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25. *Economic Report of the President, 1971* (Government Printing Office, Washington, D.C., 1971), p. 118.
26. Such a system, or variants of it, are in use in Otsego, Mich.; Springfield, Mo.; the state of Vermont; and the Ruhr Valley in West Germany (*27*, p. 187).
27. U.S. Senate Committee on Public Works, *Water Pollution Hearings* (Government Printing Office, Washington, D.C., 1970), part 1.
28. See, for example, H. C. Wallich, *Fortune* (October 1972), p. 114. For an illuminating debate on the subject of effluent charges for water pollution, see *Congr. Rec.* (2 November 1971), p. S17425; also (*27*, pp. 187–200; 346–365).
29. For example, G. Myrdal, *Challenge of World Poverty: A World Anti-Poverty Program in Outline* (Pantheon, New York, 1970).
30. There is obviously room for debate on what constitutes a country's "proportionate share" of critical world resources. If population size were to be the criterion, it is possible that some other distribution of population by nation than the current one would be used by the international administering body in apportioning resources.
31. For accounts of difficulties with past foreign aid programs, see I. Illich, *Celebration of Awareness: A Call for Institutional Revolution* (Doubleday, Garden City, N.Y., 1970); M. T. Farvar and J. P. Milton, Eds., *The Careless Technology—Ecology and International Development* (Natural History Press, New York, 1972).
32. See L. K. Caldwell, *In Defense of Earth—International Protection of the Biosphere* (Indiana Univ. Press, Bloomington, 1972) and the resolutions of the United Nations Conference on the Human Environment, Stockholm, 1972.
33. We acknowledge the inspiration for ideas in this article provided by discussions with the late Joseph F. Hodgson, and with D. Ritchey and D. Kass of Cornell University. We are grateful to A. Costin, P. Ellyard, J. T. O. Kirk, M. M. Scurrah, M. R. Scurrah, G. Smith, and J. Zwar for their comments on drafts of this article.

NEWS AND COMMENT

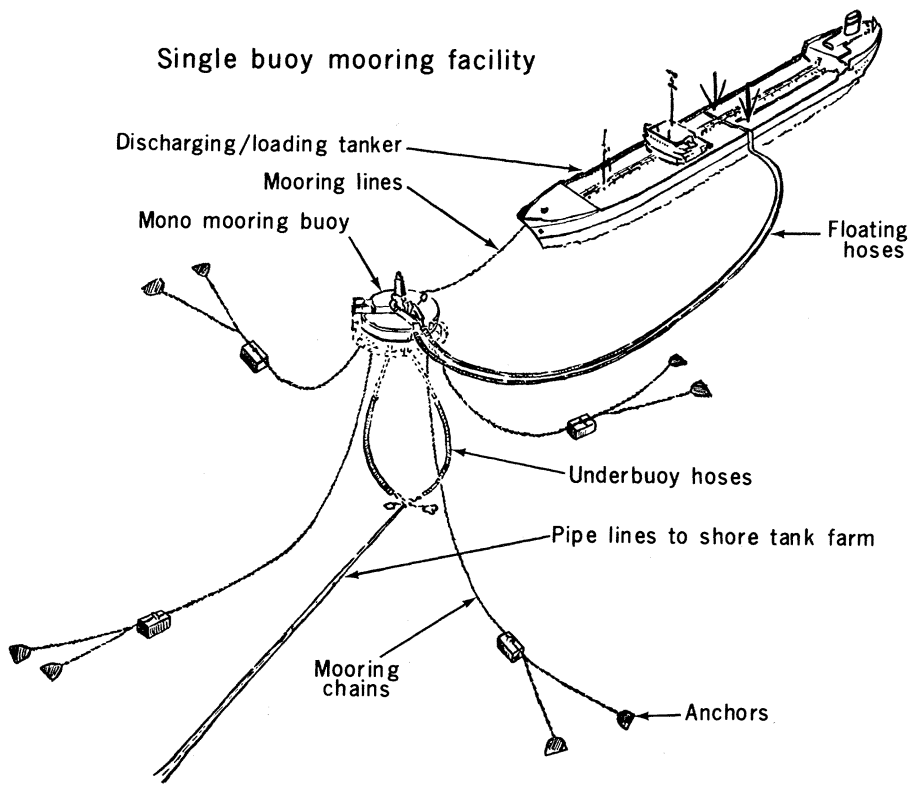
Deepwater Ports: Issue Mixes Supertankers, Land Policy

Sometime between now and 1980 two or more deepwater terminals for the delivery of foreign crude oil by supertanker probably will be established in the offshore waters of the United States. No such terminal now exists, and, given the present shortage of refinery capacity in the United States, a huge increase in the importation of foreign crude could not presently be accommodated. Thus, the federal government and the coastal states have time to develop a policy for the siting of deepwater terminals which takes account of how such terminals and massive oil deliveries may effect environmental quality in the coastal zone, offshore and onshore, and influence the growth and location of refineries and petrochemical complexes nationally. The environmental as well as economic implications of deepwater terminals may be surprisingly favorable—or, in the absence of proper policies, disastrously unfavorable.

That it should now be widely accepted as virtually inevitable that deepwater terminals for oil deliveries will be built is attributable to four things:

- First, there is the fact that, by 1980, U.S. consumption of petroleum products is expected to have increased from the total of 16.4 million barrels a day consumed in 1972 to about 22.8 million barrels a day, with the proportion imported increasing from 29 percent (the 1972 figure) to as much as 48 percent. No matter how vigorously the development of such domestic sources of energy as coal (with gasification) and shale oil is pursued, the United States will be relying heavily on foreign oil at least through the 1980's. This undoubtedly will be true even if the nation adopts significant energy conservation policies, such as discouraging the use of heavy, high-gas consumption automobiles.
- Second, most of the 11 million barrels a day to be imported (some in refined products but the great bulk in crude oil) will come from the Persian Gulf, with each tanker delivery involving a round trip of about 24,000 miles. Given the great distance, enormous savings in transport costs are possible from the use of supertankers. Oil is shipped to East and Gulf Coast ports from the Persian Gulf at about $13 a ton in a conventional tanker of 47,000 DWT (deadweight tons). By contrast, the freight cost per ton drops to $5.70 when a 250,000-DWT tanker is used.
- Third, supertankers already comprise an important part of the world's tanker fleet. The conventional tanker of World War II was the "T-2," a 16,700-DWT ship with a draft of 30 feet and a length of about 500 feet. Even today, most of the several thousand tankers still in service around the world are ships of between 10,000 and 60,000 DWT, with the great majority at the lower end of this scale. But such ships are yielding rapidly to the supertanker in the long-haul transport of crude. The supertanker is most commonly a vessel of between 200,000 and 300,000 DWT, with a draft of 55 to 80 feet and a length of more than 1100 feet. There are now at least 228 tankers of 200,000 DWT or larger; by the mid-1970's, the number of ships of this size will exceed 800. For the United States, the only real choice is whether the supertankers will bring the crude directly to U.S. terminals or whether they will deliver it to terminals in the Bahamas, the Caribbean, and Canada, for subsequent shipment by smaller tanker to U.S. ports in the form of crude and refinery products.
- Fourth, it is neither economically feasible nor environmentally acceptable to dredge out existing ports and approach channels to the depths necessary to accommodate deep-draft supertankers. U.S. ports now generally have channel and berthing depths of between 35 and 45 feet. Even a medium-sized tanker (100,000 DWT) will draw almost 50 feet fully loaded. If the Delaware River ship channel were to be deepened by only another 10 feet from its present 40-foot depth, the cost would exceed three quarters of a billion dollars, and some 330 million cubic yards of material would have to be excavated and somehow disposed of.

In view of the cost of the alternatives, the building of terminals offshore in naturally deep water can be very much a bargain, even though these facilities do not come cheap. There are widely varying concepts of deepwater terminals, ranging from the elaborate (and probably economically infeasible) notion of building an artificial island and breakwater to the relatively simple concept of the single point mooring (SPM) system. The SPM is the kind of terminal receiving most of the at-



tention, and, if one or more terminals are built in the years immediately ahead, they are likely to be of this type.

The SPM system consists of essentially four components: (i) a buoy to which the tanker is moored, and around which the ship is free to rotate in a 360° arc, like a weather-vane, always heading into the prevailing wind and sea; (ii) a flexible hose (brought to the tanker by launch) through which the oil is transferred from the ship to a large-diameter pipeline buried in the seabed; (iii) the pipeline, whch extends to a tank farm ashore; (iv) a pumping station and crew quarters, to be mounted on platforms perhaps a mile or so away from the mooring buoy.

The SPM concept has been widely applied around the world, with more than 100 SPM facilities having been built since the late 1950's, more than half of them in the Persian Gulf and the Far East. The proposed Louisiana Offshore Oil Port (LOOP), with five SPM buoys, two pumping platforms, a crew-quarters platform, and five pipelines (48 inches in diameter) each 21 miles long, would cost an estimated $180 million, substantially less than the $260 million investment necessary for the terminal's storage tank farm onshore. Situated in water of 100 to 120 feet deep, the terminal would accommodate tankers of the very largest size. It would be able to receive up to 4 million barrels of crude a day.

A deepwater terminal of the SPM type can offer environmental as well as economic advantages over alternative systems for the delivery of imported oil. Here, a few statistics with respect to maritime casualties should be kept in mind. Reports of the U.S. Coast Guard on maritime accidents occurring in U.S. domestic waters or involving U.S. flag vessels operating beyond those waters show that, for the 6-year period 1967–1972, there were (on the average) nearly 4000 vessels involved in accidents each year. In 1972, 2500 collisions between vessels occurred during ship passage, in fog, or under other circumstances. During this same year, almost 450 vessels ran aground.

That there should be such a disturbingly high incidence of maritime accidents in U.S. and foreign waters is not surprising. The world's merchant fleet, consisting of some 57,000 vessels, is immense, and many harbors and their approaches are highly congested. Better than three quarters of all accidents occur in such congested waters, so it follows that any development reducing that congestion or keeping it from growing worse will make for fewer maritime casualties.

Consider the following simplified case: Should U.S. demand for imported oil reach 15 million barrels per day by 1985, some 2700 tankers would be required to make the necessary deliveries if all those tankers were of the 50,000 DWT class. If, on the other hand, the tankers were all of the 250,000 DWT class, only 500 would be required. Furthermore, these larger tankers would be calling not at congested ports but rather at a few offshore terminals well removed from heavy maritime traffic and reserved exclusively for supertankers.

Also, the use of supertankers and offshore terminals reduces not only the incidence of accidents but also the incidence of routine oil spills occurring during normal tanker operations (as in the transfer of oil from a tanker to a shore terminal). The Council on Environmental Quality has concluded that the foregoing advantages outweigh any disadvantages posed by supertankers and offshore terminals.

Nevertheless, there are some major environmental problems and policy questions to be considered in connection with these terminals and the giant ships they will serve. Such problems fall into two broad categories: those associated peculiarly with the supertanker and those endemic to any massive increase in the importation of foreign oil, whatever the mode of delivery.

• *Problems peculiar to the supertanker.* Quite obviously, the larger the tanker is, the more disastrous the oil spill can be if the ship gets in trouble. (The wreck of the *Torrey Canyon* on Seven Stones Reef, near Cornwall, England, in 1967 was the first major incident to dramatize this—and the *Torrey Canyon*, at 120,000 DWT, was small by comparison with today's supertanker.) Furthermore, because of its great size, the supertanker is notoriously poor in maneuverability and in its ability to respond to unanticipated hazards. A fully loaded tanker of 300,000 DWT cruising at its top speed of 15 knots requires about 2½ miles in which to come to a stop. Even at almost imperceptibly slow speeds a vessel of this size moves with such momentum that, upon striking a fixed object, its hull will rupture.

Under the Ports and Waterways Safety Act of 1972, the Coast Guard has the responsibility of establishing both minimum design standards and appropriate traffic rules and schedules for U.S. and foreign flag vessels calling at U.S. ports and terminals. The regulation of ship movements should not give rise to much controversy, but there is every possibility that decisions by the Coast Guard to impose costly ship design requirements would be resisted.

Very much in point is whether new supertankers should be built with double bottoms, at a cost 10 percent or so greater than that of a tanker built with a single bottom (with oil cargoes loaded "to the skin"). For the United States unilaterally to demand such a structural feature for foreign as well as U.S. tankers is a delicate matter, especially since there is some question whether under international law the United States has the right to establish or license offshore terminals beyond its 3-mile territorial limits. The Coast Guard's attitude about imposing such requirements is decidedly cautious. Yet a double bottom could prevent a calamitous spill in the event of a grounding, both by preventing the rupture of the inner bottom containing the oil and by making the ship less susceptible to breaking up.

- *The "landside" problems associated with (though not unique to) large-scale delivery of oil by supertankers and offshore terminals.* When 2 million barrels or more of crude per day start flowing from an offshore terminal, this may precipitate a major growth of refineries and petrochemical works immediately onshore. If a concentration of such industries already exists in the onshore area, the new industrial growth could put the local environment under intolerable stress. Any major refinery-petrochemical complex causes air and water pollution, and, in addition, requires thousands of acres of land.

For instance, if a deepwater terminal were built off the mid-Atlantic coast, the landside impact could be enormous. Any traveler taking the New Jersey Turnpike from Wilmington, Delaware, to New York can see what a blighting effect refineries and petrochemical plants already have had on part of this region. Yet the huge mid-Atlantic market for petroleum products is supplied mostly by refineries elsewhere in the United States, for the output of refineries in Delaware and New Jersey is not nearly sufficient to meet the demand. All that it might take to induce the oil companies to expand refinery capacity up to the limit of regional demand would be the establishment of an offshore terminal for supertankers, as has indeed been proposed.

The U.S. Army Corps of Engineers, in its recent study of where deepwater terminals might be located, identified one mid-Atlantic coast site 13 miles off northern New Jersey and another in the Delaware Bay, 6½ miles off Big Stone Beach. The latter site is one where the Delaware Bay Transportation Company, a consortium formed by Shell and several other oil companies, would be building a terminal even now if its plans had not been flatly opposed by the state of Delaware.

In adopting its Coastal Zone Act of 1971, the Delaware Legislature established a permit system to control industrial growth in the state's coastal areas, then went beyond this by forbidding outright any new heavy industry in this area and any offshore terminals for oil or other bulk commodities. The philosophy underlying the act is that Delaware wants to strike a balance between allowing heavy industrial development in the Wilmington area and keeping the rest of Delaware free from industrial blight and attractive for tourism and public recreation.

Briefing

AEC Begins Shaping Federal Energy Policy

In keeping with President Nixon's latest dictum on the nation's energy problems (*Science*, 13 July), the Atomic Energy Commission is rapidly assuming a new role in the shaping of federal energy policy that extends far beyond th AEC's traditional ken. As evidence of the agency's lengthening reach, the White House has assigned AEC commissioner William O. Doub to conduct a sweeping diagnosis of infirmities in the federal government's tangled regulatory mechanisms for energy. An unusual assignment for an AEC commissioner, the study is expected to be finished by February and may recommend yet another reorganization of the federal bureaucracy.

At the same time, the White House has handed AEC chairman Dixy Lee Ray the responsibility for suggesting how best to spend an extra $100 million on energy R & D in the current year, and has asked the AEC to come up with a comprehensive national energy R & D plan for inclusion in the fiscal 1975 budget.

With the concurrence of the White House, Ray has picked Alvin M. Weinberg—now on leave from Oak Ridge National Laboratory, where he has served as director since 1955—to direct the drafting of this plan. This process is bound to be watched closely not only by researchers on the prowl for funds, but also by environmentalists and commercial interests. Its objective is nothing less than to set relative priorities for research into coal, nuclear, and geothermal energy; if the plan is heeded by federal budget-makers, it will influence the evolution of the nation's energy system for at least the next 10 to 20 years.

Although Weinberg's appointment as a "special consultant" for R & D has not yet been formally announced, he has already moved into an AEC office in Washington and has plunged into a round of preliminary meetings with, among others, H. Guyford Stever and other top officials of the National Science Foundation. As administrator of the NSF, Stever is now, ostensibly, the President's science adviser. But the extent of his supervision over the AEC's broad new research planning activities—particularly if they are to be directed by a luminary of Weinberg's independent bent—remains unclear. In any case, the NSF moved late in August to assert its territoriality in the field of R & D planning, setting up a new Office of Energy Policy.

The AEC's companion project, Doub's survey of regulatory affairs, promises to be unusual in several respects. In contrast to the secretiveness of the Administration's first major analysis of the executive branch (performed by the so-called Ash commission, headed by Roy L. Ash, now director of the White House Office of Management and Budget), Congress has been advised that both it and federal agencies will be fully consulted and that views of the public will be solicited.

In a news conference, Doub said that one of the operating assumptions behind the study was that Congress would approve the President's current proposal to reshuffle the energy establishment, although the study might reveal the need for still further reshuffling that may or may not require congressional consent. Doub repeatedly promised that the diagnosis would remain independent of agency biases, including the AEC's.—A.L.H. and R.G.

New Jersey is taking a similar attitude. Senator Harrison Williams (D–N.J.), testifying at recent hearings on deepwater terminals, observed that New Jersey already is the nation's most densely populated state and has much of America's chemical and petrochemical industry. Yet, at the same time, New Jersey is a major tourist state, with some 500,000 people a day using its beaches at the peak of the summer season. The new refineries and chemical works that would accompany an offshore terminal is "something that the people of [New Jersey] would not appreciate and would know they could not tolerate," Williams said.

In theory, New Jersey and Delaware could accept the offshore terminal but, by restricting growth of refinery capacity, force the oil companies to pipe all or most of the crude on to refineries in other states. The state officials shrewdly recognize, however, that construction of the terminals might be followed by persistent efforts on the part of the oil and chemical industries to overturn that restrictive policy.

All coastal states clearly do not regard offshore oil terminals and more refineries and chemical works as a dreary prospect. Indeed, all of the Gulf states except Florida (where tourism is king) very much want to have such terminals and the industrial growth they can bring. Louisiana and Texas are actively pushing the industry-sponsored LOOP and Seadock proposals, and Mississippi and Alabama are promoting the idea of an Ameraport terminal sponsored by the states themselves. In the case of each of these proposed Gulf terminals, the expectation is that part of the crude oil received would be processed at local refineries and part would go through existing pipeline systems to refineries in other regions, especially the Midwest.

Flexible as it is in application, the offshore terminal of the SPM type can be used for either the dispersion or the concentration of refinery capacity. How, then, to place these facilities in such a way, and under such conditions, that they will bring growth only to those places where the people want it and where it can be assimilated without intolerable stress? From the extensive discussion of this question before congressional committees, a few observations can be ventured.

The solution is not to be found in simply having the federal government let the coastal states decide whether they want a terminal or not. In the first place, few such facilities are needed. In the second place, a state such as Alabama or Mississippi where the environmentalists are weak and the powers-that-be are industry-hungry, might rush ahead with plans for terminal development and pay only lip service to the environment. By the same token, one can argue that, under some circumstances, the national interest would be poorly served by allowing a state to veto plans for a terminal.

The best solution seems to lie in making the licensing of offshore terminals and related onshore facilities (tank farms and pipeline) clearly a federal responsibility, subject however to certain major conditions. A prime prerequisite would be that no terminal will be licensed until a coastal zone management plan is prepared by the affected states according to guidelines ensuring that industrial growth does not flout environmental quality standards or result in major losses of wetlands or other natural resources.

Under the Coastal Zone Management Act of 1972, the states are responsible for preparing such coastal zone plans, with the only penalty for nonparticipation or inadequate performance being the denial of coastal management grants. There is strong sentiment among some senators now considering legislation pertaining to offshore terminals that the licensing of such facilities must be closely tied to land use regulation in the coastal zone.

Inasmuch as hearings already have been held this year in both the House and Senate on bills looking to a "Deepwater Port Facilities Act," Congress could enact legislation in this field by sometime early next year. At this point, it is much too early to predict what that legislation will prescribe. What can be said is that, on the offshore terminals issue, Congress has the time and the information (several useful government studies and impact statements have been done) to follow the dictates of its own National Environmental Policy Act and adopt a policy that makes both economic and environmental sense.—LUTHER J. CARTER

Biomedical Research 1973: Cancer, Heart Disease, and Everything Else

Since the winter of 1971, the Congress and the President of the United States have officially declared war on two of the nation's most devastating killer diseases. In so doing, they have divided the biomedical world into three unequal parts. First, there is cancer. Heart disease is second. Then comes "everything else." Very few people are content with this state of affairs.

From the outset, investigators whose research falls into the category of "everything else" have been distressed by the favoritism that cancer and heart research are getting, as they see it, at their expense. And they have quietly and persistently said so.

After the National Cancer Act of 1971 and the National Heart, Blood Vessel, Lung, and Blood Act of 1972 became law, with their provisions for significant increases in funds for the National Cancer Institute (NCI) and the National Heart and Lung Institute (NHLI), the rest of the National Institutes of Health (NIH) slipped from view. For the last year and a half, attention has focused on the cancer and heart institutes as each geared up to launch its special crusade. A major feature of that gearing up has been the creation of detailed plans to spell out just how the wars on cancer and heart disease will be fought. The plans took ages to prepare and months to work their way through the bureaucracy before they could be released. Finally, the heart plan is out. And, the first parts of the cancer plan, which will not be complete before January, have been made public. In each case, the plans anticipate funding levels that are higher than the Administration is willing to spend. In making them public, Administration officials made it clear that even these