tribution to respiratory diseases of earlier exposure to air heavily polluted with sulfur dioxide.

The Taft center has made remarkable advances in the technology of isolating and identifying specific pollutants in the water. It has thereby given enforcement agencies stronger weapons in their campaigns against pollution and has also made some industries more self-critical and sensitive to suggestions on antipollution measures.

But the detection of potential toxicants is so far a fairly rudimentary science. Researchers are working hard, for example, to develop ways to measure the "body burden" of pollutants in the human individual by analysis of the blood. Until such techniques are much further advanced, the problem of establishing long-term cause-and-effect relationships between pollutants and disease will remain very difficult.

This important new dimension of public health activity figures in the controversy over location of the environmental health center proposed for the Washington area by PHS (*Science* 23 Aug. 1963). The proposal's vicissitudes in Congress and what, from the outside, appears to be PHS uncertainty on just what kind of center it wants, leave it a matter of speculation as to whether the installation would be an administrative headquarters or a center for basic research on problems of environmental health.

The role of the Taft center in what obviously will be a period of expanding research in environmental health is somewhat clouded at the moment. The center has a long record of achievement in developing methods of detecting pollution in the environment and of devising practical and economic countermeasures. The tradition has been one of applied rather than basic research, a point that an extragovernmental committee on environmental health research made in its report, which recommended establishment of a separate facility for research on fundamental problems in all areas of environmental health.

The furor over fallout, which was quieted by the limited test ban treaty, and PHS involvement in the Mississippi River fish-kill case are instances of the demand for a new kind of research and of the controversy that may surround it. A pressing problem now facing PHS and its Taft center is how to organize research on these difficult but increasingly important public health problems.—JOHN WALSH

N.S. Savannah: Nine Years after Inception It Is Uncertain if Ship Is a Boon or a Boondoggle

The government-sponsored nuclear ship *Savannah* has two main functions: to demonstrate to an international public that nuclear ships are safe, and to persuade American shipping companies that they are commercially valuable. Since the public is probably as reassured by the *Savannah*'s handsome exterior as by elaborate explications of the structure of her reactor, somewhat more attention is being devoted to the second function than to the first. But the two are closely related, and perhaps the major difficulty now facing the *Savannah* is the attempt to combine the reality of severe government regulation with an appearance of independence sufficient to convey the idea that undue restrictions would not compromise the commercial viability of future nuclear ships.

These efforts have an oddly self-propelling quality. The *Savannah* was originally conceived, in part, to determine *whether* nuclear merchant ships were feasible, but much of the emphasis of her project managers has now shifted to demonstrating *that* they are feasible. Part of the reason is financial—the *Savannah* will have cost $100 million by the end of fiscal year 1965, and however experimental their original intentions, government agencies backing the nuclear ship project would feel themselves vulnerable if they had nothing to show for this expenditure in the end. An additional reason is that the nuclear ship is a cold war status symbol and failure would be humiliating politically, even where the definition of "success" is so uncertain intellectually. (It is no accident that the Russians chose last week, while the *Savannah* was making news in Europe, to invite 20 Moscow-based news correspondents for a pleasure trip on the world's only other nonmilitary nuclear ship, the icebreaker *Lenin.)* In any event, having designed the *Savannah* to be the vanguard, the government is now anxiously trying to encourage a following for it to be the vanguard of.

The theory that nuclear ships can operate as freely as conventional ones, however, is not entirely convincing. While merchant shipping has been closely regulated by the Coast Guard for many years, the restrictions placed on the operation of the *Savannah* are monumental by comparison.

Where other ships can sail easily from port to port, the visit of the *Savannah* to a foreign country is preceded by intricate international negotiations. First, the host country must be persuaded of the *Savannah*'s safety; then, for each visit, agreements must be reached detailing the procedures to be followed and the responsibilities of the two governments in the event of a nuclear accident, the extent of American liability, the responsibility for radiological control in the harbor, the right of the visited port to information about the *Savannah*, and many other technical questions. In addition, for each port visited, a Port Operating Plan must be prepared. These operating plans, which average over 20 pages, include detailed information on, among other things, the approach to the port, the berth of the ship, the availability of tugboats, the departure plan, the location of a remote anchorage to which the ship could be towed in case of accident, and the estimated exposure of the public to radiation during the visit to the port. These plans are prepared by members of the *Savannah*'s technical staff, who survey the ports months before the ship's arrival; the plans must be scrupulously followed.

The complexity of the arrangements, however, do not appear to have deterred any of the 30 ports on the *Savannah*'s 1964–65 itinerary from welcoming her enthusiastically. Of all the cities involved, only New York, which the *Savannah* will visit several times, appeared uneasy at the berthing of the nuclear ship. Prolonged citizen agitation over a Con Edison plan (eventually withdrawn) to build a power reactor in Queens was thought to be responsible for official timidity in sanctioning the *Savannah*'s visit, but in any case the reluctance was overcome and produced no public-relations difficulties. Now the successful visit is being taken as evidence that a nuclear reactor can safely be stationed in the heart of the city.

Maritime Administration—AEC

The international agreements, the Port Operating Plans, the certification of the crews, and virtually every other aspect of the *Savannah*'s operation are subject to the approval of a long chain of authority in Washington. Although the basic jurisdiction over the *Savannah* is in the hands of a Joint Group of representatives of the Maritime Administration and the Atomic Energy Commission, in any question involving nuclear safety the Joint Group is treated just like a commercial supplicant for

government benediction. Safety practices for the *Savannah* reactor are in large part modeled after those for land-based reactors, depending basically on containment, and the *Savannah* is subject to all the procedures developed by the AEC for the licensing of stationary power reactors to commercial companies. This means that, except for small housekeeping details, the Joint Group's recommendations must be reviewed by the AEC's Advisory Committee on Reactor Safeguards, by the AEC's regulatory staff, by a reactor licensing board, and finally by the AEC commissioners themselves.

For the most part the government agencies responsible for the *Savannah* appear to work together harmoniously. If they divide at all, it is over the relative emphasis given the goals of safety and commercial attractiveness. The Joint Group is in no way incautious, but it does resist the tendency of the AEC advisory and regulatory staffs to pile on additional safeguards which it feels jeopardize the *Savannah's* economic appeal without substantially adding to its safety.

Tugboat Troubles

This divergence is well illustrated by a currently unresolved disagreement about the presence of tugboats while the *Savannah* is in port. Tugs are used for the *Savannah*, as for any ship, in docking and undocking. In addition, however, the AEC has determined that tugs should stay with the *Savannah*, to remove the ship from a central area in event of an accident, until the reactor has cooled to a specified degree and the inventory of fission products in the reactor is very low. In some ports, where the harbor entrance is long and power is reduced several hours before docking, this requirement is not too burdensome. Some ports, however, can be navigated swiftly, and for these, according to the Joint Group, the necessity of keeping tugs around introduces serious problems, not only of cost but of status. The shame of being attended by a tug, to hear the Joint Group tell it, is second only to the shame of the scarlet letter.

Tugs cost about $150 to $200 an hour; if the present ruling of the AEC is adhered to, tugs might have to stand by for as long as 2 days, and tug costs in a single port might run as high as $10,000. While the cost question might not be insurmountable for the government-run *Savannah*, the Joint Group feels it is likely to have an unfavorable effect on the *Savannah*'s attempt to demonstrate the commercial potential of nuclear ships. The tug requirement, the Joint Group recently told the AEC, overlooks the complex and costly variety of safeguards engineered into the *Savannah* to prevent the effects of a possible accident from threatening the crew or public; it will therefore discourage further research on engineered safeguards; will inhibit work currently going on abroad on more powerful maritime reactors, since tugs would be needed even longer for ships equipped with such reactors; and will dampen the interest of domestic operators. It will, according to the Joint Group, encourage labor to demand hazard pay; will lessen the enthusiasm of foreign hosts; and will, in general, have the effect of making the *Savannah* experiment a failure.

Much of the discussion of the ruling now centers on whether, and how fast, tugs would respond to a distress call from the *Savannah*, with the AEC digging up instances where tugs either failed to respond to calls or responded slowly, and the Joint Group (and the tug owners) refuting the AEC's cases and defending the record of the tugs as heroic defenders of the troubled seaman. For the present, the ruling stands, but the Joint Group is busy investigating the tug question and will have an opportunity to make its case sometime in the next few months. Such disagreements, the Joint Group feels, mean not that the *Savannah* is a fiasco but, quite the opposite, that it is doing precisely what it ought to be doing—preparing the way for future generations of nuclear ships.

New Reactors

Even if their results will not always be costly, however, as in the case of the tugs, the procedures for government regulation of nuclear ships are bound to be cumbersome, at least for the foreseeable future. Added to the generally unfavorable economic picture for nuclear ships, the safety restrictions account for the rather wavering attitude of the maritime industry. One of the first positive signs of industry interest was recently expressed by the American Mail Lines, which operates ships between the Pacific Coast and ports in India, Pakistan, the Persian Gulf, and the Gulf of Aden. Partly as a result of the steamship company's interest, the Maritime Administration has initiated a feasibility study covering the possibility of effecting savings to the operator through reductions in fuel weight and increases in speed; the acceptability of nuclear cargo ships in foreign ports; design; and every other aspect of ship operation. Although industry generally has been interested in the development of two new maritime reactors (General Electric's air-cooled reactor 630-A and Babcock and Wilcox's Consolidated Nuclear Steam Generator, or CNSG), for the most part the higher costs of building nuclear ships have apparently outweighed prospects of lower operating costs in most industry calculations for the immediate future. Maritime Administration officials believe, however, that as costs come down, industry interest will rise.

The Atomic Energy Commission submitted a last-minute $13.5-million budget request to the Joint Committee on Atomic Energy for research on the 630-A air-cooled reactor, but was turned down because the committee had had insufficient time to study the request. It is likely that the research will be authorized next year. But industry interest in the new reactors raises the question of the extent to which the *Savannah*, after its long travail, will in fact be a trouble-shooting model for other nuclear ships. Although officials of the Joint Group believe that there will be a generation of nuclear ships modeled on the *Savannah*, none are now in gestation, and with the attention being given to the new reactors, it is hard to see whence they may come. Although politically and psychologically the *Savannah* has probably won some battles, new design and training and safety criteria would have to be devised for future ships, and the *Savannah* may turn out to be as irrelevant to their problems as the *Mayflower*. Thus, after expenditure of $100 million, 9 years of effort, and incalculable hard work on the part of thousands of dedicated men, it is still not altogether clear whether the N. S. *Savannah* is a boon or a boondoggle.

—ELINOR LANGER

(*This is the second of two articles on the N.S.* Savannah.)

Announcements

The National Science Foundation has announced the formation of a special commission on **weather modification.** Establishment of the 11-member commission resulted from a request by the Federal Council on Science and Tech-