STUDY REPORT ON THE PROJECT FOR SUPPLY OF EQUIPMENT FOR THE MASSAWA PORT IN THE STATE OF ERITREA

March 1996

Japan International Cooperation Agency (JICA)

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PREFACE

In response to a request from the Government of the State of Eritrea, the Government of Japan decided to conduct a basic design study on the Project for Supply of Equipment for the Massawa Port and entrusted the Japan International Cooperation Agency (JICA) to conduct the study with the assistance of the Japan International Cooperation System (JICS).

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the State of Eritrea for their close cooperation extended to the study.

March 1996

Kimio Fujita
President
Japan International Cooperation Agency

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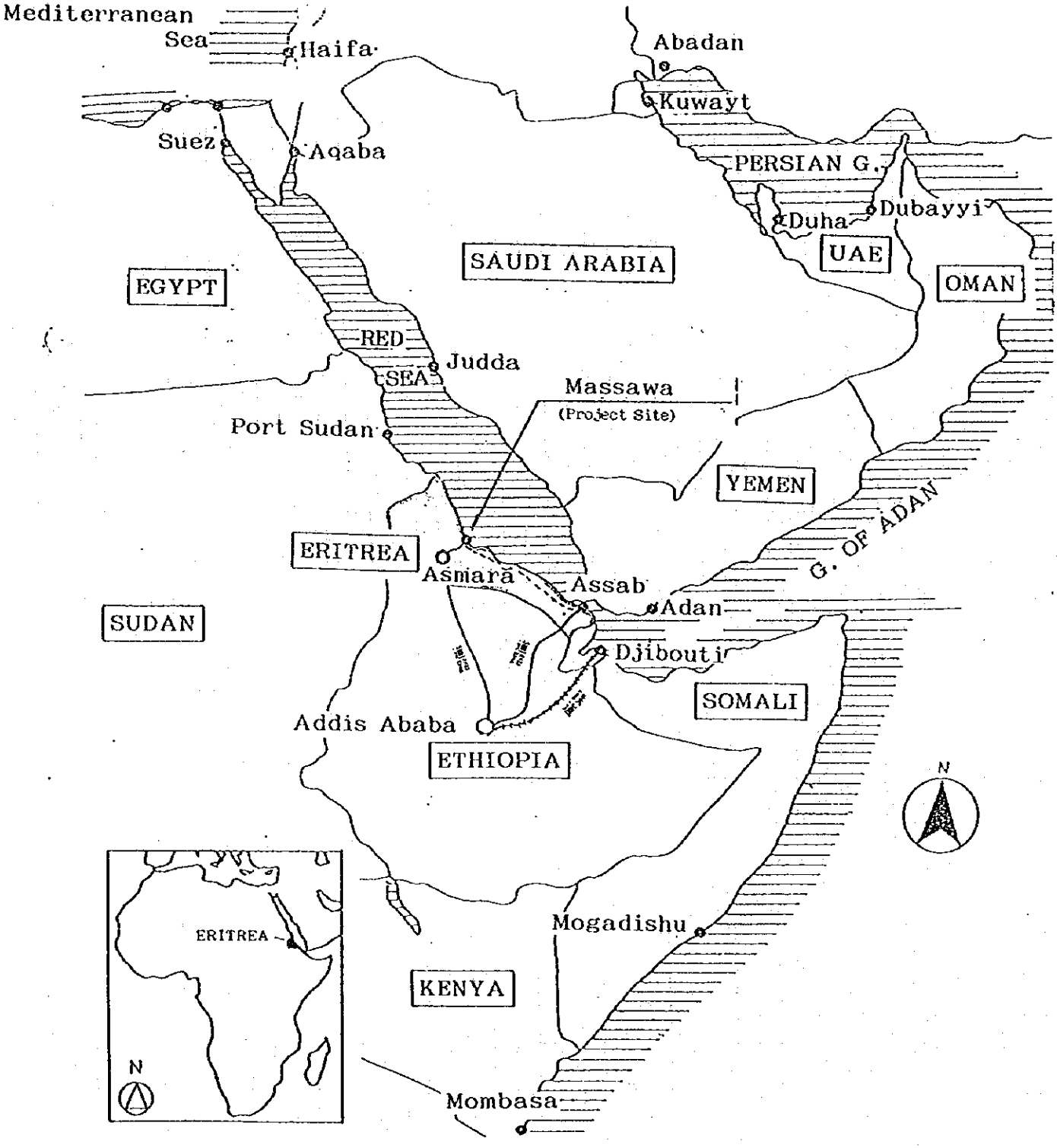


Location Map of Eritrea

Abbreviations

WFP: United Nations and FAO World Food Plan

Palletizing System: A system in which pallets (trays made of wood, etc. which can carry cargo and be lifted by fork lifts) are utilized in order to make work using cargo handling equipment (fork lifts, etc.) easy.

Gang: A team of port cargo handling workers responsible for a ship's hold. A gang consists of a deck keeper, winch keeper, quay worker, fork lift truck driver and caretaker, etc.

Man hour: An indicator of cargo handling work efficiency, expressed as the amount (tons) of cargo handled by one worker in one hour.

Chapter 1 Background of the Project

Eritrea became an Italian colony in 1890 but later fell under British rule following the end of the Second World War. In 1952, at the recommendation of the United Nations, Eritrea became an independent state in a federation formed with Ethiopia, but in 1962 Ethiopia, a landlocked state seeking to gain access to the sea (Assab Port and Massawa Port), forcefully integrated Eritrea within its own borders. Following that, the Eritrea People's Liberation Front (EPLF) continued a struggle with the central government in Addis Ababa for almost 30 years and, after gaining control of the state capital Asmara, it established a provisional government in May 1991. A referendum calling for independence from Ethiopia was held in April 1993, and the independence of the State of Eritrea as the 53rd nation in Africa was declared in May 1993.

As a result of the 30 year struggle and damage caused by droughts, etc., the national land of Eritrea has been largely devastated. The provisional government has compiled an emergency recovery program that mainly focuses on the three areas of transportation, agriculture and industry, and efforts are being made to reconstruct the economy. In particular, the establishment of a food self-supply setup is an urgent necessity and, while placing emphasis on the recovery of primary industries such as agriculture, fisheries and livestock farming, the provisional government has also made restoration of the transportation infrastructure to support the smooth distribution of goods one of its most important issues.

The centers of physical distribution in Eritrea are the two Red Sea commercial ports at Assab and Massawa, and the combined volume of cargo handled at these two ports in 1994 amounted to approximately 2,700,000 tons. These ports together with Djibouti Port on the Red Sea Coast have long acted as the main points of access between the sea and Addis Ababa, the capital of Ethiopia. In particular, Assab Port, providing the easiest access to Addis Ababa, received no damage during the war of independence and, because one of the conditions of independence was that this be used as a free trade port, it still functions as Ethiopia's gateway to the sea. As shown in Figure 1-1, there are roads linking both Massawa and Assab to Addis Ababa, but the road between the two port cities is still in the concept planning stage, and approximately 95% of the cargo handled at Assab Port is destined for Addis Ababa. In contrast to this, Massawa Port in the days before independence acted more as a regional port supplying goods to Asmara and the north of Ethiopia, however, following the end of the war, the importance of Massawa Port dramatically increased in that it more or less became the sole access port for supplying materials into Eritrea. As a result, reconstruction of Massawa Port is being advanced as a higher priority issue than the reconstruction of Assab Port.

Massawa Port, as one of the chief zones of conflict, was continually devastated during the 30 year struggle and suffered aerial bombing just before the end of the fighting in 1990, however, with the aim of making Massawa the gateway to the sea for Asmara (the capital of the new State of Eritrea), the port was reopened in 1991 following the removal of sunken vessels and partial dredging, etc. The volume of cargo handled by the port was approximately 400,000 tons immediately following its reopening, but this has increased rapidly at a rate of 20% per year to approximately 700,000 tons in 1994, and the port is now finding it difficult to cope with the growing demand with its current handling capacity. Moreover, because much of the existing port equipment is deteriorated, there are frequent breakdowns which cause delays in the cargo handling schedules. Bagging machines have been provided under the World Food Program (WFP) to deal with the unloading of food and other aid materials, however, with regard to the unloading, in-port haulage and storage of other cargo, there is an absolute shortage of handling equipment, and the effective utilization of port space and improvement in the work efficiency of cargo handling at the port through the supply of new equipment have become issues requiring urgent attention.

It is against these circumstances that the Government of Eritrea requested the Government of Japan to provide grant aid for the supply of unloading and haulage equipment at Massawa Port.

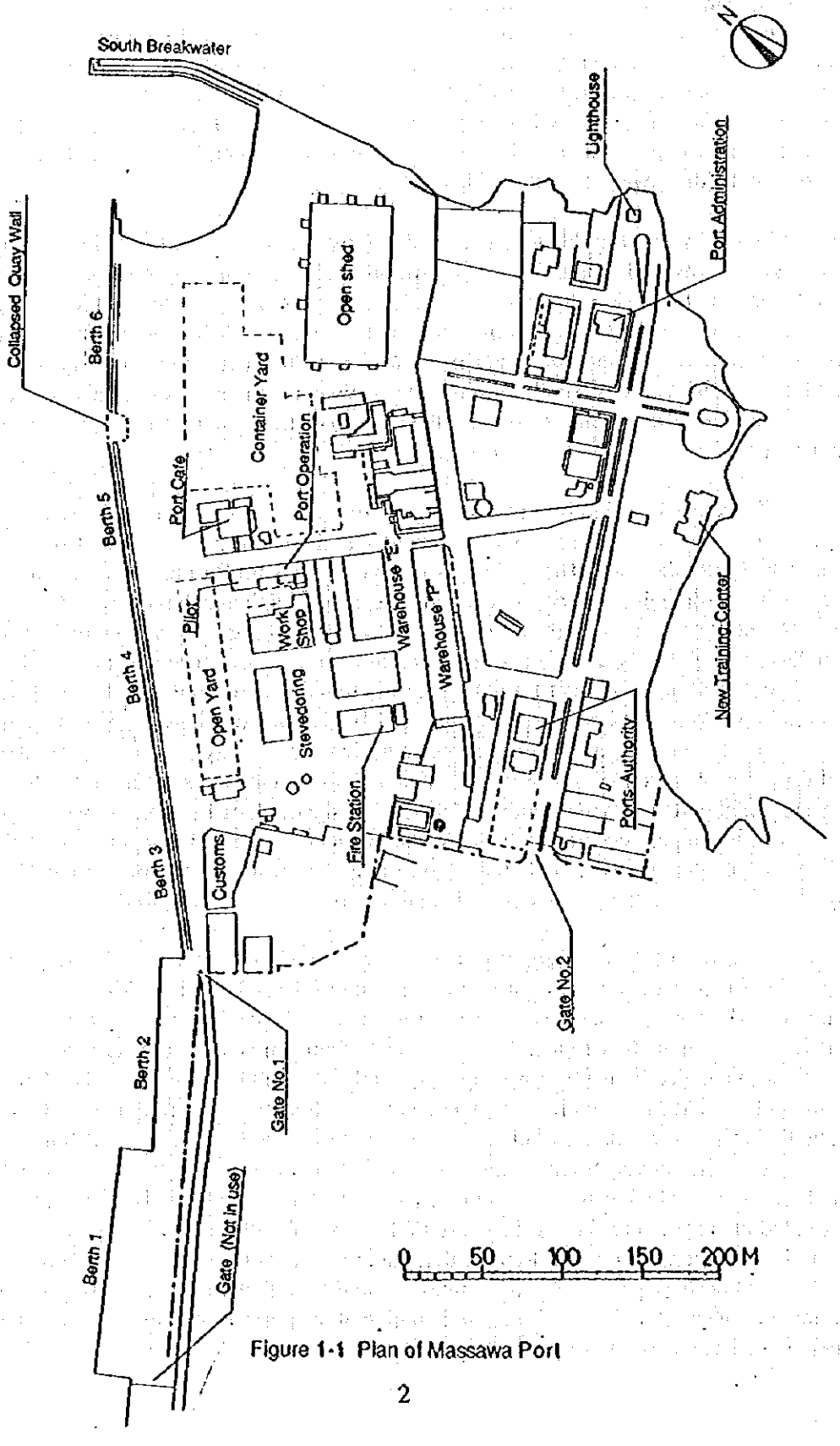


Figure 1-1 Plan of Massawa Port

Chapter 2 Contents of the Project

2-1 Objectives of the Project

In the future development plans compiled by the Eritrea Ports Authority, the expansion of the functions of Massawa Port to make it able to fully act as the gateway port for the capital Asmara and the rest of northern Eritrea has been made the top priority issue.
The objective of the Project is to restore the efficient functions of Massawa Port through procuring cargo handling equipment which, among the port equipment detailed within the first phase supply plan of the port development, is required particularly urgently.

2-2 Basic Concept of the Project

The Project, in order to respond to the insufficient capacity at Massawa Port to handle container cargoes and general cargoes, aims to procure cargo handling equipment for use in the indirect handling of cargo in the open shed, container yard and warehouses, etc. shown in the flow of physical distribution (Figure 2-1).
Regarding equipment for handling containers, in order to achieve the effective utilization of the existing container yard, efficient handling equipment shall be introduced together with equipment for performing in-port haulage. As for general cargoes, in order to make the adoption of a palletizing system feasible and raise work efficiency levels through replacing manual work in containers with mechanical handling, fork lifts and other items of cargo handling equipment shall be procured.

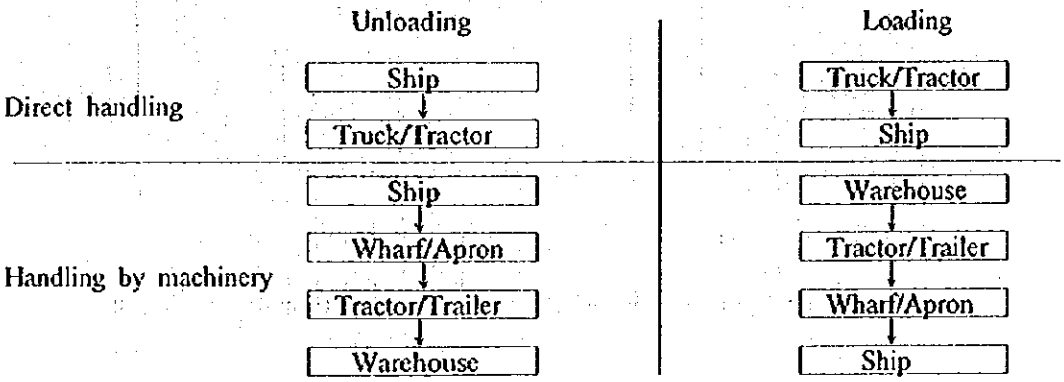


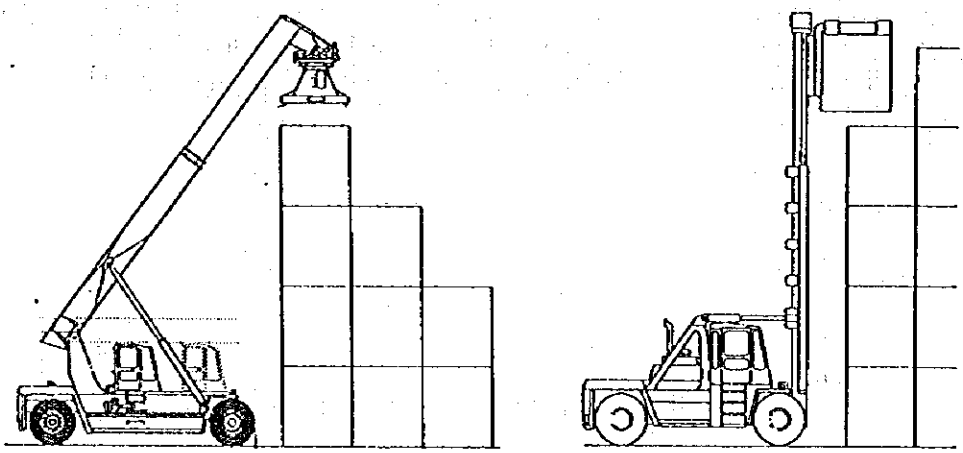
Figure 2-1 Flow of Physical Distribution

(1) Selection of Container Handling Vehicles

1) Container Stacking Equipment

Currently at Massawa Port, the stacking of containers in the container yard is carried out with vehicles known as container lift trucks. However, because the Ports Authority has expressed a strong desire to replace such vehicles with a new reach stacker, a detailed comparative examination was carried out into the advantages and disadvantages of both types of vehicle (see Table 2-1).
Of the advantages indicated in Table 2-1, the reach stacker was found to be particularly superior in the areas described below and, moreover, because the price of both types of vehicle is more or less the same, it was decided to adopt a reach stacker for the purposes of the Project.

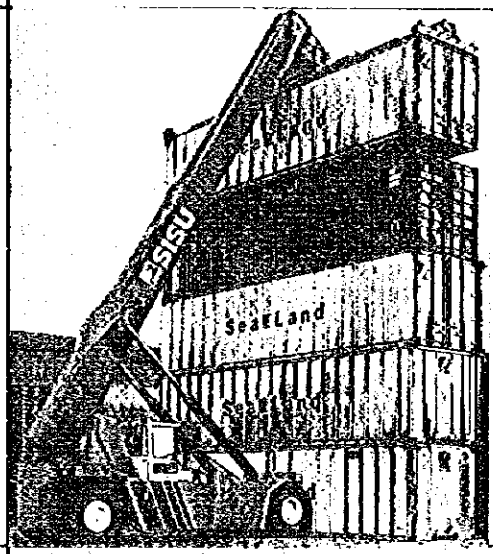
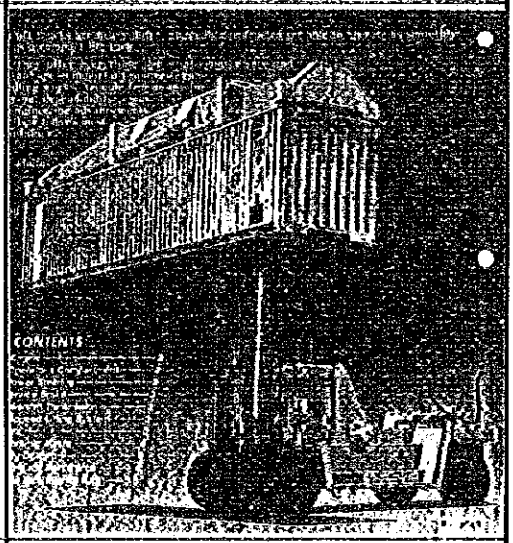
a. The container lift truck, as is also the case with a fork lift, is only able to load or unload containers on the first row of containers facing it. However, the reach stacker, possessing a telescopic hydraulic boom similar to that of a truck crane, is able to reach over the first row and handle containers on the second row (or even third and fourth rows according to conditions) (see Figure 2-2) and can thus stack more containers closer together. As a result, compared to the container lift truck, for which vehicle corridors need to be provided between every two rows of containers, it is possible to make more effective utilization of space (i.e. it is possible to store more containers within the same container yard area). It is this point which is considered to make a reach stacker more suited to the cramped conditions at Massawa Port. In specific terms, it is thought that the adoption of a reach stacker would enable the container yard (currently able to hold around 300 containers) to increase its holding capacity by between approximately 10-30% (to between 330-390 containers).
b. Although operators would need to be trained in correct container arrangement instructions and operation and control techniques, because a reach stacker offers more flexibility than a container lift truck in that it can be operated from any angle, it would become possible to shorten work times.



(Reach stacker) (Container lift truck)

Figure 2-2 Difference Between a Reach Stacker and Container Lift Truck

Table 2-1 Comparison of Reach Stacker and Container Lift Truck

Item of Comparison	Reach Stacker (RS)	Container Lift Truck (CLT)
Appearance		
Basic Structure	- Elastic and undulation hydraulic boom, same as truck crane, with telescopic spreader for containers	- Forklift with telescopic spreader
Function	- Able to grab a container in 2nd -3rd rows - Able to hold lengthwise - Able to grab and pile a container at all angles	- Able to grab a container in 1st row at front (right angle)
Diversity	- Able to rotate a container clockwise and counter-clockwise - Boom angle: 60 degree	- Unable to rotate a container - Angle of must: 5 degree in front 10 degree at the back - Side shift (slides for right and left) : ± 200 to 300 mm
Safety Device	- Automatic Load Moment Limiter	- Automatic Load Moment Limiter
Axle Load	- Well-balanced axles when loading - Less damage of ground - Less consumption of tires	- Load to rear axle when unloading, and load to front axle when loading - Great burden to ground - More consumption of tires
Operation	- Short cycle time compare with CLT - Able to operate easily by minimum practice - Able to select position of cabin by mechanical slide - Wide view at front - Able to operate hydraulic system by fingertip process of joy stick	- Long cycle time compare with RS - Fixed cabin on the chassis - Interrupted by mast, carriage, etc. - Operation of hydraulic system by 5 levers
Maintenance	- Expansion, Contraction, and undulation of boom controlled by hydraulic system	- Up-and-down motion of Spreader by side roller and chain wheel to main mast

In addition to the aforementioned equipment, fork lifts for exclusively handling empty containers are also required. Massawa Port currently possesses only one such fork lift and, because this has already reached the limit of its useful service life, its operating efficiency is low. For this reason and also in consideration of the increasing volume of container cargo handled at the port, the Project shall procure two new such fork lifts.

2) Selection of Container Haulage Vehicles

The haulage of containers between the container yard and quay (apron) is performed by the combination of terminal trailers (tugmaster trailers) and terminal tractors (tugmasters) used mainly for short-range haulage within port complexes.

Massawa Port currently possesses two terminal tractors and nine terminal trailers. Although both terminal tractors are still working, when one considers that they are now six years old and the useful life of such equipment is usually only around five years, they could become inoperable at any time. As for the terminal trailers, too, they are still operating, but deterioration has reached a serious degree. In consideration of these circumstances, terminal tractors and trailers shall be procured in the numbers described below.

In the container yard, in order to prevent the occurrence of delays in the stacking of containers carried out by one reach stacker and the two existing container lift trucks, it is thought that three terminal tractors are required. While the terminal tractors haul loaded trailers to the container yard and return back to the apron, the loading of the next trailers will be performed. Because improvements in work efficiency can be anticipated through the scheduled future construction of exclusive container berths and subsequent reduction of haulage distances, it is thought that it will be possible to perform the above-mentioned loading and haulage work by combining just two trailers with each terminal tractor. As a result, a total of six terminal trailers shall be procured.

(2) General Cargo Handling Equipment

1) General Cargo Fork Lifts

The situation regarding the existing fork lifts with respect to their useful life of roughly six years is as described below.

- Of the six 6 ton fork lifts, three are seven years old and in a deteriorated state.
- All six of the 4 ton fork lifts are seven years old and in a deteriorated state.
- Of the six 3 ton fork lifts, one is in a deteriorated state, but the other five are only two years old and in good condition. However, because new attachments have been included in the request, fork lifts to which such attachments can be fitted are necessary.

In view of the above-mentioned points, the required numbers of fork lifts have been determined in the following manner.

- Four 6 ton fork lifts shall be procured to replace the existing three deteriorated fork lifts and handle the increased volume of cargo handled at the port.
- Although all six of the existing 4 ton fork lifts are in a deteriorated state, because their work can also be performed by the 6 ton fork lifts, only four (the same number as the 6 ton fork lifts) shall be procured.
- Regarding the 3 ton fork lifts, in view of the volume of cargo handled at Massawa Port, three such fork lifts which can be fitted with attachments (clamps) are required in order to respond to temporary peaks in such cargoes as paper rolls and drum cans, etc.

2) Bagged Cargo Handling Equipment

A portable slat conveyor is mainly used in the unloading of bagged cargo (wheat and other cereals, etc.) in open sheds or other types of open air yard. In view of the volume of cargo

handled at Massawa Port and the size of the port's open shed, two portable slat conveyors shall be procured.

2-3 Basic Concept

2-3-1 Design Concept

In order to resolve the insufficient handling capacity of Massawa Port to respond to the increasing volume of cargo (in particular, the rapidly increasing container cargo) at the port, cargo handling equipment that is able to handle a wide variety of cargoes within the restricted port complex area shall be procured.

(1) Container Cargo Handling Equipment

Because the container cargo at Massawa Port comes in standard 20 feet (maximum 20 tons) and 40 feet (maximum 35 tons) containers, handling shall be performed by means of the equipment described below.

1) Reach Stacker : 1 unit

Full and empty containers are stacked to a maximum of three heights levels in the container yard. Because the reach stacker is able to reach over and handle containers on the second row and beyond, it will contribute to reducing cargo handling time and making more effective utilization of yard space.

The vehicle size and spreader (attachment for container handling) specifications shall be as follows:

- Total length : 11.2 m max.
- Wheel base : 6.0 m max.
- Spreader turning angle: ± 90 degree max.

Moreover, because this equipment is not produced in Japan, it shall be procured from a third country.

2) Terminal Tractors (Tugmasters) : 3 units

The terminal tractors need to be able to haul terminal semi-trailers loaded with two 20 feet containers (maximum weight 40 tons) from the apron to the container terminal. The traction unit shall be fitted with a fifth-wheel coupler possessing a minimum lifting capacity of 25 tons. However, because haulage will only be performed over short distances, the engine output of the terminal tractors shall be around 180 horse power.

Moreover, because this equipment is not produced in Japan, it shall be procured from a third country.

3) Terminal Trailers (Tugmaster Trailers) : 6 units

The terminal trailers shall be able to load two 20 feet containers or one 40 feet container and shall be fitted with a kingpin that allows them to be hauled by the above-mentioned fifth-wheel coupler of the terminal tractors,

Moreover, because there is only one manufacturer in Japan that produces this equipment, procurement from third countries shall also be considered.

4) Fork Lifts (10 ton) : 2 units

These fork lifts shall be equipped with attachments (side lift spreaders) that enable them to load and unload empty 20 feet and 40 feet containers to a maximum of three heights.

(2) General Cargo Handling Equipment

1) Fork Lifts (6 ton) : 4 units

These fork lifts shall be used to load general cargo and box cargo onto trucks and to carry cargo between trailers and warehouses. Maximum loadage shall be six tons. Furthermore, the fork lifts shall be equipped with overhead guards to give operators protection in the event of overturning and back rests to prevent cargo collapsing onto the operator side.

2) Fork Lifts (4 ton) : 4 units

These fork lifts shall be used to perform the same work as the six ton fork lifts. Maximum loadage shall be four tons, and work shall be shared with the six ton fork lifts according to the volume and type of cargo. Furthermore, the fork lifts shall be equipped with overhead guards to give operators protection in the event of overturning and back rests to prevent cargo collapsing onto the operator side.

3) Fork Lifts (3 ton) : 3 units

These fork lifts shall be used to perform the sorting of cargoes within containers. Because this work is currently performed by human labor, this automation will improve the work efficiency. The maximum mast height of the fork lifts shall be limited to 2,075 mm to enable them to work within the containers.
Furthermore, these fork lifts shall be equipped with attachments (paper roll clamps and drum clamps) that enable them to handle paper rolls, drum cans and other types of cargo.

4) Portable Slat Conveyors : 2 units

The portable slat conveyors shall be used to raise the work efficiency of the loading onto trucks and stacking inside warehouses of bagged cargo such as food aid supplies and cement, the volume of which passing through the port is rapidly increasing as a result of the effort to achieve restoration of the infrastructure.
Because portable slat conveyors can be used outdoors in areas without height restrictions, they shall have a maximum length of 9 m (making it possible to procure conveyors made in Japan). Moreover, because there is no electricity supply outdoors, each conveyor shall be provided with a diesel engine generator.

2-3-2 Basic Design

The main items of equipment scheduled for procurement under the Project are as shown in the following table.

Table 2-2 Main Items of Equipment Scheduled for Procureme

No	Name of Equipment	Description	Q'ty	Purpose of Use
1	Reach Stacker	35 t (loading)	1	Handling of full and empty containers
2	Terminal Tractor (Tugmaster)	40 t (traction)	3	Haulage of full and empty containers
3	Terminal Trailer (Tugmaster trailer)	40 t (loading)	6	Same as above
4	Forklift	10 t (loading)	2	Handling of empty containers
5	Forklift	6 t (loading)	4	Loading onto trucks and haulage between trailers and warehouses of general cargo
6	Forklift	4 t (loading)	4	Same as above
7	Forklift (with clamp for paper roll and drum cans)	3 t (loading)	3	Sorting of cargo within containers
8	Portable Slat Conveyer	Length:min 7 m Height:min 5 m	2	Stacking of bagged cargo

Moreover, because none of the above-mentioned equipment is manufactured in Eritrea, it shall either be procured from Japan or from third countries. The items of equipment to be procured from third countries are as indicated below.

Table 2-3 Equipment to be Procured from Third Countries

No	Name of Equipment	Reason	Country of origin
1	Reach Stacker	This equipment is not manufactured in Japan	Finland, Spain, France, Sweden
2	Terminal Tractor (Tugmaster)	Same as above	Belgium, Finland, Germany, Netherlands, Sweden
3	Terminal Trailer (Tugmaster trailer)	Only one company in Japan manufactures such equipment and third country products need to be considered to ensure a fair tendering process.	Belgium, Finland, Germany, Netherlands, Sweden

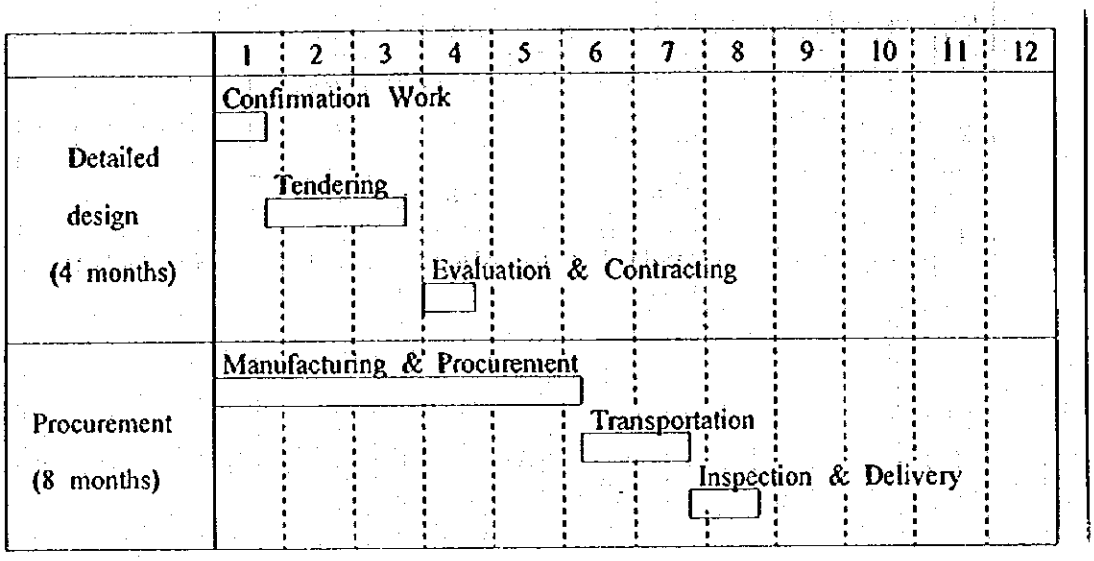
Chapter 3 Implementation Plan

3-1 Implementation Plan

3-1-1 Implementation Schedule

The implementation schedule is as indicated below.

Table 3-1 Implementation Schedule of the Project



3-1-2 Obligations of Recipient Country

The Government of Eritrea is required to take the following measures to ensure the smooth implementation of the grant aid.

1) To bear the costs and ensure the prompt execution of customs clearance and inland transportation of the procured equipment.
2) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may otherwise be imposed in Eritrea with respect to the supply of the equipment and services under the verified contracts.
3) To accord Japanese nationals, whose services may be required in connection with the supply of the equipment and services under the verified contracts, such facilities as may be necessary for their entry into Eritrea and stay therein for the performance of their work.
4) To maintain and operate the equipment purchased under the grant aid properly and effectively and to assign staff necessary for this operation and maintenance, as well as to bear all necessary operation and maintenance expenses not covered by the grant aid.
5) To conclude banking arrangements with an authorized foreign exchange bank in Japan and to issue an authorization to pay.

3-2 Operation and Maintenance Plan

(1) Operation and Maintenance Setup

The procurement of equipment under the Project includes the renewal of both poor (bad) and operating (fair) items of existing equipment. Thus, the increase in the numbers of existing equipment (increase = number to be procured - fair - bad) will be as shown in Table 3-2. Because

each item of equipment will only be increased by between one to three units, it is thought that implementation of the Project will not result in a major increase in operation and maintenance costs.
Moreover, because, except for the reach stacker, all the equipment is the same as that previously operated in Eritrea, there will be no need to increase staff numbers or take special steps to train the existing staff. Therefore, it is considered that the existing operation and maintenance setup will be able to comfortably deal with the Project equipment.

Table 3-2 Increase in Equipment Numbers Following the Project

No	Equipment	Q'ty	Existing Numbers				Increase
			Total	Good	Fair	Bad	
1	Reach Stacker	1	0	-	-	-	1
2	Terminal Tractor	3	2	1	1	-	2
3	Terminal Trailer	6	9	9	-	-	6
4	Forklift (10t)	2	1	-	1	-	1
5	Forklift (6t)	4	6	5	-	1	3
6	Forklift (4t)	4	6	4	-	2	2
7	Forklift (3t)	3	6	5	1	-	2
8	Portable Slat Conveyer	2	1	-	-	1	1

* Prepared based on response to the questionnaire

(2) Periods of Renewal

Because the periods of renewal (i.e. the useful service lives) of the Project equipment will be greatly affected following procurement by factors in Eritrea such as annual operating days, daily operating hours, climatic conditions (temperature, humidity, etc.) and the level of operation and maintenance, etc., it is extremely difficult to make any final decisions at the current point in time. Thus, the periods of renewal shall be determined based on the useful service lives of similar items of equipment as stated in the "Construction Machine Depreciation Manual" (supervised by the Ministry of Construction, Construction Economy Division, Construction Machinery Department) (see Table 3-3).
Incidentally, the Construction Machine Depreciation Manual defines the useful service life as "the normally scheduled number of years (life) of machine usefulness when normal operation and maintenance is performed and the machine is put to its originally intended purpose of use."

Table 3-3 Useful Service Periods of Equipment to be Procured

Equipment	Date of "Rental Estimation for Construction Equipment"		Note
	Name of Machinery	Durable Years	
Rreach Stacker	Truck Crane (hydraulic system)	8	
Terminal Tractor	Truck	5	
Terminal Trailer	Semi-Trailer	6	
Forklifts	Forklift	6	
Portable Slat Conveyer	Belt conveyer (for Dam)	4	

(3) Operation and Maintenance and Repair Costs

The operation and maintenance and repair costs shall be calculated as the annual expenses incurred by the increased numbers of equipment (see Table 3-2), using the thinking stated in the above-mentioned Construction Machine Depreciation Manual.

The Construction Machine Depreciation Manual prescribes machine expenses to consist of the following items:

- Machine hire (depreciation cost, maintenance and repair cost, operation cost)
- Operating expenses (fuel, oil and electricity charges, operating labor cost, expendable parts cost, miscellaneous costs)
- Assembly and dismantling cost
- Transportation cost
- Repair facility expenses

Of the above costs and expenses, it is thought that the four items underlined will be the main expenses that arise following implementation of the Project.

1) Reference Equipment

When conducting the rough calculation of expenses, the Construction Machine Depreciation Manual shall be used to provide reference for the cost rate of each item. The relationship between scheduled Project equipment and reference equipment given in the Construction Machine Depreciation Manual was indicated in Table 3-3.

2) Maintenance and Repair Cost

The maintenance and repair cost rate is the ratio of the total maintenance and repair cost that arises during the useful life of the machinery to the basic machinery price. The maintenance and repair cost refers to the cost of maintenance and repairs required to sustain the machinery's usefulness and does not include the expendable parts cost, which is part of the operating expense. Incidentally, a two-year supply of spare parts shall be procured together with the equipment under the Project.

Therefore, the average annual maintenance and repair cost of each item of equipment was calculated with the following expression by dividing the total maintenance and repair cost that arises during the equipment life (useful service life minus two years) by the number of useful service years. The calculation results are shown in Table 3-4.

The basic prices used in the calculation were based on estimate prices from manufacturers with a discount rate taken into account.

Annual maintenance/repair cost = basic price x maintenance/repair cost rate x number of units
x [(useful life - 2 years) + useful life] ÷ useful life

Table 3-4 Annual Maintenance and Repair Cost

Equipment to be procured (reference equipment given by Depreciation Manual)	Basic Price (1000 yen)	Mainte-nance and repair Cost Rate (%)	Number of Equip-ment Units	Useful Service Life (years)	Mainte-nance and Repair Cost (1000 yen)	Annual Maintenance and Repair Cost (1000 yen)
Reach Stacker (Truck Crane-hydraulic system)	35,890	25	1	8	6,729	841
Terminal Tractor (Truck)	7,443	40	2	5	3,573	715
Terminal Trailer (Semi-Trailer)	2,049	35	6	6	2,869	478
Forklift (10t) (Forklift)	19,136	30	1	6	3,827	638
Forklift (6t) (Forklift)	3,482	30	3	6	2,089	348
Forklift (4t) (Forklift)	2,199	30	2	6	880	147
Forklift (3t) (Forklift)	2,133	30	2	6	853	142
Portable Slat Conveyer	3,039	5	1	4	152	19
Total						3,328

The cost of spare parts scheduled to be procured under the Project are as follows.
The cost of a two-year supply of spare parts shall be calculated. With respect to the ratio of the spare parts cost as compared to the equipment CIF price, based on the maintenance and repair cost rates and useful service lives given in the Construction Machine Depreciation Manual, and in consideration of the points described below, a maintenance and repair cost rate of 10% has been adopted for all vehicular equipment (see Table 3-5). With regard to the portable slat conveyors, because they are not self-running and thus will not suffer as much wear and tear as vehicular equipment, a minimum supply of spare parts , amounting to just 5% of the CIF price, has been assumed.

a. Because the above-mentioned maintenance and repair cost also includes the personnel expenses of engineers performing maintenance and repairs on items other than parts, it is necessary to reduce the maintenance and repair cost rate.
b. In view of the fact that the Project equipment will be used under disadvantageous conditions (expected salt corrosion at the port, the severe climatic conditions of one of the hottest places on earth, the poor state of paving within the port complex) and the volume of cargo handled by the port is expected to rise in the near future, it is necessary to consider a maintenance and repair cost rate higher than that for general construction machinery.

Table 3-5 Spare Parts Cost Rate

Equipment	Construction Machine Depreciation Manual			Calculated Value of 2-year Supply (%)	Value Adopted Here (%)
	Reference Equipment	Service Life (years)	Maintenance and Repair Cost Rate (%)		
Reach Stacker	Truck Crane (hydraulic system)	8	25	6.3	10
Terminal Tractor	Truck	5	40	16.0	
Terminal Trailer	Semi-Trailer	6	35	11.7	
Forklifts	Froklift	6	30	10.0	

3) Management Cost

The management cost consists of the taxes and public charges, insurance premiums, storage cost and other expenses incurred as a result of possession of the equipment, and the management cost rate is the ratio of the annual equipment management cost with respect to the basic price. The composition of the management cost is as shown below.

- Insurance premiums (automobile liability insurance against damage, automobile bodily injury and property damage liability insurance)
- Taxes (automobile tax, fixed asset tax, specific tax, automobile acquisition tax)
- Storage and other expenses (machinery storage cost, storage facility cost, machinery operation administration expenses and operator expenses <excluding portion included in operating labor expense>)

All of the above costs except for the machinery operation administration expenses and operator expenses are considered to be either unnecessary or negligible in Eritrea. Thus, an annual management cost rate of 1% shall be assumed for all the items of equipment (see Table 3-6).

Table 3-6 Annual Management Cost

Equipment to be procured (reference equipment given in Depreciation Manual)	Basic Price (1000 yen)	Annual Management Cost Rate (%)	Number of Equipment Units	Annual Management Cost (1000 yen)
Reach Stacker (Truck Crane-hydraulic system)	35,890	1	1	841
Terminal Tractor (Truck)	7,443	1	2	715
Terminal Trailer (Semi-Trailer)	2,049	1	6	478
Forklift (10t) (Forklift)	19,136	1	1	638
Forklift (6t) (Forklift)	3,482	1	3	348
Forklift (4t) (Forklift)	2,199	1	2	147
Forklift (3t) (Forklift)	2,133	1	2	142
Portable Slat Conveyer	3,039	1	1	19
Total	-	-	-	3,328

4) Fuel Cost

The annual operating time of cargo handling equipment is assumed to be equal to the docking time (2,973.25 hours). As for the fuel cost rates, the values given for similar items of equipment in the Construction Machine Depreciation Manual have been used as reference. The motor output levels have been taken from the values given in maker catalogues, and the local cost of fuel (light oil) has been assumed to be 30 yen/liter.

Based on the above figures, the annual consumption of fuel was calculated in the manner shown in Table 3-7. From this, the annual fuel cost works out as follows:

Annual fuel cost = annual fuel consumption x local fuel price
= 267,957 l/year x 30 yen/l
= 8,038,710 yen

Table 3-7 Annual Fuel Consumption

Equipment to be procured (reference equipment given in Depreciation Manual)	Fuel Consumption Rate (l/PS/hour)	Horse Power (PS)	Annual Operating Time (hr)	Number of Equip-ment Units	Annual Fuel Consumption (l)
Reach Stacker (Truck Crane-hydraulic system)	0.077	288	2,973.25	1	65,935
Terminal Tractor (Truck)	0.040	182	〃	2	43,290
Terminal Trailer (Semi-Trailer)	-	-	〃	6	-
Forklift (10t) (Forklift)	0.077	150	〃	1	34,341
Forklift (6t) (Forklift)	0.077	82	〃	3	56,319
Forklift (4t) (Forklift)	0.077	85	〃	2	38,920
Forklift (3t) (Forklift)	0.077	53	〃	2	24,268
Portable Slat Conveyer	0.219	7.5	〃	1	4,884
Total				-	267,957

5) Expendable Parts Cost

Expendable parts refer to those equipment parts which come into direct contact with cargo and are relatively easy to replace. The level of damage and wear and tear in such parts varies greatly according to the work conditions.

Here, the expendable parts cost has been calculated as the tire abrasion cost and maintenance cost for all vehicular equipment (not including the portable slat conveyors), and the value given in the Construction Machine Depreciation Manual for the case of a dump truck (6-7 tons) under normal ground conditions has been used as reference. The results of the calculation are as follows:

Annual expendable parts cost
= (abrasion cost + maintenance cost) x operating time x number of equipment units concerned
= 196 yen/hour x 2,973.25 hours x 17 units
= 9,907,000 yen

The combined total of all the costs described above works out as follows:

3,328 + 1,043 + 8,039, 9,907 = 22,317 (1000 yen)

The annual maintenance and operation cost described above greatly exceeds the annual operation and maintenance cost expenditure of the Massawa Port Authority, which currently stands at approximately 1,500,000 Birr (23,900,000 yen). However, rough calculation of the income that can be gained from charges for the operation of the procured equipment shows that this will come to approximately 55,800,000 yen (see Table 3-8), meaning that it should be possible to comfortably afford the annual operation and maintenance cost.

Table 3-8 Income from Charges for the Equipment to be Procured

Equipment	Number of Units Procured	Increase in Number of Units	Use Charge (US $/hr)	Annual Operating Time (hr/year)	Annual Use Charge (US $/year)	Remarks
Reach Stacker	1	1	65.50	2,973.25	194,747.88	
Terminal Tractor	3	2	17.85	〃	106,145.03	
Terminal Trailer	6	6	1.70	〃	30,327.15	
Forklift (10t)	2	1	12.50	〃	37,165.63	
Forklift (6t)	4	3	12.50	〃	111,496.88	
Forklift (4t)	4	2	8.95	〃	53,221.18	
Forklift (3t)	3	2	7.15	〃	42,517.48	
Total	-	-	-	-	575,621.23 (55.8)	

Note 1: The charges for use are taken from the revised tariff prepared by the Ports Authority.
Note 2: The annual operating time has been assumed to be equal to the docking time.

Chapter 4 Project Evaluation and Recommendation

4-1 Project Effect

(1) Validation of Appropriateness

It is no exaggeration to say that Massawa Port is the sole physical supply center for the north of Eritrea, which contains the capital Asmara and is where most of the population is concentrated. Through restoring the functions of the said port, which was devastated during the long war of independence, the Project will secure a base for the supply of food, cement and other daily necessities and thus provide an immediate response to the need to improve the living conditions of returning refugees (estimated at between 750,000 and 1,000,000) and ordinary residents in the north of the country. The Government of Eritrea has made restoration of the infrastructure in all areas one of the top issues within its Recovery and Development Plan, and preparation of the transport infrastructure based around the country's ports, in particular redevelopment of Massawa Port, is regarded as a top priority issue within this general goal. Implementation of the Project, which focuses on the supply of cargo handling equipment to allow the effective utilization of existing port facilities, is considered to be timely as the first stage in this process of port redevelopment.

Regarding the Project implementation (operation and maintenance), this will not place any great burden on the Ports Authority (the counterpart agency) in terms of budget, staffing or organization. Moreover, because the equipment to be procured will basically either replace or bolster existing items of equipment, the Project can be said to be appropriate in terms of its content.

With respect to profitability, the Ports Authority charges shipping companies for use of the cargo handling equipment and puts the income from these charges to use in carrying out the maintenance of facilities (maintenance of paving in the sorting yard, etc.) and repair of equipment it directly manages. The equipment procured under the Project will also provide income to the Ports Authority from charges for its use, although it is thought that this will not be enough to cover the cost of maintenance and renewal of the said equipment.

In consideration of the above points, the Project is considered to be highly appropriate for implementation under the grant aid system of the Government of Japan.

(2) Beneficial Effects

The direct effects that will be brought about as a result of Project implementation are as described below.

1) Procurement of the reach stacker will enable between 10% and 30% more containers to be stacked in the container yard.
2) Procurement of the terminal tractors and terminal trailers will make it possible to shorten the time taken to unload container ships to between half and one-third of the time it currently takes.
3) The Eritrea side is planning to import 2,000 pallets in 1996 and, through procuring the various fork lifts included in the Project, it will be possible to expand the range of the palletizing system (currently covering around one-third of all cargo handled) and thus reduce cargo breakage accidents and shorten work times.

4-2 Recommendation

In addition to having a great effect in terms of improving port cargo handling functions, implementation of the Project will contribute to the stable and efficient supply of food, daily necessities and materials for use in the war recovery effort, which is the single greatest issue facing Eritrea at this time. For these reasons, it is judged that implementation of the Project under the grant aid system of the Government of Japan is highly appropriate. Moreover, in terms of operation, the setup at the Ports Authority is considered to be sufficient in terms of both budget and staffing, and the

scale and contents of the Project equipment are thought to be appropriate in view of the fact that income from charges for use of the equipment can be used to finance maintenance.
However, as is only to be expected in a country in a period of recovery following war, ceaseless effort will be required to make improvements in all areas. The effort to improve port operation and management technology currently being conducted with cooperation from Germany is an object example, and it is desired that the Ports Authority continues to maintain its earnest approach into the future. If such improvements on the software side are further advanced, there is every likelihood that the equipment procured under the Project will be put to even more effective use.
Finally, as cooperation with the State of Eritrea has only just commenced, it is thought that the Government of Eritrea may not be fully versed in the various practices of Japan's grand aid system. Therefore, in order to realize the smooth procurement of the Project equipment, it is desirable that detailed follow-up with the recipient side be conducted during the implementation stage.

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