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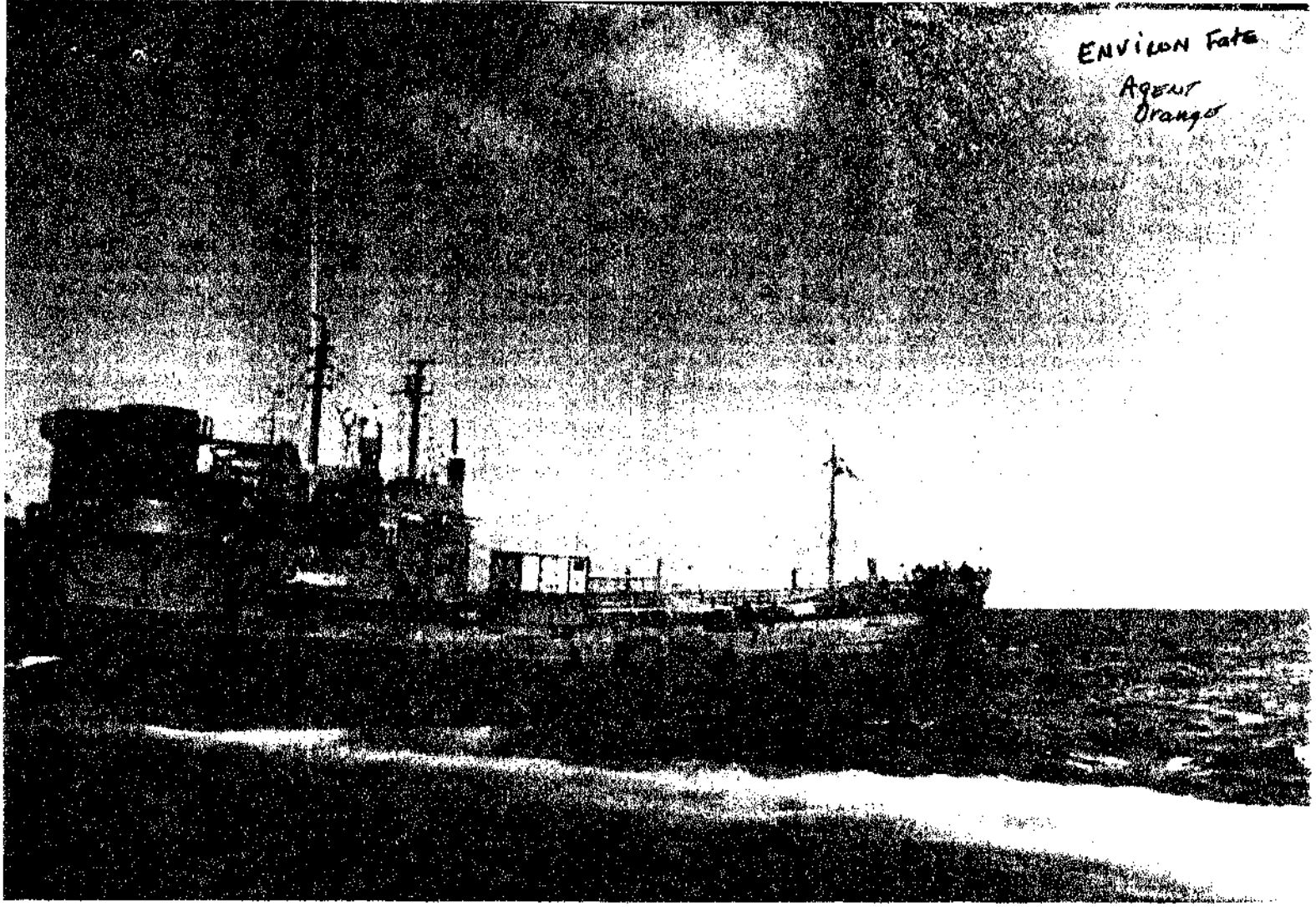

ENVIRON Fate
Agent Orange

Twin chimneys at the stern of the Vulcanus mark the location of the incinerator, which destroys toxic substances by burning them at extremely high temperatures.

Seagoing Furnace Destroys Toxics

When the U.S. Air Force began casting about eight years ago for a way to dispose of its surplus stock of Herbicide Orange, the defoliant used in Vietnam, it ran into unexpected problems.

Herbicide Orange has been under heavy criticism from scientists who warned that the dioxin contaminant in the mixture caused birth defects in laboratory animals. The Defense Department had ordered the herbicide withdrawn from use in 1970 and the Air Force found itself stuck with about 2.3 million gallons of it. (Herbicide Orange was a half-and-half mixture of 2, 4-D and 2, 4, 5-T. The latter was banned for a number of uses years ago, and the dioxin was a contaminant from the process used to manufacture it.)

One proposal to bury the herbicide in Utah ran afoul of former Governor Calvin L. Rampton, who asked Federal officials to drop the idea. His administration earlier had tried to show that Army nerve gas killed some 6,400 sheep in Utah in 1968, and State officials were understandably leery of the new toxic. Another plan called for diluting Herbicide Orange and selling it to South American farmers at cut-rate prices, an idea that encountered objections by the State Department. The Air Force also met resistance with a draft environmental impact statement proposing to incinerate the stocks on land in Illinois and Texas. Opponents said this was technically unsound, environmentally dangerous and expensive, and the plan was abandoned.

Still another major alternative the Air Force pursued, at EPA's insistence, was reprocessing the herbicide to remove the dioxin by means of special coconut shell charcoal filters. This was tried on a pilot scale in Mississippi, and the experiment was successful, but it created a new problem: There was no known way to destroy the contaminated charcoal.

In the meantime, however, a relatively new technology for managing toxic substances had been gathering impetus in Europe. German and Dutch engineers since 1969 have been using at-sea incineration to destroy organochlorine wastes. (The release of such compounds to the environment is undesirable because they are very persistent and can enter the food chain. Even small quantities of some types are acutely toxic.)

The technique employed by Europeans to manage such wastes involved specially equipped ships that burned the material at high temperatures in the North Sea. The first of these vessels was the Matthias I, a small tanker of about 1,000 metric tons that had been fitted with an incinerator and was used by a German firm for half

a dozen years. A larger tanker of 3,500 tons, the Matthias II, was modified in the same way and is still in service. Then in 1975 the Matthias III, a much bigger tanker of 19,300 tons was modified in a Germany shipyard to perform similar work. Matthias III was designed to carry 15,000 tons of liquid waste in its tanks plus several thousand 55-gallon drums on its main deck. However, this ship did not perform satisfactorily, and rather than invest any further in modifications, the company decided to take it out of commission.

But in the meantime the idea of at-sea incineration already was being examined seriously by several specialists in EPA as a way of disposing of hazardous toxics like Herbicide Orange. These men included John P. Lehman, Director of the Hazardous Waste Management Division; Russell Wyer, who had been specially appointed by Kenneth Biglane, Director of the Oil and Special Materials Control Division, to study the technology; and Ronald A. Venezia, EPA project officer for environmental assessment of organochlorine waste incineration, Office of Research and Development.

The ultimate answer to the problem turned out to be the M/T (for Motor Transport) Vulcanus, a Dutch-owned vessel that had been converted from a cargo ship to a chemical tanker fitted with two large incinerators at the stern. Unlike Matthias I and II, the Vulcanus was big enough to operate worldwide. Twin diesels gave her cruising speeds up to 13 knots and she met the requirements of the Intergovernmental Maritime Consultative Organization (IMCO) and the U.S. Coast Guard for transport of dangerous cargo by tanker.

Operated by Ocean Combustion Service, the Vulcanus had many safety features, including a double hull with 15 tanks inside the inner hull to carry the waste liquid. During normal operation the tanks could be discharged only through the incinerator feed system.

The Vulcanus had been incinerating wastes from European countries since 1972 and had acquired considerable operating experience. In late 1974 EPA issued a research permit for incineration at sea of 4,200 metric tons of organochlorine wastes from the Shell Chemical Company's plant at Deer Park, Tex. The wastes had been generated during the plant's production of vinyl chloride and other industrial products.

The burn, conducted in the Gulf of Mexico about 150 miles from land, was monitored by two research vessels for possible pollution of surrounding monitored waters and also by a specially equipped EPA aircraft to measure air emissions downwind.

EPA granted permission for incineration of another shipload a month later with some corrections in monitoring, and in December issued a third permit for incinerating another 8,400 tons of wastes.

Based on these tests, the Agency determined that the process did not result in any significant adverse impact on the environment, although some modifications in the ship and its operations were required. Measurements of emissions from the incinerator stacks showed that more than 99.9 percent of the wastes had been oxidized, that is, destroyed, by the intense heat.

Observers found no measurable increases in concentrations of trace metals or organochlorides in the surrounding sea or in marine life, and no adverse effects on migratory birds.

EPA determined that at-sea incineration was a viable alternative to other means of disposal. When it was found that the disposal of contaminated charcoal canisters was not possible, the go-ahead was given for using at-sea incineration to destroy the Air Force stocks of the Herbicide Orange. Two-thirds of the Air Force stockpile was stored at Johnston Island, a lonely and remote speck in the Pacific some 850 miles southwest of Hawaii. The other third arrived there on the Vulcanus July 11 last year from storage in Mississippi.

One of the most important features of the ship was the very high temperatures that could be generated in the incinerators. The U.S. permit for destruction of Herbicide Orange called for a minimum operating temperature of 1,250 degrees Celsius (about 2,280 degrees Fahrenheit). But as matters turned out, the temperature during the burn actually approached 1,500 Celsius (2,732 Fahrenheit), hot enough to melt steel, and more important, also hot enough to destroy the toxic materials. In fact Herbicide Orange burned so well that operators had to throttle back on the flow to keep the heat from destroying the furnace.

Along with the cargo, the ship carried a special portable laboratory on her deck just forward of the bridge where specialists could study samples and monitor instruments. Elaborate precautions were taken to assure the safety of the crew as well as of the surrounding environment. In addition to normal equipment, for example, all personnel within the incinerator area had gas masks available for instant use and those exposed to high temperatures wore fire-fighter entry suits. Pesticide gas respirators, portable monitors, Scott air packs and even portable emergency eye baths were on hand. No workers were allowed to enter the incinerator area without wearing disposable protective clothing, and upon leaving they had to throw the clothing into a barrel, take a shower, and don fresh coveralls. Contents of the barrel were routinely incinerated.

Fortunately, emergency equipment was never needed. In three separate burns about 1,000 miles southwest of Hawaii in July and August last year, the Air Force supplies of Herbicide Orange were carefully incinerated without mishap.

Instruments measured combustion effluent, and the crew took wipe samples of selected areas on the ship to confirm that no traces of the herbicides found their way into living areas. In a mop-up operation, each of the tanks that had stored the herbicide was rinsed with diesel oil which was then incinerated.

In its official report to EPA on the operation, TRW, Inc., which performed monitoring, sampling and analysis to assure compliance with the EPA permit, declared, "Destruction and combustion efficiencies measured during the Research and Special Permit burns met or exceeded requirements. All other conditions of the permits related to at-sea incineration operations were met, including adherence to a comprehensive safety plan."

The significance of the Johnston Island project, however, extended far beyond destruction of the 10,400 metric tons of Herbicide Orange. According to Lehman, some 30 to 40 million metric tons of toxic waste are produced annually in the United States, and the volume is steadily increasing.

At the same time, disposal has become more difficult because of increasingly stringent controls in the new Resource Conservation and Recovery Act to protect the environment.

Long-term storage of these wastes in above-ground tanks is unsatisfactory in many cases because of the potential for leaks, accidental ignition, and spills from natural disasters such as earthquakes.

So the at-sea incineration offers another approach to disposal of these potentially dangerous by-products. Although only about half of the annual output of hazardous waste is organic and amenable to incineration, the experiments demonstrate that under appropriate safeguards, at-sea incineration can be managed safely. As an indication of growing interest by both government and industry in this relatively new procedure, the U.S. Maritime Administration has commissioned a cost study by Global Marine, (builders of the Glomar Explorer), of ship conversion for future incinerator vessels. It is believed there are enough wastes to support the operation of four such ships under the U.S. flag. If true, then an infant industry in safe, seaborne waste disposal appears to be in the making. □