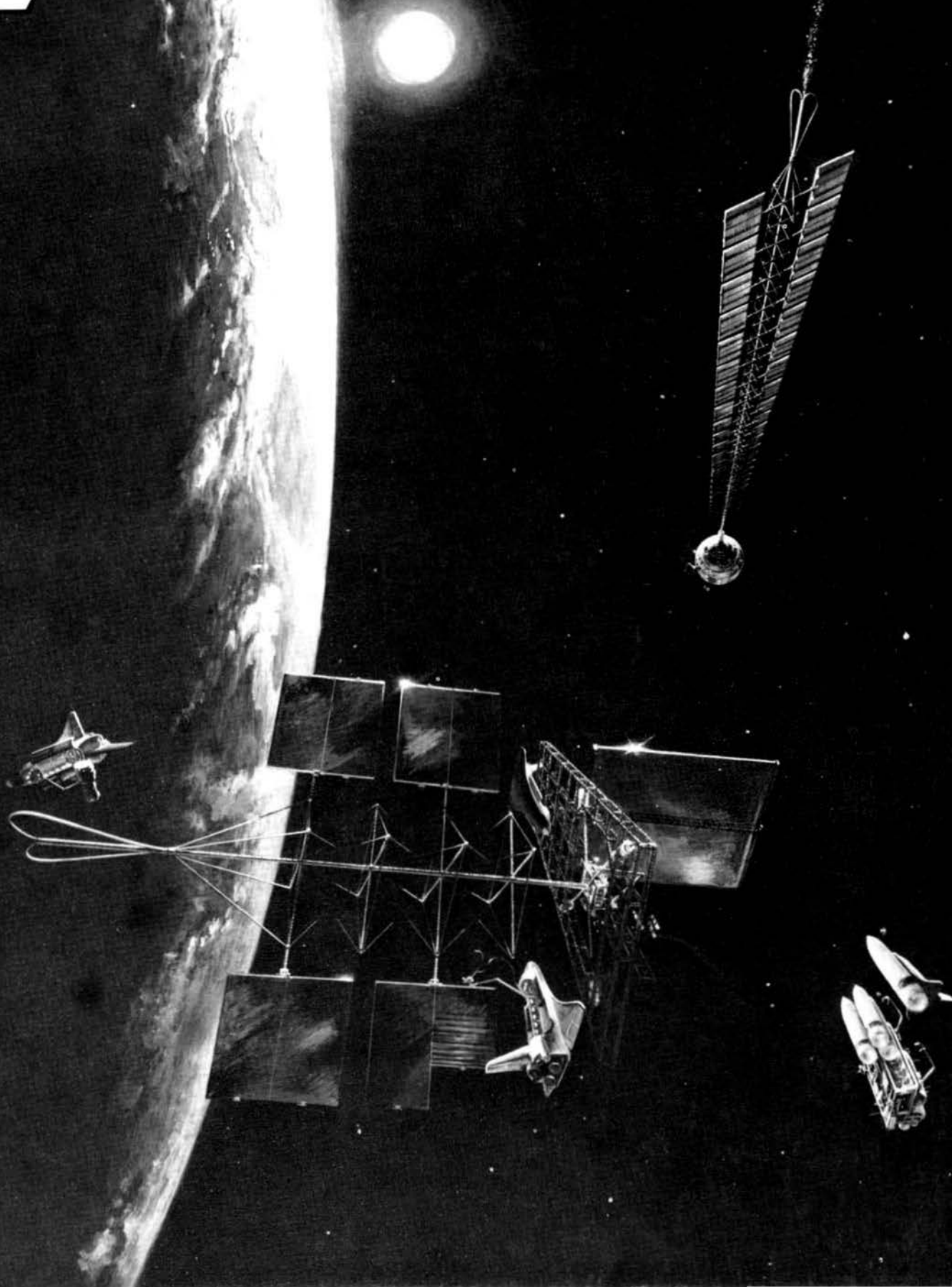


L5 NEWS

May 1978



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Cover: A mass driver reaction engine (MDRE) is ferrying cargo from one orbit to another. In the foreground a second MDRE is being constructed from parts brought up by several space shuttles. (Artwork courtesy Johnson Space Center.)

Back Cover: A chemical processing plant in space which could convert lunar ores into metals, silicon and oxygen. (Artwork courtesy Johnson Space Center.)

SPS Hearings: Momentum Lost?

by Ken McCormick

Solar power satellites were the subject of joint hearings on April 12, 13 and 14 before the House Subcommittee on Space Science and Applications and the Subcommittee on Advanced Energy Technologies and Energy Conservation Research, Development and Demonstration. Under consideration was a bill, HR 10601, sponsored by Rep. Ronnie G. Flippo, which would establish a solar power satellite (SPS) research, development and demonstration program.

Witnesses testified to the need for more experimental data in several problem areas of SPS evaluation. There was considerable enthusiasm displayed for HR 10601, until government witnesses from DOE and NASA appeared before the subcommittees to attack certain provisions of the bill. By the time the witnesses from NASA and DOE were done testifying, it seemed that HR 10601 had lost some of its momentum.

Undersecretary of the Department of Energy Dale D. Myers began his testimony by reminding subcommittee members that he had undertaken a more vigorous evaluation of SPS at the urging of the Space Science and Applications Subcommittee on February 8. Since then, he said, he had had intensive discussions with NASA administrator Robert Frosch and NASA Deputy Administrator Alan Lovelace on the subject of SPS. It became clear, he said, that an SPS project management office should be established within the office of the director of energy research. With Myers was Mr. Frederick A. Koomanoff, the newly-appointed chief of the project office, which will administer the funds appropriated by Congress for the study of SPS.

The existing SPS Development and Concept Evaluation Program, which the provisions of HR 10601 would supersede, calls for an exploratory research plan to be developed by October 1978. Undersecretary Myers said that he had accelerated efforts on SPS research, so as to have the research plan completed for consideration in the fiscal year (FY) 1980 budget.

Myers thus appeared to have pre-empted two of the main provisions of HR 10601: that a program office be established within DOE, and that a comprehensive plan for

SPS research be submitted by Sept. 30, 1978. "Based on steps taken by DOE," said Myers, "it is our judgement that the provisions of HR 10601, except for space-related technology development and demonstration, have been accomplished. Both DOE and NASA feel that space technology development and demonstration would be premature."

There remained the provision by HR 10601 for \$25 million in FY 1979. Myers immediately addressed himself to this: "We have not at this time identified a requirement for additional funds. Should we find such a need, we will not hesitate to request them in the normal fashion."

Mr. Koomanoff then testified, describing DOE and NASA's formulation of a plan for SPS evaluation. He said that much progress could be made in the SPS systems definition "without extensive new technology development or flight demonstration activities."

Koomanoff then pointed to several potential problems with respect to the SPS microwave beam, including radio interference and biological, ecological and atmospheric effects. He suggested that a number of societal issues yet to be studied are perhaps some of the most serious obstacles to SPS. They include: the question of central versus dispersed power, international space law regarding space usage, international microwave standards, the perceived military threat of SPS, the vulnerability of SPS to attack, the question of energy export, ownership, interface with utilities, regulation, population and individual migration, capital formation, land, materials, facilities, labor and energy requirements.

HR 10601, he said, "would add technology development and orbital demonstration to the present SPS evaluation program. In my opinion, which is shared by NASA, many key systems development and environmental issues must be resolved in the current study before such advanced efforts are warranted. The requirements for . . . experimental equipment will evolve from the current study. The HR 10601 provisions for technology development and orbital demonstration are premature. The present study is properly scaled to the current level

of understanding of SPS issues."

Space Science and Applications Subcommittee Chairman Don Fuqua questioned Koomanoff: "Mr. Koomanoff . . . we've had hearings yesterday and this morning and this afternoon by other people who have talked about the need for a continuation of the microwave testing and the environmental effects that that might have. This afternoon, you've heard other witnesses testify that we ought to get on with the program, and I just have difficulty in really understanding your statement."

Koomanoff explained that several microwave test programs were scheduled for the near future and further explained his position: "We have to move piece by piece down the road, because if we don't, then we're going to have too many differences between designs and concepts, and we won't have one overall direction, and that's what we're trying to do, and that's what NASA's in the process of doing right now. They will have their preferred systems concept by October as far as our plan is concerned, and at that time point, then, we can really start moving out in much more detail."

Representative Flippo questioned the men from DOE: "I was wondering, Mr. Koomanoff, or Mr. Myers, if you share the sense of urgency in regard to the solar power satellite that has been expressed by the members of this committee and by the witnesses that have appeared before this committee over a period of time. Do you share that sense of urgency in regard to SPS?"

Myers answered: "Mr. Flippo, I think we share the very strong sense of urgency for new supply. The SPS is another possible new supply area, and we are extremely interested in comparing it with the other systems, and making sure that we as a nation are moving in the desired direction as far as our supplies are concerned. It is a major undertaking. It would be an undertaking which I am sure, in our present views of . . . budgets in the future, would certainly have to take a part away from other systems, so that all of these, to me, have to be compared and the proper balance of programs for this country have to be undertaken."

A DOE technology evaluations section leader who accompanied Mr. Koomanoff to the hearings was perhaps more frank in a conversation with this reporter after the hearings. "Flippo has Huntsville in his district. (Rep.) Gammage has Houston. You can see what they're trying to do. They don't want research; they want hardware. They just want to pump money into NASA. You're looking at something that's far in the future, anyway. What's the difference whether we have SPS in the year 2000, or the year 2005? We're still going to need fossil fuels and nuclear energy."

The next day brought testimony from NASA which echoed that of DOE. NASA Deputy Administrator Alan M. Lovelace appeared, instead of NASA administrator Robert Frosch, who had originally been scheduled to testify. "We are currently working with DOE to determine whether a FY 1980 exploratory research budget request would be appropriate. The space-related technology development and demonstration portions of . . . HR 10601 appear to be premature."

Dr. Lovelace's statement prompted Representative Fuqua to remark: "I realize that there's another agency in town, Dr. Lovelace, besides NASA, and the faceless people at OMB, it appears to me, have put bridles on both NASA and DOE. I would hope that they would come out of hiding sometime, and maybe we need to ask them to come up and testify . . . I am very much disappointed in their (the government witnesses) lack of imagination and enthusiasm for trying to help solve the earth's energy problems."

Dr. Peter Glaser (who first proposed the solar power satellite concept) testified, on the last day of hearings, that continuing with paper studies alone until 1980 will simply produce a delay of another year in the evaluation of SPS. Nonetheless, the momentum of HR 10601 had clearly faltered, at least temporarily. More than one co-sponsor of the bill remarked that perhaps they had acted prematurely. Advanced Energy Technologies Chairman Mike McCormack stated, "the environmental problems associated with the project may make all the environmental problems associated with nuclear fission look like a Sunday-school picnic." Mr. McCormack was absent from the last day of the hearings, as were most of his colleagues.

Washington, DC May 3: in spite of the heavy opposition to HR10601 that surfaced in these hearings, the Science and Technology Committee voted 30 to 1 (Rep. Ottinger cast the sole "nay" vote) today in favor of the bill. Supporters hope approval from the full House will be obtained by mid-May.

Melcher Introduces Senate Solar Power Satellite Bill

Senator John Melcher (D-MT) has introduced S 2860 which is the Senate version of HR 10601. He informs us that the Senate Committee on Energy and Natural Resources has jurisdiction over the bill. The Commerce Committee, which handles NASA authorizations, did not request jurisdiction over S 2860 as the funds it authorizes go to NASA indirectly through the Dept. of Energy.

Hearings on S 2860 have not been scheduled. First, the House Science and Technology Committee must report HR 10601 to the floor for a vote. If it is passed, the Senate can then go to work on S 2860. If HR 10601 is not scheduled for a vote in a timely manner, it could be delayed so long that it will not be able to pass until the next session of Congress. (Being an election year, Congress plans to adjourn October 6 or 7.) The leaders responsible for scheduling HR 10601 for a vote are Rep. James Wright (D-TX) and Rep. "Tip" O'Neill (D-MA).

If the bill makes it through the House, then the Senate Energy and Natural Resources Committee Energy R & D Subcommittee will hold hearings on S 2860.

Energy R & D Subcommittee members:

(phone 202/224-4971)
Frank Church (D-ID), chairman
Mark O. Hatfield (R-OR) ranking minority member
Spark M. Matsunaga (D-HI)
James Abourezk (D-SD)
Dale Bumpers (D-AK)
Wendell H. Ford (D-KY)
John A. Durkin (D-NH)
Wendell Anderson (D-MN)
John Melcher (D-MT)
Pete V. Domenici (R-MN)
James A. McClure (R-ID)
Dewey F. Bartlett (R-OK)

Other Senators on the Energy and Natural Resources Committee but not on this subcommittee are:

Henry M. Jackson (D-WA), chairman
J. Bennett Johnston (D-LA)
Floyd K. Haskell (D-CO)
Howard M. Metzenbaum (D-OH)
Clifford P. Hansen (R-WY)
Lowell P. Weiker, Jr. (R-CT)
Paul Laxalt (R-NV)

These Senators must vote favorably on S 2860 in order to send it to the floor of the Senate for a vote. If the bill passes—next comes the appropriations process! When that step looms on the horizon we will bring you details on that process.

Microwave False Alarm

The **Washington Post**, in an article dated Feb. 21, 1978 by Thomas O'Toole, reported that solar power satellites (SPS) would "heat the ionosphere to the point of jamming most of the world's police and citizen band radio transmission".

This was reported as the tentative conclusion of scientists at the National Astronomy Atmospheric Center in Arecibo, Puerto Rico, "site of the world's biggest radio telescope.

However, before you CB fans rise up in arms to block SPS development — the report was a false alarm. According to W.E. Gordon, who conducted the Arecibo microwave test on the ionosphere, "We heated the ionosphere at frequencies of 10 MHz, 430 MHz and 2380 MHz attempting to simulate the heating effects of the solar power satellite. We looked for communications effects with a sensitive radar properly located to observe any effects if they were to occur. No communications effects were observed in any of the tests! ... If the ionosphere is heated at a radio frequency that resonates with the local

ionization, a strong disturbance, an instability, is produced that is known to provide communication paths not normally present." However, adds Gordon, "The solar power satellite would operate at microwave frequencies far too high to excite this instability."

Nevertheless, Gordon does not totally rule out adverse effects of SPS on the ionosphere. "There has been some theoretical speculation that an instability of a completely different kind *might* be produced by strong microwave heating of the ionosphere. This speculation is recognized by the originator of the solar power satellite idea, Peter Glaser, and by the proponents of further study of the idea. The tests we performed last summer and the test we propose using higher powers to simulate the conditions more closely of the solar power, satellite are based in part on this same theoretical speculation ... We and others recommend that additional tests be included in the evaluation of the solar power satellite concept and that the tests be performed at higher power levels."

SPS—"A Gross Perversion of Our Solar Energy Priorities"

(Text of a letter sent to all members of Congress April 11, 1978 by Rep. Richard C. Ottinger, D-NY)

Dear Colleagues:

Solar energy, particularly in its decentralized, locally applied forms, has been strongly supported by both houses of Congress. Now, however, we are being asked to support a massive, multibillion dollar corporate boondoggle—the solar power satellite—all in the name of solar energy!

A Jet Propulsion Laboratory study estimated that the R & D costs alone would come to \$60 billion. The industry estimate confirms this, citing a \$40-80 billion R & D cost range. The Jet Propulsion Laboratory further estimated the cost, excluding RD & D for a 5 billion watt plant startup in the year 2000 at \$26.5 billion. Not only are the taxpayer financed R & D and the capital costs of a solar power satellite horrendous, but the environmental consequences are frightening.

The satellite would use microwaves to beam energy back to Earth. Microwaves, even at low levels, have been shown to cause central nervous system disorders, cataracts, genetic changes and other disorders. You may recall the furor when the Soviets beamed low level microwaves at the U.S. embassy in Moscow.

Both NASA and DOE have ongoing studies of the SPS concept. An ERDA task group in November 1976 recommended a three year, \$19 million program for "proof of concept" which is still underway.

Yet the giants of industry—Boeing, Lockheed, Westinghouse and others, are urging us to support a full scale demonstration program before the facts are in. We are being asked to prematurely commit ourselves to what could be the greatest white elephant since the Spruce Goose—at the taxpayers' expense, of course. I urge you to look before you leap. Enclosed is a recently released article which will appear in the May issue of *Mother Jones*. I hope you will read it carefully. When you consider the solar power satellite, I hope you will see it for what it is—a gross perversion of our solar energy priorities.

Sincerely,
Richard C. Ottinger

HR 10601: FOCUS OF CONTROVERSY

by Carolyn Henson

What was in that article in *Mother Jones* magazine that Rep. Ottinger sent to all members of Congress? Highlights were brought out in a press release *Mother Jones* staffers handed out at the April 6 Sunsat Energy Council press conference. Following is the complete text of the release:

"Shuttling Manhattans to the Sky"

By Adam Hochschild

The aerospace industry has finally found a way to cash in on the current popularity of solar energy—and the result may hit millions of us with deadly microwave radiation.

Picture it, if you can: a vast rectangular metallic field, glistening brightly with reflected sunlight, in stationary orbit some 22,300 miles above the earth. It's called a Satellite Solar Power Station, and it's bigger than New York City.

According to a peculiar array of bureaucrats, businessmen and dreamers, this and a hundred similar units will constitute a major solution to America's energy problems. If the backers have their way, a prototype Satellite Solar Power Station (SSPS) will be aloft within a decade.

The SSPS is a major environmental rip-off of the 1980's:

- one critic compares it to a "giant microwave oven cooking all people, plants and animals caught in the wandering beam"
- the SSPS is a potentially lethal weapon: reaimed by a few degrees, the microwaves it generates could hit New York or Moscow instead of the receiving antenna
- it would take each SSPS more than ten years to repay the earth for the

energy necessary to build and launch it.

Several hundred scientists and engineers are at work on the idea, the Department of Energy is now in the act, and some \$12 million has already been spent on the SSPS. You're about to be asked to ante up several hundred billion dollars in tax money to pay for these giant microwave ovens in the sky. At the same time, the Carter Administration is cutting by some \$10 million this country's already meager budget for earthbound solar research.

MOTHER JONES editor Adam Hochschild is available for interviews.

What's going on here? Did the *L-5 News* miss a major issue by failing to see that an SPS can become a weapon merely by reaiming it? (Long term *L-5* readers will remember a series of articles on the potential for using SPS to power space lasers for military use.) Not so, according to the supposed "critic" of SPS quoted by *Mother Jones*. Following is the statement attributed to him:

• An SSPS is potentially a lethal weapon. One critic, Dr. Aden Meinel, Professor of Optical Sciences at the University of Arizona, compares it to a "giant microwave oven cooking all people, plants and animals caught by the wandering beam." You don't have to convert an SSPS into a weapon; it is a weapon already. All you have to do is reaim it by a few degrees so that the microwaves hit New York or Moscow instead of the receiving antenna.

—reprinted from "*Shuttling Manhattans to the Sky*" *Mother Jones*, May, 1978, pp. 39,40.

Dr. Meinel, upon hearing this quote, told the *L-5* staff, "I sure don't recognize

it." He added, If a hostile nation wanted to make it into a weapon they could. I see that as a reason for international control of SPS." Dr. Meinel added that he does not believe that the unmodified system as proposed by Dr. Glaser, however, could be used as a weapon or accidentally wander about cooking things.

How about the energy payback issue? All we can say at this point is that NASA studies indicate that ground launched SPS will pay back their energy cost in 3 years. This figure is in conflict with the **Mother Jones** figure, quoted from Dr. Piet Bos of the Electric Power Research Institute. Who is right? At this point the total research behind SPS is small enough that there is a great deal of uncertainty over its costs in terms of dollars, energy and the environment. Only a vigorous research program, such as proposed by HR 10601, the Solar Power Research, Development and Demonstration Act, can move these issues out of the range of disputes between experts and into the realm of facts.



Adam Hothschild, editor of **Mother Jones** (circulation 150,000) and author of "Shuttling Manhattans to the Sky".

The following was inserted into the April 6 Congressional Record *Extension of Remarks* by Rep. Richard L. Ottinger:

• Mr. OTTINGER. Mr Speaker, this morning I attended a most amazing press conference. The likes of Boeing, Lockheed, Martin-Marietta, GE, Westinghouse, Southern California Edison, Grumman, and Arthur D. Little announced the formation of a new "non-profit" corporation to lobby for solar power satellites—the Sunsat Energy Council. The collusion of the high technology-space industrial complex in assuring full corporate socialism for the next 20 years, much like that which American taxpayers have provided for the last 20 years, should be ripe for the chutzpa-of-the-year award.

House Committee Calls for NASA Budget Increases

by Carolyn Henson

The House Science and Technology Committee has authorized the following NASA funding increases over Carter's Office of Management and Budget allowances:

\$7 million for advanced programs (this includes space colony research funds)
\$3 million for solar power satellite research (this is in addition to the funds—\$25 million—called for in the Solar Power Satellite Research, Development and Demonstration Act, (HR 10601)

\$3 million for large space structures and microwave transmission research

The Committee also approved funds to go ahead with a five shuttle orbiter fleet (OMB had only approved four). Current Carter Administration plans are to mothball the Enterprise without using it as a space vehicle.

In order for these increases to stick, several steps must be taken. The Senate Commerce Committee must also approve them. Then both the House and the Senate will vote on the NASA authorization. If it passes in both houses, then the next step is to appropriate the money. (In effect, authorization bills only set ceilings on how much money can be spent.) The House and Senate Appropriations Committees will hold hearings on the NASA budget and vote on it. After being voted out of committee the bills go to the full House and Senate for a vote.

What happens if the House and Senate pass different versions of the bill? A "conference committee" is formed from members of the House and Senate committees responsible for having reported out different versions of the bill. When they reach a compromise, this final version of the bill is sent back to the full House and Senate for a vote.

After passage, it will go to President Carter. If he chooses to veto the bill, Congress can pass it over his head with a 2/3 vote.

Another option the President has is to impound the funds. This was a favored tactic of President Nixon; however, Carter has been less inclined to oppose the will of Congress.

"High Frontier" Bill Update

Senator Harrison Williams' (D-NJ) "High Frontier" amendment to the National Science Foundation (NSF) authorization bill (S 2549) was introduced too late to be included in the House version of the NSF authorization, which had already been reported out of the Science and Technology Committee.

The "High Frontier" amendment calls for NSF to spend \$1 million over a two year period to evaluate the construction of solar power satellites and other large manufactured assemblies" with a "High Frontier Program Feasibility Study." At the end of the study in 1980, the Director of NSF is to report to the President and Congress on "the advisability of adopting the development of the High Frontier as a national goal." Also, "At any time during the course of the study, the Director shall make recommendations to Congress as to whether accelerated funding should be provided for current and future research concerning the development of the High Frontier."

A conference committee between the Senate Human Resources Committee and the House Science and Technology Committee will be necessary in order to resolve the differences between the two NSF bills.

LIS

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Microwaves: SPS Hazard

by Eric Drexler

Publication of **The Zapping of America: Microwaves, Their Deadly Risk, and the Cover-Up** could zap the SPS. Written by Paul Brodeur (a **New Yorker** staff writer specializing in environmental and occupational medicine), it documents non-thermal effects of low-level microwave exposure. Since SPS advocates have consistently claimed that microwaves can only harm people by overheating them, the public may be somewhat upset to learn of experiments indicating neurological effects and **genetic damage** from supposedly safe levels of microwave exposure.

Since many people are already exposed to possibly hazardous levels of microwaves, concern over the effects is building rapidly. In a recent interview (see "Microwaves: The Ultimate Air Pollution," **New Times**, 6 March 1978), Paul Brodeur said: "This is becoming a big story . . . really taking off. Whoosh!" The battle lines are forming: citizens, researchers, and environmentalists vs. the military and industry. The motives: combating an invisible health-risk (whose reality some still debate) vs. protecting a massive vested interest in existing equipment and standards. Debate over microwave safety will surely increase over the coming year; it may well become a major national issue, just as nuclear power plants have.

The SPS cannot escape involvement in this debate. On first hearing of the SPS concept, virtually everyone worries a little about having millions of kilowatts of microwaves beamed at the Earth. Consider people's concern after hearing rumours of **genetic damage from microwave**, "radiation", and consider how that concern will intensify and spread as low-level microwave exposure becomes a national issue. The SPS could be shot to bits in the crossfire, and the bits could be hard to pick up for years afterwards — unless we take effective action, and take it now.

Microwave exposure could easily become a very emotional environmental issue and many people stand ready to distort such issues for their own ends. Consider nuclear power: Who would guess (from listening to nuclear power's opponents) that coal plants spread more radioactive material than nuclear plants do? Consider the SPS: Who doubts that our potential opponents would gladly "educate" the public—into thinking of the SPS as a giant death-ray machine in the sky?

We have a small advantage in the

coming debate, but one which may prove decisive if used vigorously and early: The facts are on our side. Even assuming the worst about the effects of chronic, low-level microwave exposure, a properly designed SPS system remains the safest, cleanest means of power generation ever proposed. The problem is to convince the public of this before someone else convinces them of the opposite.

Many readers of the **L-5 News** write articles and give talks which touch on the SPS. I believe our strategy should be as follows:

1) Become familiar with the evidence for non-thermal microwave effects, and with the microwave issue as a whole.

2) At every opportunity, discuss the microwave issue and present a clear explanation of why the SPS is safe in this regard.

3) Take a leading role in informing the public about microwave hazards.

For strategy's sake, supporters of the SPS should accept the most gloomy interpretation of microwave hazards that remains scientifically credible. This will do two things: First, it gives us the most convincing position from which to defend the safety of the SPS; second, it will serve the public interest by helping to establish a concerned middle-ground in what could become a polarized debate. I urge the reader to read Mr. Brodeur's book or the article cited above before deciding what position to take in this matter. Certain government agencies have clear-cut motives for covering up evidence of microwave hazards, and Mr. Brodeur cites a mass of circumstantial evidence suggesting they have done so. This, of course, makes the story that much bigger.

We need to tell people that the SPS is a safe system, and we can no longer say "Since heating is the only effect microwaves have on biological tissue there would be no cumulative effect after repeated exposures" ("**SPS: Near Future Energy Source?**", **L-5 News**, February 1978). If we are to keep our credibility and block possible attack, we must have the right reasons and explain them clearly. The following shows one way of stating our case.

The SPS will have little environmental impact because it lies beyond the Earth's environment. Return of microwave power (which will be converted to ordinary electricity in the receiving antenna) will be its only major effect. Nevertheless, people may worry about being exposed to the microwaves in two different ways: the

microwave beam wandering off the receiver to inhabited land, or the SPS broadcasting in directions outside the main beam.

Surprisingly enough, the first problem simply can't occur. The transmitter and receiver depend on each other: in particular, without the receiver to direct the beam, the transmitter would be unable to form any beam at all, much less a beam pointed in the wrong direction. If the system failed, all it could do is spray out a harmless signal, like a distant TV station. Even if someone tried to fool the system with an elaborate imitation receiver, the system would automatically shut off because of safety devices. And even if someone got into space, sabotaged the satellite's safety devices, built an elaborate imitation receiver, located it in a city without being detected and successfully misdirected the beam for a while, nothing spectacular would happen. The most intense beam that an SPS can form (without being totally rebuilt first) is less than one fifth the intensity of sunlight, and only twice the intensity of microwave exposure that the U.S. government presently regards as safe in workplaces. The SPS isn't very dangerous even if it is misused.

The same factors that prevent the SPS from producing a more intense beam also keep it from forming a beam with perfectly sharp edges. Therefore, fence would be built beyond the edge of the receiver to keep people from wandering into the low-intensity fringes of the beam. (Aircraft are shielded by their metal bodies, and shouldn't be in the beam in the first place.) Outside of the fence, microwave levels can be kept to Soviet exposure standards—a level considered safe around the world—if it becomes necessary to do so.

Some evidence suggests that long-term exposure to microwaves at intensities near the U.S. exposure standard (1,000 times the Soviet standard) may have effects resembling those of nuclear radiation, including genetic damage and increased risk of certain cancers. If so, the SPS remains safe, even though much equipment now in operation is hazardous. Still, since most people believe that all levels of nuclear radiation are harmful, we might wonder if **any** level of microwave exposure is completely safe. In discussing this, it will help to know what sort of thing we're talking about.

Microwaves are a form of radiation, but so are light and sound. None of these forms has much in common with nuclear

radiation except that they radiate, or move out from a source. If made intense enough, all forms of radiation can damage people; consider the light from a laser or the sound from a rock concert. Most forms of radiation can be thought of as ripples moving through something: air in the case of sound, the electromagnetic field in the case of microwaves. When something absorbs these ripples, it gets jostled in some fashion. When these forms of radiation become very intense, the jostling can become destructive. Why they become very weak, the jostling can become unnoticeable.

Nuclear radiation is different. Unlike other forms, it comes in small particles. Lowering the intensity of nuclear radiation does not make it qualitatively different, like weaker ripples: it just means that a person (or whatever) gets hit with fewer particles, each doing a certain amount of damage. For this reason, no level of exposure to nuclear radiation is completely without harm.

Because microwaves differ so greatly from nuclear radiation, we have every reason to believe experiments which show no adverse effect below a certain intensity. The waves simply become too gentle to harm anything in living cells. This is why the SPS can be made safe by making it meet strict enough standards. Before one is built, we will know far better just what those standards should be. The Russians are rumored to be thinking that theirs are unnecessarily strict.

Some of you may have heard talks in which DOE spokesmen showed tables indicating that tremendous amounts of land would lie within the guard fences of a full-blown SPS system, if that system were made to meet strict standards of microwave exposure. Beware! As usual, figures don't lie but . . . DOE's figures refer to an irrelevant case, in which the system was not re-optimized to take account of the high land-cost of a comparatively sloppy beam. Since no one would build such a system, DOE's figures only serve to cloud the discussion. With a larger antenna in space, the SSPS can deliver a more sharply defined beam to the ground. See Drexler and Heppenheimer, **Journal of Energy**, June 1977 for discussion of a concept that may make better beam control quite cheap.

In summary, we have helped misinform the public on what may soon become a major issue. A system we support may soon be looked on as "obviously dangerous." Our best way out of this situation is to jump on the microwave-issue bandwagon and to help steer it, while vigorously publicizing the arguments for SPS safety. We have nothing to gain from delay.

Lunar Resources Study Underway

by Carolyn Henson

NASA has initiated a three part study on construction of large space structures from lunar materials (often called the "High Frontier" concept).

Edward Bock at General Dynamics Convair Division in San Diego is study manager of one part (if the program. He will consider the possibility of using mass drivers as mass driver reaction engines (MDRE) which operate kind of like a kid throwing bricks off a boat. As Newton said, for every action there is an equal and opposite reaction. Using this principle, the mass driver, first conceived as a means to lob lunar ores to a catcher in space, could also, in its MDRE form, be used as a "space tug." Bock will look into using lunar dirt, space industrial wastes and discarded parts (such as shuttle main fuel tanks) as reaction mass for the MDRE. Also to be considered are chemical propulsion systems which might use lunar derived oxygen and calcium, magnesium or aluminum as fuel.

Bock's study group will also consider the value of the moon as a construction site and compare lunar vs. orbital manufacturing facilities. Finally, the study will evaluate what types and levels of space activities are needed to justify use of lunar materials.

Richard Williams of NASA and Dave Criswell of the Lunar Science Institute in Houston will consider moon mining activities. They will consider what are the preferable ores and the equipment needed to mine them. They will study chemical processing of these ores, with special

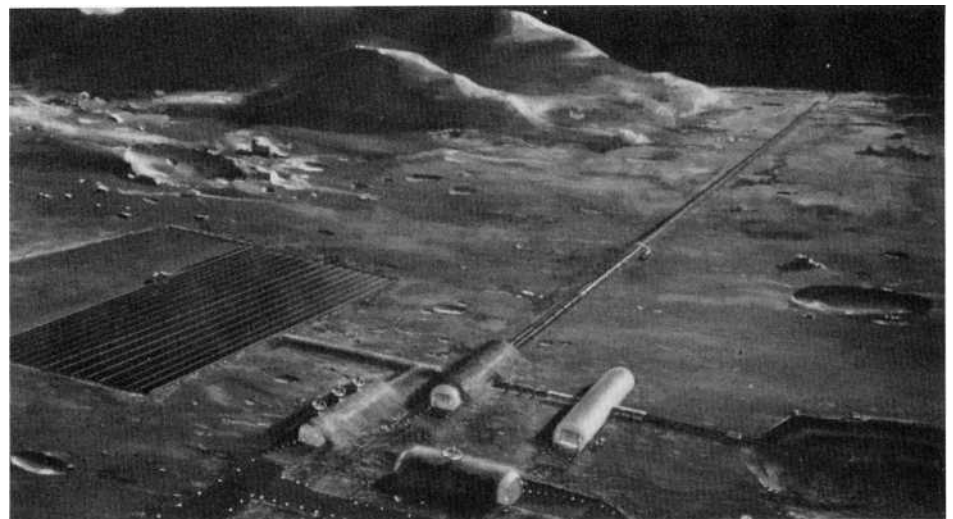
emphasis on producing aluminum, silicon and oxygen for construction of solar power satellites. Criswell adds that the theme emerging from their study is "On the basis of present and very near future term technologies, how small can we make the initial investments in a lunar supply base, chemical processing units and space manufacturing facilities and still create a rapidly growing economy in space?"

Over at Marshall Space Center in Huntsville, Alabama, Peenemunde veteran George von Tiesenhausen is managing a study of the production of alloys and fabrication of space structures from lunar derived resources. The equipment and facilities needed will be determined. The manufacture of glass fiber composites, radiation shielding, solar cells and other solar power satellite parts will be studied.

Von Tiesenhausen will consider what items should be imported from Earth vs. manufactured in space. Three different rates of space construction activities will be considered in determining the import vs. space manufacturing options. The first year of the study only space manufacturing will be considered; the second year lunar surface industries will be evaluated.

Von Tiesenhausen will be backed up by the materials processing lab at Marshall. He sees this study as "an outgrowth of the 1977 Ames Summer Study on Space Manufacturing Facilities."

The overall management of this three part lunar resources study is being conducted by Stan Sadin at NASA headquarters in Washington, D.C.



Lunar base (artwork courtesy Johnson Space Center).

Soviet Spacecraft Mysteries

Intensify

by Jim Oberg

An incredible array of Soviet human-related space hardware is now appearing in the flight test stage. Observers are amazed at the number of different projects, just as they are baffled by the ultimate purpose of many of the test flights already observed. Whatever it will be, it will be big.

Somebody, five years ago, passed a book of blank checks to the Soviet space program directors. The payoff is imminent.

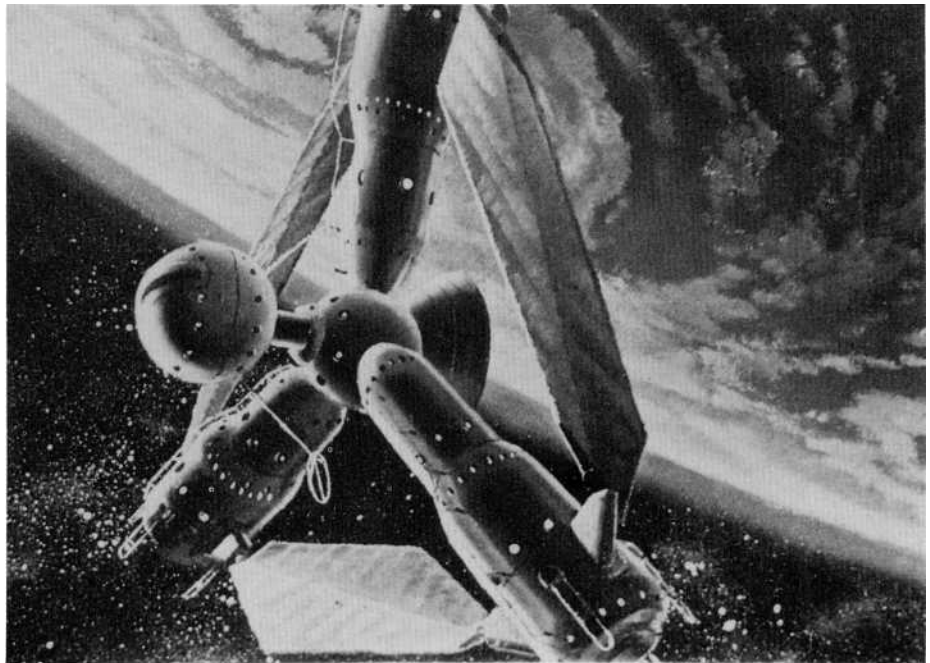
The impressive flight of Salyut-6 early in 1978 is only the tip of the iceberg, with its new-designed double docking ports, its use of new space suits, and the introduction of a major redesign of the Soyuz spaceship, called 'Progress,' for automatic docking and resupply/refueling.

In addition, four other 'families' of space hardware have appeared. Their mutual relationships, and their precise future goals and schedules, cannot yet be determined. The very fact of their existence, however, bespeaks a major new forward thrust in the Soviet space program, a thrust which has been quietly gathering momentum over the past few years.

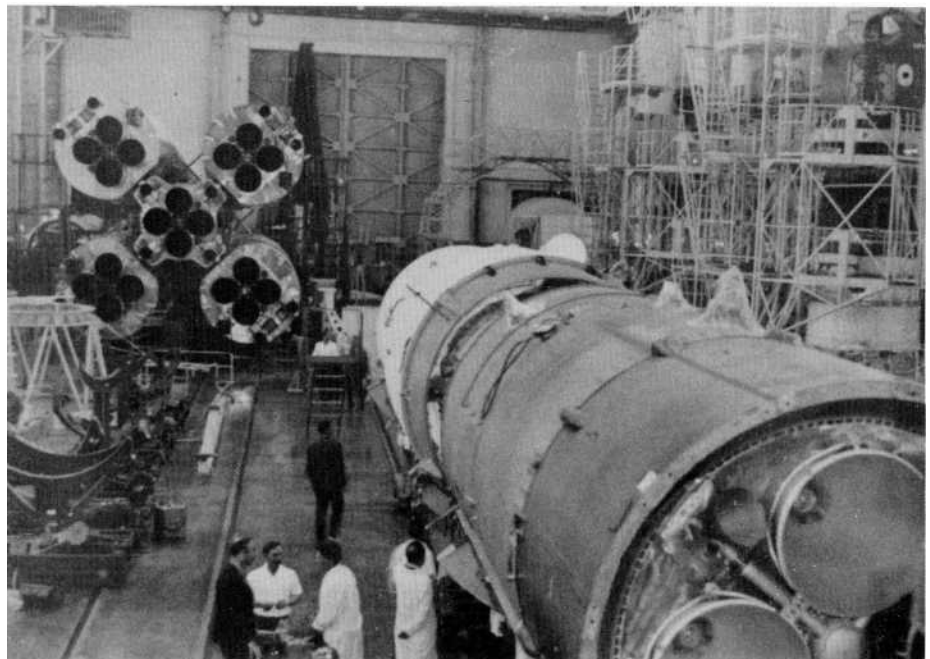
Kosmos-929: This one-member family flew two hundred days of major maneuvers in July 1977 - Feb. 1978, it weighed more than forty thousand pounds, carried large solar panels, and contained an impressive sized fuel tank. The best guess is that it was a 'space tug' (KOSMO-BUKSIR) designed to assemble Salyut-sized modules together into a modular space station.

We also have the Kosmos-758 family, five of which have been launched since September 5, 1975. This spacecraft circles the earth for up to 30 days on photo-reconnaissance missions out of the Plesetsk Cosmodrome. It is suspected to be a modified Soyuz spacecraft. It may soon replace the older-model Vostok-based photo satellites which the USSR has been launching at a rate of twenty to thirty per year for fifteen years.

The Kosmos-670 family, since August 1974, has seen four launches, the most recent being the Kosmos-1001 flight launched April 3, 1978. These seem to be



Front cover of Soviet weekly **Ogonyok**, showing the assembly of a Salyut space station with two Soyuz spacecraft. (Photo courtesy of Theo Pirard.)



Tyurotam —Leninsk Soyuz launch vehicle assembly area.

some sort of highly modified Soyuz capsule, perhaps to hold up to five cosmonauts. Piloted flights could come in the near future.

The Kosmos-881 family now consists of two twins, Kosmos-881 and 882, launched Dec. 15, 1976, and Kosmos-997 and 998, launched March 30, 1978. The twin payloads are probably launched on a Proton booster (capability, 40,000 lb. in low earth orbit), circle the earth once, and apparently independently make controlled reentries and landings at dawn in the Karaganda recovery zone. Nobody is sure what they are, but ideas about secret weapons tests have been abandoned. These big spaceships are definitely human-related, somehow.

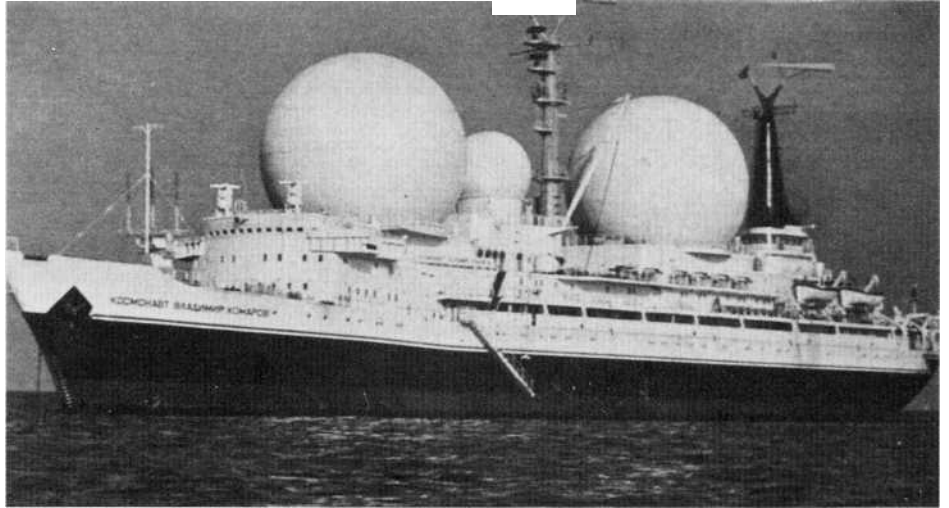
Lastly, there are more insistent and detailed reports of a Soviet Space Shuttle (perhaps called the ALBATROSS). The vehicle, we've been told by East European and Washington, D.C. sources, was dropped from a TU-95 bomber in the summer of 1977. It weighs between fifty thousand and a hundred twenty thousand pounds, and might be launched by an expendable Proton booster or by an entirely new reusable lower stage said to be under development. Orbital flight tests could take place as early as the summer of 1978, a full year ahead of the American

space shuttle. It would carry large passenger groups of cosmonauts to a permanently inhabited space station, possibly to be established by the end of 1979.

The last time a new Soviet piloted spacecraft was undergoing flight tests was in 1966-1968, with Soyuz and Zond. Ten years have passed without any significantly new vehicles except the Salyut, introduced in 1971. *Something* might have been expected, but not *four*

different classes of human-related spaceships! This stampede of Soviet spacecraft tests is a warning of something, even if we can't forecast it exactly.

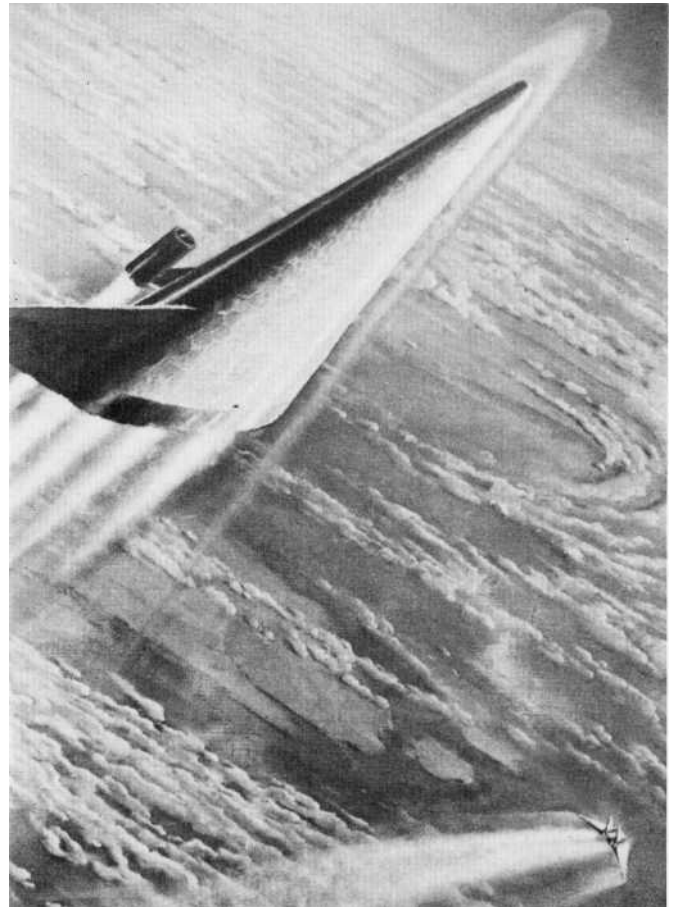
Salyut-6. Progress-1. Kosmos-929. Kosmos-758 and its brothers. Kosmos-670 and its kith and kin. The Kosmos-881 series twins. The ALBATROSS space shuttle and its new booster. The testing is getting more intense and more detailed, so we don't have long to wait. We've been alerted for . . . WHAT?



*Soviet space research tracking vessel
Kosmonaut Vladimir Komarov.*



The Soyuz 28 crew with Gubarev and the Czechoslovak Remek (see the flag on his left arm). (Photo courtesy of TASS.)



Soviet space shuttle (artwork by A. Sokolov).

Environmental Implications of SPS

by Peter Glaser

The social costs of environmental impacts of a solar power satellite power-generation system, including the opportunity costs of land used for launch sites and the aesthetic effects of such use, have to be established so that the benefits of each specific system approach can be weighed against potential dangers to human health, destruction of valued natural resources, and the intangible effects which may influence the quality of life. Failure to take these social costs into account could lead to substantial impediments to the development of the SSPS, as was proven in such major programs as supersonic transport aircraft and nuclear power.

The major social costs of environmental impacts of SSPS operations would lie in the following:

- 1) *resource allocations*, including land management, energy requirements during construction and operation, commitments of resources, etc.
- 2) *environmental degradation*, including waste heat disposal, interactions with the ionosphere and the upper atmosphere, environmental modifications noise generation, etc.
- 3) *public safety*, including long-term exposure under normal operations, disruptions in communications, accidents or abnormal situations, continuity of power generation and effects of interference with operations, etc.

The operation of the SSPS could produce environmental impacts, several of which involve a large degree of uncertainty and will require much more understanding before their effects can be reliably quantified. Each of these types is discussed in the following subsections.

A. Microwave Beam Environmental Effects [1]

1. *Atmospheric Attenuation and Scattering*: The atmospheric transmission efficiency of the microwave beam depends on meteorological conditions. Absorption by the atmosphere occurs when gaseous molecules with permanent dipole moments couple the electric or magnetic components of the microwave field to their rotational energy levels. Most of the absorption due to excitation of collision-broadened lines occurs at the 22-GHz line of water vapor and 60-GHz line of oxygen. Below 10 GHz the attenuation resulting

from molecular absorption is approximately 0.1 dB or less, depending upon the microwave beam elevation angle.

Attenuation by rain, cloud droplets, snow, and hail will depend on their size, shape, and statistical distribution and composition. Rain, wet snow, melting precipitation and water-coated ice attenuation is low at frequencies below 3 GHz. The most severe condition is expected in rain clouds, where attenuation may reach 4 percent at 3 GHz. The attenuation produced by a 1-km path through wet hail could reach 13 percent at 3 GHz.

Forward scattering by rain and hail will increase the field intensity outside the main microwave beam. For example, a 5-GW SSPS operating at 3 GHz would scatter 3 mW nearly isotropically if the storm cell height is 1 km. At a range of 10 km, the scattered microwave beam power density would be about 2×10^{-11} mW/cm². Therefore, scattering by rain or hail is not expected to significantly increase sidelobe levels or broaden the main microwave beam.

2. *Ionospheric Propagation*: Among the several possible interactions of the microwave beam with the ionosphere are the following.

Ambient refraction of the microwave beam by the ionosphere—This effect leads to a negligible displacement. If gradients are present in the ionosphere, they could result in displacements (less than 100 m) of the microwave beam.

Ionospheric electron density irregularities—These self-induced or ambient irregularities will cause phase fluctuations (less than 10 degrees) across the wave front of the reference beam propagated from the center of the receiving antenna to the transmitting antenna face. Random phase variations will subside within a few hundred meters and within tens of seconds.

Power beam dispersion due to ionospheric density fluctuations will increase the field intensity at the beam edges by up to 30 percent. At low power densities, these fluctuations at the edges of the beam will not cause any significant power loss.

Experiments at Platteville, CO, and Arecibo, Puerto Rico, indicate that modest fluxes can produce significant changes in

the thermal energy of the plasma in the 'D' (A/60-90 km), E (A/90-150 km), and F (0.150-340 km) regions. The direct effect on high-power microwave transmission with densities of 20-30 mW/cm² is likely to be small, since the absorption at the 3-GHz frequency remains negligible, even with an order of magnitude increase in electron temperature and density. However, power densities greater than 100 mW/cm² could produce large horizontal electron density gradients that could cause significant beam displacement and dispersion.

Although only a small fraction of the microwave beam is absorbed, it is still significant compared to the natural thermal input to the ionosphere. For a 5-GW SSPS, about 0.2 mW/s is absorbed during the 50-s interval when thermal equilibrium is reached, which compares to a heat content of about 1 mW/s in the volume of the ionosphere traversed by the microwave beam. For an incident flux of 20 mW/square cm, the ratio of the ohmic loss to the natural input due to photoelectrons and heat conduction in typical ionospheres ranges from 10 to 40 during the day and from 40 to 160 during the night. These significant changes in ionospheric properties will most likely be local and reversible, but they will have to be evaluated, particularly for continuous operation. A microwave flux of 100 mW/square cm could double the F-region's electron temperature and cause a 20- to 50-percent local reduction in electron density. Microwave heating in the D and E regions could increase the plasma density by about a factor of 4.

Given these considerations, it appears that microwave power densities above 20 mW/square cm could result in major changes in ionospheric properties. Microwave power densities greater than 20 mW/cm² could be employed once more data on these interactions have been obtained in experiments conducted with Earth-based as well as space-based transmitting antennas.

Faraday rotation effects relating the total polarization twist of a linearly polarized wave to the total columnar electron content of the ionosphere under geomagnetically quiet conditions are projected to produce insignificant polarization losses. During geomagnetically disturbed periods—severe

geomagnetic storms occur about three times a year—Faraday rotation and polarization loss is projected to be less than 1 percent.

The effects of changes in ionospheric electron density caused by microwave power densities of 20 mW/sq cm at the SSPS operating frequency will have to be investigated for possible effects on other uses of the ionosphere.

B. Stratospheric Pollution by Space Vehicle Exhaust Products

The potentially harmful effects of supersonic and space transport exhaust in the stratosphere are receiving considerable attentions.

Injections of water vapor and NO (which are involved in the complex sequence of chemical reactions governing the abundance of ozone in the region from 20 to 35 km) are projected to result in a reduction of the mean abundance of ozone, although there is still uncertainty regarding the roles of each of these components [2]. The actual effects of any given rate of injection of either of these two components are difficult to determine because of uncertainties regarding the vertical and horizontal movements in the stratosphere which govern the rate at which they are injected, distributed and ultimately removed from it, the lack of experimental observations on space vehicle emissions, the composition of the stratosphere as a function of altitude, location over the surface of the globe, and the nature of the chemical and photo-chemical reactions which determine the abundance of chemical species involved in the ozone equilibrium. Because vertical mixing in the stratosphere is very slow (about 2 years at 20 km and 4 to 20 years at 50 km), and declines with increasing altitude, gases injected into the stratosphere will accumulate even at a low annual rate of injection and could yield a large equilibrium value at very high altitudes. (The region from 50 to 100 km contains only 0.1 percent of the total mass of the atmosphere.)

Although the chemistry of water vapor in the upper stratosphere has been studied, there is uncertainty regarding the possible consequences of incremental additions of water vapor. Water vapor is photo-dissociated to form radicals and molecules which will react with ozone and molecular and atomic oxygen. Furthermore, changes in the water vapor content could influence the natural flux of NO to the level of the ozone layer. Consequently, the effects of the space transportation system on water vapor injection, particularly in the upper stratosphere, require further investigation.

C. Microwave Biological Effects

At present, various standards for microwave exposure have been

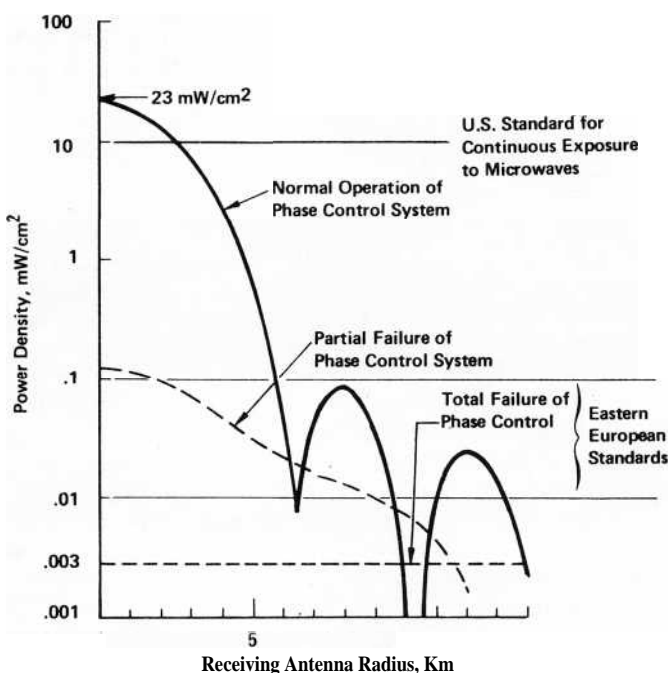


Fig. 10. Effects of phase control on microwave power distribution

established, ranging from 10 mW/cm² for the United States to 0.01 mW/cm² for the Soviet Union. The U.S. standard is based on microwave heating of body tissue. The Soviet Union's standard is based on possible effects on the central nervous system, even at low exposure levels. The SSPS microwave transmission system must be designed so that the range of frequencies and microwave power flux densities will meet accepted international standards. The SSPS will incorporate several fail-safe features to assure control of **microwave beam pointing and instantaneous shutoff of power to the microwave generators.** Failure of the microwave beam-pointing system would not result in exceeding the international standards for microwave exposure (Fig. 10) Predictions, analyses and measurements of the SSPS's specific microwave-induced biological effects will be an essential component of the development program.

In addition to direct biological effects, interference with electronic equipment, medical instrumentation, and electric explosive devices must be avoided. Any sensitivity of such equipment to the low level of microwave exposure will have to be determined; if required, industry-wide standards will have to be established.

Possible effects, if any, on birds flying through the microwave beam will have to be established. Preliminary evidence indicates that birds can be affected at levels of microwave exposures greater than 25 mW cm² of radiation in the X-band. The evidence suggests that birds avoid such exposure.

The effects of microwave exposure on aircraft flying through the beam must also

be considered. The shielding effects of the metal fuselage and the very short time of flight through the beam are unlikely to result in significant human exposure. The means for protecting aircraft fuel tanks from electrical discharges are now standard design features, but the absence of microwave-induced hazards will have to be confirmed. In addition, the extent of possible interference with aircraft communication and radar equipment will have to be established.

D. Radio Frequency Interference [3]

World-wide communications are based on internationally agreed upon and assigned frequencies. Because the frequency bands spanning the most desirable frequency of the SSPS are already in heavy use, the potential for RF interference (RFI) of the SSPS with existing communication systems is high. The microwave generators will have to be designed to filter out most spurious outputs. RFI could occur during the shutdown of the microwave generators or result from fundamental microwave frequencies and its harmonics, random background energy, and other superfluous signals. Although RFI can be controlled by the selection of frequency, narrow band operation, and use of filters, detailed and specific effects and impacts on radio astronomy, shipborne radar, and communication systems will have to be determined before the international acceptability of specific frequency allocations can be assured. The RFI effects and international agreements on frequency assignments are issues that will have to be faced at various stages during the SSPS development.

E. Other Impacts

The following summaries of environmental impacts are those where data are expected to be more readily available once system design parameters are established:

Thermal pollution—Waste heat released at the receiving antenna site could be limited to about 15 percent of the rectified microwave power, which is less than one-third the waste heat released from power generation methods based on thermodynamic cycles.

Land despoilment—The land requirement for the receiving site, from which the public would be excluded, could be limited to about 270 sq km. This compares favorably with land areas required for terrestrially based 5-GW solar-powered plants [4] of similar output (150 sq km for central receiver; 400 sq km for photovoltaic conversion without energy storage). The land could be developed to productive uses because only about one-third of it would be covered by the receiving antenna, which is a lightweight structure 80 percent transparent to sunlight and unobstructive to rain. Microwave radiation can be excluded from beneath the antenna, maintenance will be minimal, and transportation of supplies to the site will be infrequent compared to conventional power plants. Land use for transmission lines could be reduced if receiving antennas were located near major users. Offshore locations should be considered as alternative receiving antenna sites.

Resource consumption—Materials required for construction are limited largely to those which are in plentiful supply, such as silicon and aluminum. Each SSPS would require less than 2 percent of the yearly supply of critical materials, such as platinum, available to the United States. Increased production capacity will be required for argon, oxygen, and silicon [4].

Energy consumption—The energy required to produce the materials for SSPS construction as well as the propellants to place it into orbit would be repaid—i.e., regenerated—in less than three years of SSPS operation, depending on the power delivered at the receiving antenna [4], [5].

Noise pollution—The noise from launch operations will be of concern in the immediate vicinity of the launch facility. Suitable location of the launches could reduce noise pollution to acceptable levels.

[1] Raytheon Company, "Microwave power transmission system studies," NASA CR-134886, ER-75-4368, Dec. 1975.

[2] M. I. Hoffert and H. Hidalgo, "Stratospheric impact: Two letters," *Astronaut. Aeronaut.*, vol. 14, no. 11, pp. 60-62, 1976.

[3] Arthur D. Little, Inc., "Feasibility study of a satellite solar power station," NASA CR-2357, NTIS N74-17784, Feb. 1974.

[4] NASA, Lyndon B. Johnson Space Center, "Initial technical, environmental and economic evaluation of space solar power concepts," JSC-11568, Aug. 1976.

[5] G. H. Stevens and R. Schuh, "Space-to earth power transmission system," NASA Tech. Memo., Lewis Research Center, NASA TMX-73489, Nov. 1976.

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"Humanization of Space" Show

The Tessmann Planetarium in Santa Ana, California will present a show, "The Humanization of Space" at 7:30 PM May 9, 11, 16, 18, 23, 25, 30 and June 1, 6 and 8. Admission is free, but reservations are necessary. Please call the Office of Community Services, 835-3000, extension 317.

The Tuesday night programs will be geared for younger audiences (children under 14). Children under five will not be admitted.

Major Photovoltaic Program To Begin

A major applications program will get underway in June when DOE announces awards to design novel concentrating photovoltaic arrays. The awards are intended to stimulate innovative, reliable concentrating systems from private industry at gradually decreasing costs. A comparable solicitation for photovoltaic systems using flat-plate arrays is scheduled later this year. Both the concentrating and the flat-plate applications will be conducted in cycles over the next several years. For more information, contact: Department of Energy, Office of Public Affairs, 20 Massachusetts Avenue, N.W., Washington, DC 20545, 202-376-4064.

Meanwhile, a program to establish performance criteria and standards for photovoltaic equipment has begun. Still in the preliminary stages, the program involves the Solar Energy Research Institute (SERI), National Bureau of Standards (NBS), DOE and private industry representatives. For more information, contact: Gary Nuss, SERI, 303-234-7346.

Astronaut To Lead Site Visit Group

Dr. Philip K. Chapman, a former Apollo astronaut, has been chosen by the Earthport Project to head a group to identify the most attractive locations for the establishment of an international space launching area.

As head of the Site Choice Committee, Chapman will supervise initial screening of potential sites for Earthport, and then visits to areas for first-hand analysis. Recommendations by his committee will be presented to the Earthport advisory board upon conclusion of the site visits.

Among the considerations of Chapman's study group will be the latitudes, launch azimuth limits, accessibility, altitude, economic potential, geology, climate, proximity to oil or natural gas, and political conditions at the sites.

An Australian-born scientist, Chapman received a degree in physics in 1956 from Sydney University. After spending time in Antarctica upon graduating, he came to the United States for studies in physics, astronautics and aeronautics, and experimental astronomy. He received a PhD from MIT in 1967.

While at MIT, Chapman became interested in the possibility of creating a new international, equatorial launching facility. He helped prepare a proposal that New Ireland in the Pacific be considered as a world launch site at a time when the French government was moving to establish a national launch center near the equator in French Guiana.

Chapman became a scientist astronaut in 1967, and flew on the Apollo 14 mission in 1970. His responsibilities on the flight included crew training and coordination experimentation.

Since leaving NASA in 1972, Chapman has studied the feasibility of laser spacecraft propulsion for AVM, and Solar Power Satellite prospects for Arthur D. Little, Inc. He has been an active advisor to the Earthport project since early 1977.



Philip K. Chapman

Earthport Launch Site Proposal Draws International Response

With commercial launch providers at the verge of doubling in number within five years, a total of eight nations have so far expressed interest in the creation of a new international launching center for peaceful uses of space.

Five of the countries—Liberia, Sudan, Panama, Rwanda, and Sierra Leone—say they welcome the concept of an equatorial launching facility within their borders. The Earthport launch site would be established as an international free trade zone to generate income for space activities and for the host country.

Three other countries, Indonesia, the Cook Islands, and the Pacific island nation of Nauru, have requested further information about the project. Approaches are now under way to a variety of other nations near the equator, which has been chosen as the primary area for study because of the intrinsic economies of equatorial launch.

The study is being sponsored by the Sabre Foundation, a California-based public policy research group. Among the advisors are Dr. Nelson de Jesus Parada, director of the Brazilian space effort; Professor Marcel Barrere, president of the International Astronautical Federation; Buckminster Fuller, the noted designer and futurist; Frank J. Malina, cofounder of the Jet Propulsion Laboratory; and former Apollo astronaut Philip K. Chapman.

"We are very pleased with the interest of equatorial countries to date," said Mark Frazier, director of Earthport feasibility study. "As the commercial uses of space grow, we believe an international launching facility will help people around the world to enjoy the benefits."

Recent studies funded by the National Aeronautics and Space Administration, as well as by private groups, have described impressive commercial prospects in space for the next two decades. Present \$2 billion-a-year communications satellite revenues are expected to multiply several times. Tens of billions of dollars may also be spent on solar-powered satellites, beaming an inexhaustible supply of energy to earth.

Increases in space activity promise to make launch economics important in the future. In contrast to ranges at higher latitudes, an equatorial site could offer several inherent advantages for launch into orbit:

- *Additional momentum for launch vehicles.* At the equator, the spin of the

earth amounts to almost 1000 miles an hour in an easterly direction. Satellite launches into equatorial orbit from low latitudes thus are more efficient than from other locations, where the boosters have less momentum from the earth's rotation.

- *Simplified orbital paths.* To enter an equatorial orbital plane, most satellites now launched must make wasteful "dogleg" maneuvers. An equatorial launch site can render doglegging unnecessary, and simplify landing procedure. A launch area near the equator, moreover, permits insertion of a satellite into any orbital plane with relative ease.

- *More frequent "windows."* Because satellites launched from the equator can pass overhead on each circuit, launch opportunities open up with each orbit for a minimum energy/fuel rendezvous. If a space vehicle in equatorial orbit is to return to earth, landing procedures are simplified by the recovery site's position in the orbital plane.

These benefits have already been instrumental in persuading two commercial launch organizations to establish equatorial sites. A private West German company, OTRAG, has spent approximately \$30 million to date to develop a range in Zaire, which is scheduled to become fully operational within three years. The European Space Agency will begin offering launch services by 1980 from a base in Kourou, French Guiana. In addition to these sites, equatorial for suborbital "sounding" rockets—used for atmospheric tests—exist in Kenya and India. An Earthport might be established at one of these existing locations, or at an area yet to be determined.

Earthport researchers believe that the international status of the spaceport would help to further reduce cost barriers for launches. Rather than having to build duplicative facilities near the equator, launch organizations in the future could benefit from the savings of shared ground support services at Earthport.

To draw in a range of investment and build an economic infrastructure at the site, Earthport is planned as an international free trade zone of approximately 200 square miles. The host country would retain sovereignty and ownership over the zone, leasing it to an international Earthport Authority for administration. Exempting commercial activities at the site from tariffs and taxes

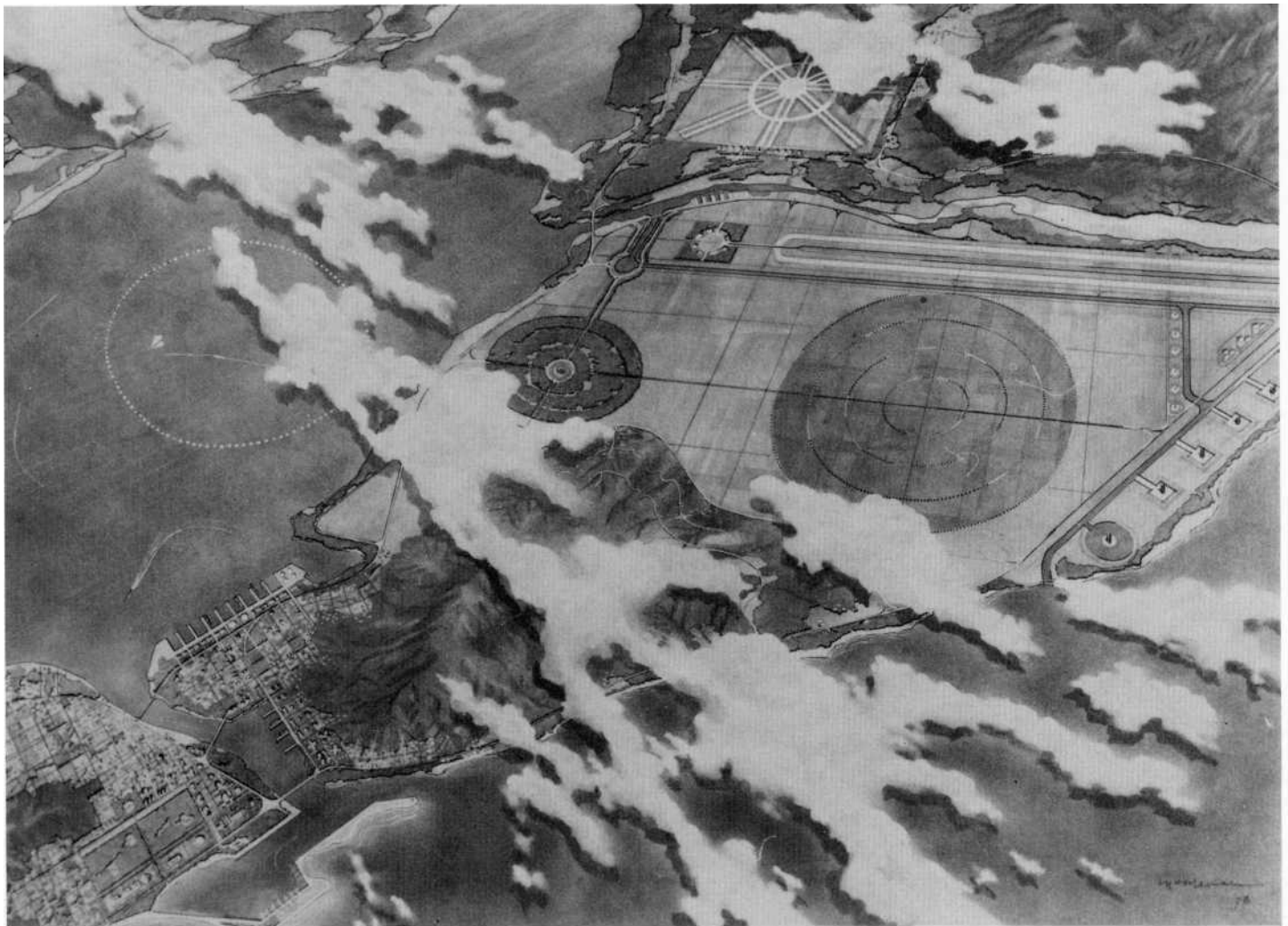
would raise land values substantially, to the point where annual lease revenues could generate large sums for launch services and for the host country. Some developing nations, offering limited exemptions to commercial users, now reap from \$2-4 million in rentals per square mile each year at free zones.

A portion of Earthport leasing income would be set aside to finance a World Space Center, which would help developing nations make greater use of space services. Besides offering independent consulting services to nations on technical issues in the short run, the Center might establish a network of training centers for nations desiring to acquire space-related skills. An international research institute, a space resources clearinghouse, and a fund to help finance launch activities would also be desirable.

As an area in which nations could conduct space efforts at substantial savings, Earthport might play a role in reducing the proliferation of potential weapons delivery systems within countries. In coming years, nations will increasingly desire to begin launch programs of their own. Cost savings at Earthport could help persuade them to undertake peaceful space activities at a world site, rather than to attempt establishing far more expensive launch operations within their borders, where they would invite use for military ends.

The degree of investment in Earthport launch facilities would be decided by space-going organizations leasing land at the site. While rudimentary launch facilities can be constructed at low cost for suborbital rockets—and for launchers such as the OTRAG vehicle or Boeing's original, now demilitarized, Minutemen boosters—a full-scale space launch site would cost far more. Earthport leasing revenues might be applied towards some of the capital requirements, estimated by launch consultant Richard Gompertz to be at least \$200 million.

For the first stage in creating a world spaceport, the Earthport project is conducting a feasibility study under the guidance of an international advisory board. Any developing nations may appoint representatives to the project to see that their interests are presented. If located in tropical regions, nations may also decide to explore, as eight countries are now doing, the potential benefits of hosting an international space launch center.



Proposed Earthport launch facilities and free trade zone (Artwork copyright Earthport Project).

Further information about the Earthport project and related developments is available upon request from the Sabre Foundation. Please write or call Mark

Frazier, Earthport Project, 221 West Carrillo Street, Santa Barbara, California 93101; telephone 805/965-7947 or 7166.

Student Programs Called For

In testifying before a Congressional committee on the National Aeronautics and Space Administration's (NASA) budget for Fiscal year 1979, the Forum for the Advancement of Students in Science and Technology (FASST) recommended that steps be taken to develop new educational initiatives for students to participate in the national space program.

In presenting testimony, requested by the Senate Subcommittee on Science, Technology, and Space, FASST recommended that the NASA budget include funding for programs such as student internships for the various space projects.

"Programs such as the Space Telescope, the Jupiter Orbiter Probe, Galileo, and numerous Earth application satellites could all include active intern programs, and should be looked upon as valuable

new educational tools," commented Leonard David, Program Director of FASST. "Monies for these activities would be included as line items within the budget of the specific space projects," David suggested.

Present to hear the FASST testimony were Senators Adlai Stevenson (D-Ill) and Harrison Schmitt (R-N.M.). Senator Stevenson thanked FASST for its testimony and indicated that he was definitely interested in pursuing the area of student programs with NASA officials.

Other recommendations presented by FASST included:

- urging NASA to develop an expanded student space experiments program, involving both the Spacelab, the Long Duration Exposure Facility (LDEF), and the \$10,000 "Getaway Special;"
- creating a focal point within the space agency for developing student

involvement programs, particularly for the undergraduate;

- re-evaluating current NASA offices for University Affairs and Educational Programs in regards to how they interact with the college/university student. **It was specifically** recommended that the budget for the Office of Educational Programs be increased and removed from the division of Public Affairs.
- requesting the Sub-Committee to investigate and identify new sources of funding for student programs from agencies such as the Office of Education at the Department of Health, Education and Welfare, and the National Science Foundation;
- using student programs at NASA to serve as models for student involvement with other government agencies; and
- consulting with the program directors of the student divisions of other science societies for their ideas on possible student programs.

Inside the L-5 Society

Melbourne L-5

Florida Institute of Technology of Melbourne, Florida has formed a local chapter of the L-5 Society. About 20 people attended their first meeting on April 17th and the closeness of the Kennedy Space Center should invite some interesting speakers in the upcoming months.

President is Michael Dalton; vice-president is Maurice McDonald and elections for treasurer and secretary will be made soon. If you are interested in our group, please contact Mike Dalton, CB 6359 F.I.T., Melbourne, FL 32901.

Raleigh L-5

I am pleased to announce that as of this date, a new student organization officially exists in Raleigh—The North Carolina State University L-5 Society. We received a letter of recognition today from the NCSU Department of Student Development. As a campus organization, we now have access to equipment, and facilities of NCSU. We now have eleven official members, and some twenty people actively involved in the promotion of settlement, development, and exploration in outer space. We have a good chance of being featured in an article in the NCSU student newspaper, which we hope will attract more members.

Although we are just getting ourselves organized, we have been as active as possible. We produced a flyer describing the advantages of Solar Satellite Power Stations, which we distributed at a rally in opposition to the construction of the Shearon Harris nuclear power plant near here. We are preparing an exhibit on solar power from space, which we will present on May 3, as part of the worldwide SUNDAY effort to promote the development of solar power. We also have established as a long range goal the creation of a small library of information on space colonization, development and exploration. We have set up a checking account, which presently contains the meager sum of \$50, which we got as a speaker's fee for lecturing on space colonization at one of NCSU's dormitories.

"Spaceworks" Action

The Spaceworks: An L-5 Society is busy at the Auroria Higher Education Center in Denver, Colorado. They have made presentations on radio talk shows and organized eight discussions and lectures on topics related to the settlement of space.

Spaceworks is currently sponsoring a

series of discussions every Wednesday at 7:15 p.m. in the Auroria Student Center. Room location varies, and is posted weekly.

For more information, contact Robert Toppole, 1930 Quince St., Denver, CO 80020 or Mark Corske, 3286 S. Oneida Way, Denver. CO 80224.

Mills High School Space Workshop

Mills High School, in Millbrae, California, will present "What's Up", a workshop on aviation/aerospace activities June 2 and 3.

Activities on Friday, June 2, will last for six hours, beginning with an all school assembly in the morning. Students will then be able to participate in off campus tours of NASA Ames Research Center and San Francisco International Airport facilities, and attend on-campus seminars and lectures. Suggested seminar topics include the History of Aviation, Women in Space, Space Settlements and Industrialization, Astronomy, UFO's, Space Phenomena, Aerospace related industry, commercial aviation, military aviation, and past and future space experimental projects such as the Viking Mars probes and the Space Shuttle.

In the afternoon, student participants can observe exhibits, demonstrations and displays, possibly including aircraft brought on campus, hot-air balloons and helicopter demonstrations.

On the following day, Saturday, June 3, substantial portions of the program will be repeated for the community and for visiting students from all over the Bay Area.

For more information, call Steven Finacom, 415/697-3344 or write to him at Mills High School, 400 Murchison Drive, Millbrae, CA 94030.

Earthrise Synergy Coalition News

I wish to personally apologise to all coalition members who have written and not received a reply. Medical problems have kept me from coalition duties. With the completion of Project Moon Base, the Earthrise Synergy Coalition will officially shut down. Many thanks to all those who have contributed so much to coalition activities and especially to Dr. L.J. Friesen and James Bennet.

Sincerely,
S.A. Varughese

L-5 Society

Local Chapters

Williamsburg L-5
Box 1795
Williamsburg, Virginia 23185
Clint Wolf (Executive Director)

Mississippi L-5
c/o Robert D. McWilliams (President)
Box 5563
University, Mississippi 38677

Austin L-5
University of Texas, Austin
P.O. Box 8213
Austin, TX 78712

Houston L-5
c/o Larry Friesen
(Committee Coordinator)
502 South Austin #17
Webster, Texas 77598

John Muir High School L-5
1905 Lincoln Ave., Pasadena, CA 91103
Taylor Dark III (President)

Huntsville Texas L-5
c/o George Timothy Bigham (Pres)
Route 2 Box 82
Huntsville, TX 77340

Maryland L-5
(Maryland Alliance for Space Colonization)
M.A.S.C.
c/o Gary Barnhard
4323 East-West Highway
Bethesda, MD 20742
Ray Hoover (Chairman)

Michigan L-5
Box 126
Michigan Union
Ann Arbor, Michigan 18109
John Beckerman (Chairman)

Raleigh L-5
P.O. Box 5381
Raleigh, NC 27607

Urbana L-5
co Steve Vetter (Pres.)
167 Townsend,
Urbana, Ill. 61801

Space Colony Speaker Needed

If you live near Las Cruces, New Mexico and would like to give a presentation on space colonies to a high school group, please contact Sunny Wilde, NASA White Sands, P.O. Drawer MM, Las Cruces, NM 88001.

Letters

Did you see the item in Aviation Week (April 10, 1978, p. 11) in their Washington Roundup section? There was a resolution introduced in the House by 23 Democratic congressmen "urging President Jimmy Carter to ban the use of all nuclear material in all space vehicles." I realize that this is outside the normal L-5 area, but the effects of this could be disastrous to future space missions—especially deep-space probes. The principal sponsors of the resolution are Reps. Richard L. Ottinger (D-NY) and John F. Seiberling (D-Ohio).

Tarzana, CA

More than 2/3 of Detroiters approve of space colonization. In a Detroit Free Press Sound Off survey 70.9% of those polled responded that they would be willing to live in an outer space city. This should prove the wide public support O'Neill's work has gained, Darth Proxmire take heed.

Michael G. Strong
Swartz Creek, MI

Having just received my first issue of L-5 News, I realized that the L-5 Society is unaware of a certain method of communicating and popularizing the goals of L-5. A radio campaign.

Sound expensive? Not at all, when you consider a very important fact: L-5 IS A NON-PROFIT ORGANIZATION! All non-profit organizations are entitled (in a sense) to what amounts to free publicity. Free publicity in the form of Public Service Announcements.

I am Production Manager of KPAR-AM/FM of Albuquerque, New Mexico, and I can assure you that PSA's are a long standing tradition in radio. And they are FREE! The Determining Factor as to how much a particular PSA is to be aired is how well it is written (readability, length, etc.) Substance comes second. Another factor is station prejudice of the nature of the organization. As long as we physically and verbally present ourselves in a positive light, this prejudice should work in our favor. Most of the people I know in media, management included, are very much in favor of the exploration of space.

In the March '78 issue of L-5 News, Richard Bowers spoke of buying ads in local newspapers. Hate to tell you folks,

but newspapers are dying right and left (or changing drastically). One of the reasons is special interest magazines, L-5 News being just one example. So let's stick with radio PSA's, local newsletters, special interest magazines, billboard announcements, and TV when we can get a hold of it.

Now, how to write a PSA? First of all, have everything completed at least 2 weeks beforehand. Stations need LEAD TIME. Now here's your formula. The local chapter of the L-5 Society is having a meeting on (date). Speaker-presentation will be..... The meeting will be held at (address) and LOCATION corner of Springfield and Sproul road..... I cannot emphasize location enough! Then tag it, twice if possible, with a phone number for further information. Make sure it's a phone that is going to be covered day and night by an informed person.

Your PSA's should be timed out to 10 sec. and 30 sec., no longer. Here's a rough example of a short, simple, PSA using information culled from Richard Bower's letter:

"THE L-5 SOCIETY, AN ORGANIZA-

TION DEDICATED TO ACQUIRING

CHEAP, LIMITLESS ENERGY FROM

SOLAR POWER SATELLITES, WILL

BE HAVING A MEETING ON

SATURDAY, APRIL 1ST AT 2 PM.

THERE WILL BE A LECTURE, SLIDE

SHOW, AND) FILM ON SPACE

COLONIES. THE MEETING WILL BE

HELD AT THE MAPLE TOWNSHIP

LIBRARY AT THE CORNER OF

SPRINGFIELD AND SPROUL ROAD,

IN BROOMALL, PENN. CALL 739-7780

FOR FURTHER INFORMATION.

Notice that the PSA is typed in capital letters and triple spaced. It's little things like this that help get it on the air. You might then type it out on a small index card, also. You can mail these, (make sure you have everyone's correct, up-to-date address), or you can deliver them to the station in person. Personally, I recommend hand delivery. Look and act your best, even if the front office secretary isn't very receptive. People make judgements on clothing, so look sharp. Ask that the written materials be forwarded to the person in charge of PSA's. Ask for both the news director and public affairs director. Chances are, one or both might talk to you right then. If not, arrange an exchange of phone numbers and names. Something should come of it, since American society seems to be riding on a crest of interest in space, due to such movies as "Star Wars" and "Close Encounters", so anything having to do with space can be very interesting to the listening audience, therefore, from the station's point of view, newsworthy. I realize that L-5 is far more of a serious thing than the celluloid pulp of George Lucas, but we can still take advantage of the interest in space that he has generated.

Remember that mass communication is not so much a magnifying glass as a massive prism, multiplying an act of communication hundreds of thousands of times. In closing, I must stress that your publicity campaign must be done right or not at all. It can be a tightrope. If you've tried to do something along these lines, and it failed, write to me and tell me what happened. I may be able to detect mistakes that only the broadcast-minded would see. I'll be happy to answer any questions you have, and supply you with needed tactical/strategic information.

Space colonization, especially in light of recent budget developments, is in sore need of many quantum leaps in the way of popularization. Let's go together.

Allen H. Ward
124 Harvard SE, Apt 21
Albuquerque, N.M., 87106

In a recent issue of the L-5 News, a letter writer raised the issue of interior deterioration of colonies. And in the current (April 1978) **Scientific American** there's a possible solution: Metallic Glasses.

A fairly new material, still experimental in application, metallic glasses are alloys (notably iron and boron) that solidify into glasses before they freeze into metals. (See the article in Science and the Citizen for further details on

freezing/glass-solidifying).

To quote the article, "Glassy metals can

exhibit very high tensile strengths even in bulk materials, and the strength is comparatively (to crystalline metals) insensitive to small imperfections. This combination of qualities gives the amorphous metals a toughness that may lead to applications as structural materials."

The manufacture of glassy metals requires rapid cooling—as fast as 10MC°/sec. Like many elect'onic components, these metals require a costly, difficult-to-maintain environment that is extant in space.

There's more in the article, but as you said, brevity is the soul of getting a letter published in **L-5 News**. I only mean this to be a tip-off. A lot more research needs to be done in metallic glasses, but by 1995, they may be right where we need them.

Luke McGuff
Chicago, IL

Michael Mautner's point concerning corrosion in the January letters section is very important. I have had personal experience with the failure of galvanized steel water pipes in various soils. In one case, the failure took place in less than five years. It would be bad for the space colonization business to have a habitat explode in so short a time.

The solution is to have the metallic interior of the habitat urethane coated before the soil is layed down. Urethane coatings are quite inert chemically and adhere very strongly. A coating twenty mils thick would probably be sufficient to prolong the life of the habitat indefinitely.

George Fredericks
Colorado Springs, CO

Is anyone out there a structural engineer — or an architect? Someone who has some spare time and is willing to correspond would be appreciated. I am currently looking into some alternate designs for SMFs and just want an expert's opinion on a few things. In addition, anyone who thinks he has some pertinent information on the history of space exploration and exploitation, I would appreciate being able to use such information for a thesis I am working on in which I will attempt to argue for the creation of a new history class.

I am a cadet at the United States Air Force Academy; I am planning on majoring in Astronautical Engineering and minoring in Computer Science; and I have an interest in anything that tends to broaden one's horizons. If you just want to write a friendly letter, feel free; I could use the insights that many different opinions could give me.

Cadet Lyle M. Miller, Jr.
P.O. Box 5431
USAFA, Colo. 80841

Incidentally, I just finished the Heppenheimer book and I get the feeling that a split is developing between advocates of different types of space structures. This is very disappointing since we haven't even gotten off the ground yet. I feel myself being drawn to an "O'Neill position" due to Hep's inability to consider other viewpoints than his own. This unfortunate lack of imagination is greatly in evidence by his persistence in writing in what can best be described as a "predictive" mode and tending to dismiss other alternatives without giving the reader many hard facts with which the reader may arrive independently at his or her own conclusions. At least O'Neill seems to be doing this. I strongly suggest that in order to convince the millions of people that eventually are going to pay for all this, we use our imaginations to the limit to provide as many cost-effective alternatives as possible. We must remember that space is an entirely new environment and is not subject to our "planetary bias".

Gary D. Miloglav
Piedmont, CA

There is much thought given now to the exploitation of the moon, but what about her protection? Future generations may well look upon us as oafs, if our first order of business is to take our lunabuggies and moonozers to the lunar landscape, destroying the very ancient and fragile lunar features. Even footprints last a long time on the moon! Unmarred lunar surface could become extinct in fifty years.

We need to develop a system that will make us preserve the majesty of the moon, and yet yield to us some of her metal, that we may fly amongst the stars. The lunar surface needs to be explored such that rare or beautiful features can be protected from the makers of quick bucks and aimless vandals.

Mars also presents us with the dilemma of exploitation and preservation, though the God of War may hold greater surprise defenses against our lust than airless Diana.

Taras Kiceniuk, Jr.
Palomar Mountain, CA

Here's a little item that might be of interest to the readers of **L-5 News**: Columbia Records is considering releasing the records of the Voyager ships, and letters might help them make that decision.

The person to address is:
Rick Smith
Vice President of Business Development
Columbia Records
51 W. 52nd St.
NY, NY 10010
I've already written him a letter, and another one addressed to the editor of

Karass, a fannish newszine. In the letter to Mr. Smith I suggested that Columbia donate proceeds to the L-5 Society. Carl Sagan has proposed that they donate funds to an extraterrestrial research group (which they are considering), and the L-5 Society seems to fit the bill perfectly. It wouldn't hurt to suggest the people one thinks would be interested in buying the record, and if the writer would promise to buy one.

Luke McGuff
Chicago, IL

Being a relatively young member of the L-5 Society, excited by the new ideas and concepts now being established concerning the future of space industrialization, I find the "**L-5 News**" highly informative and intellectually stimulating. Because "**L-5 News**" is a magazine of this caliber I expected you would refrain from utilizing outdated stereotypes as a method for communicating ideas. I am specifically to your statement in the January issue in "Notes from the Editor", page 19. I quote you, "You may think Joe Blow in Arkansas has fascinating thoughts about space colonies, but we can't justify spending \$400 on typesetting and printing so that Society members can hear about them."

Your implication that someone's ideas are irrelevant simply because he is from a particular territorial region, whether that region is a city, state, or country, is backwardly medieval, as well as provoking. The stereotyping of Arkansans as all "hicks and hillbillies" (quotes mine) is a completely erroneous belief encouraged by statements not unlike your own.

Although I still regard "**L-5 News**" an informative source of current events in, and possibilities of, the space program, and intend to continue my membership "til death do we part", it would be appreciated if you would refrain from using stereotyping (whether it be about Arkansans or not) to convey your messages.

Thomas Taylor
Smackover, AR

We can't justify spending \$400 to convey the opinions of Joe Blow in Los Angeles, either! My apologies to the state of Arkansas — C.H.

The two recent articles by Phill Parker (March, 1978, pp. 10, 11) illustrate the commitment of the Soviet Union to establish permanent, inhabited space facilities. This commitment appears to be even stronger than Phil indicated. According to **Aviation Week and Space Technology** (March 20, 1978, pp. 14, 15), the Soviet Union has already built a delta-winged, reusable, piloted space vehicle as the initial step in providing Russia with its own space shuttle capability. **AW&ST** reports that a space shuttle test vehicle has been drop-tested from a Tupolev Tu-95

Bear bomber to determine the aerodynamic and pilot handling qualities of the space craft. These tests are similar to those recently completed for the U.S. space shuttle orbiter.

This new Soviet program is significant because it indicates that the USSR believes it has the technology in hand to tackle the major engineering challenges involved in building reusable piloted spacecraft. Such a vehicle would provide cost savings and significant **new capability to the expanding Soviet space program.**

Obviously, a Soviet shuttle has serious implications for the U.S. utilization of space. Unfortunately, U.S. government leaders continue to ignore the Soviet Union's manifest intentions to exploit space, both for military and propaganda purposes. Thus, the U.S. "hare," while capable of great speed, dawdles, while the Soviet "tortoise" plods stolidly along. In the fable, the tortoise won the race. Will the "hare" lose again?

Richard Stutzke
Colorado Springs, CO

The existing situation in Washington is mixed: although many in Congress favor an expanded space program, the Carter administration does not. Also, since Carter wants to cut federal spending to whip inflation he may use this as an excuse to keep NASA funding at a low level.

In light of this, should we perhaps begin writing to the President in time to influence his decision on the FY '80 budget request? Of course, with the present mindset in the White House this may be a hopeless task. What do you think?

Concerning future lobbying activities: it's now or never for a Halley's Comet rendezvous/fly-by mission. If funding does

not begin in FY '80, forget it. Until then, however, this program should be top priority.

Aside from this particular mission, with its tight launch window, our continuing **number-one priority should be a permanent manned space station.** We could, with some justification, press for a "space race" with the Soviet Union, lest they get a head start in the third industrial revolution.

A PMSS would: 1. provide a platform for long-term experiments, observations and manufacturing that could make space truly profitable; 2. be necessary for any future operation, as a base for construction of SPS, return to the moon, deep space probes, etc., and; 3. **unlike one-shot spectacles, provide continuing benefits and focus attention on space industrialization-colonization.** (If Kennedy had called for a space station rather than a moon landing, we'd still be there, and still on the moon too.)

Well, what do you think? I think a space station will make space colonies inevitable.

Robert Lovell
Shawnee, KS

The following comments are submitted for use as either an article or letter.

I recently completed reading Heppenheimer's **Colonies in Space**. This book, as does other literature promoted by the L-5 Society, makes a convincing argument for space satellite construction based upon benefits to be derived. Unfortunately, the fact that a project is beneficial is often insufficient to gain the support sought from governmental decision makers.

There is another side to the coin which has not been articulated. The undesir-

able economic and political realities of the "do nothing syndrome." The United States has an unemployment rate which has held around six percent for several years. It is substantially higher among blacks and others than white males. Unless a four to six percent economic growth rate is maintained it will be impossible to keep all the people now employed at work.

Unless economic growth can be stimulated not only will the traditionally unemployed be unable to enter the paid workforce but there will be no room for new entrants, i.e., vocationally or academically trained blacks, women and other non-insiders. It is also inconceivable that the shrinking employed class will agree to ever larger transfer payments to underwrite the costs of living of an ever increasing welfare class.

Growth in a modern industrial-commercial economy is energy intensive. There is also the competing demand of third world nations for a standard of living favorably comparable to the American standard. The President has argued, in support of his energy program, that at some future date the fossil fuel producers will not be able to meet these combined demands for energy. Although the President's time table is suspect, the prophecy seems valid.

Another factor to be considered is the unfavorable U.S. international balance of payments due largely to the fact that the U.S. is on balance an importer nation, and will most likely remain so in the immediate future. If the claimed returns on investment in a solar power space satellite program can be realized, the U.S. could become an energy exporter and the aforementioned problems could become manageable.

E. Gordon Young
Madison, WI

L-5 Society Membership Form

NAME: _____

ADDRESS: _____

CITY/STATE/ZIP: _____

AFFILIATION/TITLE OR POSITION _____
(OPTIONAL)

I am _____ am not _____ interested in being active locally. Phone (optional) _____

_____ Please enroll me as a member of L-5 Society (\$20 per year regular, \$15 per year for students). A check or money order is enclosed. (Membership includes the **L-5 News**, the monthly magazine of the L-5 Society. Subscription of \$12/year included in membership dues).

Send to: L-5 Society
1620 North Park Avenue
Tucson, AZ 85719

