detailed information, is given by J. E. Blamont, T. M. Donahue, and W. Weber, *Ann. Géophys.* **14**, 282 (1958).
3. The work of Chapman, Bates, Hunten, and Omholt is discussed by Chamberlain, *Physics of the Aurora and Airglow* (Academic Press, New York, 1961), p. 467.
4. The evidence from rocket trails is discussed by J. E. Blamont, M. L. Lory, and G. Courtès, *Ann. Géophys.* **16**, 435 (1960). For the dayglow observations, see J. E. Blamont and T. M. Donahue, *J. Geophys. Res.* **66**, 1407 (1961).
5. Nightglow excitation is discussed by Chamberlain and by Bates (see *1*). The role of vibrationally excited molecules is considered by A. Dalgarno, *Planetary Space Sci.* **10**, 19 (1963).
6. H. M. Sullivan and D. M. Hunten, *Can. J. Phys.* **42**, 937 (1964).
7. Chamberlain [*Physics of the Aurora and Airglow* (Academic Press, New York, 1961)] gives a thorough treatment of resonance absorption and gives references to the parallel work of Donahue.
8. D. M. Hunten, *J. Atmospheric Terrest. Phys.* **7**, 141 (1955); the recent confirmation by W. Stoffregen was reported to me by A. Omholt.
9. The results shown in Fig. 5 are from W. R. Bullock and D. M. Hunten, *Can. J. Phys.* **39**, 976 (1961), and D. M. Hunten, A. Vallance Jones, C. D. Ellyett, and E. C. McLauchlan, *J. Atmospheric Terrest. Phys.* **26**, 67 (1964).
10. M. Gadsden and K. Salmon, *J. Atmospheric Terrest. Phys.* **22**, 75 (1961); W. A. Gault and D. M. Hunten, *Nature* **198**, 469 (1963).
11. Work before 1960 is discussed by Chamberlain [*Physics of the Aurora and Airglow* (Academic Press, New York, 1961)]; measurements of turbulence and of winds are reported by J. E. Blamont and C. de Jager, *Ann. Géophys.* **17**, 134 (1961), and by J. E. Blamont and J. M. Baguette, *ibid.*, p. 319; temperatures are given by J. E. Blamont, T. M. Donahue, and M. L. Lory, *Phys. Rev. Letters* **6**, 403 (1961); interference by the natural sodium layer is discussed by T. M. Donahue, J. E. Blamont, and M. L. Lory, *Planetary Space Sci.* **5**, 185 (1961).
12. J. E. Blamont and T. M. Donahue, *J. Geophys. Res.* **66**, 1407 (1961); evidence in agreement with twilight results is given by D. P. McNutt and J. E. Mack, *ibid.* **68**, 3419 (1963), and by H. H. Zwick and G. G. Shepherd, *Can. J. Phys.* **41**, 343, (1963).
13. Contribution No. 58 of the Kitt Peak National Observatory. The observatory is operated by the Association of Universities for Research in Astronomy, Inc., under contract with the National Science Foundation.

News and Comment

Environmental Health: Taft Center in Cincinnati Has Been the PHS Mainstay in Pollution Research

Cincinnati. In mid-June the Health Physics Society met in this city, which, because of the presence of the Robert A. Taft Sanitary Engineering Center, can be called the spiritual home of health physics. Members of the Health Physics Society are scientists, engineers, and physicians concerned with the effects of radiation on humans, one of the newer problems of pollution of the environment. And such pollution has been the main subject of interest at the research facility established here by the Public Health Service just over a half century ago.

Until the end of World War II, the center in Cincinnati was a small operation devoted almost exclusively to water pollution problems. Then after the war, for a number of reasons—sheer growth of population and industry, emergence of atomic energy with its peculiar problems, increasing realization that smog is not only a nuisance but a menace in many cities, the so-called chemical revolution with its by-product problems relating, for example, to pesticides and detergents—there occurred what might fairly be called a pollution explosion. Taft Center researchers moved into these new areas, particularly as Congress, in a rather random way, recognized the new dimensions in public health problems with new laws and new funds.

The PHS center was established in 1913 specifically to study the Ohio River which flows by the city's doorstep. By the turn of the century the beautiful blue Ohio and many of its tributaries were badly polluted with sewage and wastes from factories and mines in the Ohio basin. The PHS choice of Cincinnati, which is roughly halfway down the river, seems to have been influenced by the presence in the city of an old marine hospital operated by PHS. The center's name, orginally, was the descriptive Stream Pollution Investigations Station.

The center's current director, Harry P. Kramer, notes that primary emphasis at the station was given to establishing the principles of natural purification of water in streams, about which not a great deal was known then, and to developing treatment systems for polluted water. From the outset, says Kramer, the station was successful in attracting highly competent men from different fields—biologists and microbiologists, chemists, engineers, and physicians—thereby setting the pattern for the approach to pollution problems that has been followed at the center ever since.

The researchers soon moved on from their exclusive study of the Ohio to a concern with the problem of stream pollution in general. Work done at the Cincinnati center soon found its way into textbooks, and the station has exercised a heavy influence in sanitary-engineering education in American universities.

During World War II, the station, like most other government agencies, was called on to deal with immediate problems, such as developing waste treatment systems for military installations. One of the first intimations of the coming diversification of pollution problems, came when the station was consulted on the disposal of radioactive wastes. Then in the late 1940's, research began, in a small way, on various kinds of pollution of food and milk. In 1949 the name of the station was changed to the Environmental Health Center of the Public Health Service, and plans were developed for construction of a building to fit the center's new duties and personality.

The building was occupied in 1954, and the center was renamed the Robert A. Taft Sanitary Engineering Center, after Ohio's senior senator who had died a short time earlier. The reversion to "sanitary engineering" in the name seems to have been decided upon as a means of emphasizing the tie between the center and sanitary-engineering education in the universities.

The trend toward bigness at the center was reflected organizationally by a setting up of divisions corresponding to the four main categories of work at the center: Division of Water Supply and Pollution Control, Division of Air Pollution, Division of Radiological Health, and Division of Environmental Engineering and Food Protection.

The center and all its divisions are subordinate to the PHS Bureau of State Services and are under the super-

vision of the bureau's associate chief for environmental health. The transformation of a small, centralized agency with a tradition of autonomy into a much bigger one with multiple divisions and two bosses—one in Washington and one in Cincinnati—has, unsurprisingly, not been accomplished with perfect ease.

For one thing, the center staff has expanded in the last decade from about 200 to about 1000 and has spilled out of the main building, so that the center now has ten locations in and around Cincinnati. Nearly two-thirds of the staff members are in improvised quarters.

The PHS Division of Occupational Health also has a research and training facility in Cincinnati. Occupational health, while regarded as one of the five areas under the environmental-health umbrella, is not directly attached to the center, as the other four are.

The budget for the current fiscal year for the Taft Center is some $12.7 million. The occupational health facility, which employs 139 people, has a budget this year of $1.5 million. The breakdown of funds at the Taft center indicates fairly accurately the distribution of emphasis in research there. The biggest sum, $4.8 million, goes to the air pollution division; water pollution is next with $4 million; then come radiological health with $1.3 million, and environmental engineering and food protection, with $731,000. The management budget, which includes substantial amounts for training, is $1.9 million a year.

The Division of Radiological Health developed from original efforts at the center to deal with problems of disposing of radioactive wastes. Research in the division has been devoted in large measure to devising better means of detecting radioactivity in the environment, particularly the movement of radionuclides in streams and in the atmosphere. In the late 1950's, when fallout became a subject of serious concern because of nuclear weapons testing, the division became deeply involved in helping to set up a fallout monitoring network across the country and in setting up a national Radiation Surveillance Center. Researchers from the center also work with the Federal Radiation Council on setting radiation standards.

Radiological health research at the center, therefore, has primarily stressed detection and measurement. Work on radiation effects has been largely delegated, through grants and contracts, to university scientists. This division of labor is based in part on the access which university researchers have to closely controlled animal colonies and based in part, apparently on the center's longstanding practice of concentrating on applied research.

The Public Health Service's work on food and milk pollution would appear to bring PHS into competition with the Food and Drug Administration. While the line, in fact, is sometimes difficult to draw, PHS and the researchers at the Taft Center are interested in food and milk as part of the environment. They are concerned less with particular cases of contamination or pollution than with finding general answers to questions such as those posed by outbreaks of botulism or *Salmonella* poisoning. The process for removing radionuclides from milk, for example, was largely developed at the Taft Center.

Fish Kill

Analysis techniques which had been brought to an advanced stage in the food and milk division contributed heavily to the PHS report earlier this year that the lethal agent in a massive fish kill in the lower Mississippi River last year was a much-used agricultural pesticide called endrin. The fish-kill investigation was centered in the aquatic biology section of the water supply and pollution control division, but new gas chromatography techniques employed by researchers in the food and milk division were a key factor in the still hotly disputed PHS verdict on endrin.

In the Mississippi case PHS was invited by Louisiana state authorities to study the fish kill. The federal agency may assume the initiative only in cases of pollution covered by federal law. Despite new legislation, the area open to federal initiative is highly restricted, and even in that area the PHS seems to feel more comfortable in its old modus operandi—cooperation with state and local agencies—than in its new one—intervention.

The Air Pollution Control Act passed in 1955 basically gave PHS the task of defining the problem of air pollution and of providing technical assistance to the states in their pollution abatement efforts. A strengthened air pollution law enacted last year provided grants-in-aid to local, state, and regional air pollution control agencies for starting or expanding control programs. It also authorized the Department of Health, Education, and Welfare (the PHS parent department) to initiate abatement and enforcement activities itself or at the request of a state when the health or welfare of a citizen of that state was endangered by air pollution originating in another state.

The limitations on the agency's authority, which is based on interstate powers, are vividly illustrated by a spectacle visible most days from the windows of the air pollution division offices in the Taft Center. Flame and dense smoke pour from the stack of a reclamation foundry situated a few hundred meters beyond the city limits of Cincinnati; the city does have an air pollution control unit, but the suburb does not.

At the Taft center, a good deal of work is being done, as prescribed by the new law, on two major contributors to air pollution—motor vehicles and fuels containing sulfur. An abatement branch to enforce the new law has been proposed for PHS, but this unit would presumably provide technical support to the HEW Secretary, who alone has power, under the older water pollution control law, to initiate enforcement action.

Water pollution, the original concern of the pollution fighters, remains a principal subject of research at the Taft center. In the early days, the water researchers concentrated on disinfection problems and on combating the "oxygen lag" in water heavily polluted by organic wastes. They made notable advances in insuring that public water supplies would not be the sources of epidemics. In their efforts to make water a cheaper and safer product they have not only grappled with the esthetic problems of taste and odor but have also sought to make the much-used and reused water in our streams and rivers usable for fishing, boating, and swimming.

The task has grown more difficult as new industrial processes have introduced new kinds of wastes into the streams and rivers. Detergent foam has been perhaps the most visible sign of these new problems. But with the "chemical revolution" has come the question of what the researchers call "potential toxicants." Does the presence of nontoxic levels of pesticide in the human body, for example, have any specific effect on the susceptibility of an individual to degenerative diseases? Or what, researchers on air pollution problems wonder, is the con-

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