CENTER FOR INTERNATIONAL STUDIES
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

# SUMMARY REPORT:
# FUEL DISTRIBUTION TECHNOLOGY POLICY
## A Study of the development and Use of Artificial Offshore Islands in Japan

by

Ernst G. Frankel

A WORKING PAPER
From
THE CENTER FOR INTERNATIONAL STUDIES
Myron Weiner, Director

MIT E38-648
292 Main Street, Cambridge, Massachusetts 02139

# SUMMARY REPORT:
# FUEL DISTRIBUTION TECHNOLOGY POLICY
## A Study of the development and Use of Artificial Offshore Islands in Japan

by

Ernst G. Frankel

Professor of Ocean Systems
Department of Ocean Engineering

to

Center for International Studies
Massachusetts Institute of Technology

April 1989

This work was supported by the Japanese Ministry of Foreign Affairs through their gift to the Center for International Studies.

Overview

In the last twenty years Japan has led the world in the development of artificial reclaimed offshore islands for a multiplicity of uses. By 1988 more than 22 major offshore islands had been established in sizes varying from a few to several hundred hectares. Although these offshore islands were primarily developed for transportation-related uses, industrial, solid waste disposal, energy storage and generation as well as recreational activities are increasingly being located on these facilities.

In recent years there has been a distinct change from Jyu-Kou-Chou-Dai (heavy, thick, long, and big) to Kei-Sho-Tan-Paku (light, small, short, and thin) in Japanese industry. The mature smoke-stack industries such as steel, cement, and shipbuilding are on the decline which has had an effect on bulk material demand and therefore bulk commodity distribution systems requirements. This has resulted in the delay or cancellation of several projects in which artificial islands were to be used as major storage and distribution centers. Some efforts are underway to rationalize, relocate, and modernize existing bulk commodity and in particular energy distribution systems. Regional distribution centers for LNG/LPG, animal feed, grain, cement, construction material, and most importantly fuel are still under development.

Cargill is currently negotiating construction of an artificial island based animal feed distribution center at Shibashi (Kayoshima Prefecture), Kyushi Island. Most island

based distribution centers are now designed to serve energy, high tech, information and basic consumable supply requirements.

In recent years artificial offshore islands were proposed for development as central coal, oil, and gas storage and fuel distribution centers, so as to provide for safe deep water approach, environmentally acceptable storage, and efficient fuel distribution, and delivery of fuels.

This report presents the findings of an investigation into the development and use of artificial offshore islands in Japan, and their use as fuel distribution centers.

## General

Japan has the world's largest nationally owned and registered merchant fleet. Its ports handled 2.91 billion tons of cargo in 1980 and 2.86 billion tons in 1984, while the total cargo handled in 1987 was expected to be nearly 3 billion tons. Of the estimated 8.9 million ships entering Japanese ports in 1986, about 88,000 were ocean-going vessels engaged in foreign trade. Japan's foreign trade of 840 million tons in 1986 is nearly equal to that of the United States (920 million tons) for the same year. Japan's 1986 foreign trade was nearly 10 percent of world trade by volume and 14.2 percent of value.

Japan is an island economy consisting of four major and several hundred minor islands with a total area of 145,856 square miles, just slightly smaller than the State of California. Its economy, as measured by the Gross Domestic Product (GDP), has been growing at a phenomenal annual average rate of 13.3 percent

during the period 1976 through 1986. This is equivalent to an overall increase of about 3 1/2 times, from $561 billion in 1976 to $1,958 billion in 1986.

Several government agencies are responsible for the Japanese offshore developments. The Ministry of Trade and Industry coordinates shipbuilding as well as general trade policy. The Ministry of Transport (MOT) has responsibility for shipping and major ports in terms of planning, government assistance, and, to a certain degree, regulation (safety and service). MITI (Ministry of Industry) guides industrial development and policy.

The MOT has a Ports and Harbor Bureau which performs planning and engineering of ports, navigational channels, and coastal improvements. While the national government is not directly involved in ownership or operation of ports, it does assist to some degree with the financing of port improvements, and particularly with the design, construction, and financing of navigational channels.

According to the Ports and Harbors law, development and management of ports and harbors is the responsibility of port bodies established by local authorities. The law also provides for assistance by the national government in port and harbor construction work by the provision of subsidies or partial financing. The national government retains the responsibility for reviewing all port and harbor expansion or improvement plans. Most major as well as local ports are managed by prefectures with the remainder under agencies of municipalities. Of the 1,094 total ports, only one port is managed by a port authority, and

five by cooperative administrative bodies (Table 1).

The role of the national government and port management body in port development and improvement is shown in Figure 1.

Japan's Ports

Japan has 1,094 ports and harbors, of which 19 are specially designated major ports which handle most of Japan's foreign trade. Its ports handle nearly as much international cargo as all the United States ports, while at the same time Japan's ports handle more total cargo than ports of any other nation in the world (nearly 3 billion tons in 1986). Japan's ports have over 286,000 meters of berths with alongside depths of more than 12 meters. This is about twice the U.S. deep draft berth capacity.

Four of Japan's ports (Kobe, Chiba, Yokohama, and Nagoya) have consistently been among the world's top 10 ports in terms of volume of cargo handled since 1980. Japanese ports have continued their rapid expansion, and in recent years have developed major port islands with berths for industrial and transport developments, as well as other activities, in Kobe, Yokohama, Osaka, Tokyo, and other ports. As a result, Japan's ports have not only been able to maintain their market share but also have attracted new traffic and industrial activities.

Because of scarcity of space at the already developed ports and coast of the big bays, and because of very strong demand for the land for various purposes, man-made islands have been used to expand ports and develop offshore activities.

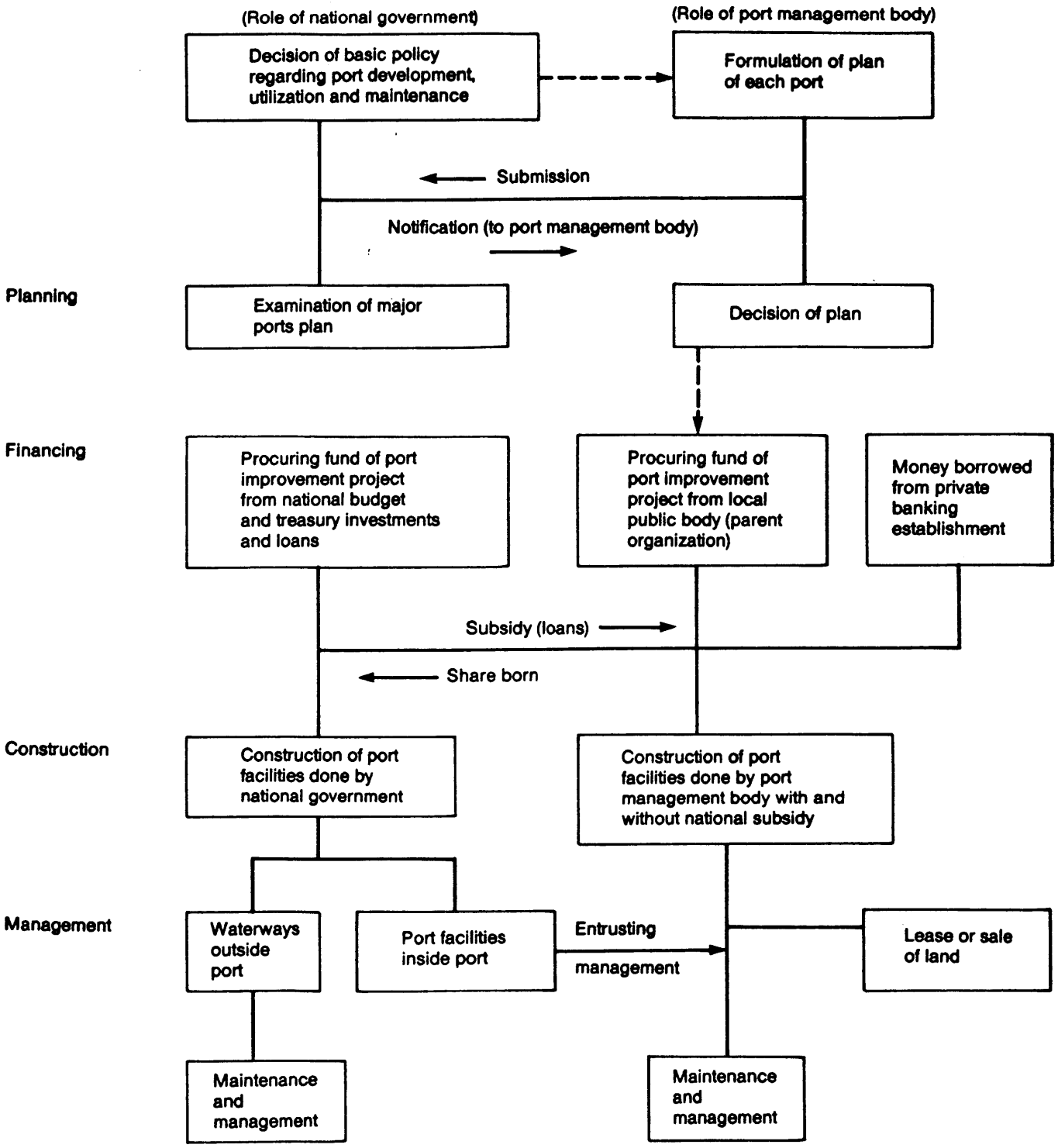
the offshore man-made islands can be defined as islands

Table 1. Management of Ports and Harbors, Japan

| Classification | Total | Prefecture | Municipality | Port Authority | Coop | Total | Others |
|---|---|---|---|---|---|---|---|
| International Port | 19 | 9 | 7 | 0 | 3 | 19 | — |
| Major Port | 114 | 91 | 20 | 1 | 2 | 114 | — |
| Local Port | 961 | 507 | 371 | 0 | 0 | 878 | 81 |
| Total | 1,094 | 606 | 398 | 1 | 5 | 1,010 | 81 |

Source: Ports and Harbors Bureau, Ministry of Transport, The Government of Japan, Ports and Harbors in Japan, 1987, p. 4.

Figure 1. **Role of National Government and Port Management Body in Port Development and Improvement**



which are detached from the shore and artificially made. The typical example in early days can be found in "Dejima", which means detached island, in Nagasaki city. Dejima was built in the harbor basin of Nagasaki port to accommodate Dutch merchant office and residence space to secure tight immigration and custom control during the Edo era. This 13,000 sq.m. island was the only gateway of Japan to the outer world at that time.

Several other islands have been built for coal mining in Kyushu area. Some of them had been developed to a town with 5,000 population but ceased operation after the mine was closed in 1974.

In recent years, with rapid growth of economy and port activities, many detached islands or man-made islands have been built in many major ports as extensions for the port facilities. Typical examples of such port facilities are Ohi terminal in the Port of Tokyo, Daikoku wharf in the port of Yokohama, Port Island in the port of Kobe, etc.

Examples of offshore man-made islands other than port facilities are Nagasaki airport and Gobo power station. The new Kansai International Airport is also planned as an artificial detached island which will have an area of 511 ha and will be built at 5 kilometers off the city of Izumisano in the Bay of Osaka.

Advantages of these offshore islands are easy to acquire, sufficient space which would otherwise be difficult in the already developed inner harbors, and eliminating or minimizing environmental influence such as noise, effect on fishing, and air

pollution.

Since demand of land along the waterfront area by many interests has become extremely strong, space for the port facilities or other purposes have to be placed at more offshore areas than ever before.

Today many studies on the offshore island are made by various sectors, including government agencies, local governments, and research institutes such as CDIT. The Ministry of Transport initiated a case study for an offshore man-made island for a coal thermal power plant from 1980 with KEIDANREN (Japan Federation of Economic Organization) and the KOZAI Club. The study is still underway with the cooperation of CDIT. Four specific sites were selected for the case studies in 1988.

Since 1975 an average of 1000 hectares (2500 acres) of land have been reclaimed annually to provide for port facilities and port related industrial activities, largely concerned with fuel storage and distribution, energy generation, or fuel refining and processing. Most of these reclamations were offshore and over 22 port/industrial islands with an area of over 7,280 ha (18,200 acres) have been developed during that period. An important purpose for these developments was the removal from inner city waterfront locations of large fuel storage facilities such as:

a. coal stockpiles at power plants, steel mills, and cement plants;
b. petroleum tank farms;
c. LNG and LPG (liquefied and pressurized gas) tank farms, gasification, and transfer facilities; and,

d. feedstock for fertilizer and petrochemical plants.

The reason for this policy included reduction of environmental impact, improved safety, relief of inner city congestion, access by deeper draft vessels, reduced storage and distribution costs, and the ability to expand facilities if and when needed.

The strategy has paid off and has resulted in major economic benefits to the ports, electric power and processing industries, as well as to the large cities affected by it which include Tokyo, Kawasaki, Yokohama, Chiba, Nagoya, Nagasaki, Osaka, and Kobe. Although Japan imports 97.2% of its requirements for steam coal, mostly from remote sources of supply such as Australia, South Africa, Canada, and the U.S., the landed cost of coal used in Japanese power plants is lower than that of comparable U.S. power plants, due to economies of scale in ocean transportation, such as the use of very large (120,000-320,000 deadweight tons) bulk carriers and efficient distribution and logistics systems. East, West, and Gulf coast U.S. power plants are usually supplied by small (20-40,000 deadweight tons) bulk carriers from coastal as well as overseas (transatlantic) sources of supply.

Similarly offshore islands serve as energy or mining bases. Such islands also provide calm, sheltered areas between them and the mainland and/or other islands. A number of different methods of construction of artificial islands are in use in Japan as shown in Figure 2.

Reclamation Type

The man-made island is constructed by reclaiming the sea

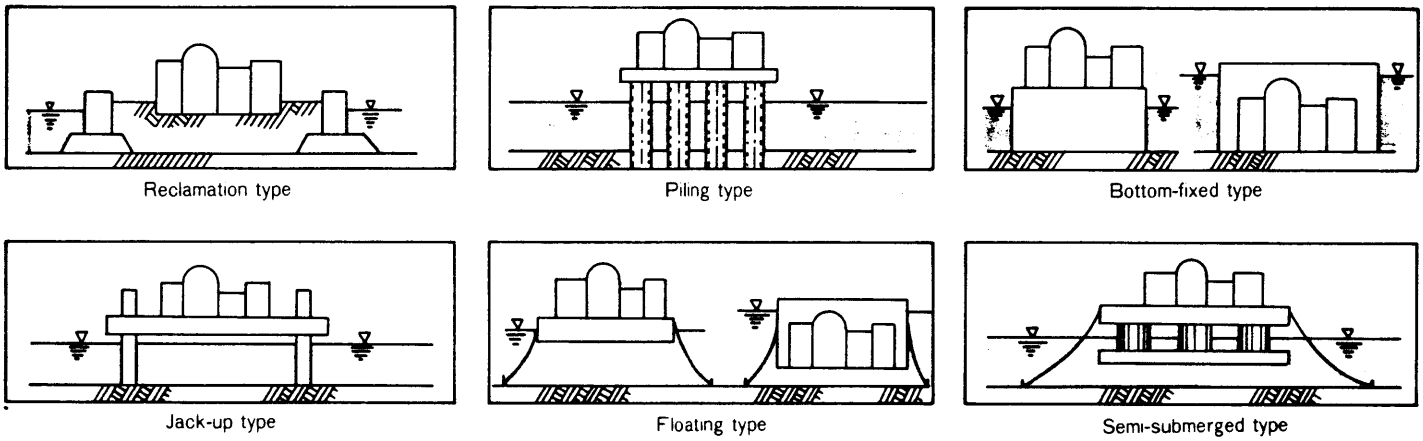



FIGURE 2

TYPES OF ARTIFICIAL ISLANDS

area enclosed by revetments using caissons, double-wall sheet piles, and other materials. An island of this type is vulnerable to earthquakes, but resists waves.

Piling Type

A platform is fitted on top of piles driven into the seabed, and structures are built on the platform. This type is comparatively less susceptible to wave action, but is affected by earthquakes.

Bottom-fixed Type

A structure built on caisson or a floating body is towed to the ocean construction site, where it is sunk and installed. This type is suitable for relatively shallow water, but seabed readjustment is required prior to installation.

Jack-up Type

A structure built on a floating body is towed to the ocean installation site, where the floating body is jacked up to the appropriate height on legs fixed to the seabed. Structural weight is restricted by leg strength and jack-up capacity.

Floating Type

A structure built on a floating body is towed to the installation site and moored there. This type is affected by pitching/rolling due to waves, but is comparatively less susceptible to earthquakes.

Semi-submersion Type

Part of floating body is submerged, so as to decrease the pitching/rolling of the body. The draft line varies greatly with the structural weight.

When building an offshore man-made island, the optimum type is selected with due consideration given to the intended use, conditions at the construction site, and similar factors. Different uses of artificial islands are diagrammatically shown in Figure 3.

Various studies have been performed for the planning and design of artificial offshore islands. The most important was the joint MOT/Keidanreu/Kozai study of offshore coal thermal power plants which concluded that in the short to medium term existing coastal coal thermal power plants were adequate, but would benefit greatly if centralized offshore coal terminal, storage, and distribution centers be established which would allow large coal ships to supply such centralized storage/distribution sites from where the coal would be distributed by fully enclosed shuttle barges which would serve as floating coal storage stacks at each power plant. As a second step, coal thermal plants were to be built on these artificial offshore islands.

The study found that the value of the stockpiling land next to each power plant, which would no longer be needed, was in excess of the cost of construction of the offshore island terminal, and that the savings in coal inventory holding costs at

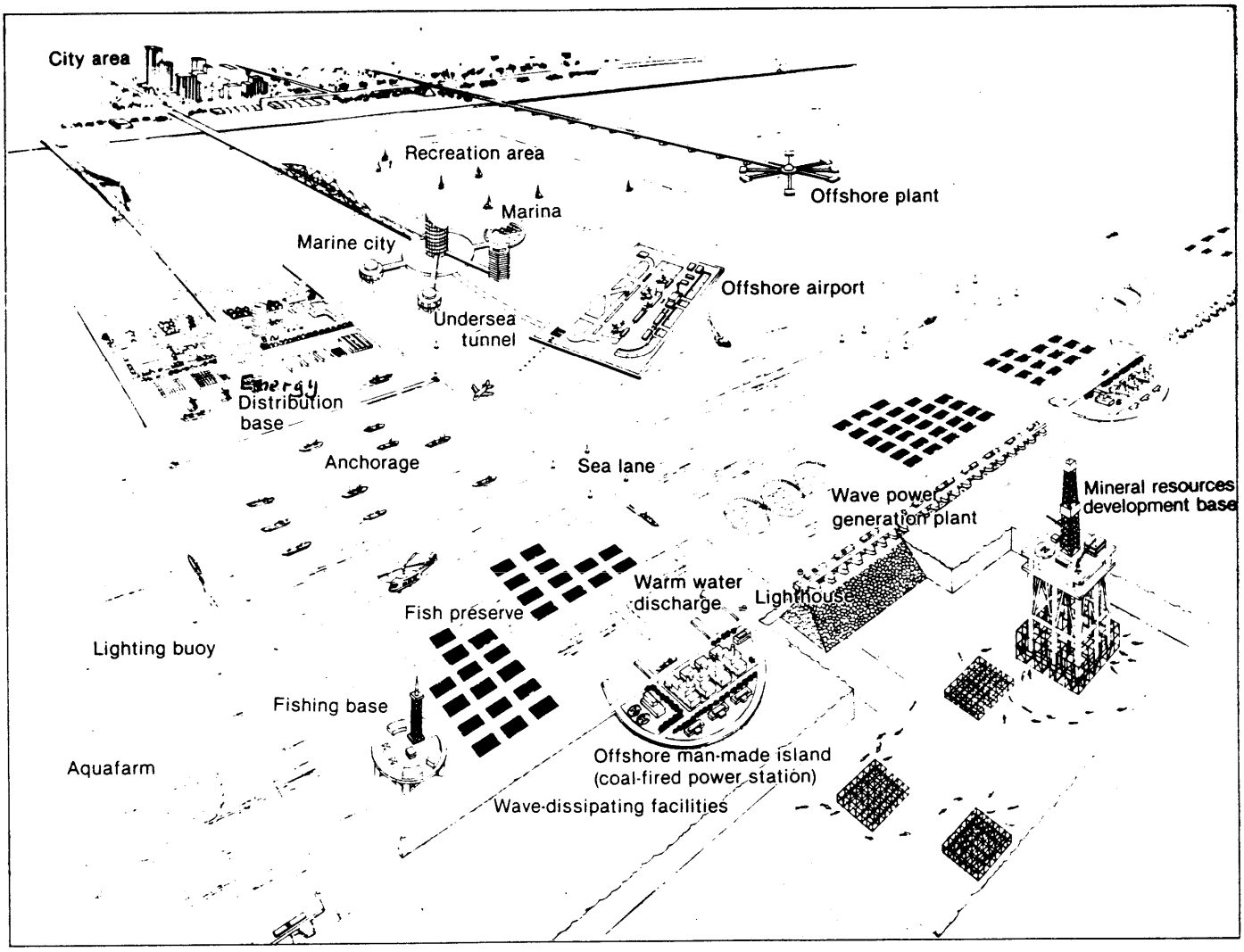



FIGURE 3

USES OF ARTIFICIAL ISLANDS

the central terminal versus the combined inventory at each power plant without the central storage depot, plus the savings in transport costs by large bulker versus the use of much smaller coal ships before, would be far in excess of the costs of the barge distribution and delivery costs. This project was implemented in the inland sea for coal distribution along its shores to 22 coal thermal power plants.

Since 1961, 4 five-year port development plans have been accepted. The current 1986-90 plan with a projected investment of Y2550 billion or about $20 billion is about 12 times the investment planned for U.S. ports during that period. The plan includes artificial offshore island construction and their use as energy bases and distribution centers.

Planning of port islands is not new in Japan and was practiced during historic times as well. The first large scale port project of recent years was the Port Island of Kobe, officially proposed to the City Assembly in 1964, constructed 1966-1980, and completed in 1981. Other large port island projects are the MM-21 project in Yokohama, the South Port Development Project of Osaka, and many others.

Fourteen new artificial offshore port projects are under construction now, most by municipal bodies. There are an additional 19 artificial island projects planned, including seven large multipurpose offshore island projects under the Ministry of Transport (MOT). These projects are 100-770 ha in size and are planned for water depths of up to 25 meters (over 82 feet) (see Appendix I).

Fuel Distribution Technology

Japan has developed significant advances in new fuel distribution technology, while at the same time adapting technology developed elsewhere. Most of these developments were undertaken by large industrial and construction firms, such as:

- Tobishima Corporation
- Mitsubichi Heavy Industries
- Mitsui Shipbuilding and Heavy Industries
- Kawasaki Shipbuilding and Heavy Industries
- Mitsui Ocean Development and Engineering Corporation
- IHI
- Kobe Steel
- Hitachi Engineering Corporation

Major emphasis was placed on the following areas of technology developments.

1. Fuel storage, stacking, reclamation, and handling or transfer technology.

2. Artificial reclaimed island technology for fuel storage and provision of deep draft terminals.

3. Floating relocatable fuel storage and terminal facilities.

4. Distribution systems technology such as submarine liquid and slurry pipelines, integrated tug barge systems, self-propelled delivery systems, inflatable storage/delivery systems, and more.

5. Fuel reception and treatment technology.

6. Fuel handling, safety, and control technology.

In addition large efforts have been expended in the development of effective fuel distribution planning, scheduling, and management systems which often include control of fuel from the origin to the final consumer.

Fuel Distribution Policy

Japan is dependent on imports for 96.8% of its fuel (which provides over 82% of its energy, including transportation) and the bulk of the petroleum inputs used by the petrochemical industry. Most of the petroleum imports come from the Persian Gulf, through an increasing percentage is now obtained from Indonesia and Malaysia, which also supply most of the natural gas used by Japan. Coal, on the other hand, is mainly imported from Australia, and to a lesser extent from China, India, South Africa, the U.S., and Canada. Over 92% of the petroleum imports and 85% of the coal imports are shipped over distances in excess of 2500 miles. Above this distance, the cost of transport by a deep draft 120,000 dwt or larger tanker/bulker is only about half that of a 30-40,000 dwt tanker/bulker as shown in Figure 4.

Since 1979, MITI and MOT have assumed a policy of moving fuel (oil, coal, gas, etc.) import, storage, and distribution terminals or facilities from inner city locations to other sites. Because of the scarcity of waterfront land (and for that matter reasonably priced and flat land), most of these relocations have used reclaimed land.

As import fuel is transported by ships and 58% of the domestic distribution of fuel is by coastal water transport (92%

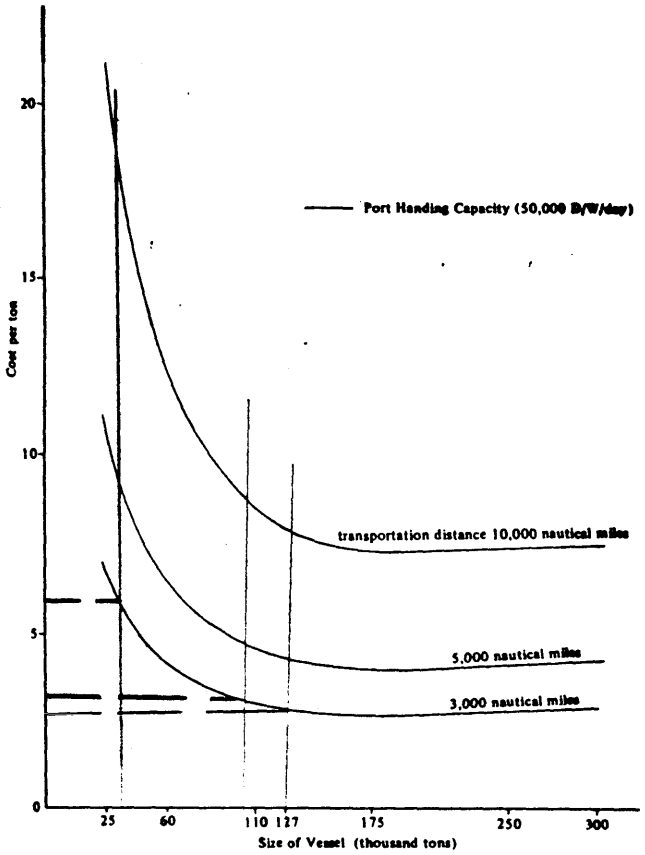



FIGURE 4

VESSEL OPERATING COSTS

of all non-transport consumers of imported fuel are located on waterfront sites), relocation of fuel storage and distribution facilities had to be to other waterfront sites. Since 1979, 3210 hectares of waterfront and offshore island land has been reclaimed for fuel storage facilities. The policy developed in 1979 was to move 50% of inner city waterfront fuel storage and distribution facilities to new, mainly offshore, sites.

For example, in Tokyo Bay (Figures 5 and 6) over 1200 hectares have been reclaimed (largely using solid waste and dredge spoils as fill) for relocation of coal, petroleum, and gas storage and distribution facilities. Major driving forces behind these national and municipal policy decisions are

1. lack of land for effective fuel storage and distribution,

2. high value of land,

3. lost real estate and business taxes to municipalities when valuable waterfront land is continued in low intensity fuel storage/distribution activities,

4. public objection to unsightly fuel storage and distribution facilities and their effect on inner city congestion,

5. environmental impact on air, water, and ground water quality, and

6. economic impact on cost of storage/distribution of fuel.

As a result, a consensus between national, prefecture, and municipal or other local agencies has been reached to move such activities out of inner city sites.

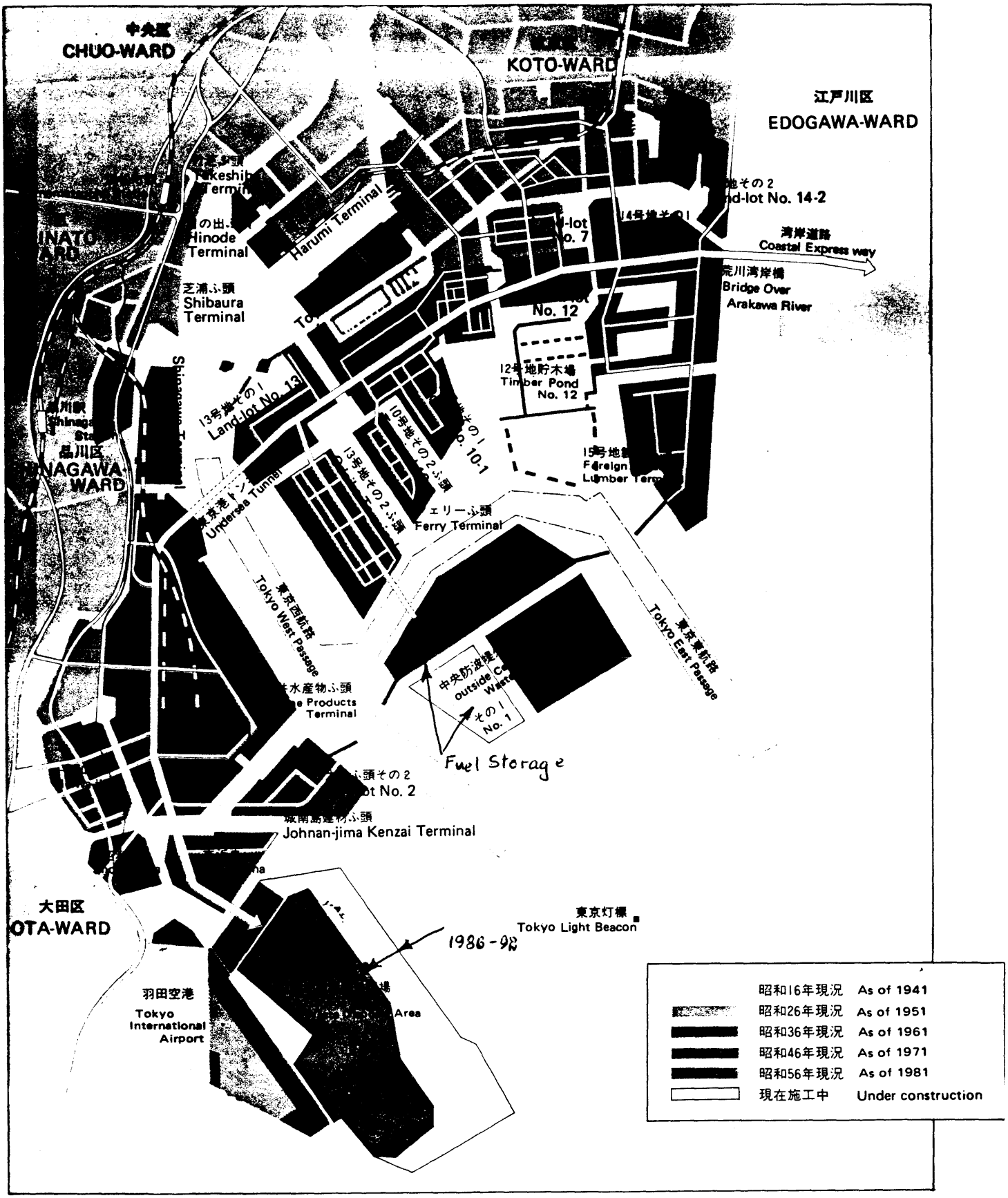



FIGURE 5 - OFFSHORE ISLAND RECLAMATION IN TOKYO BAY


FIGURE 6 - AERIAL PHOTO OF RECLAMATION IN TOKYO BAY

The policy is also consistent with Japan's acceptance of international conventions on the limitation and prevention of marine pollution and clean-up of polluted coastal waters.

Plans were also developed in 1981-85 for large centralized offshore fuel storage and distribution center islands in the Bay of Osaka (Figure 7) and the Bay of Tokyo (Figure 8). These facilities, 300-800 ha in area and partially built on solid waste disposal depositories, properly contained and covered with 8-12 m of high density hydraulic sand, were to serve as central fuel depots for power plants, petrochemical plants, industrial, and consumer (transport, domestic, etc.) fuel demand. Deep draft tanker, collier and gas carrier terminals are planned at these sites with alongside water depths of 16-26 meters, and waterborne (integrated tug-barge) feeder services formed an integral part of these plans.

While the plans are well advanced and designs are completed, implementation has been delayed because of

1. changing patterns of energy demand and fuel distribution requirements,

2. changing energy policy, particularly with regard to priority in selection of electric power technology selection for future (post year 2000) plants,

3. requirements to integrate offshore fuel distribution island development with other offshore developments such as the Tokyo-Chiba bridge-tunnel-island project.

The economics of these developments look very attractive even without considering the highly inflated value of waterfront

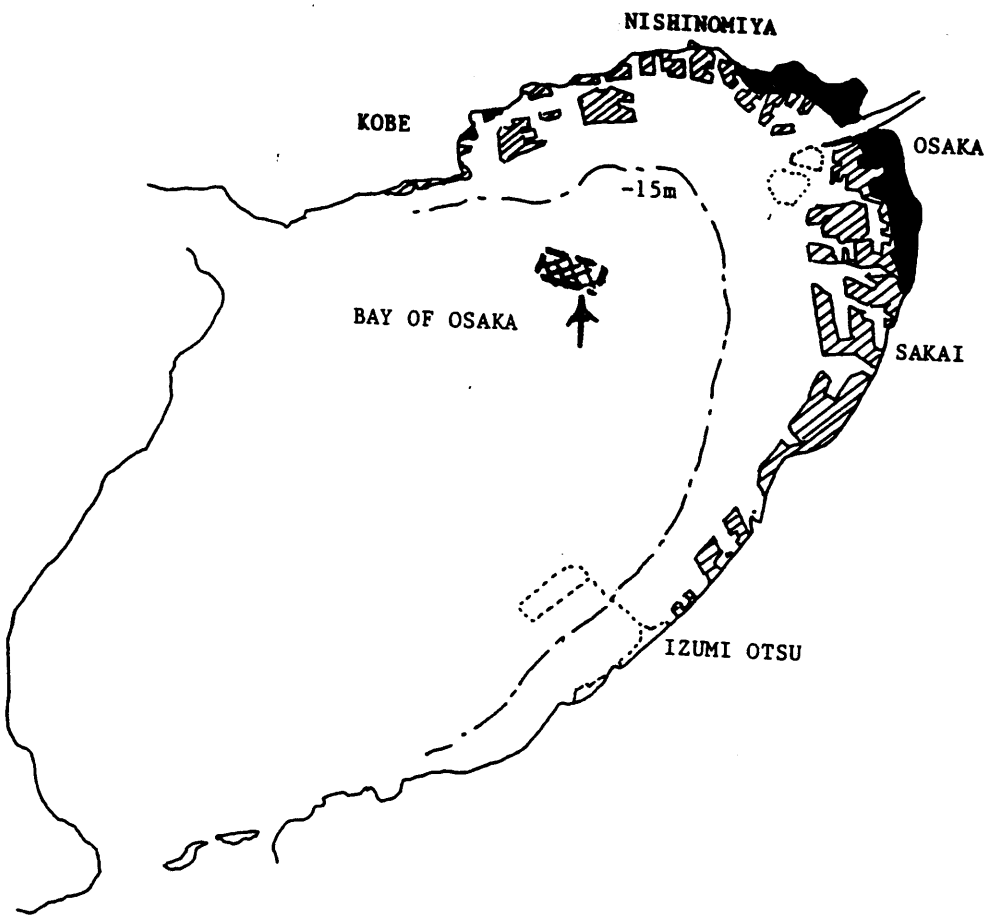



FIGURE 7 - PROPOSED SITE OF OFFSHORE FUEL DISTRIBUTION CENTER AND OTHER RECLAIMED ISLAND PROJECTS IN BAY OF OSAKA

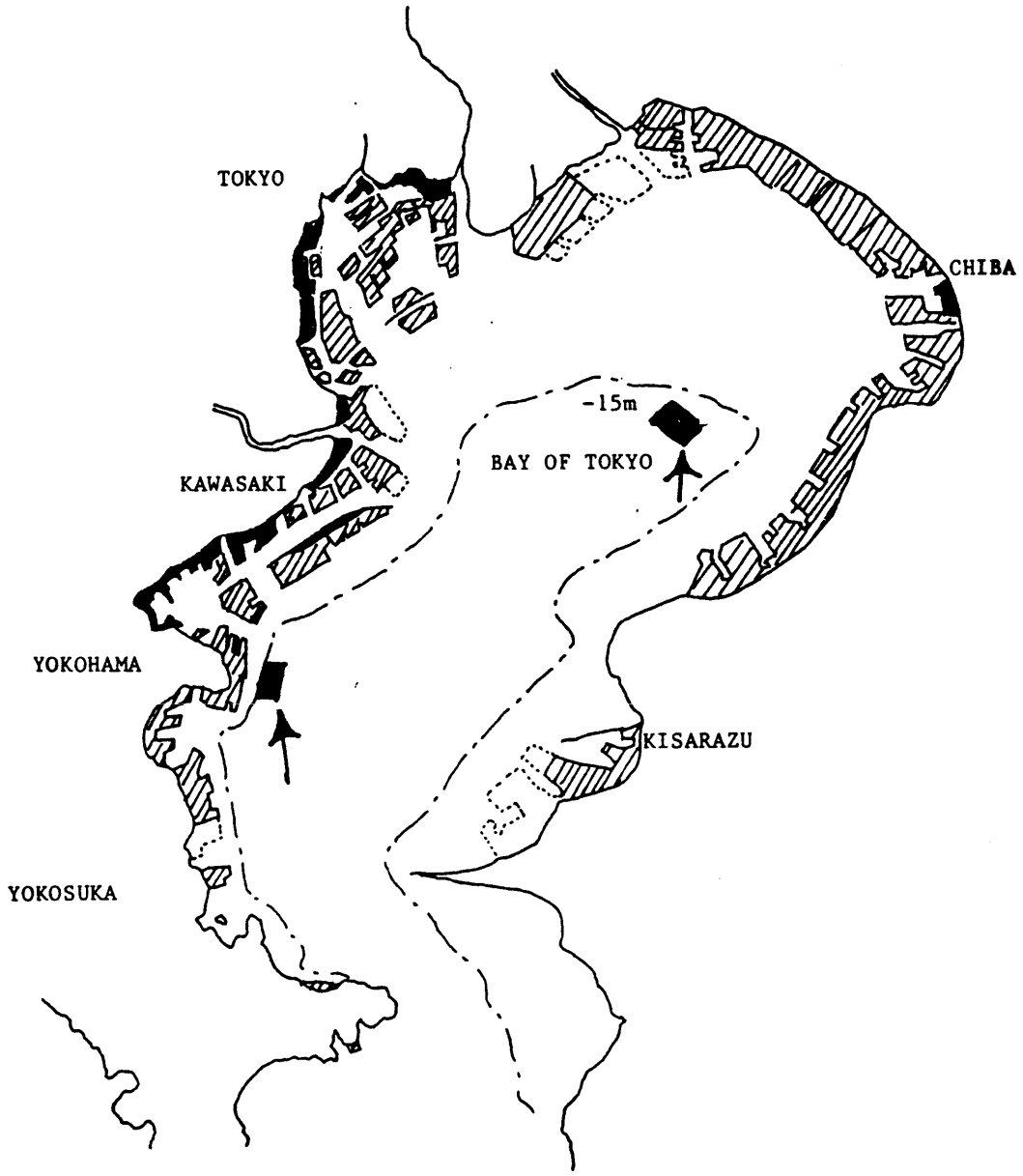



FIGURE 8 - PROPOSED SITE OF OFFSHORE FUEL DISTRIBUTION CENTER AND OTHER RECLAIMED ISLAND PROJECTS IN BAY OF TOKYO

property which would be released for alternate use if existing shoreside coal, storage, oil tankfarms, and other fuel storage and distribution facilities were moved offshore, and the released land be used for recreation and other public interest activities. Coal inventory cost savings by coal burning power plants in the Bay of Osaka and at Sakaido on the opposite shore (16 power plants consuming 39 million tons of coal/year) are estimated to be about $22 million per year. To this must be added the saving in overseas transport of coal (about $4.20/ton) resulting from the use of larger vessels. Finally, the cost of double handling and feeder distribution of coal (cost about $2.00/ton including capital investment depreciation and financial costs) should be added, resulting in a total savings of about $108 million/year which is significantly more than necessary to finance an artificial offshore coal terminal, storage and distribution facility for a throughput of 39-60 million tons/year with a storage capacity of 2-4 million tons.

The plan actually envisions relocation of gas, petroleum products, and petrochemical tankfarms, as well as the construction of a network of submarine pipelines to distribute these fuels all around the Bay of Osaka and the northeastern part of the inland sea.

The total cost of construction of the 380 ha island, including deep draft tanker and bulker terminals, is estimated to be just over 1.8 billion dollars. (The coal center alone with 80 ha would cost about $0.9 billion.) It is expected that these projects will more ahead before the end of this century.

A parallel effort is underway to develop floating (or floatable) fuel terminal and distribution technology. An example of this is the floating gravity caisson, semi-submerged catamaran coal transfer, and distribution terminal development by MODEC (Mitsui) and built for Indian, Indonesian, and Japanese users. Its function is to permit effective discharge from large vessels to terminal storage (the catamaran has a 70-120,000 ton stockpile capacity) and transfer or distribution to the ultimate users by small feeder vessels or barges.

Ocean reclamation and deposition of solid waste and even cement hardened sludge in diked offshore sites (such as those in Tokyo Bay under development now) will become future fuel storage and distribution centers. The government has developed a policy for combined development of offshore waste disposal, artificial island reclamation and full storage and distribution, with a long term goal of repositioning undesirable industrial plants, such as refineries, cement, petrochemical, solvent, chemical, plastic and electric power generating plants on the reclaimed offshore sites.

Additional fuel distribution centers are now under consideration between Shikoku and Kyushu, the large southern islands of Japan and between Hokkaida and the main island on Honshu. The idea is to concentrate Japanese fuel import and storage and develop efficient coastal waterborne distribution systems.

The government has decided that it is absolutely essential for Japan to maintain an acceptable level of economic growth which in turn demands a stable supply of all types of fuel. For

FIGURE 9 - FLOATING COAL LOADING/STORAGE DISCHARGE TERMINAL (MODEC)

these reasons facilities for landing and storage of oil, LNG, and coal are to be established at strategic locations as shown in Figure 10. When appropriate, these terminal and storage facilities should be complemented by power plants or located strategically to existing power plants. Figure 10 is a concept of an offshore power plant on an artificial island.

**Future Locations of Domestic Distribution Center Ports**

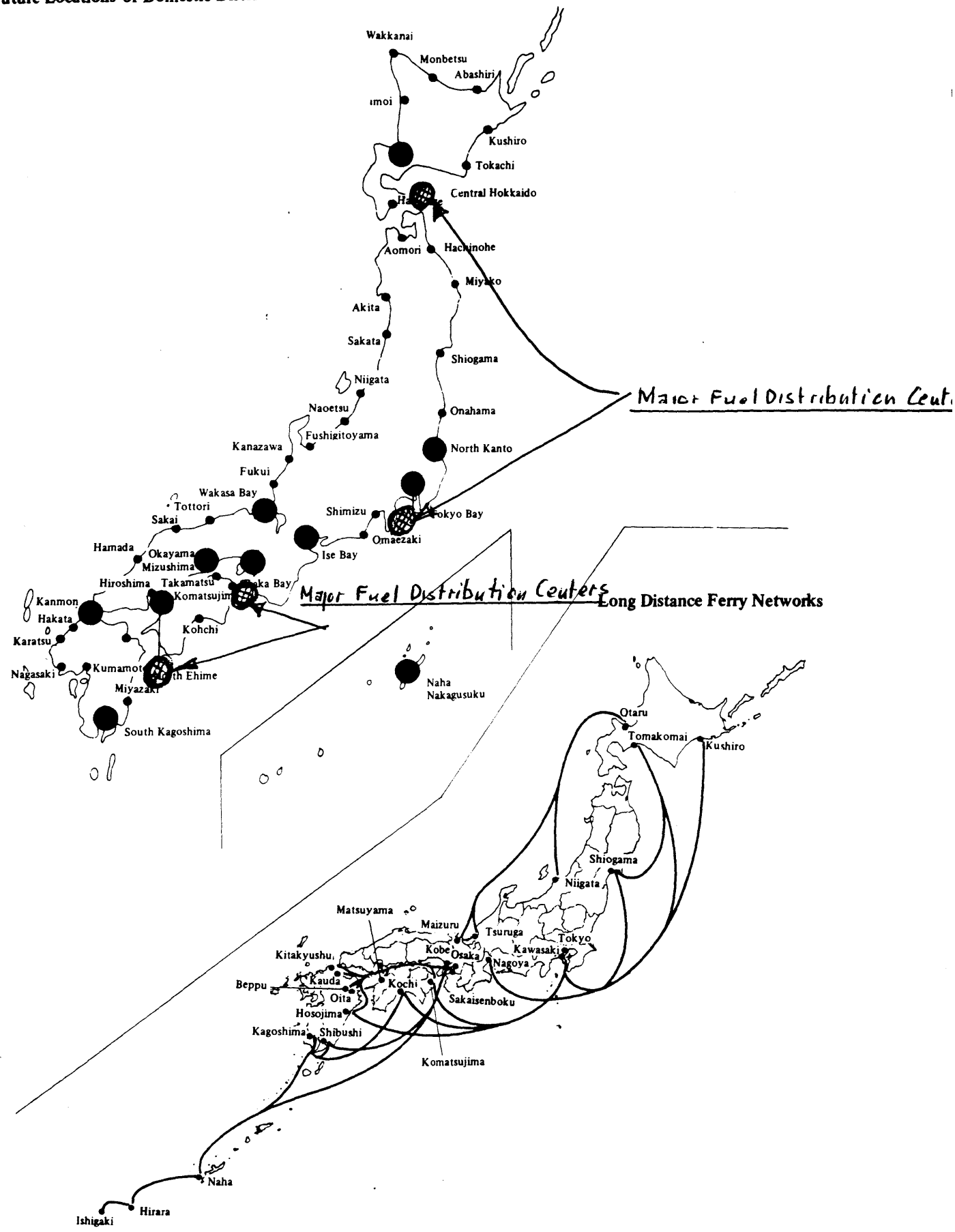



FIGURE 10 - FUEL DISTRIBUTION CENTER

## APPENDIX I

## MOT'S OFFSHORE ISLAND CONCEPTS

The creation of land by reclaiming from water-areas as designated as "port area" is a strategy by the MOT. The Bureau of Ports and Harbours in April 1988 publicized the concept of new large "Offshore Island Projects" and proclaimed the technical feasibility, in its interim report on the result of the feasibility study on offshore islands conducted since 1980. The projects still are in the conceptual stage and there will be a number of points of vital importance to be assessed and evaluated before any such project could be actually executed. Excerpts of the projects are as follows.

### A.1 Yokosuka City (Tokyo Bay Side), Kanagawa Prefecture

| | |
|---|---|
| Water depth (-m): | 5/45 |
| Average wave height (m): | H1/3=3.4 |
| Sea-bed: | Mixture of sand, sandy silt, and hard clay |
| Space projected (ha): | 160 |
| Overall length of peripheral structure (m): | 5,800 |
| Breakwater (m): | nil |
| Major facilities: | Commercial and business offices, housing, parks, cultural facilities, commodity distribution centers, energy (fuel) supply base |
| Use of water-area: | Aquacultural |
| Cost (100 mil yen): | |
| Overall | 5,200 |
| Ground infrastructure* | 2,400 |

| | |
|---|---|
| Superstructure | 2,800 |

A.2 Yokosuka City (Kaneda Bay), Kanagawa Prefecture

| | |
|---|---|
| Water depth (-m): | 15/25 |
| Wave height (m): | H1/3=4.9 |
| Sea-bed: | Sandy |
| Space projected (ha): | 105 (including 12 ha water area) |
| Overall length of peripheral structure (m): | 7,200 |
| Breakwater (m): | 450 |
| Major facilities: | Marina, recreational, man-made beach, hotels, restaurants, research laboratory for fishing industry |
| Use of water-area: | Recreational, aquacultural |
| Cost (100 mil yen): | |
| Overall | 2,000 |
| Ground infrastructure* | 1,600 |
| Superstructure | 400 |

A.3 Yokosuka City (Sagami Bay Side), Kanagawa Prefecture

| | |
|---|---|
| Water depth (-m): | 10/30 |
| Wave height (m): | H1/3=4.1 |
| Sea-bed: | Rocky, sandy |
| Space projected (ha): | 68 (including 18 ha of water area) |
| Overall length of peripheral structure (m): | 6,500 |
| Breakwater (m): | 200 |
| Major facilities: | Marina, hotels, restaurants, shopping malls, convention facilities, research laboratory for oceanography |

| | |
|---|---|
| Use of water-area: | Recreational, aquacultural |
| Cost (100 mil yen): | |
| Overall | 2,100 |
| Ground infrastructure* | 1,350 |
| Superstructure | 750 |

B. Kisarazu, Chiba Prefecture

| | |
|---|---|
| Water depth (m): | 21/23 |
| Wave height (m): | H1/3=0.6-3.1 |
| Sea-bed: | Sandy earth, hard clay |
| Space projected (ha): | 240 (including 40 ha water area) |
| Overall length of peripheral structure (m): | 11,200 |
| Breakwater (m): | 6,140 (including berthing revetment) |
| Major facilities: | Container terminals, major energy distribution center, commodity distribution center, VIS center, convention facilities, hotels |
| Use of water-area: | Recreational, weather refugee |
| Cost (100 mil yen): | |
| Overall | 5,900 |
| Ground infrastructure* | 3,400 |
| Superstructure | 2,500 |

C. Shimizu City, Shizuoka Prefecture

| | |
|---|---|
| Water depth (m): | 8/25 |
| Wave height (m): | H1/3=3.5-11 |
| Sea-bed: | Sandy |
| Space projected (ha(): | 240 (including filling of coastal area and 26 ha water area) |
| Overall length of peripheral | |

| | |
|---|---|
| structure (m): | 10,500 |
| Breakwater (m): | nil |
| Major facilities: | Container terminal, energy distribution center, marinas, hotels, convention facilities |
| Use of water-area: | Base port for oceanographic research ships, recreational |
| Cost (100 mil yen): | |
| Overall | 3,400 |
| Ground infrastructure* | 1,700 |
| Superstructure | 1,700 |

D. Tamano-Kurashiki, Okayama Prefecture

| | |
|---|---|
| Water depth (m): | 3/5 |
| Wave height (m): | H1/3=2.5 |
| Sea-bed: | Sandy gravel, sandy silt |
| Space projected (ha): | 300 |
| Overall length of peripheral structure (m): | 19,900 |
| Breakwater (m): | Nil |
| Major facilities: | Marinas, man-made swimming beach, housing, convention facilities, housing, local industry, fishing industry, fish research institute |
| Use of water-area: | Aquacultural, recreational |
| Cost (100 mil yen): | |
| Overall | 4,700 |
| Ground infrastructure* | 1,600 |
| Superstructure | 3,100 |

E. Shimonoseki, Yamaguchi Prefecture

| | |
|---|---|
| Water depth (m): | 9/20 |
| Wave height (m): | H1/3=5.5 |
| Sea-bed: | Sandy, rocky |

| | |
|---|---|
| Space projected (ha): | Phase I: 771, Phase II, 558 |
| Overall length of peripheral structure (m): | 15,650 |
| Breakwater (m): | 3,400 |
| Major facilities: | Container terminals, fuel depots, energy distribution base, ferry terminal, aquacultural, oceanography research laboratory, pleasure lands, commuter airport |
| Use of water-area: | Weather refugee port, aquacultural, recreational |
| Cost (100 mil yen): | |
| Overall | 12,100 |
| Ground infrastructure* | 5,500 |
| superstructure | 6,600 |

* Inclusive up to land filling and access bridge.

In view of the Government's commitment to the people concerning the betterment of the quality of life, such problems as (1) distortion of land prices and (2) concentration of powers to Tokyo, just name only two such problems, shall be fully taken into account in the Government's all-out countermeasures, therefore, the concept contained in the suggested "offshore islands" may well be placed in the parameters of the long-term alternatives to be chosen by policy-makers.

furthermore, in reference to the Government's commitment to the international community in respect to the enhancement of liberalization of its markets, the potential of needs for resources involved in the concept of offshore islands will offer another opportunity to materialize the goal.

The artificial offshore islands concept used in Japan were examined from a wide variety of angles to crystalize the consistency with the government's policy parameters by the decision makers.

The results should be further evaluated in conjunction with other measures and alternative proposals to be submitted by other wings of the government.

## APPENDIX II

## FUEL DISTRIBUTION TECHNOLOGY POLICY

## JAPAN VISIT - JANUARY 16-24, 1989

**Business Itinerary for**

**DR. ERNST G. FRANKEL, PROFESSOR, OCEAN ENGINEERING, MIT**
Special Advisor to the Secretary General of
International Maritime Organization (IMO, London)

Tel: 001-1-617-253-6763 Fax: 001-1-617-253-8125

Arranged by R. Kondoh, Dy. Secretary General
The International Association of Ports and Harbors (IAPH)
Tel: 03-591-4261 Fax: 03-580-0364

Kotohira-Kaikan Building
1-2-8, Toranomon, Minato-ku, Tokyo 105, Japan

| | | |
|---|---|---|
| JAN 16 (MON) | Holiday<br>Tel: 03-546-0111 | Ginza Tobu Ramada Renaissance<br>Fax: 03-546-8990 |
| 1455 | Arrival at Narita by NWA 003 | |
| JAN 17 (TUE) | | Ginza Tobu Ramada Renaissence |
| 0930 | Pickup by R. Kondoh as escort at the hotel | |
| 1000/ | Port of Tokyo (discussion + field observation)<br>Mr. Kawashima, Port Operations<br>Tel: 03-212-5111 Fax: 03-212-3539 | |
| | Lunch to be hosted by the Port of Tokyo | |
| 1430/ | Mr. T. Hirota, Director-General, Coastal Development Technology Institute (Engan Center)<br>Tel: 03-234-5861 Fax: 03-234-5877 | |
| 1630/ | IAPH: Mr. Hiroshi Kusaka, Secretary General, Mr. R. Kondoh, Dy. Secretary General | |
| 1800 | Dinner by Mr. Hiroshi Kusaka, SG, IAPH<br>At Restaurant Prunier, Kasumigaseki Building<br>Tel: 03-581-9161 | |
| JAN 18 (Wed) | | Ginza Tobu Ramada Renaissence |
| 0930 | Pickup at the Hotel by Mr. Arichi | |
| 1000/ | Mr. Y. Arichi*, Mitsui Ocean Development Co., Ltd., (MODECO)<br>Tel: 03-265-3141 Fax: 03-265-2004 | |
| 1400/ | Mr. H. Narita*, Marine Systems Div., Mitsui Engineering & Shipbuilding Co., Ltd. (MES)<br>Tel: 03-544-3324 FAx: 03-544-3021<br>Fax: 03-544-3060 | |

| | | |
|---|---|---|
| JAN 19 (THU) | | Ginza Tobu Ramada Renaissence |
| 1000/ | Mr. Nagatsuka, Japan Maritime Research Institute (JAMRI)<br>Tel: 03-265-5231 Fax: 03-265-5035<br><br>9th Floor, Kaiun Building, 2-6-4, Hirakawa-cho<br>Chiyoda-ku, Tokyo 102 | |
| 1200 | Lunch to be hosted by JAMRI | |
| 1400/ | Mr. T. Okabe, President & CEO, Overseas Coastal Area Development Insititue of Japan (OCDI) (Mr. S. Onogawa)<br>Tel: 03-580-3271 Fax: 03-580-3657<br><br>5th Floor, Kazan Bldg., 3-2-4 Kasumigaseki<br>Chiyoda-ku, Tokyo 100 | |
| JAN 20 (FRI) | | Ginza Tobu Ramada Renaissence |
| 1500 | Pickup at the Hotel by Tobishima Corp. | |
| 1530/ | Mr. Kiichi Yoshida, Vice-President, Tobishima Corporation (Professor, Nihon University)<br>Tel: 03-263-3151 Fax: 03-261-6538 | |
| | Welcome Dinner suggested by Mr. Yoshida | |
| JAN 21 (SAT) | | Ginza Tobu Ramada Renaissence |
| JAN 22 (SUN) | | Ginza Tobu Ramada Renaissence |
| JAN 23 (MON) | | Ginza Tobu Ramada Renaissence |
| 1400/1700 | At IAPH Head Office: Mr. Yasuyuki Fujimori, Director, Offce of Coast & Ocean, Development Division, Bureau of Ports and Harbours, MOT<br><br>The meeting place was set at the IAPH Head Office, in view that the atmosphere of the MOT and its premises at that time will be too noisy and people are hectic as it is the last stage of formulating a national budget.<br><br>MOT: Tel: 03-580-3111 Fax: 03-581-5788<br>IAPH: Tel: 03-591-4261 Fax: 03-580-0364<br><br>MOT's Address: 2-1-3, Kasumigaseki, Chiyoda-ku, Tokyo 100 | |
| JAN 24 (TUE) | Leave Japan | |