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NEWS AND COMMENT

Seafarer: Project Still Homeless as Milliken Says No to Navy

For the better part of a decade the Department of Defense (DOD) has been trying to meet the Navy's need to be able to communicate with its nuclear submarines while they are cruising fast and deep, and to do so without forcing the submarines to drag a possibly tell-tale antenna on or near the surface. This need could be satisfied by taking advantage of the unique properties of extremely low frequency (ELF) radio, whose extraordinarily long wavelength can penetrate seawater to a depth of several hundred feet before the signal becomes too attenuated for effective reception. But the Pentagon's dogged efforts to have an operational ELF system continues to be frustrated by severe political problems which are in no small part self-inflicted.

On 12 August Governor William G. Milliken of Michigan wrote President Carter to reemphasize that Seafarer, the current name for the ELF system the Pentagon wants to build, is still unwelcome in his state even though defense officials have been talking vaguely (and inconsistently) about drastically cutting the size of the antenna grid and, hence, reducing the amount of land affected. And he again called on the President and Pentagon to live up to past promises that Seafarer would not be imposed on Michigan over strong public opposition. Many citizens have objected to the project's large scale and have feared that ELF radiation might harm people and wildlife.

As first proposed, Seafarer was to involve building five transmitters and imposing a grid of antennas on an area of up to several thousand square miles, with the antenna cables buried to a depth of 4 to 6 feet and positioned 5 miles apart. Up to 2000 miles or more of cable were to be laid altogether. An individual antenna line might be anywhere from 30 to 90 miles in length and would carry about 100 amperes of current (an electric toaster requires about 10 amps). The current would pass from one ground terminal through the crust of the earth to a depth of a few miles then back to the opposite terminal. The entire circuit thus formed serves effectively as the antenna for transmitting the ELF signal into the atmosphere where it is trapped in the ionosphere and travels around the earth.

Milliken's rejection of Pentagon efforts to find a home for an ELF system is only the most recent in a long series of rebuffs. Sanguine, the first and by far the most ambitious ELF system to be proposed, ran into so much opposition in Wisconsin that in early 1973 Melvin R. Laird, the Wisconsin congressman whom President Nixon appointed as his first Secretary of Defense, directed that his state no longer be considered as a site for the project. Later, a plan to build Sanguine in Texas was greeted by hill country ranchers in about the same way they would receive a truck load of cattle infected with hoof and mouth disease. As for Seafarer, which the Navy began promoting in 1975, it has run into trouble in New Mexico and Nevada (where sites have also been evaluated) as well as in Michigan.

Thus far, Seafarer has continued to find support in Congress, at least to the extent that R & D money is still being provided. But this year the project ran into serious problems there too. The House would have cut off all support for Seafarer (though some money would have been allowed for a small ELF experimental facility at Clam Lake, Wisconsin), and it was only at the Senate's insistence that another $20 million in R & D funds was approved.

If Seafarer can be rescued from its present distress, it will take a determined effort on the part of the President. He must persuade Governor Milliken and key members of the House armed services and appropriations committees that the Pentagon has now come up with an environmentally and politically acceptable plan for the project—and one that it will stick with.

Despite the sharpness of Governor Milliken's rejection of Seafarer as it has been presented up until now, his letter to the President seemed to leave open the possibility that a small ELF project might not be unacceptable if ironclad as-

surances were given that it would not be the "foot in the door" for a big one. Also, on 5 August, the National Academy of Sciences finally issued its long-awaited report on the biologic effects of ELF radiation, whose principal conclusion was that, if appropriate precautions are taken, Seafarer would be harmless.

But to judge from the Pentagon's track record, things could easily get worse for Seafarer instead of better. A big source of trouble in the past has been the repeated changes made in the size of the ELF system that would be built, with the dimensions going down one year only to begin going back up the next.

The origins of Seafarer and Sanguine go back to late 1963 when the Director of Defense Research and Engineering (DDR & E) embraced the ELF system concept. It was recognized that because of its slow rate of transmission, such a system would not eliminate the need for the high frequency (HF) and very low frequency (VLF) systems that require surface or near-surface antennas. Its potential value would lie in sending brief but vital messages and, if need be, in dispatching the order for a retaliatory nuclear blow—for at that time defense planners believed that an ELF system could be designed to survive an enemy first strike.

By 1967, DDR & E and the Navy had come up with Project Sanguine. But for all its promise, the project as then designed presented what probably should have been foreseen as enormous political difficulties.

ELF transmissions require a long antenna—indeed, the antenna length must be equal to a significant fraction of the length of the radio wave transmitted, which can be up to several thousand miles. But much less was known 10 years ago about the requirements for ELF transmissions than is known today, and, as it turned out, the requirements were thought to be much more demanding than they actually were. As a result, the initial plan for Sanguine was grossly overdone, both as to antenna length and electric power input.

This plan called for an antenna grid in northern Wisconsin's Laurentian Shield country (which because of the low conductivity of its Precambrian rock lends itself especially well to ELF transmissions) that would have covered 22,500 square miles, or 41 percent of the entire state. Further, the plan called for 240 underground transmitters, 6000 miles of antenna cable buried within 25-foot-wide rights-of-way, and a power input of 150 million watts. The project was estimated to cost $800 million, but what it would have really cost is anybody's guess.

Cartoon by Draper Hill of the Detroit News.

Ultimately it was decided that an antenna grid of 3000 square miles would suffice, and that the power required would be 100 times less than had been estimated originally. But by the time the change to the smaller project plan was announced, Wisconsin was up in arms against Sanguine, and, given uncertainties as to the biologic effects of ELF radiation, the state of alarm persisted.

Furthermore, the project's rationale as a "survivable" system capable of delivering the order for a retaliatory strike was being called into question, both in Wisconsin and in Congress. For, at the same time Sanguine was being touted as a vital part of the nation's "second strike" capability, the Air Force was testing MIRV's (multiple and independently targetable warheads) and everybody knew that the Soviets would eventually be following suit. MIRV's, together with the prospect of greatly increased warhead accuracies, made it likely that Sanguine could be destroyed in a Soviet first strike.

When Secretary Laird ordered the Navy not to plan any longer on a Wisconsin site for Sanguine (doing so just as he was preparing to resign from office), he also directed that the search for a site be focused on the hill country around Llano, Texas. But, as noted previously, this too came to nothing.

After the political miscarriage in Texas, where the geology and terrain were not all that favorable for the project anyway, Sanguine dropped from sight for a while. Adopting a new strategy, the Navy was conducting "site-independent research" for the design of a system that could later be adapted to whatever site might be found suitable and available.

In early 1975 the ELF project reemerged with its new name—Seafarer—and with more modest goals. The aim of designing the ELF system to withstand a nuclear attack was dropped, although some strategic planners felt that, in a limited nuclear war, the Soviets might choose voluntarily not to attack U.S. command and control facilities.

A new attempt to select a site was begun in 1975. Preliminary to the preparation of an environmental impact statement, sites in New Mexico and Nevada were chosen for detailed evaluation, and word was passed to the upper Midwest states in the Laurentian Shield region that, upon invitation, the Navy would be pleased to evaluate sites there, too. This latter suggestion fell on fertile ground in Michigan's Upper Peninsula, a region of generally depressed economic conditions and high unemployment. For nearly 2 years, or ever since Wisconsin had been eliminated as a site for Sanguine, a few state legislators in the Upper Peninsula had, with the encouragement of some veterans' organizations, labor unions, and business groups been urging the state to make a bid for the project.

Governor Milliken, knowing what had happened in Wisconsin and aware that

some groups in the Upper Peninsula (such as People Against Sanguine and Seafarer) were mobilizing to fight any move to bring the project into their region, approached the issue warily. His science adviser, William C. Taylor, chairman of the department of civil engineering at Michigan State University, was asked to head an ad hoc committee that would recommend what he should do.

After making a quick search of the literature on ELF radio transmission and hearing a slick and apparently persuasive Navy and Pentagon presentation, the Taylor committee reported that there were "no known harmful effects of exposure to radiation at the levels and frequencies to be produced by Seafarer." Further, the committee, with a few members dissenting, recommended that the Navy be invited in if certain conditions were met, such as having the environmental impact statement on Seafarer include the National Academy of Sciences' forthcoming report on the biologic effects of ELF radiation.

As it turned out, the Navy had left the governor as well as itself open to embarrassment by its failure to inform the Taylor committee of a 1973 paper by a Navy scientific panel. This paper revealed some inconclusive but disturbing evidence that exposure to ELF radiation may have caused some persons to experience increased levels of triglyceride in their blood—a condition which can be associated with high blood pressure and heart attacks. After the existence of this report became known in late 1975, Senator Gaylord Nelson of Wisconsin accused the Navy of an attempt at suppression and deceit. Taylor himself believes the Navy acted in "bad faith" in this instance, however uncertain the suggested linkage between ELF radiation and triglyceride levels may have been (on the basis of current research and weaknesses in the earlier investigations, the recent National Academy of Sciences report exonerates such radiation on this count as well as others).

In any case, the governor took his committee's advice and invited the Navy in. But when it seemed to him that Seafarer might be put on the Upper Peninsula no matter how the environmental analysis came out, he demanded—and got—assurances that a Michigan site would not be chosen over his objection. In early 1976, Deputy Secretary of Defense William P. Clements, Jr., promised Milliken by letter that "I would not recommend a Michigan site to Congress if you object," and added that a "project of this magnitude would not be possible without the support of the people." Then, last October, as Jimmy Carter was eagerly seeking votes on President Ford's home turf, he made a similar promise. "If I am elected on November 2, Project Seafarer will not be built in the Upper Peninsula against the wishes of its citizens," Carter said.

It is now evident that these promises to allow the state a right of veto over a major military project was questionable not only as a matter of principle but also as a matter of practical politics. Conferring a veto power on the governor put him in a position where he might well *have* to veto Seafarer, because opposition to the project was growing by the day. In the advisory referendums held in five Upper Peninsula localities in the spring of 1976, Seafarer was rejected by large majorities, and, when several other communities put the issue to a vote last November, the "no" vote was still more overwhelming.

Yet, although giving the governor a veto was no doubt a mistake, the fundamental problem with Seafarer was that it involved so many uncertainties and so much that seemed arbitrary or unpredictable. As Milliken would later point out in protest to the Pentagon, Upper Peninsula residents and state officials were first given to understand that the antenna grid would cover 2500 square miles, only to see the figure later go to 3000, then 3500, and, finally, 4000. Also, whereas at first 90 percent of the antenna line was to follow existing roads or utility rights-of-way, the percentage was later to shrink to 65, and, contrary to what had originally been indicated, trees were not to be allowed to grow back on the numerous

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Odyssey of Agent Orange Ends in the Pacific

A scheme to "burn" Agent Orange sounds like material for a spy thriller, and, in fact, it does denote a Pentagon plan to liquidate a problem. And that is what the Air Force is doing in the Pacific right now. The nonfiction Agent Orange is the name for a half-and-half mixture of 2,4,5-T and 2,4-D herbicides which the military used for defoliation operations in Vietnam. The spray planes were grounded in 1970 after scientists raised the alarm about effects of the herbicide on the environment and, possibly, on humans who got in the way because of the presence in Agent Orange of the highly toxic contaminant dioxin.

When the defoliation operations were blocked, the Air Force was left with a couple of million gallons of Agent Orange on its hands. Some 1.4 million gallons were withdrawn from Vietnam and shipped to isolated Johnston Island in the Pacific about a thousand miles west of Hawaii. Stateside, another 860,000 gallons were stored in steel drums at a Navy facility at Gulfport, Mississippi.

It took the military 7 years and several rejected strategies to find an environmentally acceptable method of disposing of Agent Orange. At one juncture, a pilot scheme to remove enough dioxin to make the herbicide meet commercial market standards was tried. The problem was that the dioxin extracted was stored in charcoal-filled steel canisters, and these presented an even more serious disposal problem because of a residue of concentrated dioxin. The canisters were bounced from pillar to post, being ejected from California and Oregon and finally being flown to Johnston Island where they reportedly still repose in a locked vault.

The Air Force last year abandoned attempts to reprocess the remaining Agent Orange and retreated to a plan to burn the stocks aboard a German-built, Dutch-owned incinerator ship, the *Vulcanus*.

The Environmental Protection Agency approved a plan specifying that temperatures would not fall below 1250°C during the burn, thus insuring that 99.9 percent of the compound would be consumed. Sophisticated instrumentation is aboard the ship to keep track of incinerator temperatures, combustion rate, and efficiency, and to monitor the characteristics of the plume from the incinerators.

The Agent Orange stored at Gulfport was put aboard the *Vulcanus* and transported to Johnston Island. A test burn was successfully conducted 15 to 24 July and EPA gave the go-ahead to incinerate the main stocks. *Vulcanus* is now carrying out the incineration at a spot about 120 miles west of the island, and the burn is expected to be completed in early September. The empty steel canisters containing traces of the herbicide will be

new 10-foot-wide swaths that would be cut through the forests.

Especially galling to many Upper Peninsula people was that they might have to accept a project which a former Secretary of Defense had seen fit not to proceed with in his home state of Wisconsin—and this despite the fact that, according to accepted criteria, Wisconsin looked to be the best site of all.

Another arbitrary aspect of the site selection process was that, whereas the sites in Nevada and New Mexico were put forward by the Navy as worthy of detailed evaluation, the Navy clearly wanted no part of either of them. And, in fact, these sites—one confined to the Nellis Air Force Base/Nevada Test Site complex in Nevada, the other confined to the Army's White Sands Missile Range in the southern part of New Mexico—were unsuitable. For one thing, as the Navy's impact analysis and field hearings were later to confirm, Seafarer would conflict with the other activities going on there, making for opposition from the Army and Air Force and the towns near their installations.

To all appearances, the Navy's site evaluation exercise was a charade, and the only site it was really serious about was on the Upper Peninsula. So far as that site was concerned, the Navy was not doing any talking about trade-offs, of giving up some of the system's capabilities for the sake of environmental or local political considerations. It wanted a full system, although it was planning to begin with only 130 miles of antenna (against the 2400 miles it would eventually require) to see that all went well before the entire grid was installed.

The upshot of all this was that, by the time the Navy issued the draft environmental impact statement for Seafarer this past February, the project seemed in worse shape politically than ever before. The statement itself was hardly convincing, especially inasmuch as the National Academy of Sciences' final report was not yet finished and could not be included in it. A 10-page preliminary report by the Academy panel favorable to Seafarer was presented, but of course it contained no supporting documentation.

(Moreover, the panel's objectivity had been challenged [*Science*, 18 June 1976] because its membership included three scientists who were already on record as believing that the electromagnetic fields associated with the transmission of electric power are harmless. The charge that the panel represented a "stacked deck," heard on the CBS "60 Minutes" program in February, was clearly unfair, for the panel seems to have gone about its task conscientiously. But this accusation could only have contributed further to the atmosphere of suspicion and distrust surrounding Seafarer.)

Upset at a newspaper report that an unnamed Navy spokesman had said that his power of veto over the project had expired with the departure of the Ford Administration, Governor Milliken had written President Carter at the end of January to ask that this power be reaffirmed. What he got in reply was only a vague assurance from Secretary of Defense Harold Brown in March that "very great weight" would be given to the views of the people of Michigan. Annoyed still more by this, Milliken thereupon announced his opposition to Seafarer. Later, in June, he joined with Governor Patrick J. Lucey of Wisconsin (who has since become ambassador to Mexico) to reject Pentagon suggestions that Seafarer might somehow be divided between the two states. "Two small grids cannot be considered acceptable as an alternative to one unacceptable large one," the governors said.

This declaration might have marked the end of Seafarer except for the belief on the part of some influential members of Congress—Senator Thomas J. McIntyre (D–N.H.), chairman of the Armed Services Subcommittee on Research and Development, being a notable example—that the project is important to national security. Also, Milliken's rejection of Seafarer was less absolute than it appeared.

For, not long after his joint statement with Lucey, Milliken's science adviser was talking with Pentagon officials (albeit on their initiative) about the possi-

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crushed and ultimately melted down in steel mill furnaces at the required high temperature. And that, the Air Force hopes, will be the end of Agent Orange.

Blast-Off for Swigert, Reentry for Mosher

Recently retired Ohio Congressman Charles A. Mosher is returning to Capitol Hill to head the staff of the House Science and Technology Committee on which he served. He replaces John L. Swigert, a former astronaut, who resigned from the committee post to seek the Republican nomination for senator from Colorado.

It is highly unusual for a former member of Congress to serve on a committee staff, but the circumstances are unusual. Mosher was reportedly urged to take the job by the committee's chairman, Representative Olin E. Teague (D–Texas). Teague recently had his lower leg amputated. He still tires easily and his mobility has been restricted. The committee faces a crucial period as it works out its relationship with the new Department of Energy, for which the committee is a major congressional overseer.

Mosher, 70, a former small-town newspaper editor, was elected to Congress in 1960. He chose not to seek reelection in 1976 (*Science*, 26 December 1975). As a member, he was regarded as knowledgeable and politically astute. His popularity among his former colleagues is indicated by their reported unanimous vote of accord with his appointment to the staff job.

Mosher's party affiliation posed no problem in the appointment to the staff job, according to committee sources. Teague has made a point of filling staff positions on the basis of professional qualifications rather than party affiliation. This is in contrast to other House committees which adhere to an older Hill habit of heeding party identification when recruiting majority and minority staffs.

Swigert, command module pilot on the Apollo 13 mission, is also a registered Republican. His party affiliation apparently did cause some restiveness among Democratic members of the committee after it became known he was interested in running for political office, particularly that he was making the bid for the Senate.

After announcing his resignation, Swigert was interviewed by *Aviation Week*. Discussing the future of NASA, he noted that the utilization of research results is often thwarted by weakness in following through with applications. He was quoted as saying "All of this is compounded by a lack of technical capability in the policy-making branch of the government—Congress." Which might be interpreted as the words of a would-be, self-fulfilling prophet.

John Walsh

bility of an ELF system that would consist of the existing experimental facility at Clam Lake, Wisconsin, linked to a small Michigan facility made up of 130 miles of antenna and a single transmitter. The Michigan facility, contemplated in the original Seafarer plan as the first step toward a full system, would demand only 5 percent of the right-of-way originally to have been required. Yet, astonishingly, Navy officials were now saying that this small combination facility could, especially with a modest expansion of the Clam Lake unit, prove of real value in the principal submarine operating areas.

Up until 12 August, when Milliken sent his last letter to President Carter, the governor's staff was still weighing how to respond to this latest Seafarer proposal. William Taylor, the science adviser, thought the proposal had enough merit to warrant the governor's entering into negotiations with the Navy and DOD officials. Some others on the staff were more skeptical, but there was no one who would not have welcomed evidence that the Pentagon was at last willing to offer firm assurances that no Seafarer system would be built or subsequently expanded in Michigan without the governor's concurrence.

But whatever the hopes for another round of cooperative discussions about Seafarer, they were let down by continued evidence of ambiguity—one gubernatorial aide has called it "complicity and double-dealing"—in the Pentagon position. For instance, on the same day Milliken dispatched his letter to the White House, a news story from Washington appeared in the Lansing *State Journal* quoting a "senior Navy official" associated with Seafarer as saying that, by starting the ELF project with the small combined Clam Lake–Michigan system, the governor would be allowed "to save face gracefully."

Clearly, to break the current political impasse over Seafarer, there will have to be a recognition on the part of the Pentagon and the White House that, as one Michigan congressman has put it, "a deal is a deal." For, wisely or not, the Pentagon has made a solemn commitment to treat Governor Milliken as a full partner in the decision-making on Seafarer if the project is to be built in Michigan.

An agreement by the governor to allow a Seafarer system of even the most modest size would take political nerve, because such a system would in fact be regarded by many as a "foot in the door." Yet a politician of good will can work up his courage to make a tough decision if those he is dealing with will honor their commitments and not cause him embarrassment. In the case of Seafarer, the Navy and the Pentagon have yet to show an appreciation of this political truism.—LUTHER J. CARTER

National Bureau of Standards: A Fall from Grace

Most government agencies complain that their budgets have not kept pace with inflation and increasing demands for services. But officials at the National Bureau of Standards (NBS) say they have been hit harder than most—a view that is confirmed by a statutory Visiting Committee,* appointed by the Secretary of Commerce, and by staff members of the Senate Commerce Committee. The Visiting Committee goes so far as to say that "NBS current resources are inadequate or nonexistent in a number of research areas that have been identified as critical to national needs."

Malaise pervades NBS at its headquarters in Gaithersburg, Maryland—a suburb of Washington, D.C. Officials and laboratory scientists there see a pattern of declining performance and capability that began 10 years ago and picked up speed within the past 5 years as the bureau was loaded with new responsibilities that draw heavily on its allotted money and personnel. The causes of this situation are complex and involve a chain of government officials that stretches from NBS to the Department of Commerce (under whose aegis NBS falls) to the Office of Management and Budget (OMB), and includes members of Congress and even the President.

In recent years, Congress has made increasing demands on the technical expertise at NBS. It has passed 15 laws since 1965 giving the bureau new assignments. But during that time NBS has had a constant budget despite inflation and has had to reduce the number of its employees from 3163 permanent full-time workers to 3055. The result, say NBS administrators, is that the bureau is no longer able to fulfill its functions. The scientific reputation of NBS is also deteriorating. Morale is low and the best young researchers are no longer interested in working there. What was once a first-rate research institution is now in some danger of becoming a job shop.

The work of NBS is seldom in the news, and its mandated responsibility for developing and maintaining a large array of measurement standards hardly excites the imagination. But many of these standards are crucial to regulatory agencies, to consumers, and to businesses and industries. For example, the bureau recently established a calibration service for diagnostic x-ray units to help prevent the public from being overexposed to x-rays. It develops standards for measuring pollutants in air and water, thus ensuring that regulators measure pollutants in the same way as the industries they regulate. It issued a standard establishing safety requirements for toys. It helps industries calibrate gage blocks, which are used to check on the accuracy of measurements.

Some of NBS's work involves problems whose solutions require long-term research. One such problem is to devise means of measuring amounts of radioactivity in nuclear fuels at various stages of processing. This is necessary to provide a basis for accountability for nuclear materials. According to Arthur McCoubrey, director of the Institute for Basic Standards at NBS, these measurements "go beyond the existing state of the art," and NBS will require several years of research to come up with the necessary techniques. In the meantime,

* Members of the Visiting Committee are Edwin Gee, Senior Vice President of DuPont Company, Robert Dicke of Princeton University, Dale Compton, Vice President for Research at Ford Motor Company, William Carey of the American Association for the Advancement of Science, and Charles Peck, Group Vice President of Owens-Corning Fiberglas.