Satellite Conference," 43 Telecommunications Journal 703 (1976); see also ITU Broadcasting Satellite Conference, Document No. 181-E submitted by Australia, January 31, 1977, at 1.

52. U.N. Doc. A/C.1/PV. 2049, October 13, 1975, at 43-46.

53. See ITU Broadcasting Satellite Conference Paper No. 229-E submitted by Ecuador, February 4, 1977, at 1.

54. "Meeting of the CCIR Study Groups Joint Working Party for the 1977 WARC-BS (12 GHz Band)." 43 Telecommunications Journal 613, 614 (1976).

55. Id.

56. "WARC: It Appears 'Basic Interest' Was Protected," Broadcasting, February 21, 1977, at 71-72.

57. The agenda of any WARC may be changed in accordance with Nos. 219-221 of the International Telecommunication Convention.

58. "31st Session of ITU Administrative Council," 43 Telecommunication Journal 565 (1976).

59. See the text accompanying notes 42-43 above.

60. For a comprehensive discussion of these experiments, see D. Smith, Communication Satellite Services: Speculative Visions Chs. 8 and 9 (to be published in 1977).

61. See, e.g., "NASA Administrator and Japanese Space Officials Meet," 42 Telecommunications Journal 48 (1975); "Japan Satcom Design Contract," in id., at 363.

62. A. Wheelon, "How Worldwide Communication Satellite Services Will Expand in Next Decade," Communication News, January 1976, at 16.

63. Id., at 17.

64. Id.

65. See, e.g., P. Glaser, Perspectives on Satellite Solar Power, American Institute of Astronautics and Aeronautics. Paper No. 77-352 (1977), at 3 (1977) [hereinafter cited as Glaser, Perspectives].

66. E.g., International Problems Arising From the Exploitation of Solar and Other Related Energies, Working Paper Submitted by Argentina to the Eighteenth Session of the Committee on the Peaceful Uses of Outer Space, U.S. Doc. A/AC.105/C.91 (1976), at 10; A. Cocca, Solar and Other Related Energies and Their Impact Upon Space Law, International Astronautical Federation Paper No. IAF-ISL-76-19 (1976), at 3.

67. Id.

68. E.g., M. Markoff, Disarmament and "Peaceful Purposes" Provisions in the 1967 Outer Space Treaty, 4 Journal of Space Law, 3-22 (1976); M. Markoff, implementing the Contractual Obligation of Art. I, Par. 1 of the Outer Space Treaty of 1967, in Proceedings of the Seventeenth Colloquium on the Law of Outer Space 136, 139 (1975); M. Niciu, What is the Meaning of the Use of Cosmos Exclusively for Peaceful Purposes, in id., at 224, 228.

69. The validity of this assumption is central to the subject matter of Section 4.5 below and is examined more fully there.

70. See, e.g., Markoff, supra note 64, at 6-8; M. Dauses, The Relative Autonomy of Space Law, in Proceedings of the Eighteenth Colloquium on the Law of Outer Space 75, 78-79 (1976).

71. United Nations Charter, Art. 51.

72. Q. Wright, Legality of Intervention Under the United Nations Charter, 1957 Proceedings of the American Society of International Law 79, 82-83; J. Brierly, Law of Nations 415 (6th ed. 1963); Oppenheim, 2 International Law 15 (H. Lauterpacht, ed., 7th ed. 1952).

73. W. Friedman, Intervention, Civil War and the Role of International Law, 1965 Proceedings of the American Society of International Law 69; Roling, International Law and the Maintenance of Peace, 4 Netherlands Yearbook of International Law 1 (1973); H. Lauterpacht, The Boycott in International Relations, 14 British Yearbook of International Law 125, 130, 139 (1933); Hyde, 2 International Law, Chiefly as Interpreted and Applied by the United States, 185-86 (1965).

74. E.g., Glaser, Perspectives, supra note 65, at 8.

75. E.g., id., at 3.

76. E.g., AIAA Technical Committee on Elective Power Systems, Solar Energy for Earth: An AIAA Assessment 69 (1975).

77. Article V of the 1967 Outer Space Treaty relating to the rescue and return of astronauts is not directly relevant to the consideration of legal aspects of satellite power systems.

78. P. Dembling and D. Arons, The Evolution of the Outer Space Treaty, 33 Journal of Air Law and Commerce 419, 436 (1967).

79. Id., at 437.

80. S. Estrade, The Utilization of Space as a Source of Energy for the Earth, in Proceedings of the Eighteenth Colloquium on the Law of Outer Space 7, 11 (1976).

81. Convention on International Liability for Damage Caused by Space Objects, March 29, 1972, 24 U.S.T. 2389, T.I.A.S. 7762, entered into force for the United States on October 9, 1973.

82. See, e.g., Glaser, Perspectives, supra note 65, at 8-10; AIAA Technical Committee on Electric Power Systems, supra note 21, at 69.

83. See I. Diederiks - Verschoor, The Convention on International Liability Caused by Space Objects, in Proceedings of the Fifteenth Colloquium on the Law of Outer Space 96 (1973).

84. Staff Report, Senate Committee on Aeronautical and Space Sciences, Convention on International Liability for Damage Caused by Space Objects: Analysis and Background Data, 92nd Congress, 2nd Session, 23-24 (1972).

85. Id., at 25.

86. Id., at 27.

87. Article IX provides:

> In the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies,

it shall undertake appropriate international consultantions before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon and other celestial bodies, may request consultation concerning the activity or experiment.

88. Dembling and Arons, supra note 78, at 441.

89. Id.

90. See the text in Section 4.1 accompanying footnotes 31-32, as well as the text in Section 4.2 accompanying footnotes 65-67.

91. See the text accompanying footnote 82.

92. J. Sztucki, International Consultations and Space Treaties, in Proceedings of the Eighteenth Colloquium on the Law of Outer Space 166, 180 (1976).

93. Id., at 183.

94. Id., at 177.

95. Id.

96. E.g., id., at 169, 174.

97. Id., at 184. However, when consultations fail to achieve the desired results, resort to the provisions of Chapter 6 of the United Nations Charter may be appropriate. I. Herczeg, Provisions of the Space Treaties on Consultation, in Proceedings of the Seventeenth Colloquium on the Law of Outer Space 141, 145 (1975).

98. Sztucki, supra note 101, at 183.

99. Herczeg, supra note 106, at 143.

100. See generally, D. Smith, Communications via Satellite: A Vision in Retrospect (1976).

101. See, e.g., S. 3759, 94th Congress, 2nd Session (1976); S. 672, 95th Congress, 1st Session (1977); Senate Committee on Aeronautical and Space Sciences, An Analysis of the Future Landsat Effort, 94th Congress, 2nd Session (1976).

102. See, e.g., Committee on the Peaceful Uses of Outer Space, Report of the Scientific and Technical Sub-Committee on the Work of its Thirteenth

Session 7-19, U.N. Doc. A/AC.105/170 (1976); Report of the Legal Sub-Committee on the Work of its Fifteenth Session 7 and Annex III, U.N. Doc. A/AC.105/171 (1976).

103. Address by Delbert D. Smith, "Communication Satellites: From Vision to Reality," Carnegie-Mellon University Conference on Retrospective Technology Assessment, December 2, 1976. See also P. Mann, The International Legal and Regulatory Status of a Space-Based Power System: Present and Future, 6-9, September 3, 1976 (ECON, Inc., Paper No. 76-145-3).

104. See U.S.S.R., "Model General Principles for the Use of Artificial Earth Satellites for Radio and Television Broadcasting," in U.N. General Assembly, Report of the Working Group in Direct Broadcast Satellites in its Work of its Third Session, U.N. Doc. A/AC.105/83 (1970), Annex IV, at 27, Par. 5; U.S.S.R., Draft Convention on Principles Governing the Use by States of Artificial Earth Satellites for Direct Television Broadcasting, in U.N. General Assembly, Report of the Working Group in Direct Broadcast Satellites on the Work of its Fourth Session, U.N. Doc. A/AC.105/117 (1973), Annex III, Art. XII.

105. Argentina and Brazil, Treaty on Remote Sensing of Natural Resources by Means of Space Technology: Draft Basic Articles, U.N. Doc. A/C.1/1047 (1074), Arts. IX-X, XIII.

106. See the text in Section 4.2 accompanying footnotes 68-70.

107. The Third Try at World Order, p. 60.

108. Coping with Interdependence, Final Report of the National Commission on Coping with Interdependence.

5. POLITICAL CONCERNS ABOUT SPS

The routine development and deployment of an SPS fleet imposes a variety of risks on foreign states. The alleviation of concerns regarding these risks is key to obtaining international acceptance of the system. In this section, the types of concerns potentially imposed by an SPS are identified. Then a basis for regulation of the system and alleviation of concerns is sought, first in existing treaties and organizations and then in potential unilateral and multinational actions.

The risks imposed by SPS fall into three broad areas: hazards to individuals and structures on the ground due to "space objects" falling to the ground, potential environmental impacts, and potential effects of the SPS power beam on other systems such as aircraft navigation systems that could indirectly impose risks on the users of these systems. A legal basis for requiring alleviation of resulting concerns exists in international law. Due to the nature of the problems, and the lack of understanding at present regarding the effects that SPS might have on the environment and on other systems, it will be necessary to conduct research in these areas. The results of the research programs would obtain added credibility if the research is performed on an international basis. In addition, clarification of issues regarding liability for damage caused by SPS-associated "space objects" will be necessary.

5.1 Potential Causes for Concern Imposed by an SPS

Apart from possible concerns over adaptation of SPS technology to military applications, the routine development, deployment and operation of SPS imposes a variety of risks on foreign states. These can be classified, as shown in Figure 5.1, into three categories: transportation and construction, microwave beam, and environmental impacts. A key area that is somewhat in question here is the area of environmental impacts which, at best, is presently little understood. Both this area and the effects of microwave (non-ionizing) radiation on biological matter (people, birds, plants, etc.) need to be addressed in major research efforts that should probably be conducted on an international basis to gain credibility.

Figure 5.1 identifies the major areas of potential adverse effects imposed by an SPS. This figure can be used as a guide to identify government agencies involvement in an SPS program from one point of view.

5.2 Review of Existing Treaties and Organizations

The development of space technology since the launching of Sputnik I in 1957 has rapidly outpaced the development of positive international norms to control and regulate the uses of outer space. Far more interesting legal questions have been raised by this onrush of technology than have been answered by the cumbersome law-making process of the international community.

The principal international vehicle for the creation of international legal norms governing the control and regulation of space has been the United Nations' Committee on the Peaceful Uses of Outer Space, established in 1958. The committee, as now established, has 37 members,[1] and generally meets once a year. The Committee is organized into two subcommittees of the whole, a Legal Sub-Committee and a Scientific and Technical Sub-Committee, that generally each meet once a year as well. Since its creation, the committee has operated on the basis of consensus. While this undoubtedly has slowed

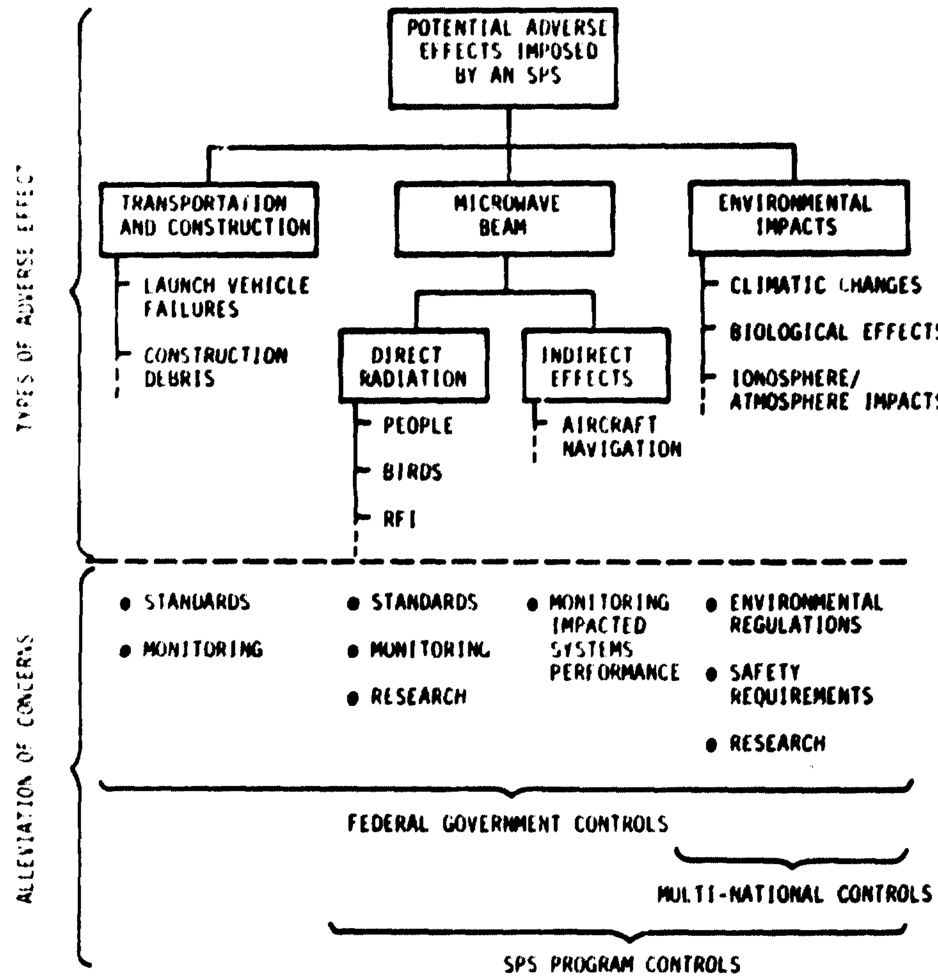

Figure 5.1 Types of Potential Concerns Imposed by an SPS and Their Alleviation

the pace of decision making and led to ambiguous and lowest common denominator drafting, it realistically recognizes the impact of national sovereignty and political power on international rule making.

Three products of the Committee on the Peaceful Uses of Outer Space especially bear on the issues of this subtask. The first is the General Assembly Resolution 1962 (XVIII), December 1963, "Declaration of Legal Principles Governing Activities of States in the Exploration and Use of Outer Space." This Declaration asserts, inter alia that:

> "1. The exploration and use of outer space shall be carried on for the benefit and in the interests of all mankind.
>
> "5. States bear international responsibility for national activities in outer space, whether carried on by governmental agencies, or by non-governmental entities, and for assuring that national activities are carried on in conformity with the principles set forth in this Declaration. The activities of non-governmental entities in outer space shall require authorization and continuing supervision by the State concerned...
>
> "6. In the exploration and use of outer space, States shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space with due regard for the corresponding interests of other States. If a State has reason to believe that an outer space activity or experiment planned by it or its nationals would cause potentially harmful interference with activities of other States in the peaceful exploration and use of outer space, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State which has reason to believe that an outer space activity or experiment planned by another State would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, may request consultation concerning the activity or experiment.
>
> "7. The State on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and any personnel thereon, while in outer space. Ownership of objects launched into outer space, and of their component parts, is not affected by their passage through outer space or by their return to the earth. Such objects or component parts found beyond the limits of the State of registry shall be returned to that State, which shall furnish identifying data upon request prior to return.

"8. Each State which launches or procures the launching of an object into outer space, and each State from whose territory or facility an object is launched, is internationally liable for damage to a foreign State or to its natural or juridicial persons by such object or its component parts on the earth, in air space, or in outer space."

The principles enumerated in this Declaration formed the basis for the Outer Space Treaty of 1966 which entered into force in 1967. The sections of this treaty which bear on the issues at hand are Articles 1, 2, 3, 4, 6, 7, 8, 9 and 11. Text and analysis of these articles is provided in Appendix C.

The third major product of the U.N. Committee on the Peaceful Uses of Outer Space that bears on the issues of this subtask is the Convention on International Liability for Damages Caused by Space Objects that entered into force in 1972. The relevant sections of this agreement are Articles 2, 3, 6, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19 and 21. Text of these articles is provided in Appendix A.

Beyond the limited positive international law examined here, there is very little other control and regulation of outer space activities that would bear on an SPS. The UN Committee on the Peaceful Uses of Outer Space has had under discussion for several years a range of other tropics including:

1. A draft treaty on the moon, principally concerning exploitation of lunar resources
2. A draft convention on the registration of objects launched into outer space
3. The regulation of direct broadcast satellites
4. Defining the precise boundary between airspace and outer space
5. The regulation and management of remote sensing of earth resources from outer space.

The pace of the committee on these topics has been slow, and although the Chairman has called its attention during its 1975 and 1976 meetings to the prospect of space-based solar power systems, it has evidenced no interest to date in examining these topics.

In addition to this relatively meager amount of positive international law bearing on these issues, there are a few more general provisions of international law that can be brought to bear on these on these issues. The most important is the treaty obligation involved in Article 2(4) of the UN Conference on the Human Environment.

Article 2(4) of the Charter declares that: "All Members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the Purpose of the United Nations." The Stockholm Declaration on the Environment adopted in 1972 declares, inter alia, that "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the respons ibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

5.3 Actions the U.S. Could take Unilaterally to Alleviate Political Concerns

With regard to risks identified in Section 5.1 imposed by routine uses of an SPS system, a series of unilateral U.S. actions are possible to assist in alleviating international concerns. With regard to those risks likely to arise from the launching and construction of an SPS system, for example, launch vehicle failures and the impact of construction debris, the following unilateral steps would be worth exploring:

- The launch facility could be constructed in an area where the critical flight path segments cross only U.S. territory or international waters. In such a case, a launch vehicle failure would be unlikely to have a significant international consequence.

- The U.S.could open the launch facility to international inspection to reassure states about such activities. This might well include a unilateral U.S. invitation to other states to share in all tracking data for every launch to remove any possibility of attempts to hide launch failures.

- The U.S. could agree to freely share with other states all test data on the launch vehicle and related quality assurance programs.

- The U.S. could announce in advance that it reaffirms its acceptance of the Convention on International Liability for Damages Caused by Space Objects and that it affirms that this Convention clearly covers any damage that might be caused by an SPS launch failure or SPS construction. This action could be strengthened by the simultaneous creation of a reserve fund to cover possible SPS claims.

- The U.S. could also augment its space tracking capability to enhance its ability to track SPS debris and agree to make the output of this system publically available.

- The U.S. could investigate "tagging" procedures for SPS components to assist in the unambiguous identification of any SPS debris.

The larger area of concern from an SPS concerns the operation of the microwave beam and associated environmental impacts. The major concerns here are simply over a lack of knowledge of the impacts of such a system. A large step toward clarifying the level of risk involved could be taken if the U.S. would immediately begin a research program, with funding appropriate to the problems, to investigate these impacts. To increase its contribution to alleviating international concern this research program might adopt some or all of the following characteristics:

- The research program could be formulated and/or reviewed by an international group of scientists, perhaps by an ICSU sponsored group.

- The research could be carried out in part by non-American scientists funded by the U.S. program.

- The U.S. could announce that all research data would be published as received to allow for timely critiques in the scientific community.

- The U.S. could set up a senior level international review body with clear decision criteria responsible for reviewing all data and making a "go/no-go" decision in reference to the impact data.

- The U.S. could establish a monitoring program responsible for the continuous assessment of an operational SPS system for the timely detection and analysis of any deleterious impact. Such a program could fund non-American, require full disclosure of data and have an international review and assessment function.

5.4 Multinational Actions that could be Taken to Alleviate Political Concerns

The alleviation of potential concerns from SPS operation through multinational arrangements is probably not an immediate, high order priority. This is the case because the Convention on International Liability for Damages Caused by Space Objects that entered into force in 1972 already covers a wide range of these concerns. This resulted from very meticulous negotiations and would appear adequate to cover a wide range of SPS concerns. It is possible that, with regard to potential environment impacts, additional multinational devices might be desirable. While the research efforts necessary to ascertain the range of impacts before the SPS system goes into operation are probably more easily obtained from unilateral activities, the maintenance of safe operating conditions in an operating system might be the appropriate subject of an international agreement. By setting forth in an international agreement design specifications for such critical elements as steering mechanisms and beam control, maintenance practices and other operating practices, some concerns might be alleviated. From the U.S. perspective, such standards, if sufficiently high, might also discourage "cut-rate" SPS designs from other space powers, although this may be a remote prospect in any case.

5.5 Issues for Follow-On Studies

Two principal types of additional work need to be done in this area. First, a more thorough identification and analysis needs to be made of the potential problem areas arising from deployment of an SPS fleet. One path worth pursuing would be a fault analysis and societal risk approach such as that recently employed in the analysis of the hazards arising in the nuclear fuel cycle. (cf. Societal Risk Approach to Safeguards Design and Evaluation, ERDA, Safeguards and Security Systems Branch, ERDA-7) This essentia in- volves an analytically rigorous effort to identify all possible hazards, identify their linkages with each other and to rank them according to the seriousness of the threat that they pose. Such an effort involves a detailed knowledge of the SPS design and should be pursued parallel with the design evolution. One obvious major hazard that needs immediate attention if SPS is to be a serious option is the range of possible environmental impacts of the system. Both the NEPA standards, as well as common prudence, requires that this area be vigorously investigated as soon as possible if SPS is to be considered as a serious energy option.

A second area in which additional work needs to be done concerns the various strategies for risk alleviation. While this study has sketched out in broad brush strokes a wide range of risk alleviation options, the time has not been available to explore in detail the full operation and implication of any of them. A logical next step would be to rank the various risk alleviation strategies against the hazards and to then develop a detailed analysis of those that are targeted on high priority hazards. For example, how would a multilateral inspection scheme to insure the peaceful character of an SPS actual operate or how would one go about establishing a multi- national consortium for SPS operation and what would be its implications?

It is furthermore clear that the problems encountered in alleviating concerns, and the approaches taken, would be quite different if the SPS was planned, from the beginning, as an international system. It is certainly worth examining the problems and issues raised here under the assumption that the SPS will be developed and implemented by an international organization such as INTELSAT.

Section 5: Footnotes

1. The 37 members of the Outer Space Committee are:

   Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chad, Chile, Czechoslovakia, Egypt, France, German Democratic Republic, Germany (Federal Republic of), Hungary, India, Indonesia, Iran, Italy, Japan, Kenya, Lebanon, Mexico, Mongolia, Morocco, Nigeria, Pakistan, Poland, Romania, Sierra Leone, Sudan, Sweden, USSR, United Kingdom, United States and Venezuela.

   The officers of the committee are the Chairman, Mr. Peter Jankowitsch (Austria), Vice-Chairman; Ion Datcu (Romania); and Rapporteur, Luiz Paulo Lindenberg Sette (Brazil).

6. INTERNATIONAL ECONOMIC AND POLITICAL IMPLICATIONS OF AN OPERATIONAL, ECONOMIC SPS TECHNOLOGY

Over the past five years, and most likely continuing over the next decade, no other resource topic has been discussed, analyzed, projected, and speculated about more than energy: its sources, technology and relation to current and future human needs. Since assessments of current energy problems diverge widely, it is understandable that, as projections are made further into the future, no true consensus exists on rational energy policy objectives, nor agreement on the facts underlying such policy and outlook. Nevertheless, the following sections outline some key considerations which are likely to hold for SPS technology, irrespective of the current wide disagreement on national or international energy policy objectives. Then a study plan is presented for a detailed, quantitative analysis of the issues identified.

Three major issues are surfaced in the following discussion. The first has to do with the geographical separation between fossil fuel resources and centers of demand. As these resources cross national boundaries, a trade flow is set up that can have considerable adverse economic impacts on the importing nations. In addition, the economic dependencies thus obtained are not always conducive to international stability and to world peace. The second issue deals with the transportation of bulky fossil fuels. Dependency on foreign supplies necessitates at least guaranteed access to, if not control of, the transportation routes. Finally, the third issue addresses worldwide per capita energy consumption. If the less developed countries are to develop, the implication is that their per capita energy consumption must rise significantly. This rise may not be possible given access only to fossil fuel energy. SPS shares with fusion perhaps the only potential for resolving these issues in the favor of energy importing nations and the less developed countries.

6.1 Current Dependence of Western Industrial Nations on Petroleum and Gas Imports

The current energy resource base in the United States and worldwide is fossil fuels. While, historically, coal has provided, and is still providing in some key regions, the major energy resource base, western industrial nations, for reasons of efficiency and economy, are largely relying on petroleum and natural gas to provide clean and efficient energy. Most of the known resources, however, lie outside western industrial nations, mostly in the Middle East, the Soviet Union, some regions of Africa, Southeast Asia and (recently discovered) in Mexico. The realizations by OPEC that oil and gas resources are finite, that in the short run OPEC operates in a "sellers" market, and just using principles of economic rationality, have led to sizable price increases since 1973 which can be expected to stay, under optimal pricing and sales strategies, at least at these levels.[1] Kalymon has suggested that under optimal pricing and sales strategies (also common to practices in industrialized nations) it is not in OPEC's economic self-interest to deplete its oil resources rapidly (that is, they should maintain a relatively high price per barrel). Thus, the current energy dependence of western industrial nations cannot be construed as due to the "evil designs" of a few policy makers that somehow can be negotiated away. Rather, the high prices associated with oil and gas resources existing today in fact reflect a long-term stable evaluation of the best economic self interests of the resource nations.

Under existing conditions, a substantial flow of funds will continue to OPEC nations. In the case of the United States alone, leaving oil imports roughly at the current levels, this means a daily inflow of seven million barrels per day, equivalent to an annual balance of payments impact of around $30 billion for the United States at today's oil prices. This constitutes about two percent of the GNP of the United States. As demonstrated by the oil crisis of 1973, the impact of a sudden cutoff of these supplies on an economic system are much more widespread (that is, the potential to inflict damage on the United States economy in the short run) than the figures and amounts above suggest. Fluctuations in random phenomena, such as weather, can already severely test the current resource base and economic balance of the United States, as shown in the winter of 1976-77.

The situation for other western industrial nations is an order of magnitude worse than that of the United States: With no significant domestic oil and gas resources, Western Europe and Japan (the latter in particular) depend almost exclusively on imports. Figure 6.1 shows, for reference purposes, the 1970 dependence of different nations on outside energy imports.[2] The figure lists population of individual nations versus the energy consumption in metric tons of coal equivalent on a log/log scale. If one were to define the energy consumption levels of the United States (or the Soviet Union) in absolute amounts as somehow representative of "great power" status and, similarly, the levels of energy consumption of members of the European economic community and Japan as representing "intermediate power" levels, the figure illustrates the drop in energy resource availability if each one of these nations or regions were shut off

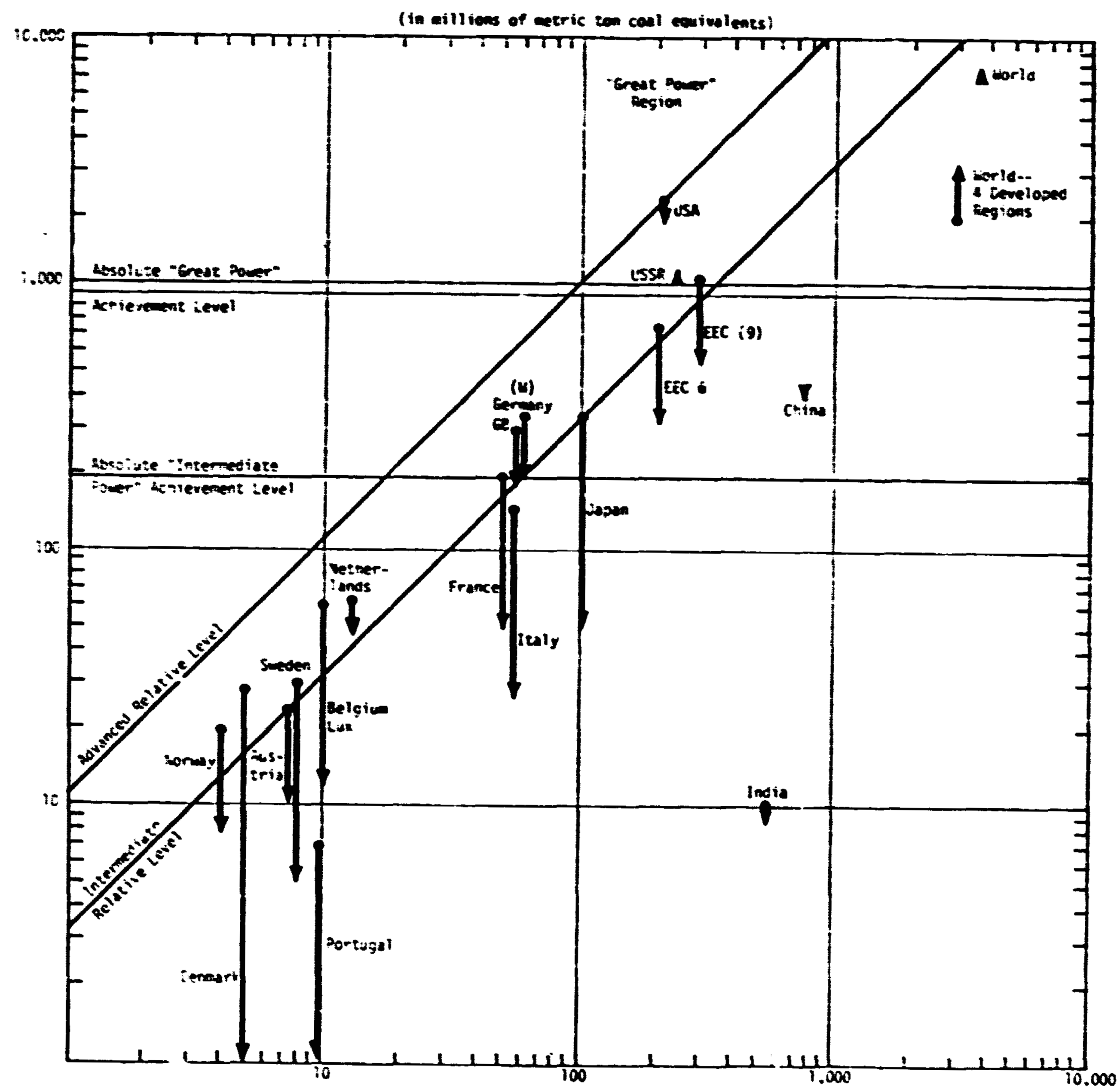

Figure 6.1 Energy Consumption, Production and Dependency by Major World Regions (Source: Heiss, Klaus P., Klaus Knorr, Oskar Morgenstern. Long Term Projections of Power: Political, Economic, and Military Forecasting. Cambridge: Ballinger Publishing Co., 1973.)

suddenly from its current importation from outside energy sources. In the case of the United States and the Soviet Union (and China) these effects--though possibly severe in the short run--are shown to have no long-term lasting impact. However, on Western Europe and Japan, key members of western industrial society, the effects would be severe, in some cases extremely severe, relegating nations like Japan, for example, to the status of at most an intermediate, less developed country.

This dependence leads to a continuing flow of economic resources ($30 billion a year in the case of the United States) to the energy source countries. While in the case of the United States, other medium- to long-term options are clearly available, the United States also has to take into account the fate of other western industrial nations in worldwide economic developments, given the high interdependence of <u>all</u> economic systems in international trade and other relations (for example, resources allocated to common defense).

6.2 Control of Transportation Routes

Another noteworthy fact is that, in addition to the energy source countries and their enhanced economic and political position in the foreseeable future, fossil energy sources <u>have to be transported to the consuming nations</u>. Hence, the control or avoidance of interference into world trade transport routes is equally important and has significant political, as well as economic implications. The fate of importing nations, in the case of a severe crisis, is not only determined by the energy source countries but also by the nations that control the transportation routes. In this case, clearly, the control and guarantee of oversea routes gives the United States a rather strong position in the foreseeable future.

However, such routes can be endangered, and at least temporarily influenced by even minor acts of irrationality. The exit of the Persian Gulf is one such example of a weak link which could be endangered.

The successful development of an SPS would constitute a dramatic realignment of economic interests and, in consequence, also political relations, essentially in the direction of the status quo ante: the situation before the oil embargo of 1973.

The large-scale deployment of an SPS fleet, a space-based technology, would in some sense increase the position of the United States in international relations for some time to come even if the fleet were developed under some multinational or international banner. It can be expected that the United States for some time will maintain a strong technological lead in space-based technology, extending over a wide variety of critical components necessary for the successful deployment and operation of SPS systems. Thus, it would give the United States a technology monopoly in terms of systems hardward, systems operations and know-how that other nations would probably find difficult to duplicate without the cooperation of the United States in several critical areas. Western Europe and Japan can be expected to also make rapid progress in SPS technology areas, and probably should openly compete for subsystems or even complete system components. However, the United States, in the foreseeable future, would still control one essential feature--the space transportation system--and, hence, the access, maintenance, deployment, as well as retrieval of SPS system components. The United States would have de facto control of the system.

In terms of the flow of monetary funds, a successful full-scale implementation of SPS could potentially lead to a "savings" of $30 billion of funds annually, if the current level of oil imports can be substituted by SPS-generated energy. However, in the context of the overall importance of energy in economic systems, this is a secondary consideration. In effect, for discussion purposes, a point could be made that the flow of $30 billion of funds from a highly advanced industrial nation to less developed areas comprising most of the OPEC countries may not be all that undesirable in the context of long-term development aspirations of nations. However, at the present time, much of these resources are returned to the United States and other developed nations in the form of arms purchases--a purpose with dubious benefits to the purchasing countries.

In terms of total flow of funds and resources, the successful development of SPS would, however, mean a dramatic qualitative change in resource requirements and, hence, also in economic dependencies. Taking the case of the United States, various energy consumption requirements can be projected over the next 75 to 100 years (with all the ensuing uncertainties as to the accuracy of such projections). Using some of the current large models used by ERDA and other research organizations, energy consumption levels in monetary terms of between $700 billion and $1,000 billion or more annually, 75 to 100 years hence, seem not completely unreasonable in the context of current energy consumption patterns in the United States with minimal growth projections. The complete provision of energy, ultimately, through a highly economic SPS would have implications that go far beyond the current considerations about "outside" oil dependencies. A "cheap" SPS substituting for these rather large projected resource requirements would have implications to the United States to an extent that is not measureable to any accuracy. At best, one can consider the availability of an additional $700 billion in disposable resources in the United States as an extremely challenging task

6.3 Industrial versus Less Developed Countries: The Equitable Access To Limited Energy Resources

Each of the above considerations we believe to be, in the long run, secondary to an even larger and even more important issue. If one accepts the premise that energy consumption--hopefully less wasteful than currently in the United States--is an underlying necessary condition to the economic development of industrial societies, the provision and development of an inexhaustible energy source, available to all nations, has to be seen in an entirely different context. Table 6.1 lists energy production and consumption for several world regions, including the United States and the European economic community, as well as worldwide data for 1970.[3] The calculations shown in this table are simple: taking the per capita energy consumption of the United States in 1970 as the standard (a premise many would dispute as an efficient pattern of energy use), similar levels of potential energy consumption are calculated for different regions such as the Soviet Union, the EEC, Japan and the world. It might be reasonable, on the other extreme, to submit that the energy consumption levels in the United States in 1970 were 50 percent higher than efficient energy use patterns would require. In this case, assume that by the year 2000, with even minimal growth in energy use requirements, the 1970 level of energy consumption in the United States is an "efficient" (that is, not wasteful) per capita energy use pattern for the year 2000. That is, energy use efficiency in the United States by the year 2000 would be increased two-fold, a rather audacious assumption. By taking these numbers or "projections" to the year 2000, the table points out that with no population

Table 6.1 Energy Production/Consumption by Major Regions

Total(in 10^6 metric tons of coal equivalents)
Per Capita(in metric tons of coal equivalents)
1970

	Energy					"Potential - 1970" Consumption at U.S. Rate 1970		
Region	Population	Production	Consumption	Per Capita Consumption	Actual Deficit Prod.-Cons.	Potential	GAP Actual-Potential Consumption	% Actual
United States	205	2,054	2,282	11.1	-228	n.a.	n.a.	
Soviet Union	243	1,213	1,079	4.4	+	2,697	-1,618	40
EEC (6)*	188	321	777	4.1	-456	2,087	-1,310	37
EEC (9)**	284	514	1,228	4.3	-714	3,152	-1,924	39
Japan	104	55	332	3.2	-277	1,154	- 882	29
China	760	420	426	.5	+	8,436	-8,010	5
World	3,707	7,000	6,843	1.8	+	41,148	-34,305	
World	2,871	3,164	1,922	.7	+	31,868	-29,946	6
4 Regions								

n.a. = not applicable

*6 Countries

**9 Countries

Source: Heiss, Klaus P., Klaus Knorr, Oskar Morgenstern. Long Term Projections of Power: Political, Economic, and Military Forecasting. Cambridge: Ballinger Publishing Co., 1973.

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growth worldwide, a dramatic discrepancy exists between developed industrial nations and less developed countries in the production and use of energy resources worldwide. While the actual energy production in 1970 was about 7 billion metric tons of coal equivalents, the extension of the identical standard worldwide would have required a production of energy resources equivalent to 41 billion metric tons, a clearly impossible level of fossil energy resource production, even if these resources were available to these nations.

What this points out, in rough outline, is that over the next several decades severe conflicts will develop between the interests of industrial societies and the interests of less developed regions of the world, with regard to access to energy resources, their disposition and their use worldwide. Since population worldwide is not a static phenomenon, the conflict of interest with regard to access and the use of energy resources outlined in Table 6.1 can only be exacerbated. We see no feasible development of current fossil or even fission-based technology, with ensuing waste disposal and proliferation issues, that can satisfy the aspirations of all nations, with regard to access to energy sources, whatever the ingenuity of economic, political and technical arrangements might be. Concurrent with this large, substantive gap between industrial and less developed nations, many other already existing social conflicts can only worsen. To some extent, the current conflict between industrial and less developed nations may already be but a reflection of the inequitable access to energy sources by these diverse nations: While industrial nations, even without access to their own fossil energy sources, can pay in real terms to the few nations that are in possession of such resources, less developed countries outside of OPEC have neither the energy resources nor the economic resources to pay for the importation of energy. It is a dilemma that cannot be solved, no matter how generous a foreign aid program might be agreed upon.

While this is not advocating the SPS as "the" ultimate promise to solve all problems, which it clearly will not, the SPS is clearly one of a very few inexhaustible energy alternatives presently under consideration for development. Other technologies along these lines would include fusion and possibly OTEC (ocean thermal). What makes SPS attractive in this general context is that the technical principles of SPS are clearly known and demonstrated to produce a net energy output--something not yet achieved in the area of fusion technology--and there is also an assurance that at some known upper cost limit, say \$20 to \$40 billion per SPS unit, indeed such energy systems can be constructed, deployed and operated. The development of SPS prototype programs in total cost may amount to just the budget of one year's funds expended today by the United States on oil imports: \$30 to \$40 billion.

6.4 Future Study Topics

A study to evaluate the benefits of SPS in international trade would seek to quantify the issues discussed above. The work would focus in five task areas described below.

Task 1. World Energy Forecasting Models

This task would address the imports and exports of energy to the United States and other nations during the time period of interest. A number of energy supply and demand models exist. These models would be reviewed and one or more of the most appropriate models selected for use. The objective will be to obtain a capability to forecast energy supply and demand by nation or region over, say, the next 50 years, subject to a number of different assumptions on resource supply, economic growth of developing nations, and the development of new energy technologies. The selected model(s) would be modified as necessary to determine the impact of an SPS on energy flow worldwide.

Task 2. The Impact of SPS on International Energy Markets

The energy supply and demand forecasting models developed under Task 1 would be exercised to determine the impact of SPS on world energy consumption, subject, parametrically, to assumptions on the cost and supply as a function of time of SPS-generated power, and on the availability of alternative energy sources such as fusion. The result of this task would be projections of energy imports and exports by the United States and by other nations or world regions, as a function of time, both with and without SPS. The differences due to SPS would then be identified.

Task 3. Benefits of SPS in International Trade

This task would quantify the economic benefits of SPS in international trade associated with the impact that SPS would have on world energy imports and exports as obtained from Task 2. It is observed that SPS could result in enormous increases in disposable resources in the United States. This task would translate that increase into a net welfare to U.S. society.

Task 4. The Impact of SPS on Energy Distribution

It is observed that energy resources are not often located in energy consuming areas. This is a particularly key problem for developing nations that cannot pay to import energy and yet have no significant energy resources within their boundaries. This task would analyze the impact of SPS technology on the potential energy supply for the developing nations and the resultant change in their rate of development The impact of these changes on the United States in terms of imports andexport markets for non-energy commodities, the requirements for national defense, and on the balance of power would be assessed.

Task 5. The Use of SPS for Peak Load Following

The requirements for electrical power vary as a function of the time of day and day of the year. In theory, at least, it would be possible with an SPS fleet (perhaps using orbits other than geosynchronous) to follow the peak power loads around the world, north and south hemispheres, as a function of the time of day and day of the year. This could effectively increase the economic worth of the SPS. This task would identify the peak versus base loads of various regions of the world and then identify potential SPS-generated energy imports and exports as a function of time. It would then assess the incremental value of an SPS fleet given a load-following of the capability versus a "fixed" mode of operation, as a function of the differential costs of peak versus base load power generation.

Clearly, the impact of an SPS in international trade would be very extensive and a thorough study of this potential impact would itself be an extensive undertaking. The above tasks would quantify some of the more fundamental issues at a reasonable level of effort (one-to-two man years) and pave the way for a more substantive study to follow.

Section 6: Footnotes

1. Kalymon, B., Economic Incentives in OPEC Oil Pricing Policy, Journal of Development Economics, Volume II, No. 4, 1975.

2. Heiss, K.P.; Knorr, K. and Morgenstern, O., Long Term Projections of Power: Political, Economic, and Military Forecasting, Ballinger Publishing Company, Cambridge, Mass., 1973, p. 125.

3. Ibid, p. 123.

7. SPS PROGRAMMATIC PLANNING

This section considers a number of issues related to SPS programmatic planning in the framework of the United States Federal Government. First, an overview of long-range programs and government support is presented. Then a discussion of the funding of the magnetic containment fusion program is given. Finally, the insights presented are applied to the SPS program.

It is observed that the fusion research program was, for many years, relatively small and that only recently has it taken on the role of a major area of federal energy research and development. Concurrent with this transition, fusion research is being challenged by a number of competing programs. The SPS program compares only with the fusion program as it stands today. Relatively large funding levels would be required early in the program, while considerable uncertainty remains in the ultimate outcome of the endeavor. The requirement for large investments well before demonstration of concept feasibility places an added emphasis on economic, technical, environmental, and legal/institutional analyses for convincing relevant officials to support the program. SPS represents certain significant departures from present practice that will need to be accepted if the program is to proceed. SPS could represent man's first reliance on space for his daily needs. To obtain SPS will require a new role for man in space, as an active participant in a major new system. SPS will also represent a tendency toward centralized solar power during a time when the general trend is toward decentralization of energy production by the implementation of solar technologies.

7.1 Long-Range Programs and Government Support

A veteran manager of government R&D programs suggested several years ago that

> The strategy of developing a long-term technology is one of the most difficult problems the government faces. The pressure is always to concentrate on the near-term payoff. Yet we must proceed with advanced high-technology programs also--and have the faith and persistence to carry them through[1]

Although this was said in the context of the NASA/AEC NERVA (Nuclear Engine for Rocket Vehicle Application) program, similar complaints have been echoed by the managers of most large-scale government applied research and development programs. And the complaints are not without basis. Most recently, for example, the Carter Administration announced its intention to reduce funding for nuclear fusion research by $80 million from President Ford's final budget request of $513 million. This cut is said to reflect "the intention of Mr. Carter and his top energy officials to switch energy funding emphasis from long-term programs to ones that will show benefits within a few years."[2]

It may be difficult to plan and carry out a long-range expensive, high-technology development program under government sponsorship, but it is not impossible. The Apollo program is a singular example of such success; in some ways, so is the light-water nuclear reactor program. This analysis attempts to identify some of the factors which relate to the possibility of successfully undertaking a large-scale enterprise and some of the barriers to such an undertaking.

This analysis argues, in the words of former NASA Administrator James E. Webb, that

> In our pluralistic society any major public undertaking requires for success, a working consensus among diverse individuals, groups, and interests. A decision to do a large, complex job cannot simply be reached "at the top" and then carried through. Only through an intricate process can a major undertaking be gotten underway, and only through a continuation of that process can it be kept going.[3]

Applied to the issue of how, in the context of federal funding and annual budgetary review, an SPS program might be initiated and carried through to a determination if such a program is in the national interest, such a viewpoint suggests that SPS programmatic planning must be understood in political, as well as economic and technical, terms. For "what distinguishes programs in government is not that some play politics and others do not, but, rather, that some are better at it than others.... Success requires skill in bureaucratic politics."[4]

At the outset, it should be clearly stated that the fact that budget reviews and subsequent allocation of resources on an annual basis would be characteristic of an SPS development program is not seen as a major issue. All R&D programs (except perhaps the most fundamental research) undergo some form of evaluation on at least an annual basis, whether the source of funds for those projects is government or industry. What is different, and problematic, is that the criteria used to evaluate a government-funded R&D project are broader than the criteria used to evaluate a privately funded project. In addition, the organizational context of government programs is quite different than in the private sector. Funding comes through a complex process involving interactions among agencies, the Presidency, and Congress. Elements of this process are open to outside scrutiny, intervention, and influence. Program management is the responsibility of officials either appointed by the President or answerable to such officials. This lends an overtly political dimension to program control (as it should in a democratic government). Congressional oversight of administrative performance is also a constant reality. From this perspective, program planning is a "dynamic process by which both inside and outside interests arrive at a new balance of power"[5] which provides the basis of support for a large-scale program during its lifetime.

It should also be clear that the term political is not used here in a negative sense. Politics is seen as one system of conflict resolution, in the inevitable situation of different actors with different priorities competing for control over scarce resources. Politics is a means of establishing a set of priorities for allocating resources when no analytical criteria for priority setting exist.

It is particularly difficult, given the nature of the American political system, to gain initial approval of large-scale enterprises, the results of which will be long in coming. The time horizons of political leaders tend to be short, and there is constant pressure to allocate resources to undertakings with relatively quick payoffs. "Securing approval of a large or novel project generally requires a major campaign to generate support both inside and outside the government. One or more credible principle advocates, capable of attracting attention and support, are usually necessary."[6] The role of "policy entrepreneurs" has been frequently noted:

> In their quest for funding and political authority, they use every available weapon: pressure from various constituencies and groups, aggressive selling inside government, attracting Congressmen as innovators or as protectors (Congressmen who in turn often lobby other Congressmen),

> pressuring the White House as well as receiving pressure from the White House, and so on through a diverse range of opportunities and strategies.
>
> . . . .
>
> Priorities are established by aggressive entrepreneurs at the operating level of government. Programs prosper because energetic division directors build political support to withstand continuous attacks upon a program's resource base by competing claims.[7]

The problem of establishing and maintaining an adequate base of political support for a program is more difficult when program benefits will not be evident until a significant time after major resource commitments must be made. "Society needs as much assurance of success as it can have when it commits its resources in large amounts."[8] But, since it is in the nature of R&D programs that their outcomes are uncertain, some means must be found to minimize as many critical uncertainties as possible <u>before</u> major resource commitments are needed, and to assure program supporters that remaining uncertainties are being addressed in a logical manner. This is one of the areas in which intelligent program planning, coupled with close and open communication with the program's supporters (and potential or actual opponents), can have highest payoff.

One aspect of program planning peculiar to technology programs has been described as a "lead-time dilemma." This is the problem posed by the necessity for decisions on future phases of R&D programs prior to the completion and evaluation of current phases. In this situation, there is strong pressure on program managers for some demonstration of what is being accomplished. In providing such demonstrations, "care must be exercised that the accumulation of these contrived performance data does not distort the operating system or swerve it from its major goal."[9]

There are other dangers in attempting to provide early demonstrations of program results. Large-scale enterprises tend to be subject to a "double standard" on the basis of which "mistakes are heavily taxed." Webb notes that "the reporting of successes and failures is frequently keyed to the spectacular or controversial. Since continued support usually depends on results, failures or the sensational forecasts of failures reduce internal self-confidence and undermine the essential element of external support."[10]

A constant danger of federally supported R&D programs is that they will be perpetuated, rather than completed. It appears to be easier "to initiate development programs than to terminate or complete them." From a program's perspective, perpetuation may be better than death, but it is "usually akin to chronic ill health and malnutrition."[11] This suggests the importance of achieving enough support not only for program initiation but also, and particularly, for vitality throughout a program's lifetime.

In order to gain and keep support, a program's managers may have to adopt a mix of strategies keyed to the various interests which compose the supporting coalition. One approach may be taken toward mobilizing support within the technical community; another, with respect to other elements of the agency within which the program operates and with other elements of the bureaucracy; a third, with respect to the White House, OMB, and other parts of the Executive Office; a fourth, and probably very different, strategy with respect to Congress; and perhaps another approach for potential users of the program's results, especially in situations where those users are outside the government, as is the case for SPS. In each situation, it is the task of the program manager and his agency superiors to match program objectives and potential results to the needs and interests of potential supporters.

Such a matching process is "political," but political factors are part of the environment of a government-funded program as much as are technical and economic factors. Making political bargains and commitments is an essential part of the executive's task. Webb remarks:

> Can the executive in charge simply point to his mandate to do a good job and demand that he be given what he needs to carry it on to completion? The executive who stands too firm in this posture is almost certain to fail. The sophisticated might say that the executive willing to make adjustments is little better off, since he becomes a bargainer likely to compromise the essence of the endeavor. While this may be true, it should not be true. An executive can extend the art of the possible to that of the best possible.[12]

Various approaches are available to creating and maintaining support for a program within its bureaucratic environment. Sapolsky, in his analysis of the Polaris system development, identifies four such strategies.

1. Differentiation: "attempts of organizations to establish unchallengable claims on valued resources by distinguishing their own products or programs from those of their competitors"

2. Co-optation: "attempts of an organization to absorb new elements into its leadership or policy-determining structure ... as a means of averting threats to its stability or existence"

3. Moderation: "attempts of organizations to build long-term support for their programs by sacrificing short-term gains"

4. Managerial innovation: "attempts of an organization to achieve autonomy in the direction of a complex and risky program through the introduction of managerial techniques that appear to indicate unique managerial competence."[13]

It is relatively straightforward to see how these strategies could be employed in the context of any large-scale program. The primary goal of such strategies is "uncertainty control," that is, control over outcomes which might be influenced by actors in an organization's environment. It is a tendency of all organizations to "seek self-control or the ability to act independent of environmental forces."[14]

The process of getting and keeping the support of Congress for a large-scale enterprise is rather different, as one might assume given the difference between the bureaucratic structure of the executive branch and the nonmonolithic, nonhierarchial characteristics of Congress. An acknowledged master at agency-Congressional relations is James Webb, and it is probably not possible to improve on his analysis of how to make that relationship work.

> A major concern of every large-scale endeavor is securing from the Congress the continuing support necessary for specific projects and the buildup and maintenance of momentum. More than has been generally recognized, assured continuity of support is of critical importance to the large, complex endeavor, particularly where the time span between the inception and achievement of goals is long. Once the endeavor has been planned and is under way, it cannot interrupt the established pattern without severe losses. Yet the endeavor, like any other government undertaking, is subject to the normal budget authorization-appropriation process. This process and the urgent need for continuity keep the endeavor and its executives continuously under the gun.
>
> Given our governmental processes, there obviously can be no guarantee and no certainty from one budget period to another that funds will be appropriated. The criteria for judging the endeavor--from the standpoint of relative urgency of goals and worth of performance--are subject to quick and far-reaching changes. It is entirely possible that an endeavor that had been strongly and enthusiastically endorsed on all sides at its inception and was making good progress toward its goals might suddenly find itself in support trouble as a result of changes completely beyond its own control. An important factor may involve changes in the public mood--changes in basic public attitudes toward the goals being sought. Congress is highly sensitive to such changes, and as endeavors become more and more complex, a greater and greater degree of confidence and trust is required to maintain essential levels of support.
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> . . . .
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> The successful executive will accept that the basic purpose of Congress and its leaders is the same as his own: the furtherance

of the national interest. He will avoid the pitfall of assuming that the Congress is on one side and he on another. He will avoid taking unalterable positions and stances. Above the "line" he has drawn he will compromise when this is clearly necessary and when he can do so without violence to his own and the endeavor's integrity. If he is forced downward toward his line, he will resist and make clear that he will not cross it.

The successful executive will readily accede to congressional participation in areas where its committees or members have a proper concern. He will, in fact, welcome and facilitate this participation. He will not let fear of influence or efforts to control paralyze his ability to work with and draw strength from congressional counsel and assistance. He will recognize that a stand-off attitude toward Congress--as a whole, to its committees, or to interested members--is the surest way to create problems.

More is required than simply keeping the Congress informed of what is going on. The executive and his associates must have an ability to sense the congressional pulse and to adjust to the implications of changes in moods and attitudes. A successful large-scale endeavor must have adequate means for letting Congress know what is going on and obtaining a continuing feedback from Congress, and the feedback cannot be limited to the requirements of the endeavor as a whole or to just enough to satisfy the needs of its chief executive. It must be available and usable at every level of the organization.

Congressional commitment to large endeavors can be seriously undermined by a failure of communication regarding problems and problem areas. The Congress must be kept advised, and on a timely basis, of untoward developments that impede or threaten the success of the endeavor. The executive must have a means of communication that keeps him informed of weaknesses and adverse developments in the work program, and he must keep open a channel to let Congress know of impending trouble.

. . . .

Contacts and exchanges with individual members, both from within and outside the committees, importantly complement and supplement work with the committees. Within the Congress there are always a number of members with great knowledge, experience, and wisdom in general and special affairs of government. Some have particular competence in special fields. Many see the total legislative-executive-public sentiment complex more clearly than busy executives. Many can sense political pressure areas or potentials for conflict of interest before they arise. They have trained themselves to do so, and their advice is of great value

> to those conducting the large special enterprise. The successful executive knows that it is important to maintain relationships of mutual respect with them. Trust, thus established, serves as a basis for frank person-to-person exchanges, for the development of an appreciation of respective responsibilities and obligations, and for a shared approach to problem solving. Such trust is essential in the effective use of the great powers entrusted to administrators and legislators in our government; without it the aggregation of power needed to accomplish great tasks would not be possible under our system.[15]

A particular feature of Congressional involvement in large-scale enterprises is that it often takes place in the context of annual budget reviews. Webb is also quite perceptive on the positive and negative features of this process.

> Some students of our federal system argue that our budgetary procedures should be so adjusted as to free large and complex endeavors from the uncertainties and vagaries of the annual authorization-appropriation process. They say that once a major undertaking like the space program or an urban renewal program is underway, too much is at stake to risk loss in momentum or a serious change in direction every twelve months; that given the complexity and importance of these things, they cannot be intermittently slowed down and speeded up, turned on and turned off, or shifted from one course to another without great damage and waste of resources; and that arrangements should be devised whereby they can be assured of support over a term commensurate with the lead time involved in their jobs (i.e., three to five years).
>
> There is much to be said for this view. From the standpoint of orderliness and effectiveness in our use of the large-scale approach, the ability to plan and operate at a committed budgetary level for periods up to several years would yield great advantages. Also, a longer period between appraisals would allow a more penetrating evaluation of performance and enable the endeavor to render a more meaningful accounting than is possible under the annual authorization and annual appropriation system. This would better enable citizens to understand and judge the worth of the job being done. On the other hand, considering the great concentration of resources and power that the large-scale endeavor represents and the far-reaching consequences that would follow from abuses, there must be effective means to protect the interests of society. A large-scale endeavor involving the expenditure of billions of dollars, the employment of hundreds of thousands of persons, and the reordering of whole communities and many of our great

> economic enterprises can have a mammoth impact. Unless kept under close observation and wise restraint, it could do great damage.[16]

Another student of the budget process, Willis Shapley, has precisely portrayed the mixed results of the annual budget process. He notes that "it simply has to be recognized, on one hand, that continuity of progress requires advance budgetary commitments, while at the same time prudent management and healthy skepticism may be fully justified in resisting them." Further,

> Only in the case of top priority national programs...do the planners have the luxury of drawing up and expecting to be permitted to follow an optimum schedule to achieve earliest success or minimum cost. Most projects must accept the delays and inefficiencies of reevaluation at each major decision point.
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> . . . .
>
> The desire to be guaranteed support and to be freed from the worries of the budget is not peculiar to those concerned with research; indeed it is probably the ultimate dream of every federal program and bureaucrat.[17]

As Shapley says, the discipline of the budget process, both within the executive branch and within Congress, is unlikely to disappear for government-funded R&D programs. In order to match program planning to the requirements of annual review, Shapley suggests that program managers attach a "special premium on budget and program planning which identifies in advance the key commitments and decision points and matches them with the experimental and study results that will be available." Finally, he reminds managers of what should be self-evident: "the best strategy for securing support....is to have a good case and see that it is presented clearly and forcefully."[18]

7.2 Magnetic Containment Fusion Program

Some feeling for the ways in which the preceding general analysis can provide insights into programmatic aspects of a specific long-range high-technology enterprise can be gleaned from applying it to the magnetic containment fusion power program. As noted earlier, this program has had a recent budgetary cutback, and has reached its current state "through a succession of scientific and financial crises."[19] A recent review of the fusion program described it "as the only technology to be identified as an energy option before it has shown the ability to produce energy."[20]

The U.S. fusion program had its origins, in one sense, in the 1952 explosion of a thermonuclear device; this demonstrated that enormously and rapidly elevating the temperature of gaseous collections of electrically charged particles (plasma) could set off fusion reactions and consequent release of fusion energy. The program since that time has, in essence, been searching for a more controlled way of releasing such energy. The major approach to such control has been attempts to experimentally confine plasma using strong magnetic fields and, on the basis of the results of such experiments, to design reactors embodying the magnetic containment notion.

The program has developed in two major stages. Before 1971, there was consensus that "scientifically speaking, controlled fusion is probably attainable."[21] But to that point, experimental results had been mixed, and the program was characterized as "a victim of false early enthusiasm."[22] The then-director of AEC's Division of Controlled Thermonuclear Research, Robert L. Hirsch, in 1973 told Congress that "plasma physics is an extremely complicated science. We found that out rather embarrassingly in the early years of the program. People looked at it and, with no experience on which to judge it, thought the problems were going to be relatively easy. And they turned out to be quite difficult."[23]

But, in late 1971, the managers of the fusion program stopped saying to Congress "we don't know how to do it," and started to say that with sufficient funds a demonstration fusion reactor could be built by 1995.

> New experimental machines were requested and approved, considerable money was spent for reactor studies for the first time, and plans were made for extensive test facilities to assess the special materials and engineering problems of fusion. Each year Robert Hirsch, director of the magnetic fusion program during the past 5 years, stressed new improvements in plasma performance, the optimism of the researchers, and the need for more money because of the intrinsic difficulty of the problem.
>
> The selling of fusion has been extremely successful. The magnetic fusion budget has exploded from $38 million in fiscal 1973 to $279 million in the upcoming fiscal year....
>
> The rapid buildup of the fusion program coincided with a great perceived need for alternative solutions to the energy problem, and energy analysts have stopped saying "if" fusion can be controlled and started talking about "when" fusion will become available. But no fusion machine has come close to producing more power than it consumes. and questions about how effective various inventions will be at giving the plasma conditions (temperature and longevity) needed for a reactor are still of paramount importance.[24]

By 1976, the fusion reactor program had become an activity of ERDA's Solar, Geothermal and Advanced Energy Systems office, and the ERDA Division of Magnetic Fusion Energy issued an elaborate five-volume program plan for <u>Fusion Power by Magnetic Containment</u> (ERDA 76/110). This plan described a range of program options, but gave most attention to one in which a demonstration of a pure fusion central electric power station for commercial application could be achieved in the "late 1990s" at a cost (in FY 1978 dollars) of $15.5 billion. It appears at this writing that such an ambitious plan has not won the support of the Carter Administration, and it is probable that the fusion program will proceed at a less aggressive pace.

This brief and superficial summary of the magnetic containment fusion program is not an adequate basis for an in-depth analysis of the program, but it may serve as a basis for some discussion of how the program has persisted through a period of little demonstrated success and how, on the basis of somewhat limited experimental success, a major development program can be proposed.

Until recently, the amount of funding required for continuation of the magnetic containment fusion program was not large, and the program's efforts were in the fundamental and applied research arena much more than in a development phase. In this situation, given the initial decision to begin the program, it was much more likely that the program would continue than that it would be terminated. In a sense, the fusion program was small enough in resource demands to go unnoticed in the "noise" of the much larger fission program. Given a potentially very large payoff, the relative lack of pressure for quick returns, the friendly relationships between the Atomic Energy Commission and the Joint Committee on Atomic Energy, and the interest of relevant portions of the technical community in the program, it was not surprising that the program was able to continue even without demonstrated success. There was a feeling that funding for fusion research was an investment with long payback time and relatively high risk of failure, and these were acceptable conditions to those who had to support the program.

Since 1971, with the emergence of the fusion program as an aggressive candidate for a larger share of the energy R&D budget, the situation has been much changed. The coming together of the "energy crisis," the creation of ERDA and the resulting emphasis on developing a wide variety of energy options, positive results from fusion experiments, and a recognized need for substantially increased resources in order to move to the next phases of the program, created a context for the "selling" of the fusion program.

The elaborate program plan for Fusion Power by Magnetic Containment (ERDA-76/110), for example, may be seen as an effort at using a strategy of "managerial innovation" in gaining support for the program. By explicitly noting the complex, interrelated, and long-term nature of the program and by suggesting that the program's managers are in control of these complexities and interrelationships, the program plan creates an impression of competence and direction to the program. Thus, in addition to its obvious technical value for program management and control, this document has also a certain political value.

That the selling of the fusion program has not been totally successful, however, may be suggested by recent budget cutbacks. Although it is not possible to specify with certainty why the coalition supporting the fusion program was not strong enough to prevent such cutbacks, some hypotheses can be advanced. For one thing, government-supported energy research projects are qualitatively different from space or defense projects in that the ultimate user of research results is not the government itself, but the private sector. Thus, it is important to the political success of a program that relevant users be supportive. There is some indication that this was not the case for the fusion program. There were reports in late 1976 that "fusion power might become a reality more rapidly if the Energy Research and Development Administration would pay more attention to the demands and needs of the utilities that will ultimately run the fusion power plants" and that "the tokamak magnetic containment reactors now under intensive study by ERDA are considered by the utilities to be too big, too expensive, and very difficult to maintain."[25]

Another problem with maintaining program support may be that important elements of the technical community have been dubious of the aggressive manner in which the program was being promoted by its managers. For example, one prominent researcher was reported to have said that "what bothers me is not that [ERDA] is going into power production too quickly, but that they are selling what is an experiment, which may or may not work, as a ce[illegible]v" and other scientists were worried that the emphasis on early power [illegible] "was a gamble that gains support from the Administration and Con[illegible]ow, but may sour them on the fusion program if the project is less than successful."[26]

There is also some suggestion that the fusion program is recognized as a potential competitor for resources by supporters of other energy R&D programs, especially the breeder reactor program. Some manifestation of this appeared as early as 1973 when Representative Mike McCormack, a supporter of the fusion program, clashed with Representative Chet Holifield, a champion of the LMFBR, over increased funding for the fusion program.[27]

The attempts to gain support for the fusion program by underplaying uncertainties and stressing positive results have created for the program risky status, one in which "fusion's expanding success coupled with its increasingly evident difficulty will remain a hard mixture to manage; it could easily inspire false optimism or false pessimism--and, either way, wrong judgments."[28] Perhaps the primary insight from this brief analysis of the magnetic containment fusion program is just how difficult is the task of organizing and managing large-scale technological enterprises.

7.3 SPS Program and Long-Range Planning

Both the general discussion of how government-supported long-range programs are initiated and maintained and the analysis of the magnetic containment fusion program are suggestive of issues that are likely to arise during the course of an SPS program. As a multi-billion dollar development effort extending over the better part of two decades, the SPS program will require strong and sustained support from a diverse constituency. Like the fusion effort, the SPS program will require the support of the electric power industry, and thus the supporting coalition will have to include relevant private sector interests. Because a wide range of government actors will have a stake in program outcomes, the SPS managers will have to be particularly skillful in bureaucratic politics. And because Congress will have to be willing to allocate large resources to the SPS program for many years, a strong base of Congressional support for the program will be essential.

There are some characteristics of the SPS program which will have an impact on how the program relates to its political environment. Perhaps foremost among these is the fact that the program is critically dependent on the role of man in routine space operations. Manned space activity has assumed a symbolic value that probably will transcend its real meaning in the 1980s, and there will be strong political opinions with respect to support of any program with a major manned element. SPS managers will have to decide how best to present the role that man will play in the program's evolution. That an SPS program would also require developing a major new launch vehicle only complicates the task of gaining support for the program.

Another SPS characteristic likely to influence program support is the highly centralized, large-scale nature of the system. Most applications of solar energy have become linked to a decentralized approach to energy supply; there seems to be a trend away from dependence on a few large systems for providing any crucial aspect of modern life.

Reliance on space technology to meet a crucial human need such as electricity may pose difficult attitudinal adjustments among the public and the policy-making community. To date, space has not played a central role in human existence, and the SPS program may be the first instance in which society has to choose to use space capability for providing a routine resource, rather than depend on more conventional, Earth-bound alternatives. How this choice is presented to society and its political representatives is obviously of crucial importance with respect to gaining approval to proceed with the program.

Unlike the fusion program, an SPS program is primarily an engineering rather than scientific undertaking. The magnetic containment fusion program has persisted to date even though major scientific uncertainties have been present; the fusion program has also been in existence for two decades without the need for highly visible resource commitments. In contrast, an SPS program could require early large commitments of funding in order to reduce technical uncertainties and to initiate development of major hardware elements of the program. This suggests that the problems of mobilizing support for the SPS program will be significantly different from all but the most recent stages of the fusion program.

Given that the SPS program implies dependence on a "nonconventional" energy source and will require commitment of major resources well in advance of demonstration of system feasibility, the role of economic, technical, environmental, and legal/institutional analyses in convincing relevant officials to support the program is likely to be critical. These analyses are likely to be the focus of discussion and debate as the political system makes and reviews decisions relating to the SPS program. Thus, supporting analyses will have to be given as much attention as engineering performance by SPS managers.

This analysis began by suggesting that "the strategy of developing a long-term technology is one of the most difficult problems the government faces." Nothing said above diminishes that difficulty in the particular case of the SPS program. But it also points out where the difficulty lies.

> Finding objectives with high social utility which can be achieved by a specific time using technologies...which are based on existing knowledge, is not difficult. What is difficult is creating a base within the political system which makes it possible for the system's leaders, while they are considering whether or not to act, to determine if they can obtain and keep the support necessary for a given program to be accomplished."[29]

In the final analysis, then, SPS programmatic planning involves risk-taking, bureaucratic skill, and the ability to mobilize support--in other words, effective leadership. Without such direction, it will be extremely difficult for a program such as SPS to become reality.

Section 7: Footnotes

1. Milton Klein, then manager of the NASA/AEC Space Nuclear Systems Office, quoted in National Journal, May 29, 1971, p. 1160.

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8. THE INTERACTION OF SPS WITH GOVERNMENT REGULATORY AGENCIES AND MAJOR DEPARTMENTS

Government regulatory policy has become a pervasive influence in modern life. Initially, regulatory controls focused on the economic aspects of private sector activities. In more recent years, regulatory influence has spread to protection of human health and safety and of the physical environment. Thus, it should come as no surprise that the development of a technological enterprise as large as the SPS program will involve meeting a wide variety of regulatory requirements which are enforced by a number of government agencies at the federal, state, local (and perhaps also international) levels.

This section presents a preliminary schedule of interaction of SPS with government regulatory agencies and major departments. A multitude of agencies and departments must be involved in an SPS program if SPS technology is to be successfully developed and implemented. It is important to identify these involvements and to properly schedule them in order to prevent program delays in the future. Important areas of concern involve frequency allocation, environmental impacts and system regulation. These areas will involve the State Department, the Environmental Protection Agency, the Federal Communications Commission and others. The involvement of these agencies and departments must begin quite soon if an ambitious SPS development schedule is to be maintained.

8.1 A Preliminary Schedule of Interactions Between SPS and Its Federal Environment

Table 8.1 lists the major ways in which the SPS program is likely to interact with its federal regulatory environment, based on the SPS program

Table B.1 Interactions of Federal Regulatory Agencies with SPS Program*

Department/Agency	Phase I	Phase II	Phase III	Phase IV
Environmental Protection Agency	Existing EPA regulations with respect to air and water quality, toxic substances, noise pollution set constraints on how any activity within the SPS program can be carried out			
	Analysis of how existing EPA regulations will influence system development and of potential SPS impacts that will likely require environmental regulation, particularly impacts of microwave beam	Monitor various elements of program, such as HLLV tests, launch of space subscale system, and environmental impact test program, for compliance with existing requirements and indentification of new regulations needed Monitor impact of local waste heat and low level microwave exposure at rectenna site	Monitor impact of launch complex operations with respect to noise and effect of launch vehicle emissions on atmosphere Monitor impact of beam operation on humans, animals and plants in rectenna vicinity	Same as Phase III
Federal Power Commission	Monitoring how development of an SPS may affect long range planning of the electric utility industry			
	Involvement in analyses of relative merits of space solar power and other power supply systems	Evaluation of end-to-end power system performance of space-based subscale system	Development of appropriate regulations affecting wholesale price of electricity derived from SPS operation	Routine regulation of electric power industry which includes SPS elements
Federal Communications Commission	Frequency allocations for SPS beam operation through 1979 WARC Evaluate results of microwave beam-ionospheric interaction test for communications impacts	Evaluate results of ground tests and space subscale test for communications impacts and development regulations based on these impacts	Monitor impacts of system operation on various forms of broadcasting, common carrier communication and other radio uses to ensure that they meet requirements set by regulations	Same as Phase III
Federal Energy Administration	Involvement in analyses of how development of SPS will affect national-level policy with respect to energy-related regulations			
Interstate Commerce Commission	Commercial carriers (trucks, railroads, ships on interstate routes) must meet existing ICC regulations			
		Transportation of system components must be accomplished under existing regulations, particularly transportation of stages of HLLV	Frequent transportation of launch vehicle and system components under ICC regulations	Same as Phase III

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Table B.1 Interactions of Federal Regulatory Agencies with SPS Program (continued)

Department/Agency	Phase I	Phase II	Phase III	Phase IV
Nuclear Regulatory Commission	If nuclear propulsion system is selected for LEO to GEO transfer vehicle, then development program for that system will have to meet NRC requirements			
			Safety of nuclear propulsion system during preparation for launch, launch to LEO, handling in LEO, and use in LEO-GEO transfer	Same as Phase III, plus disposal of radioactive wastes from used-up nuclear propulsion systems
Security and Exchange Commission	Usual provisions applying to management of, and trading of stocks in, private sector firms involved in SPS program			
				Potential of offering shares in a commercial SPS enterprise with some mixed ownership (international/national, public/private)
Equal Employment Opportunity Commission	Both government agencies and private sector organizations involved in SPS program must meet general requirements established by EEOC--Question of whether these requirements extend to work in space during operational phase of program			
Small Business Administration	Likely that appropriations for SPS development could contain "set-aside" provisions for small business participation as subcontractors in program			
Department of Interior - Office of Land Use and Water Planning	None	Possible use of public lands for launch site or rectenna location	Impact of rectenna locations on demographic patterns, including land use and demands on water resources Possible need for more/larger launch sites to accommodate frequent launches of HLLV; impact on demographic patterns as above	Same as Phase III
Department of Interior - U.S. Fish and Wildlife Service	Impact of preliminary tests of microwave radiation on fish and wildlife	Impact of ground tests of microwave power transmission/receiving techniques Impacts of other elements of ground test program (e.g., new rocket engines) Biological effects of space subscale system experiment	Possible use of wildlife areas for launch sites or rectenna locations Impact of launches on local wildlife Impact of microwave beam on local wildlife Impact of radiation/heat from rectenna on local wildlife	Same as Phase III

Table B.1 Interactions of Federal Regulatory Agencies with SPS Program (continued)

Department/Agency	Phase I	Phase II	Phase III	Phase IV
Department of Interior - Bureau of Land Management	None	Use of public land - rectenna location or new launch site	Same as Phase II	Same as Phase II
Department of Interior - Bureau of Reclamation	None	Possible use of public semi-arid or arid land for rectenna site	Same as Phase II	Same as Phase II
Department of Labor - Occupational Safety and Health Administration	Working conditions in government and private facilities involved in SPS program must meet OSHA regulations			
		Possible applications of OSHA requirements to orbital construction facility	Same as Phase II, but more likely due to near-operational status of program	Same as Phase III, but even more likely
Department of Transportation - Federal Aviation Administration	None	Impact of various test activities, both ground-based and in space (particularly subscale system test) on air navigation and traffic control systems	Impact of SPS operation on air navigation and traffic control systems	Same as Phase III
Department of Justice - Antitrust Division	None	None	None	Assurance that plans for commercializing SPS do not involve violations of antitrust statutes

*This table is based on the following assumptions:

1. The SPS program, at least until the commercialization phase, will be funded by and managed by agencies of the U.S. government, not by some international entity or by organizations in the private sector.

2. The organization of the U.S. government as of March 31, 1977 is used as the basis for the table. Specifically, there is an attempt to anticipate the impact of a proposed Department of Energy on the nature of regulatory involvement in SPS development.

3. The table does not discuss the involvement of nonfederal (state, local, international) regulatory agencies with SPS development.

4. The "Program Development Plan for the SPS" dated August 31, 1976, Figure B.1, is used as a basis for identifying program elements. Program Phases are:

   Phase I - System Definition and Exploratory Technology (1977-1980)
   Phase II - Technology Advancement (1980-1987)
   Phase III - System Development (1987-1995)
   Phase IV - Commercialization (after 1995)

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plan shown in Figure 8.1. The interactions with other, nonregulatory, federal agencies are also described briefly. The SPS regulatory interaction is time phased according to the four phases of SPS program development as shown in Table 8.1.

Table 8.1 does not list potential interactions between the SPS program and state or local regulatory agencies, even though such interactions are inevitable, particularly with respect to such areas as zoning and land use. Nor does the table discuss potential international regulatory interactions. At present, regulatory regimes at the international level are not well-developed in most sectors (frequency allocation and perhaps orbital slot allocation through the WARC being an exception); however, the SPS program is one of a oup of technological developments that seem to require regulation at the international level (for example, in terms of global effects of the microwave beam on the atmosphere) in order to function in the public interest.

The SPS program also seems to present some new regulatory challenges which need to be examined carefully if the program moves past the systems definition and exploratory technology phase. Some insight into the nature of these challenges may be derived from the following questions:

1. The SPS program poses potential threats to human health and safety (and also to nonhuman life) on earth from operations which take place in outer space, beyond national boundaries. Who has regulatory responsibility for ensuring that routine operations in outer space do no harm on earth?

2. Similarly, who is responsible for protecting the troposphere, ionosphere or stratosphere, particularly when the impacts of activities carried out by one nation or its citizens affect citizens of other countries?

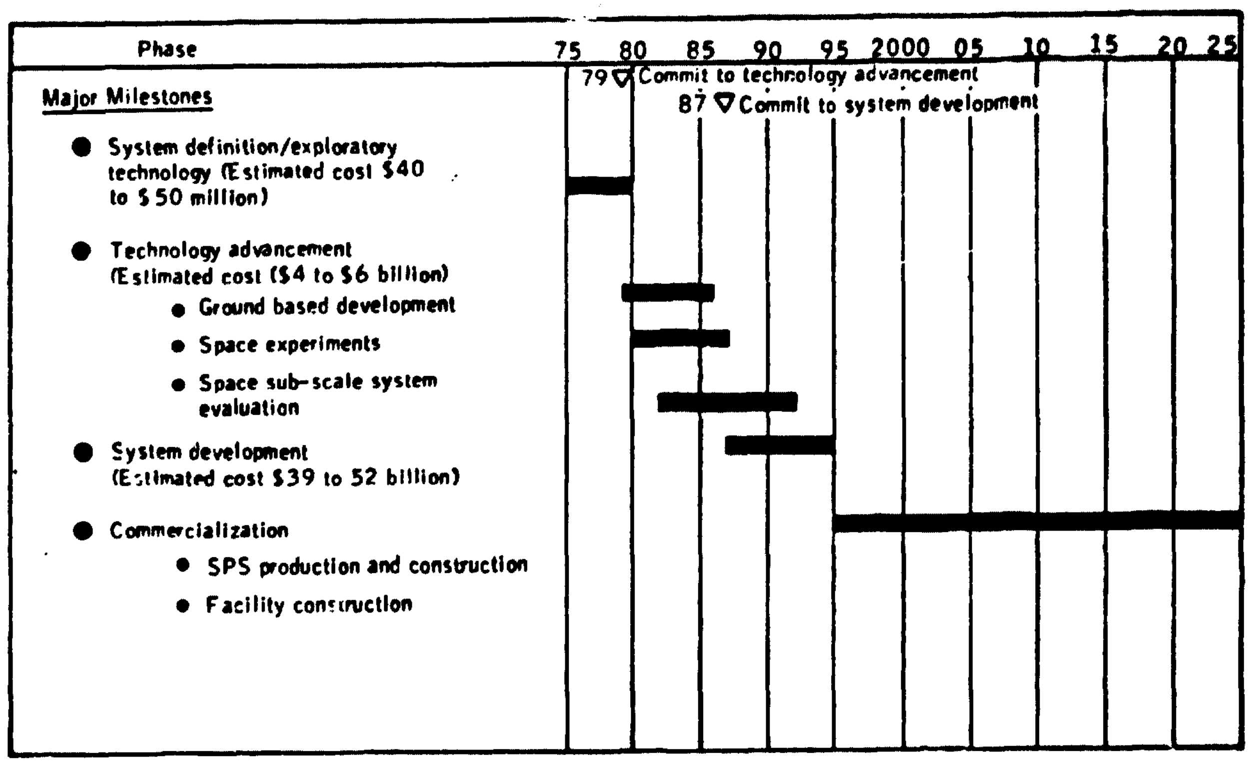

Figure 8.1 Space Solar Power Projected Program Phasing (Source: Initial Technical, Environmental and Economic Evaluation of Space Solar Power Concepts, Volume II--Detailed Report, JSC 11568, NASA Lyndon B. Johnson Space Center, Houston, Texas, August 31, 1976, p. X-2.

3. How are SPS program managers to anticipate and take account of the requirements of new international regulatory agencies which may be in place before the system becomes operational? Is operation of the system by commercial entities of one nation likely to be possible under the international political regulatory conditions of the 1990s?

4. What regulatory requirements will apply to impacts on humans who are routinely functioning in space as operators or maintainers of an SPS system? For example, will occupational health and safety standards be established? Will requirements for equal employment opportunity apply?

These questions are meant to be suggestive, not all-inclusive. What they do imply is that the task of bringing into existence a large-scale technological system with potentially great benefits, but also with potentially widespread and/or significant risks and costs, will be increasingly difficult in a world sensitized to the need to guard against abuses against the "global commons" or against individuals or the physical environment, when costs are likely to be incurred by others than those to whom the system provides benefits.

In Table 8.1, interactions are identified at the point they are most likely to actually occur. This implies anticipatory analyses to ensure that the program's activities can meet regulatory requirements at the point in time they are applied. For example, the biological impacts of the microwave beam should be identified during the system development and exploratory technology phase (as is planned), but the actual point at which those impacts must not exceed allowable levels will not come until late in the technology advancement phase, when the space subscale test is conducted, or perhaps not even until full-scale operation begins later in the program's development.

In addition to the interactions called out in Table 8.1, the agency or agencies with primary management responsibility for the SPS will have to prepare preliminary and final environmental impact statements for the overall system and probably for its major elements (HLLV, rectennas, new launch sites, etc.). Preparation of these impact statements will be an on-going process, particularly during the technology advancement and system development phases. The impact statements will be reviewed by a wide range of concerned agencies within the executive branch (as well as by others outside government), and thus will provide an occasion for interaction between the SPS program and regulatory agencies. The Council on Environmental Quality, located in the Executive Office of the President, is responsible for managing the impact statement review process.

Finally, development of an SPS system, as earlier portions of this report indicate, will involve both national security and foreign policy considerations. International agreements on topics like frequency allocation and orbital slot allocation will be required. The development phases of the program should be carried out in the context of some understanding of the mix between international and national ownership and management responsibility for operational SPS systems. These and other considerations suggest the need for continuing interaction through the phases of the program among the program's managers, the Department of State, the Department of Defense, and most likely the National Security Council and the Office of Science and Technology Policy in the Executive Office of the President.

APPENDIX A

[Excerpted from International Legal Materials, Vol. X, No. 4, July 1971, p. ?.]

Convention on International Liability for Damage Caused by Space Objects*

The States Parties to this Convention,

Recognizing the common interest of all mankind in furthering the exploration and use of outer space for peaceful purposes,

Recalling the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,

Taking into consideration that, notwithstanding the precautionary measures to be taken by States and international intergovernmental organizations involved in the launching of space objects, damage may on occasion be caused by such objects,

Recognizing the need to elaborate effective international rules and procedures concerning liability for damage caused by space objects and to ensure, in particular, the prompt payment under the terms of this Convention of a full and equitable measure of compensation to victims of such damage,

Believing that the establishment of such rules and procedures will contribute to the strengthening of international co-operation in the field of the exploration and use of outer space for peaceful purposes,

Have agreed on the following:

Article I

For the purposes of this Convention:

(*a*) The term "damage" means loss of life, personal injury or other impairment of health; or loss or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations;

(*b*) The term "launching" includes attempted launching;

(*c*) The term "launching State" means:

(*i*) A State which launches or procures the launching of a space object;

(*ii*) A State from whose territory or facility a space object is launched;

(*d*) The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof.

Article II

A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.

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*General Assembly Resolution 2777 (XXVI), 29 November 1971.

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Article III

In the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.

Article IV

1. In the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, and of damage thereby being caused to a third State or to its natural or juridical persons, the first two States shall be jointly and severally liable to the third State, to the extent indicated by the following:

(*a*) If the damage has been caused to the third State on the surface of the earth or to aircraft in flight, their liability to the third State shall be absolute;

(*b*) If the damage has been caused to a space object of the third State or to persons or property on board that space object elsewhere than on the surface of the earth, their liability to the third State shall be based on the fault of either of the first two States or on the fault of persons for whom either is responsible.

2. In all cases of joint and several liability referred to in paragraph 1, the burden of compensation for the damage shall be apportioned between the first two States in accordance with the extent to which they were at fault; if the extent of the fault of each of these States cannot be established, the burden of compensation shall be apportioned equally between them. Such apportionment shall be without prejudice to the right of the third State to seek the entire compensation due under this Convention from any or all of the launching States which are jointly and severally liable.

Article V

1. Whenever two or more States jointly launch a space object, they shall be jointly and severally liable for any damage caused.

2. A launching State which has paid compensation for damage shall have the right to present a claim for indemnification to other participants in the joint launching. The participants in a joint launching may conclude agreements regarding the apportioning among themselves of the financial obligation in respect of which they are jointly and severally liable. Such agreements shall be without prejudice to the right of a State sustaining damage to seek the entire compensation due under this Convention from any or all of the launching States which are jointly and severally liable.

3. A State from whose territory or facility a space object is launched shall be regarded as a participant in a joint launching.

Article VI

1. Subject to the provisions of paragraph 2, exoneration from absolute liability shall be granted to the extent that a launching State establishes that the damage has resulted either wholly or

partially from gross negligence or from an act or omission done with intent to cause damage on the part of a claimant State or of naturel or juridical persons it represents.

2. No exoneration whatever shall be granted in cases where the damage has resulted from activities conducted by a launching State which are not in conformity with international law including, in particular, the Charter of the United Nations and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.

Article VII

The provisions of this Convention shall not apply to damage caused by a space object of a launching State to:

(*a*) Nationals of that launching State;

(*b*) Foreign nationals during such time as they are participating in the operation of that space object from the time of its launching or at any stage thereafter until its descent, or during such time as they are in the immediate vicinity of a planned launching or recovery area as the result of an invitation by that launching State.

Article VIII

1. A State which suffers damage, or whose natural or juridical persons suffer damage, may present to a launching State a claim for compensation for such damage.

2. If the State of nationality has not presented a claim, another State may, in respect of damage sustained in its territory by any natural or juridical person, present a claim to a launching State.

3. If neither the State of nationality nor the State in whose territory the damage was sustained has presented a claim or notified its intention of presenting a claim, another State may, in respect of damage sustained by its permanent residents, present a claim to a launching State.

Article IX

A claim for compensation for damage shall be presented to a launching State through diplomatic channels. If a State does not maintain diplomatic relations with the launching State concerned, it may request another State to present its claim to that launching State or otherwise represent its interests under this Convention. It may also present its claim through the Secretary-General of the United Nations, provided the claimant State and the launching State are both Members of the United Nations.

Article X

1. A claim for compensation for damage may be presented to a launching State not later than one year following the date of the occurrence of the damage or the identification of the launching State which is liable.

2. If, however, a State does not know of the occurrence of the damage or has not been able to identify the launching State which is liable, it may present a claim within one year following the date on which it learned of the aforementioned facts; however, this period shall in

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no event exceed one year following the date on which the State could reasonably be expected to have learned of the facts through the exercise of the due diligence.

3. The time-limits specified in paragraphs 1 and 2 shall apply even if the full extent of the damage may not be known. In this event, however, the claimant State shall be entitled to revise the claim and submit additional documentation after the expiration of such time-limits until one year after the full extent of the damage is known.

Article XI

1. Presentation of a claim to a launching State for compensation for damage under this Convention shall not require the prior exhaustion of any local remedies which may be available to a claimant State or to natural or juridical persons it represents.

2. Nothing in this Convention shall prevent a State, or natural or juridical persons it might represent, from pursuing a claim in the courts or administrative tribunals or agencies of a launching State. A State shall not, however, be entitled to present a claim under this Convention in respect of the same damage for which a claim is being pursued in the courts or administrative tribunals or agencies of a launching State or under another international agreement which is binding on the States concerned.

Article XII

The compensation which the launching State shall be liable to pay for damage under this Convention shall be determined in accordance with international law and the principles of justice and equity, in order to provide such reparation in respect of the damage as will restore the person, natural or juridical, State or international organization on whose behalf the claim is presented to the condition which would have existed if the damage had not occurred.

Article XIII

Unless the claimant State and the State from which compensation is due under this Convention agree on another form of compensation, the compensation shall be paid in the currency of the claimant State or, if that State so requests, in the currency of the State from which compensation is due.

Article XIV

If no settlement of a claim is arrived at through diplomatic negotiations as provided for in article IX, within one year from the date on which the claimant State notifies the launching State that it has submitted the documentation of its claim, the parties concerned shall establish a Claims Commission at the request of either party.

Article XV

1. The Claims Commission shall be composed of three members: one appointed by the claimant State, one appointed by the launching State and the third member, the Chairman, to be chosen by both parties jointly. Each party shall make its appointment within two months of the request for the establishment of the Claims Commission.

2. If no agreement is reached on the choice of the Chairman within four months of the request for the establishment of the Claims Commission, either party may request the Secretary-General of the United Nations to appoint the Chairman within a further period of two months.

Article XVI

1. If one of the parties does not make its appointment within the stipulated period, the Chairman shall, at the request of the other party, constitute a single-member Claims Commission.

2. Any vacancy which may arise in the Claims Commission for whatever reason shall be filled by the same procedure adopted for the original appointment.

3. The Claims Commission shall determine its own procedure.

4. The Claims Commission shall determine the place or places where it shall sit and all other administrative matters.

5. Except in the case of decisions and awards by a single-member Commission, all decisions and awards of the Claims Commission shall be by majority vote.

Article XVII

No increase in the membership of the Claims Commission shall take place by reason of two or more claimant States or launching States being joined in any one proceeding before the Commission. The claimant States so joined shall collectively appoint one member of the Commission in the same manner and subject to the same conditions as would be the case for a single claimant State. When two or more launching States are so joined, they shall collectively appoint one member of the Commission in the same way. If the claimant States or the launching States do not make the appointment within the stipulated period, the Chairman shall constitute a single-member Commission.

Article XVIII

The Claims Commission shall decide the merits of the claim for compensation and determine the amount of compensation payable, if any.

Article XIX

1. The Commission shall act in accordance with the provisions of article XII.

2. The decision of the Commission shall be final and binding if the parties have so agreed; otherwise the Commission shall render a final and recommendatory award, which the parties shall consider in good faith. The Commission shall state the reasons for its decision or award.

3. The Commission shall give its decision or award as promptly as possible and not later than one year from the date of its establishment unless an extension of this period is found necessary by the Commission.

4. The Commission shall make its decision or award public. It shall deliver a certified copy of its decision or award to each of the parties and to the Secretary-General of the United Nations.

Article XX

The expenses in regard to the Claims Commission shall be borne equally by the parties, unless otherwise decided by the Commission.

Article XXI

If the damage caused by a space object presents a large-scale damage to human life or seriously interferes with the living conditions of the population or the functioning of vital centres, the States Parties, and in particular the launching State, shall examine the possibility of rendering appropriate and rapid assistance to the State which has suffered the damage, when it so requests. However, nothing in this article shall affect the rights or obligations of the States Parties under this Convention.

Article XXII

1. In this Convention, with the exception of articles XXIV to XXVII, references to States shall be deemed to apply to any international intergovernmental organization which conducts space activities if the organization declares its acceptance of the rights and obligations provided for in this Convention and if a majority of the States members of the organization are States Parties to this Convention and to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies.

2. States members of any such organization which are States Parties to this Convention shall take all appropriate steps to ensure that the organization makes a declaration in accordance with the preceding paragraph.

3. If an international intergovernmental organization is liable for damage by virtue of the provisions of this Convention, that organization and those of its members which are States Parties to this Convention shall be jointly and severally liable; provided, however, that:

(*a*) Any claim for compensation in respect of such damage shall be first presented to the organization;

(*b*) Only where the organization has not paid, within a period of six months, any sum agreed or determined to be due as compensation for such damage, may the claimant State invoke the liability of the members which are States Parties to this Convention for the payment of that sum.

4. Any claim, pursuant to the provisions of this Convention for compensation in respect of damage caused to an organization which has made a declaration in accordance with paragraph 1 of this article shall be presented by a State member of the organization which is a State Party to this Convention.

Article XXIII

1. The provisions of this Convention shall not affect other international agreements in force insofar as relations between the States Parties to such agreements are concerned.

2. No provision of this Convention shall prevent States from concluding international agreements reaffirming, supplementing or extending its provisions.

Article XXIV

1. This Convention shall be open to all States for signature. Any State which does not sign this Convention before its entry into force

in accordance with paragraph 3 of this article may accede to it at any time.

2. This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United Kingdom of Great Britain and Northern Ireland, the Union of Soviet Socialist Republics, and the United States of America, which are hereby designated the Depositary Governments.

3. This Convention shall enter into force on the deposit of the fifth instrument of ratification.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Convention, the date of its entry into force and other notices.

6. This Convention shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article XXV

Any State Party to this Convention may propose amendments to this Convention. Amendments shall enter into force for each State Party to the Convention accepting the amendments upon their acceptance by a majority of the State Parties to the Convention and thereafter for each remaining State Party to the Convention on the date of acceptance by it.

Article XXVI

Ten years after the entry into force of this Convention, the question of the review of this Convention shall be included in the provisional agenda of the United Nations General Assembly in order to consider, in the light of past application of the Convention, whether it requires revision. However, at any time after the Convention has been in force for five years, and at the request of one-third of the States Parties to the Convention, and with the concurrence of the majority of the States Parties, a conference of the States Parties shall be convened to review this Convention.

Article XXVII

Any State Party to this Convention may give notice of its withdrawal from the Convention one year after its entry into force by written notification to the Depositary Governments. Such withdrawal shall take effect one year from the date of receipt of this notification.

Article XXVIII

This Convention, of which the English, Russian, French, Spanish and Chinese texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Convention shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Convention.

DONE in ________ at the cities of London, Moscow and Washington, the _____ day of ________ one thousand nine hundred and _____.

APPENDIX B

UNITED NATIONS GENERAL ASSEMBLY

[Twenty-ninth session
Agenda item 32, Nov. 26, 1974]

RESOLUTION ADOPTED BY THE GENERAL ASSEMBLY

[On the report of the First Committee (A/9812)]

3235 (XXIX). *Convention on Registration of Objects Launched into Outer Space*

The General Assembly,

Reaffirming the importance of international co-operation in the field of the exploration and peaceful uses of outer space, including the Moon and other celestial bodies, and of promoting the rule of law in this new field of human endeavour,

Desiring, in the light of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,[1] the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space [2] and the Convention on International Liability for Damage Caused by Space Objects,[3] to make provision for registration by launching States of space objects launched into outer space with a view, *inter alia,* to providing States with additional means and procedures to assist in the identification of space objects,

Bearing in mind its resolution 3182 (XXVIII) of 18 December 1973, in which it requested the Committee on the Peaceful Uses of Outer Space to consider as a matter of priority the completion of the text of the draft Convention on Registration of Objects Launched into Outer Space,

Having considered the report of the Committee on the Peaceful Uses of Outer Space,[4]

Noting with satisfaction that the Committee on the Peaceful Uses of Outer Space and its Legal Sub-Committee have completed the text of the draft Convention on Registration of Objects Launched into Outer Space,

1. *Commends* the Convention on Registration of Objects Launched into Outer Space, the text of which is annexed to the present resolution;

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[1] General Assembly resolution 2222 (XXI), annex.
[2] General Assembly resolution 2345 (XXII), annex.
[3] General Assembly resolution 2777 (XXVI), annex.
[4] *Official Records of the General Assembly, Twenty-ninth Session, Supplement No. 20* (A/9620).

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2. *Requests* the Secretary-General to open the Convention for signature and ratification at the earliest possible date;

3. *Expresses its hope* for the widest possible adherence to this Convention.

[2280th plenary meeting 12 November 1974]

ANNEX

Convention on Registration of Objects Launched into Outer Space

The States Parties to this Convention,

Recognizing the common interest of all mankind in furthering the exploration and use of outer space for peaceful purposes,

Recalling that the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies of 27 January 1967 affirms that States shall bear international responsibility for their national activities in outer space and refers to the State on whose registry an object launched into outer space is carried,

Recalling also that the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space of 22 April 1968 provides that a launching authority shall, upon request, furnish identifying data prior to the return of an object it has launched into outer space found beyond the territorial limits of the launching authority,

Recalling further that the Convention on International Liability for Damage Caused by Space Objects of 29 March 1972 establishes international rules and procedures concerning the liability of launching States for damage caused by their space objects,

Desiring, in the light of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, to make provision for the national registration by launching States of space objects launched into outer space,

Desiring further that a central register of objects launched into outer space be established and maintained, on a mandatory basis, by the Secretary-General of the United Nations,

Desiring also to provide for States Parties additional means and procedures to assist in the identification of space objects,

Believing that a mandatory system of registering objects launched into outer space would, in particular, assist in their identification and would contribute to the application and development of international law governing the exploration and use of outer space,

Have agreed on the following:

Article I

For the purposes of this Convention:

(a) The term "launching State" means:

(i) A State which launches or procures the launching of a space object;

(ii) A State from whose territory or facility a space object is launched;

(b) The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof;

(c) The term "State of registry" means a launching State on whose registry a space object is carried in accordance with article II.

Article II

1. When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching State shall inform the Secretary-General of the United Nations of the establishment of such a registry.

2. Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object in accordance with paragraph 1 of this article, bearing in mind the provisions of article VIII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and without prejudice to appropriate agreements concluded or to be concluded among the launching States on jurisdiction and control over the space object and over any personnel thereof.

3. The contents of each registry and the conditions under which it is maintained shall be determined by the State of registry concerned.

Article III

1. The Secretary-General of the United Nations shall maintain a Register in which the information furnished in accordance with article IV shall be recorded.

2. There shall be full and open access to the information in this Register.

Article IV

1. Each State of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry:

(a) Name of launching State or States;

(b) An appropriate designator of the space object or its registration number;

(c) Date and territory or location of launch;

(d) Basic orbital parameters, including:

(i) Nodal period,

(ii) Inclination,

(iii) Apogee,

(iv) Perigee;

(e) General function of the space object.

2. Each State of registry may, from time to time, provide the Secretary-General of the United Nations with additional information concerning a space object carried on its registry.

3. Each State of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in earth orbit.

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Article V

Whenever a space object launched into earth orbit or beyond is marked with the designator or registration number referred to in article IV, paragraph 1 (*b*), or both, the State of registry shall notify the Secretary-General of this fact when submitting the information regarding the space object in accordance with article IV. In such case, the Secretary-General of the United Nations shall record this notification in the Register.

Article VI

Where the application of the provisions of this Convention has not enabled a State Party to identify a space object which has caused damage to it or to any of its natural or juridical persons, or which may be of a hazardous or deleterious nature, other States Parties, including in particular States possessing space monitoring and tracking facilities, shall respond to the greatest extent feasible to a request by that State Party, or transmitted through the Secretary-General on its behalf, for assistance under equitable and reasonable conditions in the identification of the object. A State Party making such a request shall, to the greatest extent feasible, submit information as to the time, nature and circumstances of the events giving rise to the request. Arrangements under which such assistance shall be rendered shall be the subject of agreement between the parties concerned.

Article VII

1. In this Convention, with the exception of articles VIII to XII inclusive, references to States shall be deemed to apply to any international intergovernmental organization which conducts space activities if the organization declares its acceptance of the rights and obligations provided for in this Convention and if a majority of the States members of the organization are States Parties to this Convention and to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.

2. States members of any such organization which are States Parties to this Convention shall take all appropriate steps to ensure that the organization makes a declaration in accordance with paragraph 1 of this article.

Article VIII

1. This Convention shall be open for signature by all States at United Nations Headquarters in New York. Any State which does not sign this Convention before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Convention shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Secretary-General of the United Nations.

3. This Convention shall enter into force among the States which have deposited instruments of ratification on the deposit of the fifth such instrument with the Secretary-General of the United Nations.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Convention, it

shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Secretary-General shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Convention, the date of its entry into force and other notices.

Article IX

Any State Party to this Convention may propose amendments to the Convention. Amendments shall enter into force for each State Party to the Convention accepting the amendments upon their acceptance by a majority of the States Parties to the Convention and thereafter for each remaining State Party to the Convention on the date of acceptance by it.

Article X

Ten years after the entry into force of this Convention, the question of the review of the Convention shall be included in the provisional agenda of the United Nations General Assembly in order to consider, in the light of past application of the Convention, whether it requires revision. However, at any time after the Convention has been in force for five years, at the request of one third of the States Parties to the Convention and with the concurrence of the majority of the States Parties, a conference of the States Parties shall be convened to review this Convention. Such review shall take into account in particular any relevant technological developments, including those relating to the identification of space objects.

Article XI

Any State Party to this Convention may give notice of its withdrawal from the Convention one year after its entry into force by written notification to the Secretary-General of the United Nations. Such withdrawal shall take effect one year from the date of receipt of this notification.

Article XII

The original of this Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations, who shall send certified copies thereof to all signatory and acceding States.

IN WITNESS WHEREOF the undersigned, being duly authorized thereto by their respective Governments, have signed this Convention, opened for signature at New York on . . .

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APPENDIX C

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies

Text

The States Parties to this Treaty,

Inspired by the great prospects opening up before mankind as a result of man's entry into outer space,

Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes,

Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development,

Desiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes,

Believing that such co-operation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples,

Recalling resolution 1962 (XVIII), entitled "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space", which was adopted unanimously by the United Nations General Assembly on 13 December 1963,

Recalling resolution 1884 (XVIII), calling upon States to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction or from installing such

Analysis of Treaty

The treaty's statement of policy and purpose is almost identical in wording to that in the Declaration of Legal Principles Governing Activities of States in the Exploration and Use of Outer Space, United Nations resolution 1962 (XVIII) which passed the General Assembly unanimously on December 13, 1963. This resolution represented the evolution of thinking and negotiation within the United Nations on the peaceful uses of outer space beginning in 1958. Resolution 1348 (XIII), adopted by the General Assembly on December 13, 1958, emphasized the common interest of mankind in outer space and the desire to avoid extending national rivalries into this new field which should be used only for peaceful purposes for the benefit of all people. Continued negotiation through the years led to the adoption of additional resolutions designed to ensure peace in the outer space environment: 1378 (XIV) November 20, 1959; 1472 (XIV) December 12, 1959; 1721 (XVI) December 20, 1961; 1802 (XVII) December 19, 1962; 1884 (XVIII) October 17, 1963; 1962 (XVIII) December 13, 1963; and 1963 (XVIII) December 13, 1963. With the exception of the 1958 resolution, all others were passed by the unanimous vote of the General Assembly. The treaty essentially codifies the official position on outer space of member states of the United Nations, a position which developed into a consensus during the past 9 years.

Text

weapons on celestial bodies, which was adopted unanimously by the United Nations General Assembly on 17 October 1963,

Taking account of United Nations General Assembly resolution 110 (II) of 3 November 1947, which condemned propaganda designed or likely to provoke or encourage any threat to the peace breach of the peace or act of aggression, and considering that the aforementioned resolution is applicable to outer space.

Convinced that a Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, will further the Purposes and Principles of the Charter of the United Nations,

Have agreed on the following:

ARTICLE I

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.

Analysis of Treaty

ARTICLE I

International cooperation rather than national rivalry is the policy adopted for exploring and using the outer space environment. Instead of space activities being regarded as a monopoly of those nations able to afford the expense of launching satellites, all nations are to share in the benefits of space exploration without regard to their level of economic or scientific development. This principle recognizes the fact that there are relatively inexpensive space projects and that scientists and engineers capable of contributing to the peaceful uses of outer space may be found in almost any country. This new field of human activity is viewed according to a basic tenet of democracy as "the province of all mankind" and is not restricted to a few specialists. No State is to be discriminated against and all are to be treated equally, enjoying free access to any area of any celestial body.

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TEXT	ANALYSIS OF TREATY
	International law is to be applicable to situations involving freedom and equality in participating in space exploration. Scientific investigation is to be free, whether carried on in outer space, on the moon, or in connection with other celestial bodies, and all States are to encourage and promote such space activities. This policy is similar to that in the Antarctic Treaty which provides for freedom of scientific investigation and international cooperation. The predominance of international over strictly national concepts is made easier by the inaccessibility of outer space and celestial bodies as well as the speed of spacecraft in attaining orbits which disregard national boundary lines.
ARTICLE II	ARTICLE II
Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.	The wording of this article is almost identical with that in United Nations Resolution 1962 (XVIII) December 13, 1963, the only difference being that the treaty specifically includes the Moon as one of the celestial bodies. The principle expressed in this provision is one which has been observed in practice since the beginning of the space age. Extensive exploration and use of outer space have been going on for almost 10 years and during that time neither the United States, the Soviet Union nor any other nation has made sovereign claims to celestial bodies or to the outer space environment. This situation is different from that which prevails in Antarctica where territorial sovereign claims had developed historically and had to be suspended or "frozen" so that the system of international cooperation provided in the Antarctic Treaty could become workable. Article II of the outer space

Text | **Analysis of Treaty**

treaty gives legal substance to an existing practice.

ARTICLE III

States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding,

ARTICLE III

This article makes clear that those nations which ratify the treaty will observe international law—and this includes the Charter of the United Nations—in order to promote international cooperation and peace. Thus that body of law, which has developed on the Earth in order to bring about harmonious relations between nations and settle disputes without resort to violence, would become applicable to outer space, the Moon, and other celestial bodies. An exception would be international law which provides certain conditions for national claims of sovereignty, this exception having been set forth in Article II.

ARTICLE IV

States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

The Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the Moon and other celestial bodies shall also not be prohibited.

ARTICLE IV

Paragraph 1 of this Article is based upon United Nations Resolution 1884 (XVIII) which passed the General Assembly by acclamation on October 17, 1963.[1] The resolution welcomes expressions by the United States and U.S.S.R. "not to station in outer space any objects carrying nuclear weapons or other kinds of weapons of mass destruction" and calls upon all states "(a) to refrain from placing in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, installing such weapons on celestial bodies, or stationing such weapons in outer space in any other manner; (and) to refrain from causing, encouraging or in any way participating in the conduct of the foregoing activities."

Paragraph 2 represents the final agreement on language designed to ensure that the Moon and other

[1] U.S. Deputy Secretary of Defense, Roswell L. Gilpatric, stated on Sept. 5, 1962, about one year earlier, that the United States would not place any weapons of mass destruction into orbit.

TEXT	ANALYSIS OF TREATY
	celestial bodies shall be used only for peaceful purposes. In the draft texts submitted by the United States and the Soviet Union on June 16, 1966, as a basis for discussion, Article 9 of the United States draft stated that "Celestial bodies shall be used for peaceful purposes only. All States undertake to refrain from conducting on celestial bodies any activities such as the establishment of military fortifications, the carrying out of military maneuvers, or the testing of any type of weapons. The use of military personnel, facilities or equipment for scientific research or for any other peaceful purpose shall not be prohibited." The Soviet Union's draft contained in Article IV a statement that "The Moon and other celestial bodies shall be used exclusively for peaceful purposes by all Parties to the Treaty. The establishment of military bases and installations, the testing of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden." Majority military opinion holds that orbital bombardment is not an effective strategic weapon as compared to land-based ballistic missiles. An effort to use space-based nuclear weapons would have the effect of a strategic warning, thus placing an aggressor in the position of being open to retaliation by strategic weapons. It is generally believed to be in the interest of long-range peace plans and arms control to try to ensure that the Moon and other celestial bodies will be non-nuclear, non-military zones. One question is how to be sure that nations are complying with the treaty if there is no provision for inspection. Any inspection provision would have to be made on a reciprocal basis. No nation

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TEXT	ANALYSIS OF TREATY
	could expect to inspect the spacecraft of another without having its own vehicles inspected in turn. For example, space reconnaissance capabilities are peace-keeping assets and it is unlikely that nations would wish on-site inspection of such defense methods. It is possible, however, to use existing tracking facilities to make intelligence estimates from orbiting spacecraft, and some types of electronic monitoring are already possible and may be expected to improve with advances in science and technology. The capability of the United States to detect the nature and purpose of spacecraft inimical to the national interest is a form of defense which acts as a deterrent to a potential enemy. The treaty does not change the earthly situation with regard to ICBM's, but seeks to achieve on celestial bodies a form of demilitarization which is deemed feasible from military and political viewpoints. At the same time, it is clear that aerospaced-trained military personnel may engage, as they have been doing, in peaceful space activities.
ARTICLE V	**ARTICLE V**
States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle. In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance	This provision extends to astronauts the same type of traditional assistance accorded throughout history to mariners at sea. If astronauts experience accidents, distress or have to make an emergency landing, they are assured of being treated as "envoys of mankind" and not as unwanted intruders. This article of the treaty also provides an additional basis for international cooperation in that all states parties to the treaty agree to give astronauts all possible assistance, and to report to other such states any dangers to

Text

to the astronauts of other States Parties.

States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.

Analysis of Treaty

life and health discovered in outer space, on the Moon or other celestial bodies. It is evident that the global tracking system required for following the flight paths of astronauts is a scientific and technological factor which makes international cooperation necessary while the humane subject makes it more easily attainable. The treaty establishes an attitude of international responsibility for astronauts.

International agreement on assistance to and return of astronauts (as well as objects launched into outer space which is included in this treaty in Article VIII) has been a subject for discussion in the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space, the United States having made its latest proposal in 1964. It is planned that an international agreement on assistance to astronauts, in addition to this treaty, will continue to be a subject for negotiation in greater detail by the Legal Subcommittee of the UN Committee on the Peaceful Uses of Outer Space. (See page 66 of this document for the draft text of the pending U.S. proposal on this subject.)

Text

ARTICLE VI

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require

Analysis of Treaty

ARTICLE VI

Under this article, a nation which becomes a party to the treaty agrees to be responsible for space activities carried on by one of its government agencies as well as by any nongovernmental entity. For the United States, this means that the government would accept responsibility for the activities of NASA as well as those of the Communications Satellite Corporation (COMSAT), etc. Furthermore, the government would see that such activities conform to the treaty's provisions, and also au-

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Text

authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the Moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Analysis of Treaty

thorize and continuously supervise the space activities of nongovernmental entities. The relationship between the U.S. Government and COMSAT is already defined in the U.S. Communications Satellite Act of 1962 (Public Law 87-624 (76 Stat. 419)) and in the President's Executive Order of January 4, 1965 on carrying out provisions of the COMSAT Act of 1962 concerning government supervision, including international aspects and the role of the Secretary of State.

The treaty also provides that an international organization as well as the states participating therein are responsible for compliance with the treaty. For example, the European Space Research Organization (ESRO) would be responsible for activities in outer space, including the Moon and other celestial bodies, and the states which are members of ESRO and also parties to the treaty would become responsible for compliance with the treaty's provisions.

This article is designed to ensure responsibility for space activities, inherently international in nature, at the governmental level. The provisions are similar to paragraph 5 of United Nations Resolution 1962 (XVIII), December 13, 1963, except that celestial bodies are specifically added to "outer space".

ARTICLE VII

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical

ARTICLE VII

Article VII is similar to paragraph 8 of United Nations Resolution 1962 (XVIII) which passed the UN General Assembly unanimously on December 13, 1963. In negotiating the ideas in this provision for purposes of the treaty, some changes were made. The terms of the treaty apply only to those states which are party to

TEXT	ANALYSIS OF TREATY
person by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.	the treaty rather than to all states in a general sense. The Moon and other celestial bodies have been added to the original concept which was stated only in terms of "outer space". Liability for damage is limited in the treaty to "another State Party to the Treaty" and includes situations in which a State launches or uses its territory to launch space vehicles. The term "internationally liable for damage" means that a government ratifying the treaty accepts the fact that another country may present a claim against it; that liability is accepted abroad as well as domestically. If liability is established, adherence to the treaty means the state accepts responsibility to make restitution to an injured party abroad. It is clear that the concept of liability for damage in the treaty includes damage by a space object or any part of the object whether the damage occurs in air space or outer space, on the Moon or any other celestial body. Thus the aerospace concept is extended legally, as it has been technologically, in a trajectory from the Earth through airspace to outer space and back to airspace and the Earth again. The air laws and treaties of the world may be applicable to certain situations; a new relationship might develop between air law and the law of outer space. Although there is every likelihood that objects reentering the Earth's atmosphere from outer space may burn up, a sufficient number of objects has fallen to Earth to indicate the real possibility of damage, and therefore of a liability problem. It is not always possible to identify objects which have fallen to Earth from outer space, and no solution has been advanced in the treaty for objects which cannot be identified.

TEXT	ANALYSIS OF TREATY
	The UN Committee on the Peaceful Uses of Outer Space recognized, however, that the treaty provision is a general one and that the problem of liability for damage would require more detailed study and agreement. The subject, therefore, is still on the agenda of the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, and it is anticipated that a separate international agreement on liability for damage will require negotiation as it applies to outer space. As far as the United States is concerned, such an agreement would be submitted to the Congress for approval; it would probably take the form of a treaty which would be submitted to the Senate for its advice and consent to ratification.
ARTICLE VIII	**ARTICLE VIII**
A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.	This article is similar to paragraph 7 in United Nations Resolution 1962 (XVIII) which passed the General Assembly unanimously on December 13, 1963. In negotiating the wording for the treaty, some refinements in language and coverage were made. The treaty applies only to those states which are parties to the treaty. The principle of national ownership of spacecraft and personnel thereon while in outer space is the same in the treaty as in the UN Resolution, but the treaty provision adds "on a celestial body." Ownership is extended by the treaty to include "objects landed or constructed on a celestial body" and is not affected while on a celestial body, in outer space, or by return to Earth. In other words, a nation which constructs and orbits a spacecraft, manned or unmanned, retains ownership and control over the

TEXT	ANALYSIS OF TREATY
	vehicle no matter where it is located. A state's "registry" of spacecraft is a term similar to the "registry" of ocean-going ships, such records being kept for the purpose of identifying ownership. The principle of returning to the state of origin any space objects or parts found beyond its borders, and the principle that the state of origin must furnish identifying data prior to the return of such objects, were both included in UN Resolution 1962. Under the UN Resolution the principles applied to all states; under the treaty, the principles apply only to those states which are parties to the treaty. The treaty provision as it stands, however, is not self-executing and would need to be implemented by enabling domestic U.S. legislation so that the Federal Government could obtain possession of space objects which fall on private property.
ARTICLE IX	**ARTICLE IX**
In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the	Article IX of the treaty is similar to paragraph 6 of United Nations Resolution 1962 which passed the General Assembly unanimously on December 13, 1963. The provision applies only to states which are parties to the treaty, and to that extent limits the possibility of space experiments which might cause harmful contamination and adverse changes in the Earth's environment. The treaty would not prohibit non-member nations from conducting harmful experiments, causing contamination in various forms, and engaging in potentially harmful interference with peaceful space exploration. But nations

Text

Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment.

Analysis of Treaty

which do not become parties to the treaty are not now prohibited from potentially harmful space experiments. A nucleus of states, including the two great space powers—the United States and the U.S.S.R.—observing controls in the interest of all nations, may ultimately attract the cooperation of other nations not initially parties to the treaty.

According to Article IX, a State Party to the Treaty, committed to a policy of peaceful exploration and use of the space environment, has the responsibility of considering whether a planned experiment might be harmful, and in such case must undertake to consult with other nations before proceeding with the experiment. At the same time a state, which fears another nation is planning a space experiment which might be harmful or interfere with peaceful space exploration, may request a consultation on the matter. Thus a possible course of action which might be detrimental is identified and put under general control, including that of world public opinion. The objective and procedure provided by the treaty for preventing harmful space activities are clear guiding principles which appear to be in the interest of each nation to observe not only for the benefit of the world, but also for self-protection.

ARTICLE X

In order to promote international co-operation in the exploration and use of outer space, including the Moon and other celestial bodies, in conformity with the purposes of this Treaty, the States Parties to the Treaty shall consider on a basis of equality any requests by other States Parties to the Treaty to be afforded an op-

ARTICLE X

In accepting this article, a nation would agree to consider the request of another nation (if a party to the treaty) to build tracking facilities on its territory for observing the flight of space objects which the requester nation had launched. Such consideration would be on a "basis of equality" which suggests that one

TEXT	ANALYSIS OF TREATY
portunity to observe the flight of space objects launched by those States. The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.	nation would not be favored over another. Although a nation agrees to consider the request, there is no obligation to grant it if appropriate mutual arrangements cannot be worked out. The nation on whose territory a tracking station is located, or has land which another nation might request for use as a tracking station, would be free to establish the conditions under which the representatives of other nations could use its resources. It would be necessary to negotiate a bilateral agreement between the two states concerned or a multilateral agreement in the event several nations were involved. Should the terms involving such items as cost, accessibility, and the possibility of mutual benefits, prove unacceptable to the host nation, there is no obligation to grant access to a foreign state.
ARTICLE XI	**ARTICLE XI**
In order to promote international co-operation in the peaceful exploration and use of outer space, States Parties to the Treaty conducting activities in outer space, including the Moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively.	There has been wide dissemination of information by the United States on its space activities for the past 9 years. The treaty provision is an acknowledgment of an existing situation for many nations and international organizations. The United States international space program, conducted by the National Aeronautics and Space Administration, includes cooperative projects in 69 nations and locations, and the results of such space research are publicized. The United Nations Committee on the Peaceful Uses of Outer Space publishes reports which nations have voluntarily submitted on their space efforts. There is also a UN registry for space vehicles, and data on launched spacecraft is regularly published in United Nations documents. The Outer Space Affairs

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Text | **Analysis of Treaty**

group in the United Nations receives information and answers questions.

In addition, the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) has international conferences and regularly publishes a bulletin of scientific and technical information on space research and development. Nations have voluntarily released information to promote international cooperation in the peaceful exploration and use of outer space and the treaty contemplates that they will continue to do so. The wording that information will be furnished "to the greatest extent feasible and practicable" means that if a nation which is a party to the treaty finds that it is not feasible and is not practicable, then it is not obliged to publicize information on its space activities. Thus the treaty provision is a general guiding principle rather than one requiring mandatory compliance.

ARTICLE XII

All stations, installations, equipment and space vehicles on the Moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.

ARTICLE XII

This provision does not apply to stations, installations, equipment, and space vehicles in outer space itself, but only to those located on the Moon and other celestial bodies. If two nations had space facilities based on the Moon, for example, each would agree, under this treaty, to accept visitors from another nation's space station on a reciprocal basis with the understanding that each prospective representative would give reasonable advance notice of his intended visit. This would afford time for the two nations to consult, as appropriate, with the objective of ensuring the safety of personnel and the normal functioning of space facilities.

ARTICLE XIII

Text

The provisions of this Treaty shall apply to the activities of States Parties to the Treaty in the exploration and use of outer space, including the Moon and other celestial bodies, whether such activities are carried on by a single State Party to the Treaty or jointly with other States including cases where they are carried on within the framework of international inter-governmental organizations.

Any practical questions arising in connection with activities carried on by international inter-governmental organizations in the exploration and use of outer space, including the Moon and other celestial bodies, shall be resolved by the States Parties to the Treaty either with the appropriate international organization or with one or more States members of that international organization, which are Parties to this Treaty.

Analysis of Treaty

States which are parties to this treaty accept the treaty's rights and obligations whether acting as a single state or jointly with other states or as members of an international inter-governmental organization. For example, if nations which are members of the European Space Research Organization (ESRO) also become parties to the treaty, they agree to comply with the treaty provisions on outer space, the Moon, and other celestial bodies.

If ESRO's space activities, for example, give rise to practical questions, those nations which are parties to the treaty may resolve them in one of two ways: (1) with the international organization concerned, or (2) with one or more of the states which are members of the international organization and also parties to the treaty. If the United States, for example, had a practical question arising from ESRO's space activities, the matter could be settled between the United States and ESRO or between the United States and any members of ESRO which are also parties to this outer space treaty.

ARTICLE XIV

Text

1. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and

Analysis of Treaty

Paragraph 1 provides that all states may sign the treaty, and on January 27, 1967 the treaty was opened for signature in Washington, London, and Moscow. (See pages 37–41 for a list of 77 states which signed the treaty as of February 28, 1967.)

Paragraph 2 designates the United States, the United Kingdom of Great Britain and Northern Ireland, and the U.S.S.R. as Depositary Governments, and they are to receive the instruments of ratification and accession.

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the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force upon the deposit of instruments of ratification by five Governments including the Governments designated as Depositary Governments under this Treaty.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Treaty, the date of its entry into force and other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Analysis of Treaty

required from the signatory states.

Paragraph 3 stipulates that the treaty enters into force when ratified by 5 governments, including the United States, the United Kingdom of Great Britain and Northern Ireland, and the U.S.S.R.

Paragraph 4 provides that states which ratify or accede to the treaty after it has gone into force will be considered as parties to the treaty as of the date when they deposit their necessary documents of ratification or accession.

Paragraph 5 provides that the United States, the United Kingdom of Great Britain and Northern Ireland, and the U.S.S.R. shall inform all states which sign and accede to the treaty of the dates of deposit and entry into force of each state.

Paragraph 6 calls for registration of the treaty by the United States, the United Kingdom of Great Britain and Northern Ireland, and the U.S.S.R. in accordance with Article 102 of the United Nations Charter:

Article 102, United Nations Charter:

> "1. Every treaty and every international agreement entered into by any Member of the United Nations after the present Charter comes into force shall as soon as possible be registered with the Secretariat and published by it.
>
> "2. No party to any such treaty or international agreement which has not been registered in accordance with the provisions of paragraph 1 of this Article may invoke that treaty or agreement before any organ of the United Nations."

Text	Analysis of Treaty
ARTICLE XV	ARTICLE XV
Any State Party to the Treaty may propose amendments to this Treaty. Amendments shall enter into force for each State Party to the Treaty accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and thereafter for each remaining State Party to the Treaty on the date of acceptance by it.	Amendments may be proposed by any state which is a party to the treaty. States that are parties to the treaty may then accept the amendments, and when a majority have accepted them, the amendments enter into force for those states. Thereafter, the amendments go into effect for each of the remaining states on the date when accepted.
ARTICLE XVI	ARTICLE XVI
Any State Party to the Treaty may give notice of its withdrawal from the Treaty one year after its entry into force by written notification to the Depositary Governments. Such withdrawal shall take effect one year from the date of receipt of this notification.	If a state wishes to withdraw from the treaty, it may notify in writing the Depositary Governments, *i.e.*, the United States, the United Kingdom of Great Britain and Northern Ireland, and the U.S.S.R. One year after these governments receive the notice, the withdrawal of a state becomes effective.
ARTICLE XVII	ARTICLE XVII
This Treaty, of which the English, Russian, French, Spanish and Chinese texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.	The treaty, in five languages (English, Russian, French, Spanish, and Chinese) is deposited in the archives of the United States, the United Kingdom of Great Britain and Northern Ireland, and the U.S.S.R. These Depositary Governments are then to send certified copies to every state which signs or accedes to the treaty.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Treaty.

DONE in triplicate, at the cities of Washington, London and Moscow, this twenty-seventh day of January one thousand nine hundred and sixty-seven.

For the United States of America:
DEAN RUSK
ARTHUR J. GOLDBERG

For the United Kingdom of Great Britain and Northern Ireland:
PATRICK DEAN

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For the Union of Soviet Socialist Republics:
A. F. DOBRYNIN

For Chile:
RADOMIRO TOMIC

For Mexico:
HUGO B. MARGÁIN

For China:
CHOW SHU-KAI

For Italy:
SERGIO FENOALTEA

For Honduras:
RICARDO MIDENCE SOTO

For Ethiopia:
TASHOMA HAILE-MARIAM

For Ghana:
ABRAHAM BENJAMIN BAH KOFI

For Cyprus:
ZENON ROSSIDES

For Canada:
A. EDGAR RITCHIE

For Bulgaria:
DR. LUBEN GUERASSIMOV

For Australia:
JOHN KEITH WALLER

For Denmark:
FLEMMING AGERUP

For Hungary:
JÁNOS RADVÁNYI

For Iceland:
PETUR THORSTEINSSON

For Czechoslovakia:
DR. KAREL DUDA

For Japan:
RYUJI TAKEUCHI

For Romania:
PETRE BALACEANU

For Poland:
ZDZISLAW SZEWCZYK

For Tunisia:
RACHID DRISS

For New Zealand:
JACK SHEPHERD

For Colombia:
HERNAN ECHAVARRÍA OLÓZAGA

For Finland:
OLAVI MUNKKI

For Panama:
RICARDO M. ARIAS E.

For Laos:
KHAMKING SOUVANLASY

For Greece:
ALEXANDER A. MATSAS

For the Philippines:
JOSÉ F. IMPERIAL

For Turkey:
MELIH ESENBEL

For Yugoslavia:
VELJKO MICUNOVIC

For Afghanistan:
DR. ABDUL MAJID

For Argentina:
ALVARO C. ALSOGARAY

For the United Arab Republic:
MOSTAFA KAMEL

For Haiti:
ARTHUR BONHOMME

For Luxembourg:
MAURICE STEINMETZ

For Viet-Nam:
BUI DIEM

For Venezuela:
ENRIQUE TEJERA-PARIS

For the Federal Republic of Germany:
HEINRICH KNAPPSTEIN

For Israel:
AVRAHAM HARMAN

For El Salvador:
RAMON DE CLAIRMONT DUEÑAS

For Thailand:
SUKICH NIMMANHEMINDA

For Sweden:
HUBERT DE BESCHE

For Ecuador:
GUSTAVO LARREA

For Togo:
ROBERT AJAVON

For the Dominican Republic:
HECTOR GARCIA-GODOY

For Switzerland:
FELIX SCHNYDER

For Burundi:
CLÉMENT SAMBIRA

For Ireland:
WILLIAM P. FAY

For Cameroon:
JOSEPH N. OWONO

For Indonesia:
SUWITO KUSUMOWIDAGDO

For Bolivia:
JULIO SANJINES-GOYTIA

For Botswana:
ZACHARIAH KEODIRELANG MATTHEWS

For Lesotho:
ALBERTO S. MOHALE

For Korea.
HYUN CHUL KIM

For the Congo (Kinshasa):
CYRILLE ADOULA

For Uruguay:
RUBIN A. ALEJANDRO CHELLE

For the Central African Republic:
MICHEL GALLIN-DOUATHE

For Rwanda:
CELESTIN KABANDA

For Nicaragua:
GUILLERMO SEVILLA-SACASA

Between January 27, 1967, and February 28, 1967, the following countries signed the Treaty On Outer Space:

Country	*Date*
Niger	February 1, 1967.
Somalia	February 2, 1967.
Jordan	February 2, 1967.
Brazil	February 2, 1967.
Belgium	February 2, 1967.
Nepal	February 3, 1967.
Norway	February 3, 1967.
Guyana	February 3, 1967.
Netherlands	February 10, 1967.
Austria	February 20, 1967.
Malaysia	February 20, 1967.
Lebanon	February 23, 1967.
Iraq	February 27, 1967.

The East German regime and Mongolia signed the treaty in Moscow, January 27, 1967. Sierra Leone signed in Moscow and London January 27, 1967. Iran signed in London, January 27, 1967.

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