REPUBLIC OF COSTA RICA
MINISTRY OF PUBLIC WORKS AND TRANSPORT
GENERAL DIRECTORATE OF PORT WORKS

FEDERAL REPUBLIC OF GERMANY
GERMAN AGENCY FOR TECHNICAL COOPERATION (GTZ) LTD

gtz

INTEGRATED ATLANTIC COAST PORT STUDY
MASTERPLAN LIMON/MOIN

VOLUME II
FINAL REPORT

JULY 1980

RRI
RHEIN-RUHR INGENIEUR-GES. MBH

ptc
PORT AND TRANSP.CONS. BREMEN GMBH

DEC
DECONSULT GMBH

ACKNOWLEDGEMENT

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Space limitation prelude individual mention of all.

We would like to take this opportunity to express our sincere thanks especially to

His Excellency
The Minister of Public Works and Transport

Ing. Rodolfo Méndez Mata,

and

Ing. León Venegas, Advisor to the Minister.

Furthermore, the Consultants like to mention:

MOPT, Dirección General de Obras Portuarias

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Ing. Rodolfo Cruz	Ass. Director
Ing. Rodriguez	Counterpart

MOPT, Dirección General de Transporte por Agua

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Ing. Manuel Saenz Herrero	Director General
Ing. Carlos Corales	Engineer

INTEGRATED ATLANTIC COAST PORT STUDY

MASTERPLAN LIMON/MOIN

CLASSIFICATION

Volume III

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(see Volume IV)

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Abbreviations:

MOPT	Ministerio Obras Públicas y Transportes
JAPDEVA	Junta de Administración Portuaria y de Desarrollo Economico de la Vertiente Atlantica
RECOPE	Refinadora Costarricense de Petroleo, S.A.
OFIPLAN	Oficina de Planificación Nacional y Politica Economica
CODESA	Corporación Costarricense de Desarrollo
FECOSA	Ferrocarril de Costa Rica

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by RRI, DEC, 1977

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A. GENERAL

1. Order

The Government of the Republic of Costa Rica has decided that the problems of the Costa Rican Atlantic Coast ports shall be solved within an integrated scheme of development for the ports of Limón and Moín. In order to accomplish such an objective, a Masterplan Study should be undertaken covering the following main items:

- Evaluation of the ports of Limón and Moín and other possible places for ports on the Atlantic Coast

- Review of the location and design of the port of Moín

- Short and medium term Masterplan of the ports of Limón and Moín.

In June 1978 the Ministry of Public Works and Transportation (MOPT) of Costa Rica requested consulting services of Rhein-Ruhr Ingenieur-Gesellschaft (RRI) mbH for an integrated Atlantic Coast port study project. The contracted works included a so-called "Immediate Study", which should be the basis for a Masterplan Study for the ports of Limón and Moín. The "Immediate Study" has been carried through within the time of 6 weeks in Autumn 1978.

The "German Agency for Technical Cooperation (GTZ) Ltd.", asked RRI in spring 1979 to submit an offer concerning the conduction of a "Integrated Atlantic Coast Port Study - Masterplan Limón/Moín"; for which the respective contract was signed on November 11, 1979 (P.N. 79.2054.9 - 01.100/1300).

The aim of the project is to create a basis for a systemized harbour development at the Atlantic coast of Costa Rica. One of the major goals of the Masterplan Study is to provide a planning instrument enabling the Costa Rican Government to:

- Formulate its own investment projects, justify them technically and consider them in the national investment program

- Formulate its demand towards the regional development planning, especially the location of other coast users and the planning of the infrastructure in the hinterland

- Judge and decide investment proposals that are lodged from various sides on the basis of an integrated development program

- Orientate the harbour development according to future requirements and not according to present bottlenecks

- Use in an optimal manner the limited financial means, especially use the possibilities of performance increases without extensive investments.

2. Scope of services

To fulfill the determined aim of the project the following tasks are required:

Traffic Forecast

The forecasts on traffic and cargo handling development as shown in the "Immediate Study" of September 1978 will be reviewed, updated and, if necessary, completed.

Port Operation and Organization

Based upon the results of the traffic and infrastructure study of 1978, this study will include a concept of the

- necessary quay facilities
- free space
- transit sheds and warehouses
- repair shops
- administration buildings
- connections to the hinterland etc.

all of which will be designed in a way to meet the requirements of a modern port.

Based again on this concept, recommendations will be worked out concerning the port organization, which shall cover in detail:

- basic organization of the ports
- range of responsibilities of the individual port operation sectors in the ports of Limón and Moín
- splitting up of responsibilities within the sequence of cargo handling operations
- flow of information.

Recommendations will be made concerning the port operation, especially for

- optimal operation system
- coordination
- assignment of staff, equipment and machinery
- customs clearance.

An equipment list will be set up including number and type of required equipment depending on the operational requirements.

And finally, a reasonable draft concept for maintenance and repair of equipment will be drawn up for the workshop.

Engineering Part

Based on the masterplan concept structural predesigns will be developed for all construction measures required for the operation of the ports of Moín and Limón including the respective cost estimates. These will cover in particular:

- breakwater
- quays
- buildings
- storage areas
- service roads and railways
- water supply and disposal within the harbour area
- energy supply and telecommunication
- other, as for instance lighting, access channels and turning basin

Furthermore, extensive oceanographic and hydrographic measurements will be conducted with the aim of providing especially in the port of Moín:

- an optimal arrangement of port protection structures
- basic data for the design of the structures
- knowledge of the sedimentation problem of the port of Moín by the Moín river

Traffic Infrastructure

During this study the recommendations from the traffic and infrastructure study of 1978 for an improvement of the railway and road connections in the hinterland of the ports of Limón and Moín will be reviewed and updated with the aim of a smooth transportation of the goods to and from the handling facilities in the harbour area. Special attention in this respect shall be attached to banana transport. In detail the following issues will be investigated:

- study of the traffic volume
- capacity analysis of the existing transportation means
- modal split of the future traffic streams to rail and road
- planning of the necessary infrastructure measures in future in the port and the hinterland up to the connection to the existing traffic facilities (incl. shunting yards at Moín and Limón).
- planning of traffic facilities and parking space
- cost estimates for the new facilities

Water Supply and Disposal

The study will investigate the possibilities of water supply of the port of Moín. The solution that is the best from the technical and economic point of view will be discussed in detail. The expected investment and operating costs will be estimated by use of empiric values. No preliminary design will be made, as the time needed for that cannot be estimated at this stage. But it will be indicated to what extent investigations and pre-planning work will be required to draw up the design. A structural preliminary design will be drawn up for waste water disposal and treatment facilities.

Economic Investigations

The aim of the economic studies within the investigations is to set up a cost-benefit analysis based on the operationally and technically best solution for the ports in order to provide evidence of the economic benefit for the Costa Rican national economy.

3. Assignment of Personnel

The project with the management responsibility of Rhein-Ruhr Ingenieur-Gesellschaft (RRI) mbH was carried out in cooperation with two qualified German consulting firms, Port and Transport Consulting Bremen (PTC) GmbH and Deutsche Eisenbahn Consult (DE-CONSULT) GmbH and, as external expert, Prof.Dr.-Ing. Ole Burkhardt from the Franzius-Institute of the Technical University of Hanover.

The execution of the works has been performed in two stages. At the end of phase I, that means after completion of the field investigations and establishing of design criteria in Dec. 1979, the results were presented in Costa Rica for discussion and approval. They are included in the Interims Report (Jan. 1980) which served as the basis for all further works of the study performed thereafter in the home offices of the Consultants.

To prepare the assignment of experts, make an inventory of the actual situation and conduct surveys and establish design criteria, the following experts stayed in Costa Rica in the period from October 8, 1979, to December 22, 1979.(except surveyor):

Project Management	Dipl.-Ing. Vetter	16.11.1979 - 14.12.1979
Local Project Management and Transport Economist	Dipl.-Ing. Hartmann	8.10.1979 - 14.12.1979
Traffic and Transportation	Dipl.-Ing. Nicolai	8.10.1979 - 14.12.1979
Railroad Design and Operation	Ing. Riemann	22.10.1979 - 14.12.1979
Harbour Engineering	Dipl.-Ing. Czichy	24.10.1979 - 14.12.1979
Port Organization	Oec. Hoffmann	24.10.1979 - 14.12.1979
Port Operation	Capt. Hütten	24.10.1979 - 14.12.1979
Surveyor	Ing. Heise	21.11.1979 - 22.12.1979 28.01.1980 - 26.02.1980 13.05.1980 - 13.06.1980
Oceanographical Expert	Prof. Dr.-Ing. Burkhardt	7.12.1979 - 14.12.1979

Ing. Schosinsky who resides in Costa Rica was in charge of the water supply investigations for the port of Moin.

Upon completion of the preliminary investigations, the results of the surveys, and, based there upon, the conclusions drawn from these results were presented to the employer and the Costa Rican authorities in order to discuss the available results, synchronize and coordinate them with the objectives of the Costa Rican authorities. Both presentation and interim discussions took place at Limón and San José, Costa Rica, in the time from December 5, 1979, to December 13, 1979.(In Annex A-1 of this chapter the Minutes of Meeting of this reunion are listed).

The "German Agency for Technical Cooperation (GTZ), Ltd." as employer was represented by Dipl.-Ing. Naschold and Dr.-Ing. G. Naschold as independent expert, who stayed in Costa Rica for this project from December 4, 1979, to December 14, 1979.

4. Organization of the Study

The study consists of four (4) volumes.

Volume 1, the Summary Report, gives a brief description of the works carried out, starting with the findings of the analysis phase necessary to work out prognosis results and finishes with the Masterplan recommendations.

Volume 2 contents of Chapter A, General Subjects concerning the Study, Scope of Work and Personnel Assignment; Chapter B, which gives a detailed description of the present port situation on the Atlantic Coast in Costa Rica;Chapter C, Traffic Analysis and Forecast; Chapter D, which is engaged mainly with the problems involved with containerization and Chapter E, which describes the present and future operation characteristics of the harbours of Limón and Moín.

Volume III, the second part of the study, presents the major findings of the Masterplan Report, the Consultant's recommendations concerning port development of the Atlantic Coast: Chapter F describes the future port use of the harbours of Limón and Moín until and beyond the year 2000, whereas Chapter G deals with the recommended port operation structure. Chapters H, I, J, K discuss the future nautic concept, describe and analyse oceanographic, hydrographic and hydrological investigations, give recommendations concerning the future water supply of the Limón/Moín harbour area and describe preliminary designs of the major structures in the ports of Limón and Moín necessary to maintain efficient harbour operation for the present. Chapter L, a cost-benefit-analysis, takes into account expectable port user benefits and related rehabilitation and development costs, when discussing the economic feasibility of the before proposed measures.

Volume IV is a drawing-volume to be used as a supplement for illustration to the findings described in Volume II and III.

Annex

(Chapter A)

Minutes of Meeting 15.12.79

San José

Minutes of Meeting 9./10. 1.80

San José

PORT MASTERPLAN STUDY ATLANTIC COAST

COSTA RICA

<u>Minutes of Meeting</u>

Held on December 11, 1979, in the Ministry of Public Works and Transport

<u>Participants</u>

Ing. Rodolfo Mendez Mata	Minister of Public Works and Transport
Dipl. Oec. Mathes	German Embassy
Dr. Ing. Naschold Dipl. Ing. Naschold	German Agency for Technical Cooperation (GTZ) Ltd.
Ing. Leon Venegas	MOPT, Assistant to the Minister
Ing. Rodolfo Cruz Ing. Eduardo Soto Ing. Carmen Hidalgo Ing. R. Rodriguez	MOPT, Dirección General de Obras Portuarias
Ing. Olman Elizondo Morales Ing. Napoleon Morúa	MOPT, Dirección General de Transporte por Agua
Lic. Max Alavarado	Japdeva
Ing. Caludio J. Volio	Ferrocarriles de Costa Rica
Ing. Manuel Saenz Herrero	Recope, Projecto Portuario Moín
Ing. Mario Herrera Ing. Richard J. Morris Ing. Peter Smith Ing. Frank Ulloa	MOPT, Dirección General de Planificación
Dipl. Ing. Vetter Dipl. Ing. Czichy	Rhein-Ruhr Ingenieur-Gesellschaft mbH
Dipl. oec. Hoffmann Capt. C. Huetten	Port and Transport Consulting Bremen Gesellschaft mbH
Ing. Riemann Dipl. Ing. Nicolai	Deutsche Eisenbahn Consult GmbH

2. Degree of containerization

Only general cargo and bananas have been taken into consideration. The containerization of general cargo will raise rapidly with the completion of the Proyecto Aleman and will further increase up to the year 2000. As far as the bananas are concerned, Bandeco is to be expected to containerize due to its merger with Reynolds (Sea Land). Standard Fruit and United Fruit do not foresee containerization even in the year 2000. As the Consultant doubts in these statements, two alternatives have been worked and:

Case A = No containerization of bananas for Standard and United.
Case B = 100 % containerization of bananas in the year 2000.

3. Calculation of capacity utilization

3.1. Container Terminal

In case A the projected container terminal will be sufficient up to the year 2000 with regard to one berth, projected stacking area and two container cranes (second to be installed in 1986).

In case B the situation is the same up to 1990. In 1992 the shed on the Proyecto Aleman has to be removed in order to extend the stacking area. In 1995 a second container berth must be available, additional area for stacking and two additional container cranes (one to be installed 1994/1995, the next 1998).

3.2. Ro/Ro berth

Ro/ro traffic has priority in the Proyecto Aleman; Moin should only be used in exceptional cases. The utilization of the ro/ro berth is even in the year 2000 relatively low so that general cargo vessels can be handled at this berth in addition.

3.3 Break bulk and general cargo in Limon

Up to the year 2000 sufficient berth spaces are available for break bulk and general cargo.

The Muelle 70 is capable only to operate one vessel per time, and should be reserved for break bulk.

The Proyecto Aleman will handle all arriving general cargo.

In case of high containerization (case B) in 1995 a new general cargo berth will be required.

3.4 Bananas in Moin

Up to the year 2000 one oil berth with low utilization and two banana berths will meet the forecasted cargo volume.

The utilization of those two berths never will exceed 60% (the economical utilization).

The operation system will be the elevator loading which enables the port also to handle other commodities during low utilization.

In 1990 the fifth elevator will be required. In case of high containerization (case B) the utilization of the banana berths will be zero in 2000.

The port has to decide for new commodities to be handled there.

4. Port Development

In case A, low containerization of the bananas, are after completion of the port facilities under construcion in Limon and Moin no additional berthing places necessary, In Limon only the existing railway yard should be rehabilitated and a modern workshop for maintenance and repair of the port operation equipment should be provided.

For case B, high containerization of bananas, the existing and in due time completed port facilities are not sufficient to handle the expected traffic flow. In the year 1992 an additional general cargo berthing place and in the year 1995 an additional container berth are necessary, Both berths should be located in Limon, since there is already similar berthing and operational equipment and any new (similar) development could be integrated into the operational mechanism.

Additional works will be conducted, aiming to answer the question if a container terminal located in Moin would be an economic justifiable alternative. Alternative solutions for Limon will be compared accordingly.

The following subjects have been presented and discussed accordingly:

1. Expected Port Traffic Forecast

Present situation: Limon is considered as specialized in the export trade of bananas, summing up 65% of the whole trade of the harbor of Limon. Next in importance in the export trade is coffee. Within the import trade the imports of paper (25%), iron (9%), silicate (6%) and fertilizers (5%) are of most importance.

Future development: Existing traffic forecasts (immediate study, SYSTAN-Forecast, Japdeva-Forecasts) were revised as far as their plausibility is concerned and at the same time modified in accordance with the latest research works. The year 2000 was taken as the aiming year. Structural modifications, as for instance, the Industrial Zone could not be taken into consideration as until now there are only ideas but no specific projects knowing which could lead to a further disaggregation of traffic commodities. Export volumes in a smaller extent of the planned free trade zone are included in the traffic forecast.

Banana export: Banana export may grow by 50% from 1978 to 1990 from 40 mio. boxes up to 60 mio. boxes. Until 2000 an additional export volume of 10 mio. boxes is expected because of the partly shifting of the export directed to Europe and exported nowadays by Golfito from Golfito to the Atlantic Coast. In total, in 2000 there will be exported 70 mio. boxes of banana (equivalent to 1,27 mio. tons) via Limon/Moin.

Export: The export trade volume has not been changed esentially in comparison with the immediate study. Shifting of coffee exportation from Panama to Limon were taken into consideration (because of the containerization of coffee and the beginning of container-operation in Limon).

Import: The different import goods were forecasted separately i.e., iron (staying at 10 to 12% of the import volume), paper (staying at 25% until 1990 and going down then because of a new paper factory), silicates (going up to 10% of the import volume because of enlarging the existing factory at Cartago). Within fertilizer-import forecasts there are two alternatives:

- 1st- Only bagged fertilizers will be imported via Limon (5% of the import volume)
- 2nd- Fertilizers as bulk will be imported via Limon up to 100,000 to 150,000 tons per year because of the installation of a new fertilizer factory in the industrial zone of Moin.

A special port handling problem is given by the proposed import of bulk fertilizer and the import/ export of some special liquid chemicals in Moin. In the Consultants opinion the assignment of a berthing place for handling these goods depends largely on the fact that any close location and possible connection to the banana piers must be avoided. Since at the time of the meeting the different types of fertilizer to be handled have not been known, this complex theme will be subject to further analysis and works.

As a result of the improvement of the physical port facilities as well as the operational and nautical requirements, the volume of port owned water vehicles, such as tugboats, pilot boats, etc. will to such an extent increase, that it could be advisable to have a port owned marine yard including a small slippway for repair and maintenance. For this the area at the foot of the northern breakwater at Moin seems to be the preferable location.

5. Nautical Requirements

The buoyage system in both ports should be "system A" green color at starboard side, red color at port side.

Wrecks and shallow water spots to be avoided. Isla Uvita Lighthouse to be rehabilitated. Leading light system at Moin, indicating the center line of the channel.

For ship manuevers two tugboats are required, with 20 tons bollard pull back, 20-22 in buoy, 3-4 in draft, having foam fire fighting equipment aboard.

For the safe ship manuevers at the Proyecto Aleman it is urgently AVERIG required to remove the Puesto 1 of the Muelle Metalico.

6. Hydrographical Aspects

In this context, the influence of River Moin on the hydraulic situation within the Port Moin and possible siltation of the Port is of utmost importance. For this reason, extensive measurements of the natural conditions are undertaken at present. The result of these measurements will be the basis for the necessary structural measurements. Furthermore, the most economical breakwater length will be examined in relation to the allowable swall on the different berthing places.

7. Port Organization

In order to guarantee an integrated national port policy and the organizational integration of Limon/Moin it is recommended to establish a National Port Authority as well as a Port Authority in Limon.

As far as the allocation of responsibilities in Limon is concerned, four alternatives have been evaluated. It leads to the result that one alternative should be favored choosing a limitation of the stevedoring companies to the ship's side while the Port Authority should take over the public services as well as the shoreside operation.

It could finally be stated that the decision of the organizational system has to be seen on the long run so that existing problems have to be solved now. Furthermore only one organizational system can be recommended for the whole port area, a mix-up of alternatives is disadvantageous. This includes that factories/industries which perform their operation by themselves should not be located in the public port area.

8. Traffic Connection to the Hinterland

8.1 Road

The city and the port of Limon is directly connected to the hinterland by thenew road to Siquirres (Highway 32), whereas for the port of Moin a sufficient road connection to highway 32, Limon-Siquirres is not available. The construction of this new connectional road is necessary, the shipment is affected by the existing topography.

The road traffic between the two ports will be handled via this new road. The existing road connection via the Portete-Limon road will be used in future only by passenger cars.

8.2 Railway

In order to find our proper solutions for connections of the ports to the hinderland it is recommended for the Port of Moin a double track connection to the planned yard in Moin area.

For the harbor tracks at Moin itself two solutions have been considered:

For the first solution the length of the pier of 404 m. will be sufficient. But we recommend the second solution, this means, a total length of the pier of 450 m. is necessary, The reason for this are switches and one more track crossing than at the first solution.

We recommend this solution mainly from the operational point of view. The rebuilding of the tracks at the harbor Limon will take place within two phases:

In the first phase the new part of the harbor, the so called Proyecto Aleman, is to be connected to the yard Limon. Also by this phase the western part of the harbor tracks is to rebuilt.

In the second phase the connection to the so called Muelle Metalico can be cut off. Also a new passenger station of Limon will be installed. ?

As the layouts of the harbor tracks, both of Limon and Moin and of the new planned yard at Moin have great influences on each other, special recommendations were presented in the final study.

These during the meeting presented and discussed solutions are of preliminary nature. During the further course of the study, these subjects will be in a more complex manner analysed, and presented accordingly.

San José,
December 15, 1979

INTEGRATED ATLANTIC COAST PORT STUDY

MASTERPLAN LIMON/MOIN

Minutes of Meeting

held on September 9/1o, 198o in the Ministry of Public Works and Transport, San José, Costa Rica.

Participants

Eng. Leon Venegas	MOPT, Assistant to the Minister
Eng. J. Chacón	MOPT, Director of Dirección General de Obras Portuarias
Eng. E. Marin	
Eng. Eduardo Soto	
Eng. R. Rodriguez	MOPT, Dirección General de
Eng. Carmen Hidalgo	Obras Portuarias
Eng. Napoleon Morúa	MOPT, Dirección General de Transporte por Agua
Dipl.Eng. Vetter	Rhein-Ruhr Ingenieur-Gesellschaft mbH
Dipl.Oec. Hoffmann	Port and Transport Consultants, Bremen

At this meeting the consultants presented and explained the draft of the masterplan study of July 198o.
The client accepted the study asking, however, for a more detailed description and the integration of certain subjects into the Final Report of the study.
Mainly the following items are concerned which are assigned to the individual chapters of the study:

Chapter F, Volume III

- more detailed description of development limits for the harbour of Moín,
- more detailed description of the date at which a breakwater extension shall have to be carried out when extending the harbour of Limón,
- data on possible material deposits to quarry filling material for an extension of the harbour of Limón,
- to furnish evidence whether sheds no. 2, 3 and 6 will be needed in the future and if not, whether the area can be used as ro-ro parking area.

Chapter G, Volume III

- description of allocation of tasks for the harbour organization alternatives.

Chapter H, Volume III

- presentation of lighting "System B" instead of "System A" for the harbours of Limón and Moín due to the governmental decision to introduce "System B" in Costa Rica.

Chapter I, Volume III

- more exact description of investigations which will become necessary in Moín to get more safe information on the local water rescources.

Chapter K, Volume III

- statement on the necessity of an emergency water tank in the harbour of Limón and if yes, data on the required volume.

Chapter L, Volume III

- explanation of the assumed exchange rate of Colones and US Dollar,
- explanation of the assumed inflation rate,
- explanation whether reduced freight rates were considered in the study when releasing the congestion surcharge.

The consultants undertake to treat the discussed subjects and to integrate them into the Final Report.

Dortmund,

September 22, 1980

B. PRESENT SITUATION ON THE ATLANTIC COAST

1. General Description of the ports of Limón and Moín and of the Situation on the Atlantic Coast

There are six deepwater anchorages serving Costa Rica:

Port Limón and Moín on the Caribbean Coast, Caldera, Puntarenas, Punta Morales and Golfito on the Pacific Coast (cf. Map of Costa Rica, drawing B-1.1). Except for Golfito, which is naturally protected, all other anchorages are exposed to the sea and have only the partial protection of natural shoreline features such as islands, peninsulas and coral shoals.

Port Limón is the principal port of the Republic (cf. drawing B-1.2, General view Limón/Moín area). It is situated at latitude 9° 59' 49" N, longitude 83° 00' 48" W. A good anchorage in the lee of Uvita Island, with water approaches of 14.5 to 18 meters depth is available at the port. Limón is known as a harbour place since the XVIth Century, after having been discovered by Christopher Columbus on his fourth voyage in 1504.

Now, the port of Limón handels about 88 percent of the Country's sea trade and 60 percent of the total foreign trade.

The port has three piers ; the larger piers known as the "Muelle Metalico", is a T-shaped structure having three berths: (1) 160 meters long, (2) 160 meters long and (3) 122 meters long, and the smaller pier , known as the "Muelle Nacional".

The third pier, called "Muelle 70", was originally planned as a provisional banana pier, but used only for general cargo after completion in 1970. At present, two important projects are under construction and will be completed until the end of 1981:

- Container and Ro-Ro Terminal in Limón (Proyecto Alemán)
- Moín Terminal for crude oil, Ro-Ro and Banana (under supervision of MOPT and RECOPE).

Port Limón is connected by rail to the nation's capital at San José, a distance of 165 kilometers; road via Siquirres, Turrialba and Cartago with a length of about 176 kilometers; a new highway of about 130 km length is expected to be in service by the end of 1981 (via Siquirres, Guapiles, San José - highway No. 32).

Moín has a tanker terminal with one berth connected with a ro-ro ramp, two banana berths are under construction. The terminal serves the Recope Refinery, and it is situated at latitude 10° 00' 30" N longitude 83° 05' 10" W.

River shipping in Costa Rica has traditionally been confined to the San Juan, San Carlos, Sarapiqui and Frio Rivers on the Caribbean, and the Tempisque and Grande de Tarcoles Rivers on the Pacific. Use of river transport has declined in recent years in proportion to improvements in highway access. River transport remains of significance only on the San Juan River.

Coastwise shipping along the Caribbean Coast has no more commercial significance. Improvements of canalization in the coastal lowlands between Moín and the Nicaraguan border and construction of the Moín river terminal allow river and littoral transport service for that region.

Also, improvements on rural and highway access, especially to the south (i.e.Panamenian border) shift cargo transport to landside transportation means.

In the next sections of this chapter, a more detailed analysis of the present situation of the ports of Limōn and Moīn is presented, covering such aspects as existing structures, operational and organizational aspects, nautic conditions and infrastructure available.

2. Description of structural facilities in the harbours of Limón and Moín

2.1 Description of structural facilities in the harbour of Limón

2.1.1 Off-shore facilities
(Drawing B-2.1, 2.2,2.3)

The present harbour facilities at Limón include 3 piers and one breakwater. Two berthing places including storage areas are presently under construction. The 3 piers - in the order in which they started operation - are named as follows:

1. Muelle Metálico
2. Muelle Nacional
3. Muelle Setenta

Muelle Metálico , in its original shape, was put into operation in 1904, thus being the oldest pier in the harbour. Mainly banana export is handled via this pier, but also general cargo and, in smaller quantities, liquid bulk.

Muelle Nacional was the second pier in the harbour of Limón starting operation. It has one Ro / Ro ramp and one berthing place for coasting motor vessels, and is also used for harbour-owned boats, such as tug boats, pilot boats, etc.

Muelle Setenta, which started operation in 1972, serves now for handling general cargo and break bulk.

A detailed description of these structural facilities will be given in the following.

Muelle Metálico (Drawing B-2.2)

Muelle Metálico is an all-steel construction having a T-shaped form. It has one access bridge and berth facilities located at right angles to it. The access bridge runs from north-west to south-east and consequently the berthing place from north-east to south-west. The length of the access bridge is 330 m. Its original width of about 11 m was extended by 10 m over a length of 140 m on the north-east side following the increasing mechanization of banana handling.

The total length of the berthing place amounts to about 320 m at a width of approx. 23 m. To enable railway service between access bridge and south-west part of the pier, the transition area between bridge and pier is extended correspondingly. Muelle Metálico offers 3 berthing places (Puestos 1 to 3) with the following lengths:

P1 = 160 m
P2 = 160 m
P3 = 122 m

While Puesto 1 serves for banana handling, Puestos 2/3 are used for general cargo, break and liquid bulk. During the dredging works carried out in the course of the preliminary work going on until April 1980, the 3 berthing places are being dredged to a water depth of - 10 m (NMM).

There is a berthing place for barges and mooring boats at the south-west side of the access bridge, i.e. Puesto 4. The original design of the pier was for railway service only. Two railway tracks provide landside connection, with 2 tracks branching off at the access bridge as a link to the banana handling plant, and end at the conveyor belt.

The main tracks on the south-west part are leading to berthing places 2 and 3. Each berthing place is served by two tracks being operated by points.

As the pier was designed for railway service only, mobile industrial vehicle traffic is hardly possible. Being covered with planks, the pier surface is suitable mainly for pedestrian traffic; only at some places is the surface flush with the rails. The rails are fastened onto wooden sleepers by simple wooden nails with wide heads. The wooden sleepers rest upon the steel construction. The pier is roofed in the area of the banana handling facilities. Various control, supply and repair facilities for banana handling are located directly opposite berthing place 1 beside the conveyor belt. Further facilities and workshops serving for the current repair works at the pier exist in the transition zone between access bridge and berthing pier.

A repair workshop for damaged ropes and mooring gear is situated outside the operating area at the north-east end of the berthing place. The name of each incoming ship is written on the pier surface in capital letters.

In this way, the conveyor belts can be put into a correct position for feeding through the hatches before the vessel has finished its berthing operation.

Other facilities are 5 pipelines at the north-east side of the access bridge. Two pipelines with a diameter of 6"lead to the south-west part of the berthing pier and serve for handling of liquid bulk. Two pipelines with diameters of 12"and 8" are out of order while one is operated as fire extinguishing and hopper line for ships.

The substructure of the older part of the pier consists of round steel piles with a foot resembling a disc auger by which the piles are screwed into the ground. Stiffening is achieved by transverse and longitudinal bracing consisting of crosswise arranged connecting bars tied together by coupling units. The piles have special caps to support and fasten the longitudinal and cross girders. The longitudinal and cross girders are T-profiles made of web plate, flange angles and flange plates fastened by rivets. Additional stiffening of the construction is achieved by strong horizontal bracing at the sub-girders. The substructure of that part of the acces bridge which was built subsequently is in every detail equal to that of Muelle Nacional and therefore needs no further explanation. As a result of the age of construction numerous members of the substructure have collapsed due to high corrosion. The use of this pier is therefore very limited.

Bollards tied onto the substructure by connecting bars are installed along the south-west side of the access bridge and at berthing places 1+3 in regular intervals.

Berthing places 1 to 3 are equipped with fenders. The basic structure of the fendering system at berthing places 1 and 2 consists of Peiner profiles pile blocks comprising 2 vertical piles with a pile-to-pile distance of 4 m, and one horizontal beam on top. Five such blocks form the basic structure of one fender block having a width of 4.50 m. The individual pile blocks are stiffened against one another. The distance of the front pile row from the pier edge is 100 m, that means the last pile row extends some 3.00 m into the pier construction. One lighter IP-profile is driven at either end of each fender block at berthing place 1 about 1.50 m in front of the front pile row.

These two piles are connected by 3 IP-profiles above the water with a fender diaphragm of wooden planks on the outer side. Rubber fenders as shear fenders of the "Raykin Fender Buffer US Patent 2655005" type are installed between this outer structure and the pile blocks.

At berthing place 2, the front structure with the rubber fenders is missing and the wooden fender diaphragm is tied directly onto the front pile row of the pile blocks.

Heavy rubber tyres are hanging on the fender diaphragm.

Altogether, 7 such fender blocks at irregular intervals are arranged at each berthing place over a length of some 50 m. The fender system at berthing place 3 in the outer areas consists of a couple of wooden piles one beside the other, and steel piles in the middle. There is no fender protection. Asa temporary measure, rubber tyres are hung up here too.

Muelle Nacional (Drawing B-2.1)

Muelle Nacional is also a steel structure projecting into the harbour basin in south-east direction.

The length of the pier is 120 m, its width approx. 13.5 m. To use the pier as Ro/Ro facility, a Ro/Ro ramp was built subsequently at the top of the south-east side and was extended in 1978 to permit berthing for new ship sizes.

The ramp's loading capacity is 10 tons. The water depth at Muelle Nacional is very low. It is some 6 m at the Ro/Ro berthing place, decreasing gradually towards the shore, and is about 2.50 m at the root. The berthing places at the longitudinal north-east pier side therefore can only be used by tug and mooring boats (Puesto 5) and at the longitudinal south-west side of the pier only by coastal motor ships and mooring boats.

The pier can be served by both railway and mobile industrial equipment. Three tracks connect it to the harbour area. The pier installation also includes mooring bollards at each crossbeam along the pier edges.

The substructure of this pier is in good condition, except an optimum corrosion protection.

In the area of Puesto 5, there are berthing dolphins in the front of the pier. The dolphins consist of 8 Peiner profiles arranged in 2 rows of 4 piles each. On the berthing side a 120 m high metal plate is welded onto the construction with some rubber tyres hanging on each dolphin.

At the south-west end of the pier there is a diverting dolphin consisting of a Peiner profile that forms a quarter of a circle around the pier corner. The Peiner profiles are protected by pipe profiles driven behind in groups of 4 pipes. The whole construction is connected by strong horizontal ties above water. The dolphin fendering system consists of rubber tyres hung up in front of the Peiner profiles. The substructure of the pier is made of heavy Peiner profiles driven into the ground in groups of 4 profiles each.

One crossbeam system consists of 3 such groups, two on either side and one in the middle. According to the available plans, the driving depth is approx. 7 m with a beam-to-beam distance of 9 m and 12 m resp. The crossbeams support longitudinal double T-profiles on which the tracks are placed. The pier surface between the tracks consists of pre-fabricated concrete slabs of 20 cm thickness. Outside the track area at the pier edges there are 5-6 cm thick planks.

Muelle Setenta (Drawing B-2.2)

Muelle Setenta is the newest pier in the harbour of Limón. Contrary to the other piers, it is an all-reinforced-concrete construction, projecting as finger pier into the sea in south-east direction. With its length of 325 m and a constant width of 17 m, the pier offers 3 berthing places, i.e. Puestos 7, 8 and 9. After completion of the dredging works, the water depth at Puestos 7 and 8 having a berthing length of 176 m will be - 10 m (NMM) and at Puesto 9 with a berthing length of 90 m - 6 m (NMM).

Muelle Setenta can be served with both rail-bound vehicles and mobile handling equipment. The quay equipment includes bollards installed at every third or second beam at the tip of the pier. The fender system consisting of rubber tyres of the "Bridge Stone" type BS 500 K is screwed onto the front sides of the crossbeam by 6 heavy anchor bolts.

The fender mooring system has proved to be unsuitable. The bolts which are too close to the crossbeam edges are torn out heavily due to ship impact. The damaged fenders are now being replaced by heavy tractor tyres fastened onto the bollards.

There are 3 tracks on the pier, two along the sides and one in the middle. On 10-ton electric rail-bound crane serving the 3 berthing places. A 3-water pipeline on the pier is used for feeding of vessels and for fire fighting purposes.

The pier structure consists of driven concrete piles with a cross section of 50 x 50 cm and a length of about 26 m. One pile block consists of 6 piles, the outer piles being single vertical piles. At each third point of the crossbeam there are two piles inclined towards one another at an angle of 12^{o}; their position to the pier is at right angles. The beam-to-beam distance alongside the pier is 9.50 m. The crossbeam, which ties several piles together, supports T-shaped reinforced concrete parts in longitudinal direction of a height of 1.20 m and a top width of 1.60m which, on their part, support the railway and crane tracks. The space between the rails is filled with concrete slabs, so that top rail and top surface are on the same level. The surface of the pier is at a level of + 2.65 m (NMM). The pier is surrounded by a concrete attic of 15 cm height and 12 cm width.

Breakwater

The existing breakwater protects the harbour in the north-east and east. The breakwater root is located in the extension of Avenida 1 forming the boundary between the harbour area and the town. The breakwater follows the road on the first 65 m, that means its extents eastwards.

Then it turns off to the south-east extending over the existing coral reef into the sea. After about 483 m it turns again southward on its final length of about 175 m. This makes a total length of 723 m with approx. 275 m on the coral reef.

The crest width of the breakwater is about 10 m at the first bend and decreases to 7 m right before the breakwater head. The mean crest height of the breakwater is 3.20 m NMM. The off-shore slope varies between 1:15 and 1:2, but is mostly 1:1.8. The on-shore area has a relatively constant slope of 1:1.5. During the implementation of the Proyecto Aleman the breakwater head and the superstructure are planned to be reinforced at some off-shore areas.

Container Terminal (Proyecto Alemán) (Drawing B-2.3)

The container terminal presently under construction shall be described here only very roughly. It is scheduled for taking up operation in early 1981.Being situated under the protection of the breakwater, it extends in south-east direction. The width of the terminal from pier edge to breakwater will amount to approx. 130 m. The terminal will be equipped with a Ro/Ro ramp. The length of the 2 berthing places (Puestos 10,11) will amount to approx. 420 m. The water depth at Puesto 10 will be 10 m and will be used mainly for general cargo and Ro/Ro handling. Berthing place 11, mainly meant for container handling, will have a water depth of - 11 m (NMM). Access to the terminal is possible not only for track-bound vehicles but also for trucks or mobile industrial handling equipment. Fenders, bollards, supply lines etc. shall be according to the latest standards.

2.1.2 On-shore facilities (Drawing B-2.1)

Storage sheds

The harbour of Limón has presently 7 storage sheds (Bodegas 1 to 7). All sheds have rail connection. The shed structures are not uniform, they reach from massive walls with timber roofs over steel skeleton constructions with brickwork filling to reinforced concrete structures with steel roof trusses and steel frame construction. Where the walls are not massive or consist of brickwork the wall facing is of corrugated sheet or Eternit. The roof lining also consists of corrugated sheet or Eternit. Except shed No. 1, all sheds are single storeyed, shed No. 1 is double-storeyed. The upper floor is used as office room. All sheds are provided with gates in the side walls and partly also in the front walls, i.e. either slide gates or roller gates.

Other Buildings

In addition to the handling and storage sheds, there are the following buildings in the harbour area:

- main office
- office building of the project management Proyecto Aleman
- guard house
- stevedore and warehouse administration building
- workshop
- storage shed for local handling (at present used for construction purposes)
- cafeteria

The main office is situated at Avenida 1, at the harbour entrance. It is a 3-storey massive structure with flat roof and staggered on the frontside. A conference room is added on the east side on top of the roof. The management's office is situated in the building.

The office building of the project management of Proyecto Alemán is located at the east end of Avenida 1. It is a 2-storey building. The lower floor is a massive construction, the upper floor a timber structure. Guardhouses are located at each access to the 2 piers where all incoming and outgoing vehicles are checked.

There are various 1 and 2-storey timber buildings between Muelle Nacional and Muelle Metálico along the shore accommodating harbour operation departments, stevedore administration etc. The main workshop building (taller mecânico) with vehicle workship, locksmith's shop, mechanical and electrical workshop is located at the western harbour access in the extension of calle 8. The building is a steel structure.

Finally, there is a storage shed which is presently used for the Proyecto Alemán. It is located directly opposite the Parque Varga at Avenida 1. This shed was constructed together with Muelle Metálico some 75 years ago. The station buildings are also located in the harbour area west of the main harbour access.

Open storage areas

Approx. 20,000 m^2 are available in the harbour as open storage areas. The main open storage areas are located west of Bodegas No. 1/7. Most of these areas are not paved. Further open storage areas are located east of the main harbour access between Muelle Metálico and Muelle Nacional. These areas have meanwhile been paved.

Traffic areas

1. Railway (Drawing B-2.1)

There is a shunting yard in the harbour extending in east-west direction from the western harbour entrance to the main harbour access. Its length is approx. 750 m at a width of approx. 60 m. There is a track connection between shunting yard and the individual pier facilities and storage sheds.

2. Roads

At present the harbour has 2 access roads, the main access road being situated in the extension of Calle 1 and the western access road. Both harbour accesses are connected by a harbour road leading up to the Proyecto Alemán. Here, in the eastern part of the harbour, at the beginning of the breakwater has the entrance to the Proyecto Alemán working site. The harbour road is paved on its entire length.

2.2 Description of structural facilities in the harbour of Moín (Drawings B-2.4, 2.5, 2.6.1, 2.6.2)

2.2.1 Off-shore facilities (Drawing B-2.4)

Mooring buoys

Approx. 7 km off Limón a new harbour is being constructed at the mouth of the Moín river. Only 1 off-shore handling plant for liquid bulk has been available so far in the bay of Moín. It is connected with the Recope Refinery by 4 pipelines. In particular, there are 1 pipeline 20" for crude oil (length 1,238 m) 1 pipeline 8" for fuel oil, 1 pipeline 6" for kerosene and 1 pipeline 6" for gasoline, each 1,088 m long.

After completion of the harbour facilities which, according to the present state of planning, comprise a so-called oil pier, a Ro/Ro- ramp and a so-called banana pier, oil handling will be moved to the oil pier. Until now the harbour has been protected by a southern breakwater. There are plans for the construction of a northern breakwater since the southern breakwater does not provide protection against the main wave direction. In the following, a description of the harbour facilities which have partially been completed by now is given.

Oil pier

The oil pier runs in south-east direction and has a length of 218 m and a width of 26.20 m. The slab consists of reinforced concrete with a steel pile foundation. 50% of the piles are of the "Frodingham Bore Pile No. 4" type whereas the remaining 50% are of the "Rodange Box Pile" type. The pile lengths vary between 25 and 27 m. The design load of the piles amounts to 65 t.

The pier slab consists of a frame work concentrically reinforced bottom panel slab with a thickness of 12 cm to 15 cm. In-situ concrete is filled onto this so that the thickness of the slabs will amount to 25 cm and 50 cm resp.

The bottom panel slabs are placed on top of the framework of the construction. According to the original planning the surface of support for these slabs will have a width of 5 cm. In practice, many of these slabs have only a width of 1 to 2 cm. In addition to this, the bottom panel slabs are designed to be placed upon a mortar bed. This load spreading bed is missing in several cases or it was placed afterwards as a kind of plastering to fill the gap between frame and slab. The deck of the oil pier was fitted with joints in 54 cm intervals.

To avoid washing out of the soil, concrete slabs of a width of 3.50 m were placed immediately behind the pier. The pier height is 2.89 m above NMM. Up to now the pier has been equipped with bollards and 12 fenders of the "Bridgestone Cell Type (1150)". The water depth at the oil pier will be 14.50 m after completion of the dredging works. An oil discharging tower will be installed on the pier.

Ro/Ro ramp

The design of the Ro/Ro ramp is similar to that of the oil pier. It has a Randage pile foundation whereas the slab consists of reinforced concrete. The inclination of the Ro/Ro ramp is 4.47 % at a length of 26 m. The heigth, related to NMM, varies between 1.82 m and 2.89 m. The effective width off-shore is 25.5 m, and 21.0 m on-shore. The Ro/Ro ramp, just as the oil pier, has been structurally completed by now.

Banana pier (Drawing B-2.5)

The banana pier extending southward shall have a length of approx. 404 m at a width of 26.20 m according to the present state of planning. It has a Randage pile foundation as well.

The quay construction is designed to be supported on transversal beams at a distance of 3.6 m, longitudinal beams on the seaside and landside prefabricated beams between the transversal beams, a reinforced concrete slab and a top slab of concrete separated from the reinforced concrete slab by means of a bituminous coating. The total length of the quay slab is divided into 3 parts by expansion joints. The piles have a center-to-center distance of 3.6 m in each direction. In the midst of the quay slab 8 piles are driven. The first 3 rows of piles have a pile length of ca. 22 m, the other 5 rows of piles have a pile length of approximately 20 m. On top of the piles the main supporting transversal beams are constructed at a center-to-center distance of 3.6 m. They have a width of 1.5 m and a depth of 1.05 m. The beams in the areas 146, 186 and 215 are designed for the formation of the expansion joints as well as the beams in axis 111 to allow a future extension of the banana pier to the south. The longitudinal beam at the seaside has a width of 0.9 m and a depth of 1.05 m.The depth of the beam will be increased where a fender will be fixed, i.e. every 14.4 m. The longitudinal beams at the landside have the same dimensions as the seaside beams. The beam is supporting the approach slab too. The prefabricated beams form a T-shape with a width of 0.6 m and a depth of 0.5 m. There, two types of beams are designed. Type 1 is the standard beam and type 2 is the higher loaded beam which will be located below the rails of the banana elevator.

The longitudinal bars and the stirrups are designed to end in the transversal beams and in the slab of 20 cm thickness on top of the beams respectively. After pouring of the slab the prefabricated beams are integrated in the monolithic structure of the quay construction. After pouring the first part of the transversal and longitudinal beams and after placing of the prefabricated beams this slab with a thickness of 20 cm will be poured. This slab will guarantee the equal distribution of the wheel loads and will give the required stiffness of the quay construction.

After placing and fixing of all rails for the banana elevator and the railway this slab will be poured. The slab will be divided by expansion joints so that the size of a single slab should not exceed 50 m^2. To allow different movement due to expansion and contraction a bituminous coating will be painted on top of the concrete slab before pouring of this top slab. The approach slab has a thickness of 0.35 m and a width of 3.50 m. The length of the slab will be divided by expansion joints at a distance of 3 x 3.6 = 10.80 m.

The approach slab can only be poured after placing of all pipes and cables which will be made for the infrastructure. At the time of the preparation of the redesign of the banana pier the results of this study were not available. For this reason it was decided to make provision in the quay construction to allow the arrangement of all kind of supply lines at a later stay.

For the supply of drinking water and electricity and telephone, provisions were made to install the piles and cables below the quay slab. By means of conduits in longitudinal beam at the landside and of conduits and recesses in the longitudinal beam on the seaside the respective pipes and cables can be laid and the recesses will be grouted after placing of the fittings and the necessary equipment. The pipes and cables can be fixed either on the outer face of the transversal beams or can be hung onto the prefabricated beams. The fire hydrants will be located in the area of or behind the approach slab.

2.2.2 On-shore facilities

There are presently no facilities in the harbour of Moín determined for harbour operations. The buildings existing in the harbour area belong to the site installation. Five pipelines with diameters of 20", 20", 8", 6", 6" are being laid through the harbour area to the future oil discharging tower.

2.2.3 Extension of the Northern Breakwater
(Drawing B-2.6.1; B-2.6.2)

The design concerning the extension of the northern breakwater in Moín has been drawn up and submitted by Rhein-Ruhr Ingenieur-Gesellschaft mbH at an earlier date. The report deals with the problem by which length the northern breakwater of the port of Moín, now under construction, must be extended and how it has to be designed so that the significant wave height

$$H_{1/3} = 0.3 \text{ m}$$

at the berths designed for banana handling is exceeded on no more than 18 days a year on an average.

On the basis of the results of former studies a statistic of the wave heights to be expected in the sea area in front of the port was drawn up first. From refraction and diffraction investigations, constraints were taken for a mathematical model which applies the wave height reduction coefficients at the berths for the wave directions occurring in the sea area.

The wave height reduction coefficients combined with the wave action statistics were used to calculate the probabilities of occurrence for permissible wave heights as a function of the breakwater length.

According to these calculations a necessary breakwater length of

$$L = 190 \text{ m}$$

for berth 1 results. To fulfill the requirements demanded for berth 2 the northern breakwater would require a length of

$$L = 420 \text{ m}.$$

At a length of 190 m the exceedance frequency of wave heights

$$H_{1/3} = 0.3 \text{ m}$$

at berth 2 amounts to 41 days a year on an average or, assuming an exceedance frequency of 18 days, the permissible wave height increases to

$$H_{1/3} = 0.4 \text{ m}.$$

In the opinion of the consultants a breakwater length of 190 m can be regarded as sufficient. (see also Chapter L-6).

As far as the structure and cross section of the breakwater are concerned, the following can be said. The breakwater crest over its entire length is fixed at a height of + 5.70 m over NMM with a width of 5.0 m. The slope inclinations both on the sea side on the portside are 1:2. The breakwater structure consists of a soil filter onto which the breakwater core is filled. The latter again is consolidated by a filter layer and a cover layer.

To avoid base failure, the breakwater foot is set back by about 10 m the port side opposite to the slope of the port access channel.

3. Infrastructure

3.1 Traffic infrastructure (Drawing B-2.1, B-2.4)

3.1.1 Road

At present, the city and the port of Limón are directly connected with the hinterland by the new road to Siquirres (Highway 32) and further on to San José (Highway 10). Highway 32 was completed in 1976 and is in a very good condition. In the suburbs of Limón, it is 12.00 m wide. A typical cross-section shows a width of 6.70 m with unpaved shoulders of 1.80 m width each.

The harbour in the situation as experienced by the consultants in Autumn 1979 has three entrances:

- the main channel, in prolongation of Calle 1 from the Avenida Central
- in the eastern part of the harbour, at the beginning of the breakwater
- in the western part of the harbour, in prolongation of Calle 8, between the workshop (Taller Mecánico), and the former Tropicore.

All these entrances to the harbour are connected by a port road giving direct access to all piers.

There is no adequate road connection between the port of Moín and Highway 32, Limón Siquirres. The existent road No. 240 from Moín via Empalme Moín to Highway 32 and that from Moín via Portete to Limón are in poor condition and not suitable for heavy truck traffic. Recommendations concerning future access road to the two ports are made in chapter F.

3.1.2 Railway

At present, railways link the port of Limón and San José, the capital of the country, with the Río Frío and Estrella region, where the major banana plantations lie. A marshalling yard is planned for an area about 1.5 km south of Moín, with lines leading to the harbours of Moín and Limón.

The FERROCARRIL DE COSTA RICA intends to rehabilitate all lines in the Limón/Moín region by 1982; that is, to replace the ballast bed and the rails. The Moín - Siquirres line is to be electrified. The present workshops for maintenance and repairs in Limón are to be moved to Moín, next to the new marshalling yard.

In 1980, it is planned to remove temporarily the passenger station of Limón outside of the city. When carrying out the planning and rehabilitation of the Limón port, the passenger station is once again to be located near the city centre of Limón.

The tracks and switches in the port of Limón are no longer in keeping with safety and operating requirements. The building of a central marshalling yard in Moín will allow the track facilities for the port to be simplified.

3.2 Water supply of the harbours of Limôn and Moîn

3.2.1 Harbour of Limôn

The water supply of the city of Limôn and thus also of the harbour represents a great problem especially during the dry season. During the inventory in autumn 1979, there was hardly a day on which this problem was not referred to in the newspaper. As a consequence also strikes took place. It can be assumed that at present the water demand is covered only by about 60 %. During bunkering of ships it could be recognized that entire town districts were without water. This lack of water can easily lead to catastrophies in case of fire. For this reason, the fire brigade of Limôn desires a larger number of permanently installed seawater hydrants. The distribution network itself appears to be sufficient. For new supply possibilities , see chapter J.

3.2.2 Harbour of Moîn

Up to now, the pier facilities in the harbour of Moîn do not include any water supply equipment. The harbour construction site itself, is presently supplied by a well from which the water is pumped to a distribution tank and from there to the various consumers. There is no external water supply system to the harbour. The present water supply is not sufficient to cope with the expected future demand of the harbout area. Concerning the possibilities of supply, see chapter J.

3.3 Energy supply of the harbours of Limôn and Moîn

3.3.1 Harbour of Limôn

The harbour and the city of Limôn are presently being supplied via a dead end line (34.5 KV/60 Hz) from the power station adjacent to the oil refinery Recope. Current undulation amounts to ± 10 %. During the rainy season mains failure often occurs due to fallen poles etc. The power supply up to now cannot be considered satisfactory because of the frequent mains failures.

There are plans to install a ring supply with connections to Limôn and Moîn. When this system is completed the supply problems will be eliminated.

3.3.2 Harbour of Moîn

Up to now the harbour of Moîn is not connected to the general power supply system but has its own power station. It is envisaged to connect the harobur of Moîn to the new ring supply system to be constructed.

4. Port operation and handling systems

4.1 General

The port of Limôn was constructed formerly for the export of bananas and coffee which are the main products of Costa Rica. Secondly, all imports coming from the Atlantic side should be handled there.

The design and construction mainly considered the special handling methods regarding bananas and coffee.

The harbour of Moin is presently still under construction. Although the port is not completed, the already existing facilities are utilised if berthing spaces are not available at Limôn. The oilpier which is completed now is operated by container vessels with ship's own gear. The ro-ro-ramp adjacent to the oilpier also serves for ro-ro-vessel frequently.

4.2 Storage facilities

The port of Limôn provides 14,458 m^2 shed storage area plus a recently completed shed near Muelle Setenta with 4,300 m^2. Open storage area is available with 21,000 m^2. Moin does not have any storage area at the moment and all cargo operation is performed directly.

4.3 Operation system

The whole cargo operation is under the control of the Japdeva-operation-department. The ship agents have to deliver the cargo manifest, a stowage plan and a hatch list to the operation department. For each vessel a preplanning then takes place.

The operation department prepares hatchwise a stowage scheme, indicating only cargo for Puerto Limôn. In a discussion with the stevedore, agent and the Japdeva railway coordinator the berth place, shifts, gangs and needed rail-cars are determined.

Actually, the preplanning meeting is a loose agreement on gangs and railcars. The number of shifts is estimated according to the experienced productivity. Equipment preplanning, except that for railcars, does not happen.

When the operation of a vessel starts, the berth supervisors control and follow up the cargo flow. But they do not influence the performance directly. Their function could be regarded as an administrative and documentary one because the Japdeva staff is only operating the transport of the cargo from the pier to the storage area in case that trailers and forklifts are involved. This only occurs at the Muelle Nacional and Muelle Setenta during indirect handling. All transport from the Muelle Metâlico and all direct handling takes place by railcars, the operation of which is performed by Fecosa, the railway company.

In case of the banana export at the Muelle Metâlico, berth No. 1 and 2, Japdeva personnel rigs up the conveyor loading system and is responsible for the maintenance. The cargo handling is done by stevedores and the transport to the loading station by Fecosa.

Thus the port authority has only a supervising function regarding the operation, but no direct influence.

4.4 Organization of operational procedures

In the following sections the most important aspects of operational procedures and related documentation shall be described for the different kinds of cargo handling.

4.4.1 Import (indirect handling)

a) 1-2 days prior to the start of operation, the agents deliver their manifests, stowage plans and cargo summary to the operation department of Japdeva. A hatch list is prepared as a basis for the coordination section, supervision and Fecosa.

b) The cargo summary will be passed on to the shed and the manifest will be delivered to the coordination-section, where a store-book is prepared.

c) One day prior to the start of operation, the operational pre-planning is performed in a meeting between Japdeva, the agent, the stevedore and Fecosa, in order to define the number of gangs, productivities etc. The number and kind of equipment required, however, will be decided by the stevedore in connection with the supervision personnel of Japdeva.

d) Afterwards, the ship's operation will be performed by the stevedore, whereas the supervision personnel of Japdeva controls the productivities, working-time, waiting-time as well as the general condition of the cargo in the hatches. The time- and productivity sheets are passed on the statistic department via the manager operation.

e) A checker of the agent tallies the cargo at the pier whereas Japdeva personnel tallies the cargo at the shed. In case of differences, the tally of Japdeva is valid.

f) The tally-clerk of Japdeva at the shed notes the damages, shortages etc. in a cargo-summary and works out a general report per vessel, of which one copy is passed on to the statistic department.

g) The shed-master establishes a storage list, including the following data:

- bill of lading
- mark
- number of pieces
- storage place.

One copy of this list remains in the shed, while another one is passed on to the coordination section.

h) The forwarder prepares his customs documents and produces them to the invoicing department of Japdeva (payment of dues) and to the stevedore's office (payment of handling dues).

i) In order to perform the customs clearance, the forwarder has to contact first the coordination section where he receives information about the storage place of his cargo. Afterwards he contacts the customs administration for cargo clearance, where the completeness of documents is checked.

j) The forwarder now has to contact the respective shed to present his customs documents to the store-keeper and to transport the cargo (parts of it) to shed 1, where the customs execute the physical checks, weighing etc. The shifting of cargo is reported by the store-keeper of the shed on a special document which will be passed on to shed 1, as the examined cargo will remain there after customs check.

k) Now the forwarder pays his customs dues and also the storage fees.

l) As a last step, the forwarder presents his customs document to the store-keeper of Japdeva and delivers the cargo onto truck/rail-car by his own personnel. The store-keeper has to cancel the delivered cargo in his storage list and the forwarder confirms the reception of cargo on the customs document; one copy remains in the shed.

4.4.2 Import (direct handling)

a) Direct cargo handling has to be announced by the agent to Japdeva and customs; if it is confirmed, the same operational procedures as described under 4.4.1 a) to d) are performed.

b) Regarding the documentation procedures, the points 4.4.1 h) and k) are valid, too.

c) When the discharging operation starts, Japdeva is tallying the cargo by the shed supervision at the pier, where the cargo is directly transferred onto truck or railcar and transported out of the port.

4.4.3 Import of ro/ro-trailers and containers

a) The documentation procedures are as under 4.4.1.

b) Additionally the agent issues a container-list which is handed over to Japdeva and the customers.

c) During the discharging operation Japdeva delegates personnel to control the condition of the container, the number and to seal the container.

d) Then the trailer/container is directly transferred to the private depot or the consignee, where the final customs clearance and inspection have to be performed.

4.4.4 Export of coffee (direct handling)

a) The agent presents a loading list of the coffee to be exported to Japdeva and notes the kind of cargo, the amount, place of origin in Costa Rica and the destination abroad.

b) For customs purposes a "formulario de exportación" has to be issued which must be presented to Japdeva invoicing department, the stevedore and the customs for payment of duties (prior to delivery of cargo to the port).

c) Prior to the ship's arrival and start of loading, Japdeva coordinates the rail transport to the port. Japdeva receives from Fecosa the railcar-numbers and types of shipment and requests them to be at ship's-side according to the loading-plan.

d) During the operation, Japdeva is tallying the goods and the "oficina de café" is taking samples.

e) Since summer 1979, the port requires one half of the shipment to be in the port when the loading operation starts; in case the cargo will not be available to continue loading, the ships are requested to go back at anchor to avoid delay-times and unproductive operation.

4.4.5 Export of ro/ro-trailers and containers

a) Customs clearance for trailers and containers takes place already in San José or in private yards.

b) The trailers/containers are trucked to Limón and will be accepted inside of the port area without check of the documentation. The trailer/container will be parked on a special area in the port.

c) Prior to the start of operation, the agent hands over a hatchlist to Japdeva who delegates personnel to the vessel in order to check the number and seal of each trailer/container (no additional check of documentation).

d) If both numbers are according to the hatch-list, the trailer/container can be loaded; if there is a difference the trailer/container will be rejected.

4.4.6 Export of bananas (direct handling)

a) The "formulario de exportación", issued by the exporter will be presented to Japdeva, the stevedore and the customs for payment of port dues, handling charges and customs dues.

b) Once a week (on Thursday) the Japdeva operation department prepares the banana loading program for the following week starting on Monday up to Sunday.
During this meeting, the three banana companies name their expected vessel, arrival date and time as well as the amount of shipments. Furthermore, the department responsible for the conveyor belts and Fecosa attend this meeting.
Then the sequence of ships and companies will be decided.

c) Prior to the ship's arrival the railcars are requested and dispatched to the port.

d) The loading operation is performed by the stevedoring company and the cargo is tallied by private checkers contracted to the banana company concerned. No official count of cargo is performed, only the quay supervision of Japdeva controls the loading operation regarding waiting-times.

4.5 Handling methods

The handling method mainly is performed manually, mechanisation is poor.

The cargo aboard is handled according to its nature by wire, ropes, nets and special gear (paper, container and bulk silicate). No further specialized handling gear is used such as pallets, drum gear etc.

Aboard the ship the cargo is shifted and slinged by workforce and expectionally a forklift is assisting the gang in the hatch.

Being transferred to the quay-side by ship's own gear, the goods are stowed directly on the railcar or trailer. On the Muelle Metálico all cargo has to be stowed directly on the railcar. Although sometimes a forklift is assisting, the manoeuvring space is limited and the pier platform not suitable to speed up the operation.

On the Muelle Setenta direct delivered cargo is also stowed on the railcar or trailer. In case that indirectly delivered cargo is operated, forklifts and small trailers are used to move the goods to the yard. Mainly the transportation is performed by forklifts.

Container, if handled, are stowed directly on trailers.

Bananas are operated by conveyors feeded directly from the railcar and then transported to the vessel's hatch via mobile and portable conveyor bridges. In the hatch the banana cartons are stowed manually by the longshoremen.

Oilproducts are discharged at Moín. At a multi-buoy-mooring system in the Bahia de Moín the tankers are connected to an underwater pipeline which transfers the liquid to the refinery ashore.

4.6 Productivity

The effective productivity is the hourly average performance per ganghour. It excludes the interruptions which tend to happen during any shift. This idletime reduces the rated productivity which is the theoretical tonnage handled by the gang, crane etc. without any interruption.

The chapter of analysis of the present situation will compare the below indicated effective productivity with the rated productivity with all its consequent aspects.

Productivities in Limón have been researched in former times by "Transmar" in 1977/1978 and Japdeva in 1979. The Consultant's comparison with the present situation comes to the following result of effective productivities:

Imports

iron	19	tons per ganghour
paper	22	tons per ganghour
fertilizer (bagged)	17	tons per ganghour
silicate*	18	tons per ganghour
general cargo	5	tons per ganghour
containers	8	boxes per shiphour
ro/ro-units	9	units per shiphour

Exports

Banana	1,800	boxes per hatchour
General cargo	5	tons per ganghour
coffe (bagged)	13	tons per ganghour
container	8	boxes per shiphour
ro/ro-units	9	units per shiphour

The table indicates the overall productivity, and differences are obvious when comparing the type of piers.

So the effective productivities are valuable for the Muelle Nacional and Muelle Setenta due to the operation method.

On the Muelle Metålico the effective productivity decreases by approx. 30 % because the forklift operation is almost impossible and the cargo must be transferred by railcars to the yard.

The difference results by the fact that the Muelle Nacional and Muelle 70 be operated by forklifts and trailers which allows a constant cargo flow to the storage area.

4.7 Working intensity

The working intensity is defined by the manner e.g. how many gangs are used per hatch and ship, how many shifts per day.

Combined with the effective productivity it indicates the long term performance or capacity.

Generally each workable hatch is operated by one gang. Depending on the size of hatch and the ship's crane equipment, a second gang is provided or gangs are

*Estimated because silicate was imported in bulk and no relevant data were available.

splitted. This situation would be regarded as the exceptional case.

Investigations show that the following gang intensity per vessel is reached:

General cargo[1)]

Import	3 gangs per vessel
Exports	2 gangs per vessel
Banana exports	3,3 gangs per vessel

Although four shifts are applicable at Limôn, three shifts per day on general cargo. The first shift from 00-06 hours only serves to complete vessel operations or at peak times, mainly for coffee exports.

For banana vessels four shifts per day or a round-a-clock work is the normal case.

4.8 Shiftsystem

Ship operation

Ship operation takes place during shifts. At Limôn three systems exist, one for cargo handling and two for banana loadings.

Cargo handling is performed during four shifts:

No. of shift	Time from	Time to	Break from	Break to	Remarks
1	00:	06:	03:00	03:30	normally not worked except during peak time of coffee exports
2	07:	12:	09:30	10:00	
3	12:	18:	15:00	15:30	normal shifts
4	18:	24:	21:00	21:30	

Actually, the shift starts 15 to 30 minutes later because of the arriving of personnel and ends 20 - 15 minutes earlier.

The break of half an hour usually is extended because the longshoremen have to walk to the cantina and then to return to the ship. Thus the break comes up to 45 - 60 minutes.

Generally, the idletime must be calculated at 1.5 to 2 hours per shift. This idle time does not include any delays and breaks caused by other operational matters.

Regarding the banana loading two stevedores have different shift- or working systems. One company works with the same gangs a whole ship, i.e. the longshoremen start operation after the ship's arrival and remain working aboard until the loading is completed. Although the workers are paid by cartons having stowed, the productivity decreases the longer the loading takes.

1) Source: "Rail transportation for the banana industry", Transmar, 1977

The other banana loading stevedore works four shifts per day, 6 hours each until the loading of a vessel is completed. The gangs rotate in a way that after 6 hours the same worker reoccupies his function and therefore a breakless shift change is guaranteed.

Storage and shed operation

The working time for the cargo transfer from the piers to the storage area is congruent with the shiftsystem for ship-operation.

The same applies to the unloading of the railcars or trailers in the shed or yard if required by the operation. The bottleneck occurs when the cargo is tallied or checked and received by the shed administration of Japdeva. The official working time of the Japdeva-staff is from 07:00 - 11:00 and 13:00 + 17:00 hours. During this time, the receipt of cargo is guaranteed; during all other times the unloading and receiving is stopped except special application has been made by the consignee or ship's agents. Thus the cargo flow from the ship to the storage is disturbed.

Regarding the delivery of cargo to the consignees, furthermore the customs authority has a different working time, namely from 07.00 - 12.00 - 13.00 - 16.30 hours which again hinders the flow of delivery of cargo to consignees.

4.9 Gangstructures

Ship operation

Due to the low mechanisation of the cargo operation, the amount of longshoremen per gang is relatively high. Furthermore, contracts with the local unions are fixing the gang-structure also for cargo which requires less personnel such as container- and ro/ro-handling.

The general gangstructure consists of 19 workers:

1 hatchforeman aboard
1 hatchforeman ashore
1 signalman
2 winchmen
8 workers aboard
6 workers ashore,

additionally forklift drivers are involved if forklifts are required. The drivers are supplied by Japdeva including the equipment.

Usually, one gang works one hatch. One top of the total gangs per vessel a shipforeman supervises the whole operation. All staff, excluding the forklift drivers, have to be provided by the private stevedores. The above mentioned gangstructure is valid for all cargo commodities including container and ro/ro.

In case of the handling of container and ro/ro-vessels, also 19 workers are involved but do not involve the operation because the shipping and container lines provide their own driver personnel and crane operators. The longshoremen then are assisting the lashing and unlashing of the containers and trailers.

Banana operation requires another gangstructure which is determined by the use of the conveyor belt system and the amount of shipment.

For this discharge of railcars the number of workers ranges between 12 and 16 longshoremen, for the stowage aboard the range lies between 21 and 26 longshoremen. The total gang structure on average could be regarded at 38 persons including foremen, one stevedore even uses 45 men.

4.10 Waiting times

Special attention was drawn to the investigation of waiting times of ships calling Limón/Moín. Three periods have been distinguished:

1. Waiting time between arrival at the anchorage and the proceeding to the berthing place.

2. Waiting time at the berth without interference of gangs working the ship, i.e. dead time at berth.

3. Waiting times occuring during work, i.e. with interference of gangs working the vessel.

The analysis has been made for the representative period of January to June 1979.

General cargo vessels

1. Waiting time between arrival at the anchorage and proceeding to the berthing place.

   On average each general cargo vessel had a delay of 22 hours which was caused by following reasons:

Waiting for a berth place	86 %
Waiting for agent's order	13 %
Berthing manoeuvres	1 %

2. Deadtime at berth occured to each general cargo vessel on average 18 hours caused by following reasons:

Waiting for agent's order	57 %
Bad weather	22 %
No longshoremen available	16 %
Other reasons	5 %

3. Delays during operation happened on average at 21 hours per general cargo vessel, split up into following reasons:

Gang breaks (rests)	28 %
No longshoremen available	17 %
Rigging vessel's gear	15 %
Bad weather	13 %
Shunting or railcars	7 %
Waiting for agent's order	6 %
Other reasons	14 %

Banana vessels

1. The average waiting time in the Bahia de Limôn for a berth place was 30 hours per banana vessel. The dominant reason (approx. 99 %) was the lack of an adequate berth place.

2. Deadtime at berth No. 1 for banana vessels amounted on average to 7 hours per vessel, split up into the following reasons:

Installations of conveyors	63 %
Waiting for agent's order	20 %
No longshoremen available	12 %
Other reasons	5 %

Deadtime at berths where bananas were loaded are higher because of the provisional facilities and could not be regarded as significant.

3. The delays during operation at berth No. 1 were on average 2 hours per vessel with the following breakdown of reasons:

Waiting for cargo	38 %
Shunting of railcars	21 %
No gangs available	19 %
No railcars available	8 %
Other reasons	14 %

4.11 Port capacity

Considering the berth available 24 hours per day and calculating the berthhours used by ships, the following breakdown of occupancy applies for Limôn/Moîn:

Berth No.	Occupied by % of total available time (May/June 1979)
1	93 (Banana vessels only)
2	54 (Banana and general cargo vessels)
3	40 (General cargo ships)
5	40 (Banana and general cargo ships)
6	9 (Ro/ro and container)
Moîn-pier	22 (Ro/ro and container)
7	72 (General cargo)
8	96 (General cargo)
9	13 (General cargo)
Moîn-seaberth	30

Analyzing the table of occupancy with regard to the economical utilization of 60 %, it is obvious that Limón/Moín is congested and that waiting times for berthing will increase. The table displays only one period which represents an experienced yearly average. Additionally to the occupancy, the peak factors of traffic must be considered.

The peak factors for Limón display as follows regarding the arriving number of ships:

	high	low
Banana vessels	1.1	0.9
General cargo	1.2	0.7
Ro/ro	1.5	0.7
Tankers	1.1	0.7

Considering these factors, the occupancy of berths reaches the full congestion in case of berth No. 1 and 8; 86 % for berth No. 7. With regard to the narrowness of the pier of No. 2 and 3, where actually only one vessel can be worked or the number of gangs must be reduced for each vessel, the occupancy reaches 94 % or full congestion, if this pier facility will be considered it is suitable for one vessel only.

The following table shows the increase of cargo flow from 1977 to 1979:

(Source Japdeva) Commodity	Tonnage (1,000 tons) 1977	1978	1979[1)]
Import			
iron	34.0	31.2	22.3
paper	77.1	84.0	83.6
bagged cargo	18.3	15.1	19.4
bulk silicate	--	14.6	29.4
general cargo	133.4	137.1	179.0
container	10.7	26.4	38.7
ro/ro	54.7	40.2	63.4
TOTAL imports	328.1	348.6	435.8
Export			
general cargo	28.8	31.6	32.2
bagged cargo (coffee)	43.6	54.6	64.9
banana	699.7	723.5	741.5
container	3.1	20.7	21.7
ro/ro	32.4	48.6	62.2
TOTAL exports	807.6	879.0	922.5

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1) Data available from Jan.-Sept. 1979, then estimated for the whole year.

The next table gives the characteristics of vessels calling at Limón/Moín:

Average characteristics of vessels attending at Limon/Moin

Type of vessel	time in Port	at anchor	at berth	total delays at berth	effectively worked	average shipment	productivity per eff. workhour and vessel
Banana	55	30	25	9	16	114,000 cajas	7,100 cajas
General cargo	234	116	118	50	68	1,200 tons	25.5 tons
Ro/RO	11	2	9	3	6	950 tons (53 units)	9 units
Crude oil tanker	51	3	48	10	39	26,500 tons	680 tons
Gas tanker	17	3	14	2	12	498 tons	42 tons

(sources: Japdeva statistics 1978/1979)

4.12 Equipment and workshop

Equipment

The cargo handling equipment of Japdeva consists at the time being of the following items:

- one quay - crane (at Muelle 70;.capacity = 10 t)
- two mobile cranes (35 t/50 t capacity)
- 30 forklifts (up to 4 t capacity)
- 21 trailers (mostly small ones)
- conveyor belts (for banana handling)
- four gantries (for banana handling; not yet used in Moín)
- a variety of special cargo lifting and slinging gear (must be rented by the stevedoring companies)

Due to the variety of makes and difficulties with spare parts the intentions of Japdeva are to replace all forklifts by new ones of one make.

In connection with the construction of the new container terminal in Limón, also new and additional equipment shall be purchased under the loan of the financing bank. This equipment shall consist of:

- one container crane
- three straddle carriers 3-high
- 31 forklifts (up to 15 t capacity)
- 10 trucks
- 34 chassis / trailers
- a variety of special cargo lifting and linging gear

As far as the existing handling equipment is concerned it can be stated that approx. 50 % of the cranes and forklifts are available for operation, i.e. the remaining 50 % are under maintenance and repair.

Workshop facilities and M & R procedures

The existing workshop covers approx. 2,500 m^2 and is located in the western end of the port of Limõn. The responsibility for the maintenance and repair of equipment is distributed to three different departments:

- Engineerig Dept. = quay - crane, banana conveyor belts, building, pins and surface
- Desarrollo Dept. = banana gantries in Moîn
- Maintenance and Repair Dept. = remaining cargo handling equipment

Engineering department

The personnel for the maintenance & repair of banana conveyor belts is also responsible for the mounting of the equipment and available for 24 hours during the operation. Insofar sufficient maintenance and repair is possible and longer breakdowns can be avoided. As the quay crane on the Muelle 70 is only used approx. ten times a year no problems occur with repair to periods for maintenance and repair.

Desarrollo department

The second-hand banana-gantries in Moîn are provisionally located on the pier since approx. one year. During that time no preventive maintenance of the gantries has been performed.

Maintenance and repair department

The workshop personnel is working from 6.00 a.m. until 3.00 p.m. with a break of one hour in between. Working hours exceeding 3.00 p.m. are possible but have to be considered as overtime.

As far as the preventive maintenance of equipment is concerned, no fixed intervals exist so that the maintenance is performed by chance. The coordination between the operation department and the workshop is absolutely insufficient. The performance of repair suffers from the non-availability of spare parts due to missing organisation and time-consuming purchasing procedures.

4.13 Analysis of present port operation

To increase the attractiveness of the port the following improvements are necessary:

General Cargo

1. Lowering the waiting times at the berth by reducing:
   - the times vessels wait for agent's orders, i.e. the preplanning of ship operation and delivery of necessary documents must be improved;

- the times when no gangs are available for operation, i.e. to increase the number of fixed gangs in the port (at present only 20 fixed gangs are available for the whole general cargo operation;

- gang breaks to a necessary minimum, e.g. to implement a three 8 hours-shift system.

2. The productivity of the gangs should be improved by
   - introducing adequate handling gear;
   - supplying more forklifts and trailers;
   - changing the handling method of loading railcars (by forklifts) and transferring goods to the storage area by forklifts (short distance) or trailers;
   - implementing the same shift system for ship and shore (shed) operation;
   - performing training courses in port operation.

Bananas

1. The reduction of waiting times at the berth No. 1 can hardly be realized substantially because the installation of the conveyors could be performed only after the vessels mooring and takes approx. 3 hours and 1 hour after the completion of loading.

   During the berthing manoeuvre shore gangs are already rigging the ship's gear and a pre-installation of hatch loading gear is impossible due to the swell at the anchorage.

   Thus only two main savings of time could be performed:

   - to diminish the waiting time for documents in receiving them in the Bahia, i.e. as soon as the loading gear is taken from board, the ship proceeds to the anchorage.

   - having more longshoremen available to reduce the non-operational times

   - reducing the waiting times for cargo.

   Altogether 2 hours per vessel will be saved.

2. The reduction of waiting time for a berthing place only could be reached in creating another berth with a sufficient productivity and lower installation times.

   The increase of effective productivity of the conveyors will not be possible as they are working at their highest capacity.

3. The working intensity must be improved by:

   - increasing the number of gangs per vessel, e.g. further longshoremen must be recruited, being able to work each vessel with a maximum number of gangs.

The foregoing already will reduce the stay-time at berth and consequently the waiting-time at anchor will decrease also.

- As this could not be regarded as sufficient, new adequate berthing places must be provided. The occupancy should not exceed 60 % at economical calculation but never 85 % because of the negative influence on the productivity;

- necessary manoeuvring space on the pier for ship operation must be provided so that the cargo traffic on the pier will not be disturbed.

Organization of operational procedures

As far as the operational documentation is concerned, it is of real advantage that for the import of cargo one uniform document, the "formulario de importación" is available for the following procedures:

- confirmation of the agent that the forwarder is allowed to take the cargo out of the port,

- customs clearance,

- payment of handling dues to the stevedores,

- payment of dues and fees to Japdeva,

- delivery of cargo.

This situation simplifies the organization of procedures in the port. The same applies to the export of cargo where also one document ("formulario de exportación") exists, although this document does not accompany the cargo when arriving in the port. This handicap leads to the result that especially containers and trailers arrive in the port area without clarification of documents.

Therefore, the Japdeva operation department does not know but a short time prior to the operation what containers and trailers shall be loaded (no pre-stowage according to vessel and port of destination).

Another positive aspect with regard to documentation is that there exist working-sheets, which are established by the supervision-personnel of Japdeva. These working-sheets form the basis for the invoice of the invoicing department of Japdeva, the operational statistics and the analyses of the planning department. This also simplifies the operational documentation and administrative procedures.

It has to be considered as a disadvantage that no official count of bananas is performed and all statistics, productivities and invoices depend on the statements of the banana-companies only.

Regarding the procedures of operation itself it is of real advantage that the port as well as the customs have already simplified procedures for the handling of containers and trailers. Customs clearance can be performed already in San José or the yards of the consignees/shipping lines, then the containers are sealed and the seal-No. is checked prior to operation. The procedure for export of containers/trailers is the other way round.

The existence of such procedure supports the implementation of future container handling in Limón.

The customs procedure for conventional general cargo, however, is complicated and time-consuming due to the following reasons:

- intensive physical checks of cargo,

- customs inspection is centralized, i.e. the cargo has to be moved to the customs shed instead of being inspected by the customs at the original storage-place,

- the available time of customs inspection is too short due to uncoordinated opening-times of the shed (Japdeva-customs).

As far as the operational pre-planning is concerned, it has to be considered as positive that pre-planning meetings between the various parties are already implemented, although, however, the sphere of activities/decisions and the preciseness must be extended and the coordination must be improved.

Analysis of existing equipment and workshop

The before-mentioned description of the existing situation shows that the distribution of responsibilities for the various kinds of equipment is not logical and in our opinion disadvantageous as no coordination and exchange of personnel between the three departments is guaranteed.

No considerations have been taken by Japdeva with regard to plannings for a suitable location and necessary dimensions of a new workshop which copes with the requirements of the new container terminal. It is absolutely clear, that the existing workshop will not be in a position to maintain and repair the straddle carriers, so that a new workshop must be available with the completion of the new container terminal.

The equipment of Japdeva is in no good condition due to following reasons:

- no existence of preventive maintenance
- deficient cooperation between the operation department and the workshop
- no proper treatment of equipment by the drivers (renting; overloading)

The organisation of the store in the workshop request when stock = 0 as well as the time - consuming purchasing procedures lead to the result that the repair of equipment needs a period of sometimes half a year. This situation is reflected by the operational availability of the equipment of 50 % only (standard in modern ports = 85 - 90 %).

5. Existing port organization

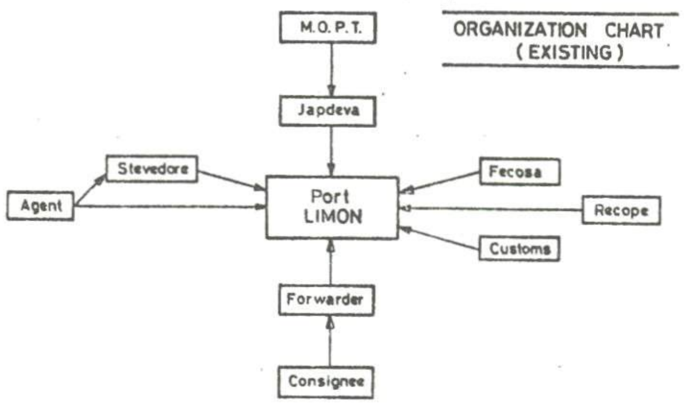
5.1 General

The general port organization in Limón shows various institutions and companies which are participating directly and/or indirectly in port business.

These institutions / companies are:

- Ministry of Transport (MOPT)
- Japdeva
- Agents
- Stevedoring Companies
- Fecosa (Costa Rican Railway)
- Recope (Costa Rican Petroleum Company)
- Customs
- Forwarding Agents / Consignees

The chart below gives a rough indication of the connections between the port and the parties concerned.



The following chapters describe in detail the functions and responsibilities of each party at present.

5.2 Organization and responsibilities of parties concerned

5.2.1 Ministry of Transport (MOPT)

As a governmental institution, responsible for transportation and public works, the MOPT is intensively engaged in port activities in general.

The MOPT has to delegate one member of the Ministry as member in the Board of Directors of Japdeva, which is responsible for the port administration in Limón.

The main responsibilities of the MOPT in connection with Port Limón are:

- nomination of foreign consultants / companies for larger port projects in Limón
- reception of loans from international financing institutions for port projects
- port planning or final decision about port planning
- awarding and supervision of port construction work (infrastructure facilities)
- approval of larger investments of Japdeva
- approval of port dues of Japdeva

Due to the fact that many port projects are under performance in Costa Rica (Proyecto Alemán / Limón, port facilities Moín, Proyecto Caldera), the Government decided in autumn 1978 to establish a council for the overall coordination of general port policy in the entire country. This council ("Consejo Portuario Nacional") is adhered to the MOPT and consists of the following members:

a) Minister of Transport (president)
b) Minister of Finance
c) Executive President of INCOP (Port Administration of Puntarenas/Caldera)
d) Executive President of Japdeva
e) Executive President of Recope
f) Executive President of Fecosa

The duties of this council are as follows:

- establishment of a detailed catalogue of all existing port facilities
- establishment of a rehabilitation program for those port facilities, indicating the costs and financial funds
- establishment of a catalogue of projects under construction in Costa Rican Ports, with special regard to port facilities at Moín
- establishment of a study regarding the future organization and administration of the ports in Costa Rica
- supervision of the performance of approval programs and consideration of possible modifications in order to increase the efficiency.

This council is to be considered as a first step to establish an integrated planning and supervision of port development / administration.

5.2.2 Japdeva (Junta de Administración Portuaria y de Desarrollo Económico de la Vertiente Atlantica)

a) General

In 1963 Japdeva was founded as an autonomous entity of the State which will undertake the construction and administration of the canalization project of the North Atlantic region of Costa Rica as well as the administration of the lands and property. It has also to control the faithful fulfillment of the contracts the State has for railroad and pier services.[1]

The control of the railroad services, however, has been taken over by Fecosa since 1977.

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1) see: "Organic Law" of Japdeva No. 3091, 18th February 1963, Article 1

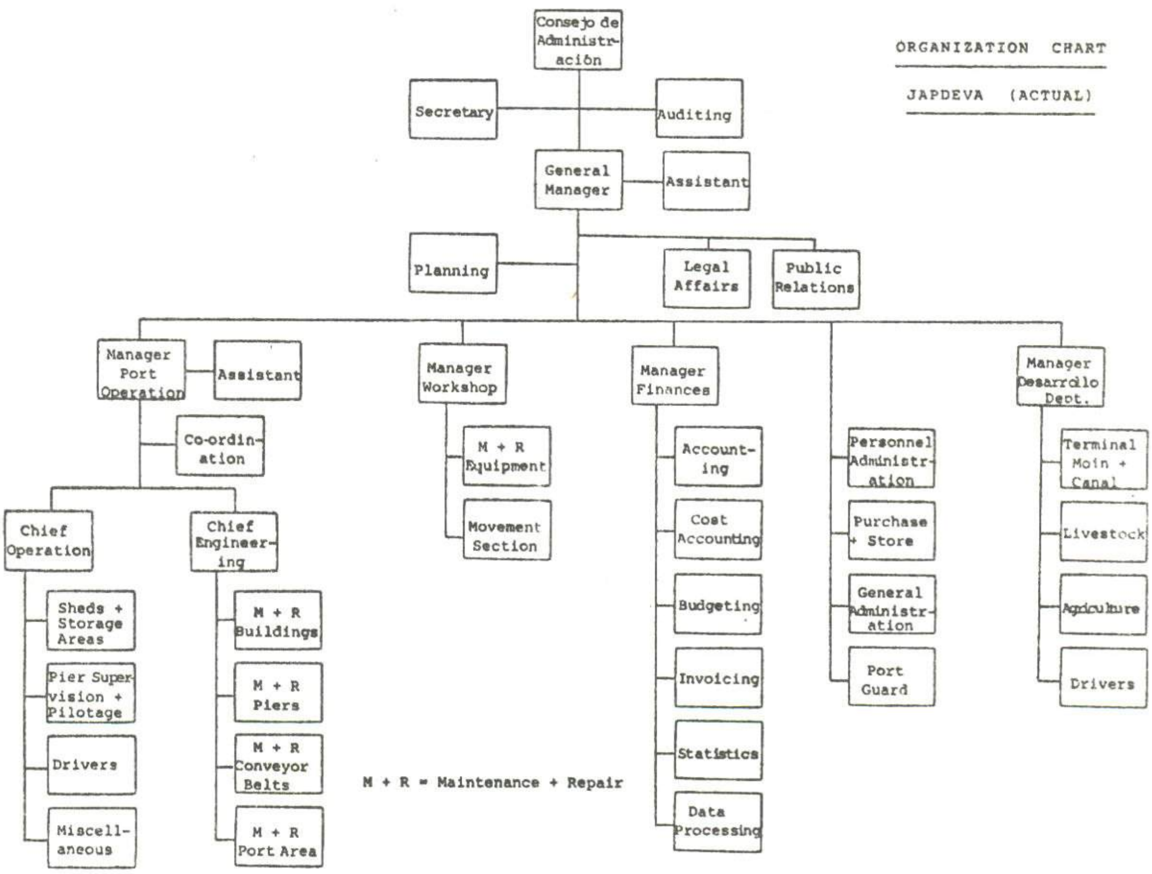
b) Responsibilities of Japdeva

Japdeva is generally responsible for the following activities in the port of Limón and the Atlantic Slope:

- Administration of the port of Limón (public services)
- Undertaking of superstructural investments (shoreside facilities, port equipment)
- Maintenance of port waterways, port facilities, rail tracks in the port area and equipment
- Landside movement and warehousing of cargo
- Disposition of the berths and rail-cars
- Pre-planning of operation together with the stevedoring companies
- Supervision of port operation
- Establishment of the port tariffs and collection of dues
- Preparation of port planning activities
- Economic development of the Atlantic Slope

c) Organization Chart

The internal organization of Japdeva is described in the following graph:



Besides some advisory sections, such as planning, legal affairs and public relations, Japdeva is divided into five main departments, directly adhered to the General Manager:

- Port Operations, including the disposition of port activites, storage of cargo in the port, movement of cargo, supervision and documentation of operation, pilotage, mooring/unmooring as well as the maintenance and repair of the port facilities and mounting of conveyor belts.

- Workshop, including the maintenance and repair of equipment.

- Finance Department, including accounting, budget, invoicing, statistics and data processing.

- Various administration departments, including the personnel department, purchase general administration and port guard.

- Desarrollo Department, including the terminal in Moín, as well as the development of the Atlantic Slope.

d) Personnel

The total personnel staff of Japdeva consists of 916 persons and is divided between the different sections as follows:

Management and Administration	:	268 persons
Operation Department	:	265 persons
Engineering Department	:	235 persons
Workshop	:	86 persons
Desarrollo Department	:	62 persons

5.2.3 Ship's agents

The ship's agents have quite close connection to Japdeva with regard to ship's operation. They are obliged by the Port Regulations[1)] to announce their vessels and deliver their documents to the following extent:

- name of vessel and captain
- port coming from
- cargo volume to be discharged / loaded
- information about dangerous cargo
- allocation of cargo in the hatches
- stowage plans
- ship's manifest

The above information should be delivered to the Operation Department of Japdeva approx. one week prior to arrival of the vessel.

In addition to the announcement of the vessels, the agents sometimes perform their own tallying of cargo at the piers, as no ordinary tally companies exist.

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1) see: Reglamento de Operaciones Portuarias, Japdeva, Limón, January 1979

5.2.4 Stevedoring companies

a) General

In Limón there exist three stevedoring companies for the performance of the operation. These companies decided their activities as follows:

- ESTIBASA = banana operation
- ESTIBA = banana and general cargo operation
- CADESA = general cargo operation

b) Responsibilities of the stevedores

The stevedoring companies are generally responsible for the following activities in the Port of Limón:

- Discharging of cargo from board of the vessels to the pier
- Loading of cargo from the pier aboard
- Loading / unloading of railcars, trailers on the piers and in the sheds / open storage areas
- Lashing / unlashing of containers on the ro/ro- and container vessels.

Approx. one year ago, Japdeva implemented operational pre-planning and the stevedores also participate in these meetings. In the meetings the number of gangs, the necessary railcars, the sequence of operation (various hatches), the storage facilities as well as the planned productivity fitures are roughly defined.

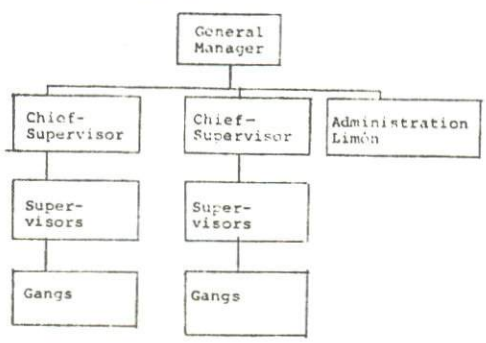
It has to be mentioned in this connection that the stevedores are not allowed at present to use own port equipment and gear;they have to rent such equipment from Japdeva.

c) Organization Chart

The organizational structure of the stevedoring companies is more or less the same and shall be described only in general. The "Junta Directiva" and the Director General have their head-office in San José. The companies are represented in Limón by a General Manager who is responsible for the stevedoring activities in the port and the necessary administration work.

The following chart shows the system of organization, neglecting, however, number of chief-supervisors etc. which is different between the companies.

General Organization Chart



d) Personnel

The stevedoring companies divide their personnel into fixed employed gangs with guaranteed wages, casual labourers with priority and small guaranteed wages and casual labourers without guarantees. It should be mentioned in this connection that Estiba has no possibility (according to the contract with the unions) to exchange personnel between the general cargo operation and banana operation.

The allocation of personnel is as follows:

employment / companies	Fixed employed	Casuals with/ without priority	Total
Cadesa	180	150	330
Estiba	515	400	915
Estibasa	360	90	450
Total	1,055	640	1,695

5.2.5 Fecosa

Since 1977 Fecosa took over the operation of the railway in the Port of Limôn. As more than 90 % of bananas, coffee and general cargo is tranpsorted by rail and the total export operation is performed by direct handling (from rail-car to the vessel), Fecosa possesses a very important position in port organization. They are at present responsible for the delivery and taking off of rail-cars to/from the port area, the shunting in the port and the shunting-yard, as well as the disposition of rail-cars and locomotives in coordination with the agents and Japdeva.

5.2.6 Recope

Recope, the Costa Rican oil refinery, is located in Moín and imports crude oil, gaz etc. by tankers. The operation is performed by Recope itself without any need of Japdeva. The oil discharging operation takes place at present at buoys in the bay of Moín; in future this operation will be performed at the oil pier by a discharging oil-tower.

5.2.7 Customs

The customs in the Port of Limôn are responsible for the following activities:

- assessment and collection of taxes on imports and exports as fixed in the existing tariff and customs law

- prevention of activities against customs law

- execution of customs clearance of cargo, i.e. physical checks, classification, weighing, appraisals

- reception of the manifest and bills of lading from the captain of a vessel at the time of arrival.

The customs clearance will be performed by order of the forwarding agents and in cooperation with Japdeva as store-keeper of cargo.

5.2.8 Forwarding agents

The various forwarding agents are responsible for the preparation of the customs and port documents in order to clear their cargo for customs check.

It has to be pointed out that the forwarders are picking up their cargo in the Japdeva-sheds, move it to the customs-shed (shed no. 1) and after customs clearance the forwarders take their cargo by themselves back to former storage area or leave it in the shed no. 1. The final delivery of cargo to rail or truck is also performed by the personnel of the forwarding agents.

5.2.9 Other parties concerned

a) Health Control

Japdeva does not include a Port Doctor in its organization; health control activities for all arriving vessels are performed by one official of the Ministry of Health, branch Limón.

b) Harbour Master

The activities of immigration, ship's clearance etc. which are often executed by the Harbour Master are taken over in Limón by one official of the Ministry of Interior.

c) Fire-brigade

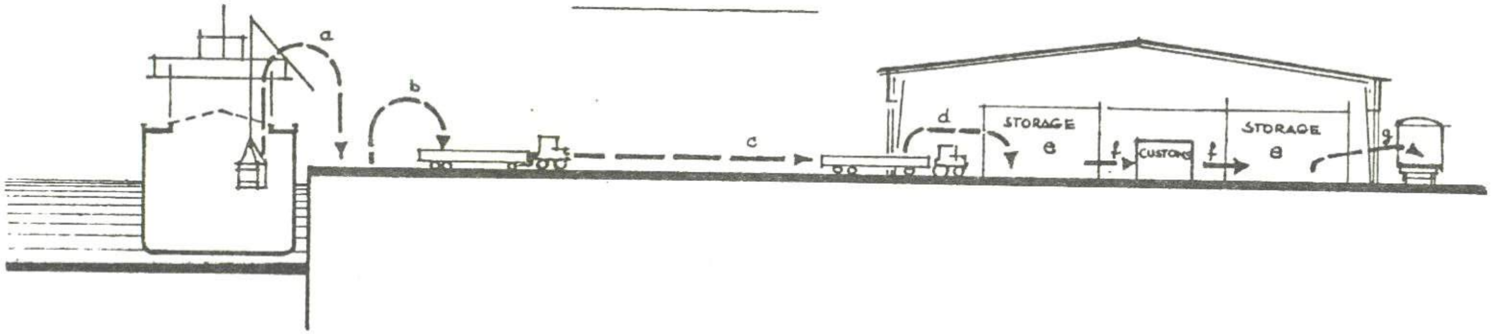
The port does not possess an own fire-brigade; these activities belong to the fire-brigade of the municipality of Limón.

5.3 Scheme of responsibilities of port organization

As described in the foregoing chapters, the various responsibilities in port operation are allocated to many parties. In order to emphasize this allcoation very clearly, the following chart (see: Fig. 1) shall demonstrate the present situation in Limón, taking the example of the import cargo procedure (indirect handling).

ALLOCATION OF RESPONSIBILITIES

(INDIRECT IMPORT)



a)	Discharging	= Stevedore
b)	Loading on trailer/waggon	= Stevedore
c)	Transportation	= Japdeva
d)	Unloading of trailer/waggon	= Stevedore
e)	Storage	= Japdeva
f)	Cargo movement for customs clearance	= Forwarder
g)	Delivery of cargo	= Forwarder

FIG. 1

5.4 Important administration procedures of Japdeva

5.4.1 Establishment of the budget

In the autumn of every year, the budget department has to establish the budget for the next year.

Each department of Japdeva calculates its anticipated expenditures for the next year; this "sub-budget" is passed on to the budget department where the coordination and summary is performed. In addition, the budget department has to estimate the Japdeva dues and fees for the next year, and has to calculate reserves (for unforeseeable cases), levies, consulting fees, interests for loans etc. Then the budget is finalized and presented to the Board of Directors for approval.

After positive decision, the budget is valid for the next year; amendments and changes are possible in special cases. In the middle of the running year, the budget department is obliged to check whether the development of income and expenditures in reality is in accordance with the estimates. If there are remarkable differences, changes of the budget have to be performed.

It should be mentioned in this connection that Japdeva does not receive any subsidies etc. from the MOPT in order to undertake investments. All port investments for which Japdeva is responsible have to be financed by own income or loans.

5.4.2 Purchasing procedure

In general, Japdeva can purchase materials etc. up to an amount of ₡ 30,000.-- without tendering. If the value of the purchase ranges between ₡ 30,000.-- and ₡ 1,000,000.-- tendering is obligatory. An amount exceeding ₡ 1,000,000.-- has to be approved by the congress in San Josê.

Tendering procedure

The tender documents are prepared by the purchase department together with the department(s) concerned. The documents are delivered to the Director General; after approval they are passed on to the Consejo Administraciôn for further approval. As the last ressort the "Contraloria" also has to approve the tender documents.

In the affirmative, the documents come back to the purchasing department and the tender can be flown. After receipt of the offers and evaluation of bids, a final proposal will be prepared and passed on to the Director General. After his approval and furthermore the approval of the Consejo Administraciôn, the purchase can be performed.

The time for the above complete procedure varies between 4 and 6 months, so it often occurs that prices have been increased in the meanwhile.

5.4.3 Invoicing procedure and tariff

The tariff of Japdeva, valid at present, consists of more than 40 positions of dues and fees for various activities. These dues and fees have to be paid by the ship's agent on one hand and the forwarders on the other hand.

The most important items of income are:

- "Muellaje de Importación" (cargo dues; to be paid by the forwarders)
- personnel for the conveyor belts (to be paid by the banana companies)
- use of equipment (to be paid by the forwarders)
- use of conveyor belts (to be paid by the banana companies)
- breakwater dues (to be paid by the ship's agent)
- "Muellaje de Exportación" (cargo dues; to be paid by the forwarders)

The above six items of dues are guaranteeing approx. 70 % of the total income of Japdeva per year.

a) Payments of the ship's agent

Prior to the arrival of the vessel, the ship's agent has to arrange for a bond which roughly equals the estimated dues (transfer from account to account).

During the ship's operation the supervisor of Japdeva notes all information about operation and services. These papers are passed on to the invoicing department via the operation department.

Now the invoicing department works out the invoice for the ship's agent, including all dues to be paid by the vessel. The invoice is sent to the agent, who compares the amount of invoice with his bond and has to arrange for payment in cash or by cheque if the bond was not sufficient.

b) Payments of the forwarding agents

Prior to customs clearance, the forwarder has to arrange for a bond which roughly equals the estimated dues for "Muellaje" and storage. After having paid the handling dues at the stevedore's office, the forwarder has to present his documents to the invoicing department of Japdeva in order to pay the "Muellaje". Then customs clearance will be performed. After having paid the customs dues and having fixed the date of delivery of cargo (free storage time = 12 days), the storage fees have to be paid at the invoicing department of Japdeva. The fees, fallen due, are compared with the advance bond and differences will be settled in cash or by cheque.

In case of ro/ro-trailers and containers, the forwarder has to pay the dues in advance.

As far as the "Muellaje" for bananas is concerned, the forwarder has to present the "customs manifest" to the invoicing department of Japdeva which is the basis for the calculation of dues.

5.5 Analysis of existing organization

The following analysis shall briefly describe the most important positive aspects and bottleneck of the existing organization as a basis for the future recommendations.

5.5.1 Structural organization and allocation of responsibilities

The past showed that no integrated port planning and port policy between the MOPT, Japdeva and also Recope existed. This statement applies to port facilities (e.g. berths in Moín), equipment (e.g. tugboats) as well as to organizational questions for the Port of Limón.

This general situation was the reason, in connection with the development of Puntarenas/Caldera, to found the "Consejo Portuario Nacional" in order to coordinate all general port activities in the country.

As far as the existing allocation of responsibilities for the operation in the Port of Limón is concerned (see: Fig. 1), this allocation has to be considered as extremely complicated and disadvantageous. The cargo transport chain from board of vessel to the shed and vice versa is interrupted by many points of transfer of cargo between Japdeva, stevedores and forwarding agents. Needless to say that an exact definition of responsibilitiy for the cargo, coping with the requirements of the customers is not possible.

In this connection, the tallying of cargo must be mentioned, as this is also a question of liabilities of the partners in port operation activities.

No coordinated tallying of cargo takes place at the time being, as the agent (sometimes) tallies at the pier, while Japdeva tallies in the shed. The period between pier and shed is not covered, so that nobody is liable for damages etc. to cargo during this time of transport and handling.

Furthermore, the liability of Japdeva as store-keeper is negatively influenced by the activiteis of the forwarders in the Japdeva-shed (movement of cargo to customs; landside delivery). That means that third parties perform intensive work in facilities which belong to another institution. This practice may cause uncontrolled damages to and possible thefts of cargo.

The existing allocation of responsibilities between the three partners in port operation has also to be considered as disadvantageous as it is not suitable for the new container-terminal. The operation within a container-terminal does not allow a split-up of discharging/transport/stacking and stacking/landside delivery of containers between two or three institutions. These handling activities must be in one hand, as this is the rule in all container terminals in the world.

As far as the organization chart of Japdeva is concerned (section B-5.2.2) two main disadvantages should be mentioned. Due to the importance of port administration and operation today and especially in future, Japdeva should concentrate on the port activities only, without being burdened by the development of the Atlantic

Slope which has to be considered as "foreign body" in the organization. Secondly it would be of interest of the port, with special regard to the new container-terminal, to perform marketing-policy, i.e. to sell the attractiveness, special conditions etc. by a marketing department to shipping lines and other possible customers. This strategy is not known within the organization of Japdeva.

5.5.2 Administrative procedures

Taking into consideration that especially administrative procedures reflect the general conditions of the administration in a country, the criticism and further recommendations should be restricted to the most important items which badly influence the port operation.

Based on this statement, two items should be mentioned only with regard to Japdeva. When analyzing the purchasing and tendering procedure it is obvious that

- too many persons are involved in the process of approval,
- the amount of ₡ 30,000.-- without tendering is too low,
- the time for the total administrative process is too long (4-6 months) until the required materials are available.

These disadvantages of the existing procedure affect especially the availability of necessary spare parts for the workshop. The non-availability of forklifts of approx. 50 % reflects this statement.

In addition, the time-consuming tendering and approval procedures lead to the result that increases of prices will take place in the meanwhile, so that the procedure of approval has to start once more. Especially the port operation (availability of equipment) has to suffer from this situation.

As far as the structure of the tariff is concerned, the existing one has to be considered as too extensive, i.e. it includes too many items with low revenues. This voluminous tariff induces also intensive administration processes for the supervision of the operation and the invoicing department.

The draft of the new tariff (see Chapter G) has not yet been approved by the MOPT, but it eliminates the variety of positions and shows a clear division into dues for the vessel and the cargo. The recommended reduction of positions, however, bears risks of disadvantages, e.g. a vessel must pay the summarized rate without having required special services (tug-boats!).

Two main points of criticism which apply to the existing and drafted tariff, shall be mentioned below:

a) The "Muellaje" which is the most important revenue of Japdeva is only divided by some kinds of cargo, neglecting, however, the aspects of value, volume and weight of the goods. It is quite usual and logical to declare higher charges for goods of high value (e.g. electronic articles, construction parts) than for goods of low value (iron, wood). This diversification seems also to be recommendable for the Port of Limón.

b) The charges for the use of equipment are based at present on the actual time (₡ per hour). This "cost-plus-rate" does not bear any risk for Japdeva, but includes the large disadvantage that increases of productivity will be transferred by 100 % to the customer. In case the charges would be based on tons/pieces, independent of the time used, two positive aspects can be realized:

- the increase of productivity is to the benefit of the port;
- the customer can exactly calculate his dues.

The calculation of charges has to take into consideration the various kinds of cargo, combined in special classes.

6. Present situation of nautics

6.1 General nautical situation

Puerto Limõn has a direct access to the Caribbean Sea and is therefore a favorable location for a port. Regarding navigable water ships do not encounter substantial risks during their approach.

The coastline in the north and south of Limõn enables ships to pass safely up to a distance of 1.5 nautical miles from the coast, no dangerous obstacles outside the 20 meter line have been reported. Navigation at the Costa Rican coast by means of radar is possible, visual navigation by landmarks and buoys suffers by lack of navigational aids; the only long range navigation mark is the lighthouse of Isla Unita.

During nighttime and rainy season, when the visibility is poor, masters complain that they face difficulties of an accurate navigation in the near vicinity of Puerto Limõn. Navigation in the near vicinity actually is not without danger. Heavy swell, rain and thunderstorm sometimes influence the radar navigation and a proper identification of the approach by the coastline is impossible due to missing buoys and radar marks. The light of Isla Uvita has a range of only approx. 5-7 miles of working.

6.1.1 Limõn

Entering the Bahia de Limõn, vessels are advised to anchor approx. 0.5 naut. miles eastly of the Muelle Metálico.

Approaching the anchorage vessels endanger to ground on several wrecks because the waterdepths and the positions have not been surveyed. Only one wreck is marked out by a buoy which is unlighted and too small for being noticed in the heavy swell and being displayed on the radar screen.

Pilotage is compulsory for all vessels and the pilot boards the ship in the anchorage area. Pilotage is performed by experienced seamen and meets international requirements because of valid master licenses of the pilots.

Together with the pilot mooring gangs board the ship. They are in charge to berth and moore the vessels alongside the pier under the pilot's command. The unusual mooring performance with shore gangs is caused by the difficult manoeuvres by the vessel's own means due to heavy swell and the lack of adequate tug assistence. Furthermore, ships are forced to use shore wires for mooring which are difficult to handle due to their state.

Usually, the time for berthing is calculated between 0.5 and 1 hour, but often takes longer if the vessel's engine or the anchors do not work properly and if rain and heavy swell are hindering the manoeuvres.

The existing tugboat is kept on stand-by during berthing manoeuvres but could not be regarded as a help because of its low power (800 HP theoretically) and its unmaintained state. The tugboat has not been repaired for years.

All the facts create a great risk to vessels and port facilities. Only the capacity and experience of the pilots prevented in the past bigger damages.

During nighttime even for the pilots, who know the surroundings quite well, the undazzled pier illumination and not existing lighted marks arise confusion. During poor visibility caused by rain also a safe approach to the piers by means of radar is impossible because significant marks have no radar reflector.

6.1.2 Moín

The Bahia de Moín and the new piers under construction are located approx. 7 km west-north-westerly of Limón.

Vessels to moore there at the pier or at the tanker seaberth first take the pilot at Limón and proceed under his advices to Moín. The way to Moín is safe and takes approx. 0.5 hours.

The tanker seaberth is situated 1 mile north-westerly of the port of Moín between the shoreline and a shallow water spot of corals. Proceeding to the seaberth tankers must round the bank in the west and immediately drop anchor and turn towards the mooring buoys.

Vessels up to a draught of 36 feet could pass there, but due to the narrowness of the manoeuvring space and the heavy swell the draught is limited to 32 feet. Furthermore, prevailing current to the south makes safe manoeuvres difficult.

The bank is buoyed out by a small buoy without light and without radar reflectors. This could be regarded as unsafe. Frequently the already completed oilpier is used for container vessels and the ro/ro-ramp for ro/ro-vessels.

The vessels have to pass the designed entrance channel presently under dredging and berth with bow to the port. Tugboat assistance is not available in sufficient manner.

6.2 Navigational aids

Presently only the light-house of Isla Uvita could be regarded as a navigational aid according international standards.

In the Bahia de Limón a buoy indicating a wreck and the buoy in the Bahia de Moín indicating the coral bank have not the required outfit according sea law.

The antennas of the radio station at Punta Blanca and the airport could not be regarded as proper aids although they could be used by vessels.

The lighthouse does not work continuously because power failures and careless maintenance are leading to breakdowns. The light range as indicated in international seacharts and handbooks is much less (approx. 5-7 miles instead of 15 miles). The buoys do not indicate the functions properly and are too small to be observed during heavy swell and rain.

Buoyage system

A clear and international system of colours, lights and functions of buoys does not exist. The port limits (inner and outer harbour) are not defined.

Radio communication

Puerto Limón has VHF station for short range communication. Due to the few channels operable by the equipment port to ship, ship to ship, connections often are disturbed by other operators at sea.

Pier marks and illumination

No marks indicating pier aids by radar, leading lights exist. A few available pier lights for navigation are disturbed by dazzling port illumination.

6.3 Floating equipment

Floating equipment fulfilling services to vessels are also part of the nautical evaluation. Bunkerboats, pilot launches, taxiboats and tugs belong to the required services of a port.

Tugboats

Although a tugboat is available, it cannot be regarded as a safe and sufficient aid to manoeuvring vessels because of the small power, which does not reach at all the theoretical output. The tug has not been docked and repaired properly for years. The communication between ship and tug by wireless radio is not possible due to lacking of equipment.

Bunkerboats

Vessels requiring fuel supply are served by tankvans only. A bunkering boat which provides fuel to vessels directly is not available.

Pilot launches

Pilot launches are not available, although the former pilot launch lies ashore for repair since a long time. Meanwhile, taxi boats are taking the pilot and the mooring gangs to the vessels.

The swell, especially in the rainy season, induces a great danger to the boarding person caused by the heavily rolling vessel and the quick vertically moving launch.

At Moín, the pilot is taken from the sea berth to the shore by a fisher boat. Although those fisher boats are seaworthy, it can not be regarded as adequate.

Other floating equipment

Other floating equipment such as a device for laying out buoys, maintenance dredging, a floating crane is not available.

Repair facilities

The presently available floating equipment - if maintained or under repair - will be drawn ashore and be worked there under ordinary workshop conditions. The same applies to the very few buoys.

A certain workshop department which is responsible for floating equipment and navigational aids does not exist. The tugboat for example must be docked in Panama or Nicaragua because a simple slipway is not available at Limón.

6.4 Organization

No particular department or function have been determined to administer or observe the wide range of maritime services.

Traditionally the operation and survey of the services like pilotage, tugboat assistance are connected to the operation department of Japdeva. Thus, the care for navigational aids, mooring gangs and equipment is the responsibility of the operation manager.

It goes without saying that only a well trained nautical expert can fulfill the tasks in all their varities.

Technical supervision has been covered by the technical department. But the situation of the lighthouse on Isla Uvita indicates clearly that coordination does not work.

6.5 Summary

With the expansion and reorganisation of the port complex Limón/Moín the following improvements should be carried out resp. investigated. The list below indicates the main and necessary aspects in short sketches.

The investigations and recommendations are detailed in the nautical chapter of the anticipated situation.

- implementation of the buoyage system "B".
  which means red colour to starboard and green to port.

- surveying the water surroundings and marking out port limits, anchorages, approaches and dangerous water spots with navigational aids of international standards

- facilitating berthing manoeuvres by means of tugboat assistance, creating sufficient manoeuvring spaces (demolishing of berth No. 1 for the Proyecto Alemán) and clearing methods
- rehabilitation of the lighthouse of Isla Uvita
- reorganisation of mooring system
- improvement of radio communication
- purchase of necessary floating equipment
- improvements of bunker and water supply to vessels
- improvements regarding repair and maintenance of floating equipment and navigational aids
- organisation and administration of maritime services (harbour master).

C. TRAFFIC ANALYSIS AND FORECAST

1. Traffic analysis (Drawing C - 1)

1.1 Traffic development up to the present time

In the course of the past years the harbour of Limôn has become the most important one in Costa Rica. Thus, in the last years about 60 % of the total foreign trade of Costa Rica was done through the harbour of Limôn.

Taking shipments by sea only into consideration, which amount to nearly 90 % of the total export trade in Costa Rica, one arrives at the following results:

Limôn / Moîn	64 %
Puntarenas	23 %
Colfito	13 %.

Splitting up export and import trade between Limôn and Puntarenas one can see the special importance of the harbour of Limôn for the export trade of Costa Rica:

Year	Import trade		Export trade	
	Puntarenas	Limôn	Puntarenas	Limôn
1970	67.7 %	32.3 %	16.7 %	83.3 %
1974	43.9 %	56.1 %	13.1 %	86.9 %
1977	49.8 %	50.2 %	11.6 %	88.4 %
1978	50.0 %	50.0 %	11.5 %	88.5 %

According to the nature of the goods transshipped at the harbour of Limôn, the latter may be considered as specialized in the export trade of bananas which, having amounted to 723,000 tons in 1978, was estimated at 82 % of the export trade of Limôn or 65 % of the whole trade of Limôn.

Crude mineral oil is unloaded at the "RECOPE" refinery facilities at Moîn, and the tankers must actually remain at anchor in the bay of Moîn.

1.2 Export of bananas

The banana export on the Atlantic side was resumed in 1965 with more resistant species. From the new beginning onwards the Atlantic area, and with it the harbour of Limôn has been developing into the most important production area and export harbour in Costa Rica. The importance of the banana export on the Atlantic side is reflected by the following figures:

Year	Export of bananas (in mio. boxes)		
	Atlantic side	Pacific side	Total
1974	38.3	14.9	53.8
1975	40.5	13.9	54.4
1976	38.5	15.1	53.6
1977	37.7	15.1	52.8
1978	38.1	14.5	52.6

1.3 General cargo - export and import

Compared to the banana transports, the remaining export and import trade differs by the fact that, without considering the local percentage at the harbour of Limôn, it has its origin and destination exclusively at Valle Central. These are all transports which must be carried through the mountain area.

Next in importance of export trade - beside the banana export - is the export of coffee that amounted to 55,000 tons in 1978, i.e. about 35 % of the export trade not considering banana exportation. Rice exports and meat exports amounted to about 21 % each of the export trade in 1978. The total export trade (without bananas) was 155,000 tons in 1978.

The import trade amounted to 350,000 tons in 1978. 25 % of the import goods was paper (85,000 tons), 9 % was iron (31,000 tons) 5 % were fertilizers in bags (15,000 tons). In 1978 the import of silicate started for a new glass factory near Cartago, amounting to 6 % of the monthly import trade in the last months of 1978. The potential of Valle Central covers approx. 65 % of the whole import. The remaining 35 % are designated for local use at the harbour of Limôn and its surroundings (mainly paper rolls for cardboard box production, used in banana wrapping and partially fertilizers and other goods).

Approx. 58 % of the imported goods are unloaded directly on trucks (35%) and on railcars (23 %), the remaining 42 % are dispatched indirectly, after a previous storage in warehouses and yards.

2. Traffic forecast

2.1 General aspects

Existing traffic forecasts(Immediate Study - RRI/PTC/DEC,SYSTAN-forecast, JAPDEVA-forecast) were revised as far as their plausibility is concerned and at the same time modified in accordance with the latest research works. The year 2000 was taken as the aiming year. The period of forecast was divided into different parts, wherein the lapse of time comprising up to 1990 should, to a certain extent, be liable to be included in the considerations. The projects surpass this and go as far as 2000. However, they are to be simply understood as forecasts in the long run. Finally, it should be mentioned that structural modifications regarding export and import trade through the harbour of Limón were not taken into consideration. Structural modifications are in this connection, the different projects regarding an industrial zone at Moín. The traffic volume which is expected to be generated by the planned industrial zone and/or free trade zone could not be considered in the present traffic forecast for lack of useful information. The area available for industrial use amounts to altogether some 1,100 hectares of which, however, no information at all is available at the moment of how this area will be divided up among the individual industrial sectors. And especially it was not possible to get an answer to the question of whether industrial estates shall be established mainly for the domestic demand or for re-exportation. Without the knowledge of these factors, not even an approximate forecast of the traffic is possible.

Studies that have been prepared with respect to an establishment of industries in Moín as early as 1973 and 1978 either are no longer up to date or are not backed politically. This concerns especially the planning of an aluminium plant the implementation of which is presently more than uncertain, not least because of the required electrical energy. According to GODESA no feasibility studies for the establishment of heavy industry are yet available. In the meantime, a Japanese-Costa Rican consortium has been charged to work out a design for the planned industrial estate, the results for this study, however, cannot be expected before mid to end of September 1980; any intermediate results were not yet available at the time the consultant stayed in Costa Rica.

Presently under discussion at CODESA[1] is the establishment of light industry, such as for the manufacturing of underwear, plastic articles and electronic units; the traffic volume which is expected to be generated by these light industries will be negligible especially when re-export goods are concerned which will not leave the free trade zone.

Given the fact that the traffic volumes of the individual industrial sectors vary considerably among one another it is not very reasonable to make a forecast of the expected traffic volume of one industrial sector and take it as the basis for the overall traffic forecast. A detailed traffic forecast should be postponed until more concrete plans exist about what industries are intended to be established at Moín and at what time, and the requirements for evtl. new port facilities then set up accordingly to the Masterplan.

The forecast is mainly based on the results of the Immediate Study but new aspects concerning banana production, import of fertilizers and silicate could be taken into consideration.

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[1] Corporación Costarricense de Desarrollo

2.2 Export trade

2.2.1 Banana export

The existing forecasts had to be modified in accordance with the development observed during the last 5 years.

One of the main development policies of the Government is to achieve an increase of the export rates in the near future. The project for development in the banana export comprises the following points, among others:

- a programme regarding increase of production, producing now less than 2,000 boxes per hectare a year up to 2,500 boxes per hectare a year (ASBANA, Câmara Nacional de Bananeros)

- a programme regarding extension of the cultivated area, aiming at the gradual and regular development of banana cultivation area. It concerns not only the extension of existing farms but also the formation of new areas, mainly in the region of Siquirres in a near future and the region of Sixaola in a long term.

According to these plans a production increase of about 50 % until 1990 will be possible, and as a result of this a performance of 1,089,000 tons (equivalent to 60 million boxes à 18.14 kilos) has been estimated for 1990.

Until 1990 the breakdown between the three largest Banana Export enterprises

- Standard Fruit Company	(52.5 % in 1979)
- Bandeco	(37.9 % in 1979)
- United Brand (COBAL)	(9.6 % in 1979)

will be more or less maintained.

From 1990 onwards there will be a shifting of the breakdown in favour of COBAL because of the idea of shifting the Banana export to Europe and the Eastern side of the United States from Golfito (Pacific coast) to Sixaola (Atlantic coast). The shifting volume was estimated up to 10 mio. boxes from 1990 to 2000, i.e. in the year 2000 there will be about 1,270,000 tons of bananas exported (equivalent to 70 mio. boxes) via Limôn.

Because of the construction of a new road to Bri-Bri and other improvements of the infrastructure of this area as well as because of political considerations it was assumed, that the export of bananas of the Sixaola region will be handled via Limôn and not via Almirante (Panamâ).

Banana export by company (in tons)					
Year	Standard Fruit	Bandeco	Cobal	Total (in tons)	Total (in boxes)
1979	390,000	281,000	71,000	742,000	40.9 Mio.
1980	410,000	296,000	74,000	780,000	43 Mio.
1985	500,500	361,000	91,500	953,000	52.5 Mio.
1990	571,500	412,500	105,000	1,089,000	60 Mio.
1995	571,500	412,500	214,000	1,198,000	66 Mio.
2000	571,500	412,500	286,000	1,270,000	70 Mio.

Finally, the natural environmental conditions for the cultivation of bananas on the Atlantic area can be considered as excellent. This is due to the type of soil, climate, minimum risk of destruction of plants because of tempest and last but not least, due to local experience in this matter.

2.2.2 General cargo - export

The export trade volume has not been changed essentially in comparison with the Immediate Study. The results of analysis on macroeconomics carried out by ECAT-researches were the basis for a forecast of the other exports (except for bananas) and imports. One can count on a doubling of exportations (net balance of export products) up to 1990.

Special considerations were made upon the coffee export. Nowadays, nearly 10 % of the coffee export is handled via Paso Canoas, Panama; this percentage is containerized coffee. It was assumed that in the moment of implementation of container operation in Limón this percentage will be shifted from Panama to Limón. A partly shifting of coffee export from Puntarenas to Limón was taken into consideration, as most of the coffee export is directed to Europe (72 %) and to the Eastern side of the United States (~14 %).

Nowadays, the percentage of the total coffee export via Limón is approx. 60 %; an increase up to 80 % in 1990 is to be assumed. This means that the percentage of coffee export within the whole export trade will grow until 1990 and decrease from that year onwards, as the coffee production will not increase considerably any more.

As far as the export trade concerns general cargo (including export of meat, rice and cacao), it will not increase considerably before 1985 as at the moment there are no new plans for factories or enterprises for export trade. From 1990 onwards the export trade including the export of industrial products will increase due to the fact of increasing industrialization.

Export trade Year	Coffee (tons)	Total (tons)
1978	54,597	155,483
1980	75,000	175,000
1985	94,000	210,000
1990	100,000	260,000
1995	102,000	330,000
2000	105,600	400,000

2.3 Import trade

The import trade volume was changed in comparison with the Immediate Study due to the new aspects "fertilizers and silicate".

2.3.1 Paper, iron, silicates

The percentage of paper import between 1976 and 1979 varied between 23.5 % and 27.5 % of the total import trade. A percentage of 25 % is assumed until 1990, as the consumption of paper in Costa Rica (especially for newspapers and cardboard production used in banana wrapping) will remain at the same level. From 1995 this percentage will decrease because of the implementation of a new paper factory.

The percentage of iron import between 1976 and 1979 varied between 9.0 % and 17.5 % of the total import trade. Until 1990 a percentage of up to 12 % of the total import trade is assumed due to continuous development and growing industrialization of the country.

Since 1978 silicate-sand is imported via Limón because of the commencement of operation of a glass factory in Loyola near Cartago amounting to 6 % to 7 % of the total import trade. It is planned to enlarge this factory (producing not only bottles but also window glass), so that imports of silicate will increase not only proportionally but also absolutely, up to 10 % of the total import trade in 1990. Slight reductions from 1990 to 2000 in import of silicates might be possible.

2.3.2 Fertilizers

Until 1976 bagged fertilizers were imported as well as fertilizers as bulk goods (11 % of the total import trade). Since 1977 fertilizers as bulk are imported via Puntarenas, and only bagged fertilizers are still imported via Limón amounting to 4.5 % of the total import trade. If no alteration is assumed this percentage may be maintained (minimum forecast). ABONOS SUPERIOR, however, is interested in importing fertilizers as bulk goods in a dimension of 100,000 to 150,000 tons per year to be bagged in Limôn / Moin and distributed in Costa Rica. This possibility has to be seen as maximum forecast for import of fertilizers; this is only possible, however, if a shifting of the fertilizer imports of Puntarenas to Limôn takes place. It can not be said at the moment if FERTICA, the main enterprise importing fertilizers will agree to it. Lower figures as those indicated by ABONOS SUPERIOR seem to be more realistic. Bagged fertilizers will not be imported any more in any case. It is assumed that from 1985 onwards imports of fertilizers will be in the range of 10 % of the total import trade.

2.3.3 General cargo

The rates of general cargo imports decreased until 1979 down to 55 % of the total import trade. A future slight reduction seems to be realistic due to a higher industrialization. The forecasted figures for general cargo (including container traffic and Ro-Ro-traffic) are slightly reduced in comparison to the figures of the Immediate Study.

Import trade in tons						
Year	Iron	Paper	Fertilizers	Silicate	General Cargo	Total (in tons)
1978	31,200	83,976	15,095	(14,563)	203,676	348,510
1980	47,000	119,500	21,500	33,000	249,000	470,000
1985	63,500	144,500	(S) 29,000	47,000	271,000	555,000
			(G) 52,000			578,000
			(G) 80,000			606,800
1990	79,000	165,000	(S) 26,500	66,000	284,000	620,500
			66,000			660,000
			101,000			695,000
1995	82,000	159,500	(S) 28,500	65,500	348,000	683,000
			71,000			726,000
			151,500			806,500
2000	85,000	154,000	(S) 31,000	61,000	393,000	724,000
			77,000			770,000
			152,000			845,000

S = bagged fertilizers
G = fertilizers as bulk goods

The figures given for the import of fertilizers have to be considered separately for three cases:

- import of bagged fertilizers only / no factory of ABONOS SUPERIOR in Moin
- import of fertilizers as bulk goods in a conservative forecast (factory of ABONOS SUPERIOR in Moin)
- import of fertilizers as bulk goods as forecasted by ABONOS SUPERIOR (factory of ABONOS SUPERIOR in Moin).

D. DEGREE OF CONTAINERIZATION AND MODAL SPLIT ROAD-RAIL

1. Trend of world shipping and containerization

1.1 General statements

Significant structural changes have affected the shipping industry worldwide during the past 25 years. There is a definite trend towards specialized vessels, meeting the requirements of the shipping lines and consignees, because once the cargo flow has reached a certain volume, it is more economical to employ special ships in order to reduce transport- and cargo handling costs as well as to avoid damages to the cargo. This trend could especially be recognized for the tremendous changes regarding the transport of general cargo. The degree of containerization of cargo increased rapidly during the last 10 years and affected also the developing countries. This trend of containerization can also be observed in the general policy of large shipping lines, which already decided to concentrate on container vessels only (Sea-Land, Sea-Train, Hapag-Lloyd at 1984).

Nevertheless, there will be a certain volume of cargo also in the future, which cannot be containerized. This statement applies especially to break ulk (iron, wood, paper, cellulose etc.) rolling stock, dry and liquid bulk cargo as well as special general cargo like parts for plants/factories. The shipping lines, however, are building vessels for these kinds of cargo in such a way that they can carry unitized as well as non-unitized cargo without too great a loss of cargo space.

This leads to the result that a 100 %-containerization (overall) of the general cargo will not be reached in the future. It can be expected that trades which are containerized by various consortia will be amended by special general cargo- or ro/ro-vessels in future (once a month or once every two months) in order to transport also special general cargo which cannot be containerized. This trade will be called "back-up-service". It is not finally decided whether these "back-up-vessels" will be pure modern general cargo vessels or combined general cargo/container vessels.

As far as the ro/ro-trade is concerned, this kind of traffic will keep a market share also in the future, without being able to seriously complete with the container traffic. The ro/ro-vessels will concentrate in future on markets where the cargo volume is limited. Nevertheless, kinds of cargo will remain, e.g. cars, large machinery, locomotives etc., which will be handled by ro/ro-vessels as this kind of operation is faster than in the conventional way. In addition the ro/ro-traffic, which can be considered as a sort of ferry-traffic (short distances; mostly with trailers) will also remain in the future, without considerable extension, however.

For the break bulk / bulk trade special vessels will be available in future in order to carry these voluminous trades.

With regard to the sizes of new vessels, no considerable changes can be foreseen. It is a matter of fact that also the future vessels will be limited by the width of the Panama Canal (PANMAX), except tankers. The size of the third generation of container vessels (290 m length, 14 m draught, approx. 3,000 TEU) will be also the maximum for the future. As far as the ro/ro-vessels (size and draught) can also be expected in the future, that means vessels up to 160 m length in the "ferry trade" and vessels up to 210 m in special trades, depending on the kinds of cargo and break-bulk-vessel will not significantly exceed the size of the modern vessels of this type which are already in operation.

1.2 Shipping trend aspects for Limón

Also for Limón a fast development in containerization has to be expected after the completion of the new container terminal. Due to the volume of cargo and the largeness of the Central American countries only container vessels of the so-called second generation have to be expected in future (210 m length, 11 m draught, 1500 TEU capacity), as well as smaller container vessels operating for trades within the Caribbean Sea. As far as the ro/ro-trade is concerned it will mainly apply to the United States with normal-sized vessels and the cargo will mainly consist of trailers and containers as at present.

With regard to break bulk / bulk vessels and specialized general cargo vessels as a "back-up-service" it can be expected that these vessels will also call at Limón in future without inducing problems concerning length and draught of the vessels.

1.3 Containerization in Limón by commodities

In order to define the expected degree of containerization for Limón in future, the most important commodities should be described and evaluated.

Iron / steel

This commodity mostly consists of steel bars, coils and iron bars, which cannot be containerized. Therefore, this kind of cargo has to be considered as break bulk / conventional general cargo also for the future.

Paper

Due to the dimensions of the paper rolls (1,5 m x 1,5 m) they are not generally suitable for containerization. Nevertheless, a certain percentage of this kind of cargo has to be considered as containerized, due to the facts that Sea-Land already transports paper in containers and that tremendous damage of rolls could be realized in Limón.

Bulk cargo (dry and liquid)

This commodity will be shipped in any case in special bulk vessels.

Coffee

This commodity should be analyzed separately from general cargo due to its importance for the export of Costa Rica.

It is a matter of fact that there are no more technical problems in transporting coffee in containers. At present Costa Rican coffee is sometimes transported in containers by truck to Corinto (Nicaragua) and Cristobal (Panama) to be shipped to Europe, as Limón has no container terminal. There is no doubt that coffee will be containerized in future, if the container terminal in Limón is available, as both, shipping lines and coffee exporters are waiting for that date of completion.

General cargo

This commodity covers all other kinds of cargo, except bananas (see below). The largest portion of general cargo will be containerized in future, taking into consideration, however, that special general cargo will be transported in a conventional way also in future.

Bananas

The possibility of transportation of bananas in containers is no longer denied by the shipping lines, banana companies and importers, as the technical problems are solved.

Intensive discussions with the banana companies and shipping lines have led to the conclusion that containerization of bananas is anticipated differently.

Hapag-Lloyd (Carol Service) transports already bananas in containers from Guatemala, Honduras and Belize. The Carol vessels are equipped with 120 CONAIR containers 40' which have been especially developed for banana transportation. At present, Hapag-Lloyd only covers peaks in banana transportation; nevertheless, the volume in the Carol Service in 1979 amounted already to approx. 1,200 containers, i.e. 1,15 million cartons. Hapag-Lloyd is able and interested in carrying more banana containers, as the vessels are occupied to nearly 100 % in the westbound trade, whereas in the eastbound trade only 50 % of the capacity is booked. Insofar special rates could be offered.

The experience of Hapag-Lloyd regarding the transportation of bananas in containers is excellent; no claims occurred, and the quality of the bananas has improved. Nevertheless, due to hesitation of the German importers, the portion of containerized bananas will not go up tremendously in the next few years. Hapag-Lloyd, however, will carefully observe the market and probably adapt its CONAIR capacity per vessel to increasing demands.

The French shipping line "CGM" also started with the transportation of containerized bananas and will reach a 100 % containerization at the end of 1980. This applies to the traffic between Martinique / Guadeloupe and Europe. This system of transportation is also based on the CONAIR container.

As far as Standard Fruit (largest exporter of bananas from Costa Rica) is concerned, they do not anticipate significant containerization on bananas, not even in the year 2000.

It has to be mentioned in this connection that Standard Fruit possess a quite modern fleet of vessels and also own conventional banana terminals in the United States. Due to the high export volume from Costa Rica, it would become necessary for Standard Fruit to invest in own container vessels with sufficient equipment if containerization came true.

However, the conventional banana vessels of Standard Fruit will carry in future some banana containers on deck, handled by ship's crane in Moín.

The Consultants learnt that Del Monte (= Bandeco; second largest exporter of Costa Rica) merged with Reynolds / USA. As the shipping company Sea-Land also belongs to Reynolds, this merger has to be seen in a special light. Due to the strong containerization policy of Sea-Land and their intensive technical developments for the containerization of bananas, it can be expected by experience that Bandeco-bananas will be shipped in containers in future. This statement is supported by the average age of Bandeco vessels (14 - 18 years) and the fact that no new investments are necessary, as Sea-Land has a fleet of container vessels and calls already at Limôn. Sea-Land intends to come to Limôn with container vessels of the second generation after the completion of the container terminal.

This transportation system is not based on CONAIR-containers but on reefer containers which would be able to perform the ripening process already during the land and sea transport.

United Brand (smallest banana exporter in Limôn) told that they do not have definite plans to transport bananas in containers via Limôn.

On the other hand it is a matter of fact that United Brand already transport large quantities of banana containers between Honduras (Puerto Cortes) and USA (Gulfport) by own vessels. There are in addition first considerations to use this experience for possible developments in other countries and ports operated by United Brand. United Brand will in any case carefully recognize the future development, especially the merger of Bandeco with Reynolds and they see a possible trend effect which may probably force them to containerize as well in the long run.

Due to various reasons, the Consultant has doubts as to the statements of Standard Fruit and United Brand as far as the period of 1995 - 2000 is concerned. We are of the opinion that the realization of an overall containerization of bananas will need time. It is also clear that the containerization will first apply to short trades (e.g. Central America to USA) before starting with large quantities on the long trades to Europe. But as far as the long run is concerned we are convinced that the containerization of bananas will come true; this standpoint is based on many arguments described in Table D-1.

As the opinion of the Consultants differs from the statements of Standard Fruit and United Brand, two alternatives have been formulated which will be taken into account for the masterplan:

- case A = statements of the banana companies

- case B = opinion of the Consultant which means full containerization in the year 2000.

Regarding the ro/ro-trade, the actual percentage has been taken as basis, as the ro/ro-lines more or less have balanced trade with full vessels. Due to the plans of CCT to call Limón with larger ro/ro-vessels (up to 180 m length), the new ro/ro-vessels of Armasal and Nordana-Line, the portion of ro/ro-trade can be increased for the year 1980.

Due to higher productivity of pure container handling, the percentage of ro/ro-trade should be assumed as constant for the future. This of course includes that possibly other ro/ro-shipping lines may call Limón.

As far as Sea-Land and Carol (today Eurocaribe) are concerned it is expected that both lines will increase their market shares to a certain extent. This is due to the plans to call at Limón with container vessels of the second generation and the attractiveness of container handling in general. It has also to be taken into consideration that USL (United States Lines) will probably call Limón with container vessels, as USL transports at present some 2,200 containers by road from Costa Rica to Panama (Balboa) and vice versa.

It is also assumed that in future semi-container lines will come to Limón (e.g. Baltcaribbean) and that also general cargo vessels and possibly bulk vessels will transport container inbound and outbound. Therefore also a certain percentage of containerization for these miscellaneous lines has to be calculated.

As far as the containerization of bananas is concerned, the percentages of Standard Fruit and United Brand are calculated with 3-5 % up to the year 2000 in case A. In case B, however, a degree of containerization of 35 % in 1995 is expected, increasing to 100 % in the year 2000. With regard to Bandeco the percentage of containerization for 1985 is anticipated with 70 %, increasing to 100 % in the year 1995.

2. Change of modal split road-rail

2.1 Present situation

The railway is the most appropriate means of transportation for bananas, not only because of capacity but also quality, as there is less damage to the goods in transit than if they are carried on trucks.

Fecosa transported about 89 % of the total exports of bananas in 1979. When one, however, considers the three banana companies separately, there are differences. The Bandeco has more banana plantations that are relatively near Limón / Moín, and now transports about 20 % of its export produce by truck, whilst Standard Fruit uses trucks for 5 % and Cobal for 10 % of their exports. This necessitates a differentiation between short-distance and long-distance transportation and Fecosa can be expected to keep the latter form of transportation as a potential.

As to the volume of traffic in other export goods including coffee, a modal split of 35:65 was found (railway:truck). 100 % of the roll on - roll off traffic and about 90 % of the container traffic was by road; the two types accounted for 45% of the total export (excluding bananas).

In the case of imports, the modal split is 25:75 (railway:truck) there are however great differneces in the modal splits for the various import commodities. Whilst 100 % of the iron and fertilisers were transported by rail, 88 % of the paper, 100 % of the silicates, 100 % of the ro-ro traffic, 90 % of the container traffic and 90 % of the general cargo were carried by truck.

2.2 Assumed future developments

The measures taken by the Fecosa concerning rehabilitation of its Atlantic network play a decisive role in assessing the development of future railway transportation. The railway company should however offer better services to exporters, as was stated in the study carried out by Transmark entitled "Rail transportation for the banana industry" in November 1977. The railway should also revise its tariff system, as the present system favours the use of trailers. The long-range forecast for the modal split took the building of a new container terminal in the neighbouring town of Heredia by 1990 into account, especially in connection with container traffic between San José and Limón / Moín.

Reduced times in transit, particularly for bananas coming from the plantations to the ports of Limón and Moín were taken into account, as well as greater punctuality and reliability in railway operations.

The containerization of import and export goods will exert a great influence on the modal split, as will ro/ro-traffic. Most of this traffic will be over the roads if the railway does not develop a suitable and effective form of operation.

The following modal split figures were assumed for the various commodities.

Banana exports

As stated in Section D 1, we considered two alternatives for the containerization of bananas: these two alternatives have an important influence on modal split figures in the long-range forecast.

Case A is the alternative with no substantial containerization of bananas by Standard Fruit and United Fruit (only about 5 % in the year 2000).

Case B is the alternative that assumes 100 % containerization of bananas in the year 2000.

The Forecast modal split figures for these two alternatives are given below:

	year	conventional trade				container trade				Total	
		road		railway		road		railway		road	railway
		%	tons	%	tons	%	tons	%	tons	tons	tons
Case A	1980	11	87,000	89	693,000	-	-	-	-	87,000	693,000
low con-	1985	10	68,500	90	614,500	60	164,000	40	106,000	232,500	720,500
taineri-	1990	10	68,500	90	615,500	42	172,000	58	233,000	240,500	848,500
zation	1995	10	75,000	90	671,500	42	192,500	58	259,000	267,500	930,500
	2000	10	81,500	90	733,500	42	195,000	58	260,000	276,500	933,500
Case B	1980	11	87,000	89	693,000	-	-	-	-	87,000	693,000
high con-	1985	10	68,500	90	614,500	60	164,000	40	106,000	232,500	720,500
taineri-	1990	10	68,500	90	615,500	42	172,000	58	233,000	240,500	848,500
zation	1995	10	51,000	90	459,000	36	247,500	64	440,000	298,500	899,500
	2000	-	-	-	-	27	336,500	73	933,500	336,500	933,500

The figures reveal that the modal split in conventional banana trade will not change essentially; when containerization commences, a higher percentage of containers will be carried over the roads, but the percentage will begin to decrease in 1990 due to the above mentioned improvements made by Fecosa.

Export trade

As to the rail transportation of coffee, Section D 1 predicts 100 % containerization; this means that conventional trade will decrease, particularly when one considers the percentage of the total export volume represented by coffee. The modal split for containerized coffee will begin to change in favour of the railway in 1985 due to the improvements effected by Fecosa.

The modal split figures for outgoing general cargo are listed in the table on the following page:

	mode of transportation	Export trade in tons / year									
		1980		1985		1990		1995		2000	
		%	tons	%	tons	%	tons	%	tons	%	tons
Ro-Ro traffic	road railway	100	53,000	100	63,000	100	78,000	100	99,000	100	120,000
container traffic	road railway	90 10	32,000 3,000	90 10	79,000 9,000	70 30	89,000 39,000	60 40	101,000 68,000	60 40	130,000 86,000
conventional cargo	road railway	35 65	30,700 57,000	50 50	29,500 29,500	50 50	27,500 27,500	50 50	31,000 31,000	50 50	32,000 32,000

Import trade

In the following table the modal split figures for imported commodities are given below:

	mode of transportation	Import trade in tons / year									
		1980		1985		1990		1995		2000	
		%	tons	%	tons	%	tons	%	tons	%	tons
paper	road railway	85 15	93,000 16,500	85 15	110,500 19,500	85 15	123,000 22,000	85 15	117,500 21,000	85 15	111,500 19,500
iron	road railway	100	47,000	100	63,500	100	79,000	100	82,000	100	85,000
fertilizer	road railway	100	215,000	30 70	24,200 56,600	30 70	30,000 71,000	30 70	45,000 105,000	30 70	46,000 106,000
silicate	road railway	100	33,000	100	47,000	40 60	26,500 39,500	20 80	13,000 52,500	20 80	12,000 49,000
Ro-Ro traffic (general cargo)	road railway	100	74,000	100	81,000	100	85,000	100	101,500	100	118,000
container traffic (general cargo)	road railway	90 10	45,000 5,000	90 10	103,000 1,100	70 30	97,000 42,000	60 40	103,000 69,000	60 40	127,000 85,000
container traffic (paper)	road railway	90 10	9,000 1,000	90 10	12,000 1,500	70 30	14,000 6,000	60 40	12,500 8,500	60 40	14,000 9,000
conventional general cargo	road railway	90 10	112,500 12,500	85 15	64,500 11,500	85 15	51,000 9,000	85 15	5,500 9,500	85 15	53,500 9,500

TAB. D-1

CONTAINERIZATION of BANANAS

1. Containerization Process in General

Increased productivity in cargo handling (more than 300 t/h)

Increase of quality of cargo (avoiding damages and pilferage)

Tremendous increase of containerization during the last ten years (also in developing countries)

Intensive development of container vessels and related equipment

Intensive development of container terminals and related infrastructure (also in developing countries)

2. Containerization of Bananas in General

No technical problems to containerize bananas (CON-AIR- and reefer-system)

Already at present containerization of bananas

- Carol Service (to Europe)
- CGM (to Europe)
- United Brand (between Honduras and USA)

Excellent experience with the transport of bananas in containers

Increase of quality in bananas:

- less handling of bananas (60 % of all manual procedures between cutting of bananas and delivery to the wholesaler can be eliminated if the container is packed at the farm and the banana is able to ripe during the transport)
- prolongation of the ripening process at the farm
- immediate start of the cooling process after packing of boxes

Upspeeded transportation and handling (one container crane has a productivity of four banana gantries)

Already technical developments regarding possible ripening-process in CONAIR-containers

Already technical development for special reefer-container vessels for bananas and other kinds of fruit.

High increase of personnel cost favours containerization[1)]

Intensive impulses have to be expected from the intentions of US-American importers to receive already bananas in containers; this will influence the total situation.

Also managers of shipping lines with conventional reefer vessels anticipate containerization in the long run[2)]

3. Containerization of Bananas per Company in Costa Rica

Bandeco

No additional investments in vessels and containers due to merger with Reynolds (= Sea-Land)

Sea-Land policy means containerization

Containerization of bananas supports in the beginning the establishment of a balanced trade for SL-vessels

Age of Del-Monte vessels 14-18 years on average, i.e. new investments would become necessary if containerization did not take place

Standard Fruit

Negative arguments:

Relatively new fleet of conventional vessels

Own terminals in the USA

At present no adequate marketing- and organization system for containerization

Purely one-way-trade in case of containerization (under the existing marketing concept)

Positive arguments:

Necessary renewal of vessels between 1990 and 1995 which means decision regarding containerization or conventional trade

No chance to neglect containerization due to all points under 2) and advantages (quality) of Bandeco; i.e. Standard Fruit will be forced to follow the trend

Standard Fruit will already use some containers for bananas in the next few years

United Brand

United Brand already transports containers with bananas between Honduras (Puerto Cortes) and USA (Gulfport)

Good experience with transportation of bananas in containers

Already considerations about possible containerization (transfer of experience from Honduras)

United Brand will be forced to follow the trend which is not denied.

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1) (M. Merlin, Technical Director of CGM: "Containerization of bananas will take place when the two conditions are fulfilled: There must be an adequate supply of containerizable return cargo and the trade must be between high labour cost countries." See: UNCTAD Report, The Marketing and Distribution System for Bananas, United Nations 1978, page 53).

2) Mr. James G. Payne (President of Blue Star Line) is convinced that most bananas and other fruit will be shipped in containers at the end of this decade (see Handbook for Ports and Handling Techniques. The optimum reefer vessel, page 134).

3) United Brand statement: "The main advantages of containerization are lower freight rate per box, better quality of fruit to less handling...." See: same sources as under [1)].

TAB. D - 2

DEGREE of CONTAINERIZATION

(SPECIAL COMMODITIES)

commodity / year	Paper	General Cargo (Ex + Im; incl. coffee) Ro/ro	Sea-Land USL	Eurocaribe/ Carol	Misc.	Total	Bananas Standard Fruit	Bandero	United Brand	Total
1978	6,500 7.7 %	91,000 25.4 %	55,000 15.3 %	(61,500) 1) 17.1 %	–	146,000 40.7 %	– –	– –	– –	– –
1979	9,000 8.2 %	108,000 26.5 %	72,000 17.7 %	(47,000) 1) 11.5 %	–	180,000 44.2 %	– –	– –	– –	– –
1980	10,000 8,4 %	127,000 30.0 %	85,000 20.0 %	(55,000) 1) 13.0 %	– –	212,000 50.0 %	– –	– –	– –	– –
1985	14,500 10.0 %	144,000 30.0 %	120,000 25.0 %	72,000 15.0 %	10,000 2.1 %	346,000 72.1 %	15,000 3.0 %	252,500 70 %	2,500 2.7 %	270,000 28,3 %
1990	20,000 12.1 %	163,000 30.0 %	152,000 27.9 %	98,000 18.0 %	16,000 2.9 %	429,000 78.8 %	28,500 5.0 %	371,500 90.0 %	5,000 4.8 %	405,000 37.2 %
1995	21,000 13.2 %	200,000 30.0 %	187,000 28,0 %	120,000 18.0 %	34,000 5.1 %	541,000 81.1 %	case A 28,500 5.0 %	412,500 100 %	10,500 4.9 %	451,500 37.7 %
							case B 200,000 35.0 %	412.500 100 %	75.000 35 %	687.500 57 3 %
2000	23,000 14.9 %	238,000 30.0 %	222,000 28.0 %	158,000 19.9 %	48,000 6.1 %	666,000 84.0 %	case A 28,500 5.0 %	412,500 100 %	14,000 4.9 %	455,000 35.8 %
							case B 571,500 100 %	412,500 100 %	286,000 100 %	1,270,000 100 %

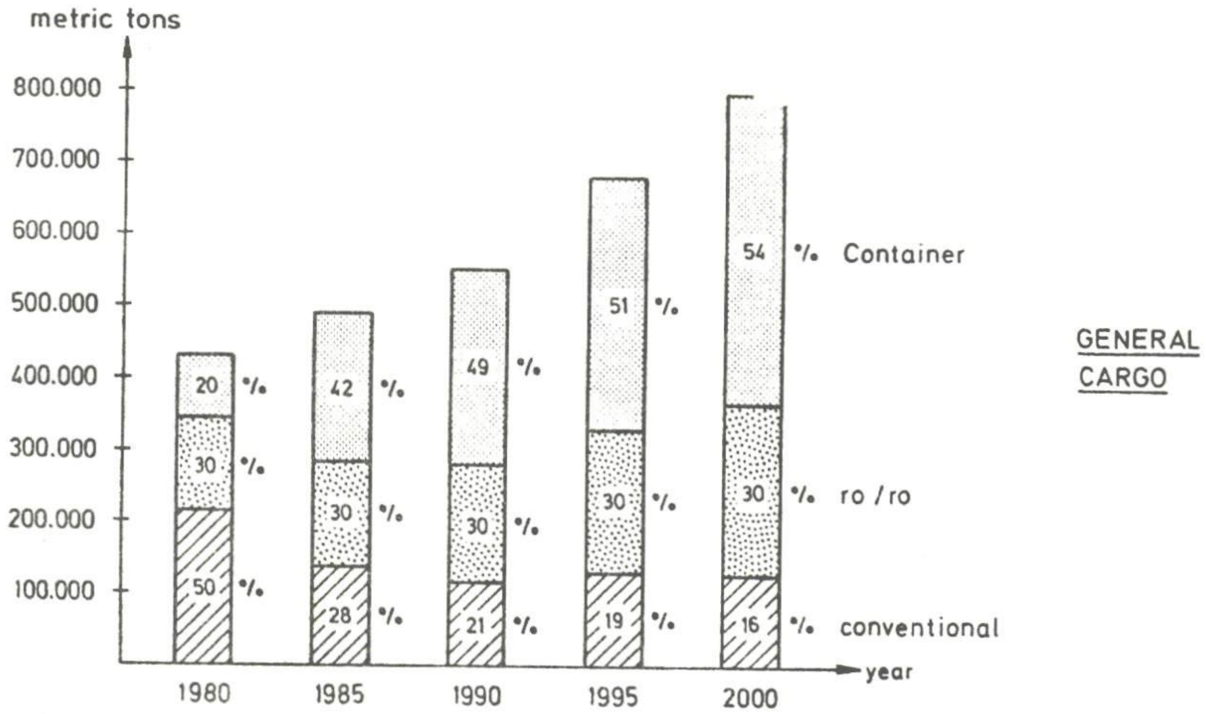
OVERALL DEGREE of CONTAINERIZATION

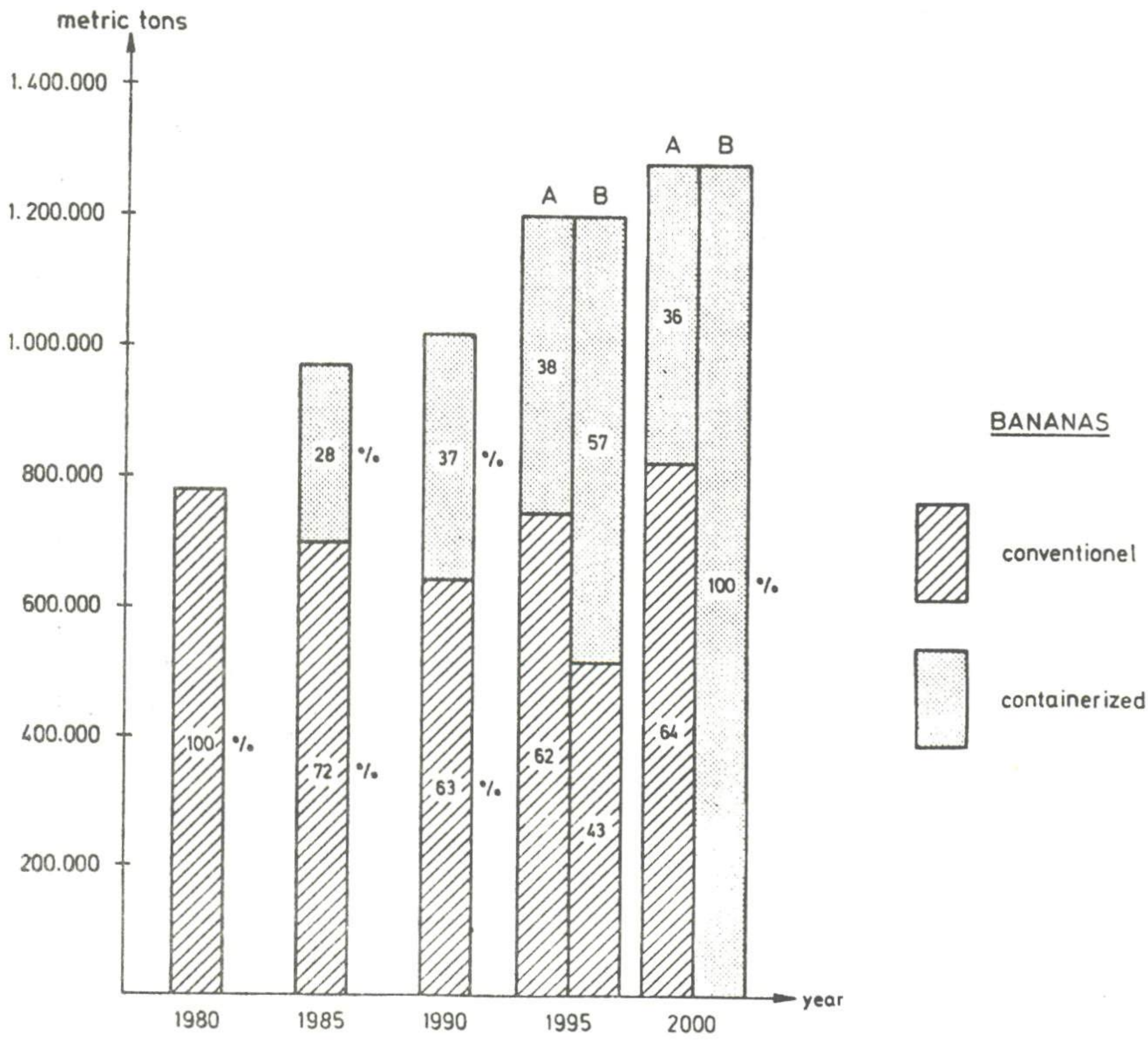
year	Container (t)	ro/ro	Convent. gen. cargo	Bananas (conv.)	Break bulk high estimate	Liquid bulk	Total	Overall degree of containerization/ ro/ro (excluding liquid bulk)
1980	95,000	127,000	212,000	780,000	211,000	760,000	2,185,000	15.58 %
1985	486,500	144,000	135,000	683,000	321,000	965,000	2,734,500	35.63 %
1990	691,000	163,000	115,000	684,000	391,000	1,170,000	3,214,000	41.78 %
1995	case A 813,500 case B 1,049,500	200,000	137,000	case A 746,500 case B 510,500	437,500	1,350,000	3,684,500	case A 43.41 % case B 53.52 %
2000	case A 906,000 case B 1,721,000	238,000	127,000	case A 815,000 case B	429,000	1,500,000	4,015,000	case A 45.49 % case B 77.90 %

1) Eurocaribe 1978: conventional general cargo
(ab 1985 already CAROL-container service)

DEGREE OF CONTAI

D-1





E. PORT OPERATION

1. Introduction

This chapter deals with the anticipated port operation and surveys all necessary aspects required for an efficient and attractive cargo handling. The main results are the determination of required berths, storage facilities and operation system to achieve the standards for a proper port operation. As far as additional outlooks and aspects are necessary, they are explained in the relating subsections which are split up into the different general commodities which are expected for Limón and Moín.

1.1 Shiftsystem

The present shift systems in the harbour of Limón are different between berthside operations and shed operations. Also banana handling is performed in different working systems by the stevedores. To ensure the transparency of the work system to the port's customers a common shiftsystem should be established for all the port authority is involved directly. Furthermore the introduction of a common shiftsystem will rise the port's efficiency because the shed operation then will be congruent with the shipside operation.

Presently the operation suffers from breaks during the shift and breaks resulting from shift changes. This fact cannot be avoided in future but reduced. The present system of 4 shifts loses following times:

4 regular breaks of 0.5 hrs	=	2.0 hours
4 shiftchanges, losing 0.5 hrs each	=	2.0 hours
1 shift with reduced working time (07:00 - 12:00)	=	1.0 hours
Total time loss per 24 hours	=	5.0 hours
or	=	21 %

In other ports in the world the standard shift system is 3 shifts per 8 hours per day, e.g. 0600-1400, 1400-2200, 2200-0600 hours. This system leads to lower time losses:

3 regular breaks of 0.5 hours	=	1.5 hours
3 shiftchanges, losing 0.5 hours each	=	1.5 hours
Total time loss per 24 hours	=	3.0 hours
or	=	13 %

Thus the advantage of 3 shifts per 8 hours will result in a higher daily efficiency of 8 %, the introduction by a 3-shift system does not require investments but contractoral measurements and would be the first step to increase the port's attractiveness.

1.2 Commission days and operation days

The operation is considered to perform on 360 days a year, i.e. also work on sundays and normal holidays should be provided if required. Only the high holidays are excluded for cargo handling.

Thus the availability of berths is 360 days a year, internationally called commission days. This applies to all berths and commodities.

The only exception will be the particular requirements of banana export due to the cutting procedures of the producers. The cost situation in Costa Rica requires a compromise to avoid the spoiling of the world market price by extensive production costs. Therefore we estimate that the banana handling will be performed from Monday noon to Saturday midnight. Thus the bananas cut in the early Monday morning will be loaded in the afternoon up to Saturday night when the last bananas cut on Friday will be handled. 5.5 banana operation days per week result which leads to 286 operation days per year. Remains the fact that 1.5 days per week the banana piers are open for other performances which could be the eliminating of traffic peaks.

1.3 Effective and gross productivities

The productivities calculated in this study represent the effective productivity which result from operation without any interruption. The consequently occurring delays during operation caused by weather influences, operational measurements we call unforeseen delays during operation and are calculated at approx. 20 % of the effective operation time if not otherwise mentioned.

Beside the unforeseen delays which cannot be determined accurately there are the regular breaks which decrease the efficiency. In a 3-shift system 3 hours per 24 hours the operation will be stopped, this amounts to 13 %, and will affect the effective operation time at the same rate.

The effective operation time plus unforeseen delays plus regular breaks sum up to the total time required for the handling of a certain amount of cargo and results in the gross productivity which logically is lower than the effective productivity.

Hereby we must mention that additional time will be consumed for berthing, unberthing and documentary clearance and possible hatch preparations prior to loading. This time we calculate at 3 hours, in case of oiltanker this value increases to 4 hours because of longer berthing manoeuvres.

1.4 Economical and limited berth utilization

The determination of the numbers of berth required to handle a certain amount of cargo leads to the decision of the calculated utilization of facilities. From the experience of many ports in the world the economical utilization of 60 % is regarded suitable to minimize waiting times for berth space of arriving ship to acceptable rates, to allow proper cargo handling without crowded traffic space and guaranteeing a safe spare capacity for traffic peaks.

The more a berth facility is used the more ships must wait for space and the more cargo flows in the port area. From a certain point all those facts will influence the ports capacity in a negative manner so that congestion may arise and the peaks will not be eliminated. This figure will be reached at approx. 85 % utilization. The planner's premise should be the economical utilization of 60 % per year.

1.5 Premises necessary for calculation

The calculation of capacities and utilizations are based on the determination of above mentioned premises drawn from international standards and from the consultant's experience. Consequently all other premises as far as mentioned in the relating context also have to be regarded with above mentioned aspects.

2. Container handling

2.1 General

The following calculations are divided into requirements for berths, container cranes, storage area and straddle carriers.

Calculations of berth and equipment are based on moves (= containers), indepen ently of size and weight, whereas calculations of space are based on twenty-foot-equivalent-units (TEU). The 35'-and 40'-containers to be stacked in the terminal must therefore be considered as 2 TEU's as far as the utilization of the storage area is concerned.

Prior to the calculation of requirements, the special aspects of the shipping line Sea-Land should be mentioned.

Sea-Land possesses its own yard (container storage area) a few km away from the port. It is a matter of fact, that Sea-Land-vessels will be operated in the new container terminal, the discharged containers will be loaded on own Sea-Land chassis directly by the container crane and the chassis will immediately be trucked to the yard. The same procedure applies to export containers for which the sequence of operation will be planned by Sea-Land and the containers will be trucked directly from the yard under the container crane.

This kind of operation (chassis-system) reflects the world-wide policy of Sea-Land and has also to be expected by the port of Limón. This system implies the large advantage that Sea-Land containers do not affect the storage area in the port as far as the containers will be transported by truck to/from the hinterland.

The overall modal split for containers, however, shows that also containers on railcars have to be taken into consideration. Due to the high ranking importance of the railway for Costa Rica, it is assumed that also Sea- Land will use the railway in future to a certain extent, especially for banana-containers which can be transported in liner trains. As the Sea-Land yard has no railroad connection, these railway containers have to be handled in the container terminal by straddle carriers.

Due to the limited space of the terminal, Sea-Land must be forced that these containers will be stacked on the area by straddle carriers without using chassis.If Sea-Land will not agree, they must truck their containers to their own yard immediately after the re-handling operation.

The above statements also apply for USL (=United States Lines), as they follow the same policy of Sea-Land. In case USL will also call Limón in future, it can be expected that the operational coordination will be taken over by the Sea-Land in Limón.

2.2 Productivity

As Limón has no experience in handling containers by crane (at present only with ship's gear), the productivity which can be achieved is to be estimated with regard to productivities in similar container terminals. It can be expected, that an average productivity of 20 containers per hour can be achieved.

2.3 Daily capacity

The daily capacity amounts to 420 containers per day/per crane, based on 21 operation hours and an effective productivity of 20 containers.

2.4 Berth requirements

When calculating the berth requirements, the number of containers, the capacity of a container crane as well as the berthday requirements have to be analysed.

2.4.1 Expected containervolume

Based on the forecast figures, the anticipated degree of containerization and the following premises:

- Sea-Land handles only 35'-containers; the allocation regarding the size of containers for the other lines will be 20' = 65 % and 40' = 35 %;

- banana containers are assumed to be 35' / 40'-containers as this kind of cargo is homogenous and will be shipped in large lots;

- the cargo weight of a 35' / 40'-container can be expected with 18 tons average (banana containers = 17.4 tons per 40', 16.3 tons per 35'), whereas the cargo weight of a 20'-container will be 13 tons on average;

- the handling figures of full containers will be increased by 20 % for empty containers (M/T); in case of banana containers the increase of empties has to be calculated with 80-100 %.

The volume of boxes can be calculated. The detailed description of the various calculations is shown in Annex E-1 in this chapter; the results are as follows:

year	container (pcs)
1985	44,619
1990	63,626
1995 (case A)	73,856
1995 (case B)	105,466
2000 (case A)	79,623
2000 (case B)	178,129

The separation into cases A and B depends on the different opinions of the banana companies and the consultant regarding the degree of containerization of bananas.

2.4.2 Capacity of a container crane

The number of gangs working on a container vessel depends on the availability of container cranes. This calculation influences the further calculation of berth-day requirements.

The maximum utilization of a container crane sums up as follows:

360 commission days x 21 hours x 20 moves	=	151,200 container
./. 20 % unforeseen operational delays	=	30,240 container
		120,960 container
./. 20 % maintenance and repair	=	24,192 container
		96,768 container per year

This figure, however, has to be considered as a theoretical one. Practical experiences in developed and developing countries (e.g. the Philippines) show that an additional container crane should be installed if the yearly turnover figure exceeds the amount of approx. 50,000 containers per crane. This statement applies also to Limón, based on the following arguments:

- one crane means, that only one vessel at the same time can be operated;
- one container-vessel berth should be equipped with two cranes in the medium-run;
- quicker dispatch of container vessels in case of two cranes per berth (e.g. a vessel with 600 moves has to be berthed for approx. 2 days, if only one crane is available);
- semi-container vessels have to be expected at the Proyecto Alemán;
- ro/ro vessels have to be expected in future, carrying containers on deck (e.g. Nordana),
- container crane can also be used for heavy lifts (increase of flexibility in the port).

These arguments and the practical experience to calculate with approx. 50,000 containers per crane as an economical utilization, lead to the result, that a second container crane becomes necessary in the year 1986. (see Drawing E-1)

As far as case A is concerned, two container cranes will be sufficient up to the year 2000.

With regard to case B, a third container crane must be installed between 1994 and 1995, whereas a fourth one becomes necessary between 1997 and 1998.

Percentage of utilization

port development	year	container (pcs)	econ.max. utilization per crane (pcs)	% utilization per crane			
				1 crane	2 cranes	3 cranes	4 cranes
	1985	44,619	50,000	89.2			
	1990	63,626	50,000		63.6		
case A	1995	73,856	50,000		73.9		
case B	1995	105,466	50,000			70.3	
case A	2000	79,623	50,000		79.6		
case B	2000	178,129	50,000				89.1

These calculations are based on figures only. It may happen in future, that the port has to invest earlier in additional container cranes due to requirements of the shipping lines (quick dispatch, guaranteed moves per hour etc.).

2.4.3 Berthday requirements

The requirements for container operation days per year are listed below based on the daily capacity:

year	container volume (expected) (pcs)	effective operation days	number of cranes used
1985	44,619	106	1
1990	63,626	76	2
1995 (A)	73,856	88	2
1995 (B)	105,466	84	3
2000 (A)	79,623	95	2
2000 (B)	178,129	106	4

In order to calculate the total berthday requirements unforeseen operational delays of 20 %, maintenance and repair time for the crane of 20 % as well as the time for mooring / unmooring, customs clearance etc. of 3 hours per vessel have to be added. Delays caused by breaks and shift changes are already included in the daily capacity.

An estimate of the number of expected container vessels will be difficult because of the unknown sizes of shipments per vessel. It seems to be realistic, however, to expect average shipments of appr. 250 to 400 containers per vessel / call (including empties), depending on the period and the containerization of bananas. Thus the following number of vessels could be anticipated:

year	number of vessels p.a. PORTACONTENEDORES	average shipment (container)
1985	170	262
1990	190	335
1995 (A)	205	360
1995 (B)	310	340
2000 (A)	230	346
2000 (B)	415	429

Based on the effective operation days, the unforeseen operational delays, maintenance and repair time for the crane(s) and the deadtime for the vessel, the berth-day requirements come up as follows:

year	effective operation days	unforeseen operation delays (days)	M+R-days for crane (days)	deadtime (days)	berthday requirements
1985	106	21	25	21	173
1990	76	15	18	24	133
1995 (A)	88	18	21	26	153
1995 (B)	84	17	20	39	160
2000 (A)	95	19	23	29	166
2000 (B)	106	21	25	52	204

The number of berths required for this demand, based on 360 commission days and 60% utilization, will be:

year	berthdays	required berths	utilization (%)
1985	173	0.80 = 1	48
1990	133	0.62 = 1	37
1995 (A)	153	0.71 = 1	43
1995 (B)	160	0.74 = 1	44
2000 (A)	166	0.77 = 1	46
2000 (B)	204	0.94 = 1	57

Due to the additional installation of container cranes, the berth utilization decreases between 1985 and 1990, whereas the utilization between 1995 and 2000 (case B) increases relatively slowly. The result would be also in case B the one container berth would be sufficient if it is equipped with four cranes. This statement, however, has to be considered as theory, as container vessels mostly can only be operated by three cranes in maximum. Also for such operation, normally the full productivity of three cranes cannot be achieved as an average for the total operating time of the vessel. This depends on the fact, that three cranes cannot work to their maximum because of the limitation of hatches to be operated and the difficulties regarding the coordination of three cranes on one vessel. The most economical way is to equip one container berth with two cranes and to have the possibility to use the third crane from time to time. (see Annex E-2).

These explanations lead to the result that in case B two container berths are necessary as the berth utilization nearly reaches 60 % resp. 100 %, if the productivity of each berth is calculated on the basis of two cranes.

2.5 Storage area requirements

This calculation is based on the projected storage area of the new terminal, the handling figures of Annex E-1 and the following premises:

- capacity of storage area = 442 TEU ground- lots
  + 80 ground-slots area = 522 ground- lots
  in total.

- storage-factor = 2-high

- dwell-time of containers:

  5 days on average for export- and import-containers (except Sea-Land)
  0 days for Sea-Land containers per truck
  2 days for Sea-Land containers per rail

The results of this calculation are as follows (see detailed calculation in Annex E-3 of this chapter).

year	utilization
1985	46.6 %
1990	72.8 %
1995 (A)	89.0 %
1995 (B)	172.0 %
2000 (A)	100.0 %
2000 (B)	395.0 %

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The above percentages of utilization show that in case A the available storage area will be sufficient up to the year 2000, although the situation will become critical sometimes in the year 2000 (100% utilization). It has to be taken into consideration, however, that it is also possible to extend the storage capacity by using the third layer for short times or by decreasing the dwell-time of containers in the terminal. The use of a third layer of containers applies especially to empty containers (handled by kind and not by numbers) as well as to banana containers in the prestowage.

As far as case B is concerned, which means a 100 % containerization of bananas in the year 2000, it is absolutely clear, that the existing storage capacity of the terminal will not be sufficient already between 1991 and 1992. Therefore, at that time, the shed at the ro/ro and general cargo pier at the Proyecto Aleman must be removed in order to extend the storage area to a capacity of 1540 TEU's (in two layers). However, this extension will only be sufficient up to the year 1993/94, due to the high increase of container volume, so that additional stacking area must be available after that date. (see Drawing E-1).

2.6 Operational system in the container terminal

The areas for container operation and storage are already fixed in the planning of the "Proyecto Alemàn". Therefore, only the special operational conditions shall be described. For better illustration refer to Drawing F-2.2 where the recommended allocation of the available areas is indicated.

2.6.1 Ship's operation

The areas at the quayside for crane operation are fixed with approx. 15 m between the legs of the crane and approx. 20 m as backreach of the crane.

Withregard to the optimum operational system we have to distinguish between "normal" container operation (all lines except Sea-Land) and Sea-Land operation.

a) For the normal container operation it is recommended to use the pure straddle-carrier system, which means a direct transportation of the container from the stacking area to the crane by straddle carrier. This system is the most suitable one due to two important reasons:

   - the location of the stacking area is very close to the container berth (max. distance approx. 220 m, except refer area), so that straddle carriers will not have long ways;

   - in case the straddle carrier would only be used for the stacking and trailers would perform the transport of containers to / from the crane, too much equipment would be used at the same time on a small area; these traffic jams will negatively influence the speed of operation.

The straddle-carrier system has also the advantage that the rhythm of the straddle carriers must not be 100 % simultaneous with the rhythm of the crane, as containers can be pre-stowed either by the crane or by the straddle carriers. Due to the dimensions of the straddle carriers it is recommended to operate the containers in the backreach of the crane, while the area between the legs should be used for the storage of the hatch covers. This separation guarantees the highest degree of safety when using the pure straddle-carrier system.

b) As far as the Sea-Land operation is concerned, it is a matter of fact that Sea-Land will also use its world-wide chassis system in Limón. The performance is as follows:

- a Sea-Land truck transports the container on chassis from the outside Sea-Land yard directly under the crane;

- the crane picks up the container directly from the chassis;

- the procedure for an import container is the same, i.e. direct loading by crane on chassis and trucking of chassis directly to the Sea-Land yard.

For this chassis operation it is recommended to handle the containers between the legs of the crane, while the backreach will be used as storage area for hatch covers / lashing-frames.

The pure chassis system does not require the use of straddle carriers except in case that Sea-Land will transport containers by rail as anticipated in the modal split (e.g. banana containers). These containers have to be transported to the crane by straddle carriers.

2.6.2 Stacking area

The stacking of containers on the yard can be performed either parallel or at a 90^{o} angle to the quay. The choice of system depends on the size of the stacking area.

As the relatively small stacking area in the terminal is limited by the backreach of the crane and the rail tracks, the position of containers at a 90^{o} angle to the quay has the following disadvantages:

- the rail-cars on the tracks would block the entrance of the rows for the straddle carriers, or an additional operation way of approx. 21 m has to be provided;

- the straddle carriers would enter the backreach of the crane at a 90^{o} angle and would hinder the crane operation, or an additional operation way of approx. 21 m has to be provided.

Due to these disadvantages it is recommended to stack the containers on the area in parallel direction to the quay.

Operational experience shows that one row should consist of 12 TEU at maximum to facilitate straddle-carrier operation without too many difficulties. This leads to the proposal to stack the containers in three blocks, consisting of 13 rows each and with 12 resp. 10 TEU per row. These blocks are separated by a 21 m wide operation way for straddle carriers.

The containers should be stacked two-high due to the limitation of area and the fact that the straddle carriers can move a container over a stack of two containers.

The triangle at the end of the terminal was planned in former times as storage area for general cargo. We would now recommend to use this area also for container operation due to the following reasons:

- general cargo storage should be separated from a container terminal, as it requires different gangs, equipment, operational conditions and means of landside transportation;

- due to the chassis system of Sea-Land, a special area is needed for a short-term pre-stowing of empty chassis and export containers on chassis, this pre-stowing will, however, only take place a few hours prior to the Sea-Land operation until a few hours after the operation.

As the container stacking area is very limited, the port should reject a permanent storage of empty chassis or Sea-Land chassis with containers (except the above pre-stowing).

2.6.3 Take-over areas

The railway operation will be performed on two tracks, located between the stacking area and the terminal road. The rail-cars have to be separated and shunted in such a way that their location corresponds with the length of the container blocks. This system guarantees free operation ways between the area and the road. In case the container berth is not occupied it is also possible to handle the railway containers on the tracks at the pier side.

As far as the truck operation is concerned, no special take-over area is available without shortening the yard. Therefore it is recommended to perform the landside truck operation on the road which is 17.5 m wide. Two lanes should be provided, guaranteeing a continuous by-passing of trucks and straddle carriers.

2.6.4 Gang structures

Due to the different operational systems and the separation of quay operation and truck / rail-car operation there exist three different gang structures:

a) crane gang (straddle-carrier operation)

- 1 foreman at the crane
- 1 foreman on deck
- 1 crane driver
- 1 checker at the crane
- 1 foreman on the area
- 2-3 straddle-carrier drivers

Port Authority

- 1 lashing-foreman
- 5 lashers

Stevedore

It depends on the transportation distances, the qualification of the straddle-carrier drivers, the speed of the crane and the quality of pre-planning, whether three straddle carriers will be necessary for one crane. With regard to the expected situation in Limón, two straddle carriers may be sufficient.

b) crane gang (Sea-Land operation)

- 1 foreman at the crane
- 1 foreman on deck
- 1 crane driver
- 1 checker at the crane

Port Authority

- 1 lashing foreman
- 5 lashers

Stevedore

c) gang for take-over area

- 1 foreman
- 1-3 straddle-carrier drivers (depending on the volume of containers per shift)

2.7 Equipment requirements

As already explained under 2.6, it is recommended to use the pure straddle-carrier system for the performance of container operation.

The maximum utilization of one straddle carrier can be calculated as follows:

360 days x 21 h x 5 moves	=	37,800 container
./. 20 % maintenance + repair	=	7,560 container
		30,240 container

The productivity of 5 p.h. per straddle carrier has to be considered as an average for landside re-handling operation, movements to/from the shed as well as direct services of the container cranes during ship's operation.

The total container movements for the straddle carrier are calculated in detail (see Annex E-4 of this chapter) based on the premises, that the Sea-Land containers coming and going by truck do not require straddle containers.

Percentage of utilization

year (1)	container movements (number) (2)	max.utilization per straddle carriers (containers) (3)	number of required straddle carrier (4)	% utilization per straddle carrier (5)	recommended number of straddle carrier (6)	% utilization per straddle carrier (7)
1985	81,418	30,240	3	89.7	5	53.8
1990	134,465	30,240	5	88.9	7	63.5
1995 (A)	162,020	30,240	6	89.3	8	66.9
1995 (B)	216,860	30,240	8	89.6	13	55.2
2000 (A)	178,427	30,240	6	98.3	9	65.5
2000 (B)	414,618	30,340	14	97.9	22	62.3

The figures of the columns 4 and 5 of this table are theoretical due to two reasons:

- technical equipment should not be utilized up to the maximum;
- the number of straddle carriers depends on the number of cranes, combined with necessary landside movements (guarantee of operation service).

Especially the second item shall be analyzed in more detail. If one container crane is available, this shipside operation must be performed with 2-3 straddle carriers, under the presumption that the containers are directly transported under the crane without using chassis in between. Besides that operation, a terminal must have the capacity to properly perform the landside reception and delivery of containers. In addition, some equipment is not available due to maintenance and repair.

As a matter of fact, the peaks of container handling on the landside will be mostly at the same time when the ship's operation shows that a utilization of approx. 60 % per straddle carrier has to be considered (columns 6 and 7 of the above table).

3. Ro/Ro - handling

Despite of the fact that two ro/ro-ramps will be available in future (one in Limôn, one in Moîn), the berth requirements are calculated for one terminal only. The expected allocation of ro/ro-vessels to both terminals will be described below.

3.1 Productivity

The present productivity for loading and discharging of ro/ro-trailers amounts to 9-10 trailers per hour. This turnover figure could be increased in our opinion, as the existing facilities in Limôn and Moîn are provisional and limited by intensive construction work. Therefore, a future effective productivity of 12 trailers per hour is calculated.

3.2 Daily capacity

The daily capacity of the ro/ro-terminal amounts to 252 trailers, based on 21 operation hours and an effective productivity of 12 trailers per hour.

3.3 Berth requirements

When calculating the berth requirements, the number of trailers as well as the berth-day requirements have to be analysed.

3.3.1 Expected trailer volume

Due to the fact that also in future more than 90 % of the ro/ro-cargo will be transported between USA and Costa Rica in a "ferry-service", and that this consists of nearly 100 % of trailers, the following calculations are based on trailer units.

According to the forecast figures and the following premises:

- one trailer is calculated with an average cargo weight of 17 tons;
- the handling figures are increased by 20 % for empty trailers (M/T);

The number of trailers amounts to:

1980	127,000 t :	7,471	full trailers	+ 20 % M/T	= 8,865 trailers
1985	144,000 t :	8,471	full trailers	+ 20 % M/T	= 10,165 trailers
1990	163,000 t :	9,588	full trailers	+ 20 % M/T	= 11,506 trailers
1995	200,000 t :	11,765	full trailers	+ 20 % M/T	= 14,118 trailers
2000	238,000 t :	14,000	full trailers	+ 20 % M/T	= 16,800 trailers

3.3.2 Berthday requirements

The requirements for ro/ro-operation days per year are listed below, based on the daily capacity:

year	expected number of trailers (pcs)	effective operation days
1980	8,865	35
1985	10,165	40
1990	11,506	46
1995	14,118	56
2000	16,800	67

In order to calculate the total berthday requirements, unforeseen operational delays of 20 %, as well as the dead-time of three hours per vessel have to be added. Delays caused by breaks and shift changes are already included in the daily capacity.

The calculation of the number of expected ro/ro-vessels is relatively easy for the year 1980, as the ro/ro-lines are known. Due to the completion of the container terminal in 1981 it is expected that the number of ro/ro-vessels will remain as it is in the medium sum, whereas the number will only slowly increase up to the year 2000.

Thus the following number of vessels can be anticipated:

year	number of vessels per year RO-RO	average shipment (tons)
1980	158	57
1985	158	64
1990	175	66
1995	192	74
2000	192	88

Based on the effective operation days, the unforeseen operational delays and the dead-time for the vessels, the berthday requirements come up as follows:

year	effective operation days	unforeseen operation delays (days)	dead time (days)	berthday requirements
1980	35	7	20	62
1985	40	8	20	68
1990	46	9	22	77
1995	56	11	24	91
2000	67	13	24	104

The number of berths required for this demand, based on 360 commission days and 60 % utilization will be:

year	berthdays	required berths	utilization %
1980	62	0,29 = 1	17
1985	68	0,31 = 1	19
1990	77	0,36 = 1	21
1995	91	0,42 = 1	25
2000	104	0,48 = 1	29

This relatively low percentage of utilization even in the year 2000 shows that one berth for ro/ro-vessels is not only sufficient for the next 20 years, but contains furthermore considerable spare capacity for general cargo vessels.

3.4 Allocation Limón-Moín

As a general fact, the ro/ro-vessels shall be berthed with priority at the new ro/ro-terminal in Limón due to the following facts:

- the Proyecto Alemán offers a special berth for ro/ro-vessels and an integrated documentation for containers and trailers;
- there is a modern shed available in Limón for packing and unpacking of cargo;
- if ro/ro-vessels carry containers and/or heavy lifts on deck, this cargo can be discharged in Limón by container crane.

Only in case that two ro/ro-vessels arrive at the same time or the operation will overlap, a ro/ro-vessel should be ordered to Moín. It can be assumed that approx. 90 % of the ro/ro-cargo will be handled in Limón for the periods after completion of the Proyecto Alemán until 1985/90.

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5 and 1990 and afterwards, a change of the allocation
the fact, that a second container crane will be in-
possibility to use the ro-ro-berth in Limôm for the
ler container vessel, if the container berth is occu-
time).

els could be operated in Moîn. It is therefore expec-
veen 1985 and 1990 and afterwards the allocation of
75 % for Limõn and 25 % for Moîn.

rements

ea requirements is based on the following premises:

is based on trailers;
f the trailers is one day on average;
to be discharged before loading operation can start.

have to take into consideration a realistic maximum
h is estimated at approx. 100 trailers.

s are packed in opposite areas, so that only one
This system applies to Limõn, where the trailers
he new shed near Muelle 70, as no space is availa-
in front of the ro-ro ramp if sheds No. 2, 3 and 6
is concerned, the above-mentioned area would also
an be packed behind the oilpier. In case this area
y for fertilizer products, the packing area for trai-
-up area parallel to the banana pier.

e for manoeuvring road must be doubled, whereas
as it is. This results in a storage area require-
ad.

gang structure

ading and discharging of ro-ro-cargo is already
lf. The trailers will be packed besides the Mu-
oard of the vessel. The discharging operation
trailers have to be checked regarding damages
resp. inside of the vessel.

elatively small (except CCT), it is recommen-
This means that the loading and discharging
trucks and the following personnel:

port authority

stevedore

3.7 Equipment requirements

The ro-ro-operation is only performed with trucks, other equipment is not necessary. Due to the long distances between the packing area and the ro-ro-ramp in Limôn, four trucks will be used for a propoer performance of operation. This number may be reduced to three trucks, if the vessel will be berthed in Moîn. In case, two ro-ro-vessels will be operated simultaneously in Limôn and Moîn, it is recommended to rent the additionally needed trucks, as there is no sense to invest in additional trucks only for this exceptional case. It is recommendable to equip the ro-ro-truck with couplings which fit the trailer operation regarding break bulk and general cargo as outlined in the chapters E-5 and E-6.

Thus the utilization of the truck will increase to an economical scale. (see also Chapter F-10, "Equipment and Workshop"). This measurement requires an additional ro-ro-truck as spare capacity for maintenance and repair.

Thus altogether 5 ro-ro-trucks are necessary.

4. Break bulk cargo handling at Limôn

4.1 Productivities

The effective productivities of today for the break bulk commodities of iron, paper bagged fertilizer and bulk silicate (arena silica) will increase by the changed port situation. It should be noted that bagged fertilizer, although expected at low quantities will be dealt under break bulk.

The future expected effective productivities per gang hour show as following:

commodity	1985	1990 (tons/gang hour)	1995*	2000
iron	25	30	42	42
paper	30	32	34	34
bagged fertilizer	20	25	31	31
bulk silicate	20	25	25	25

* These effective productivities have been calculated by the Transmar Study 1978

The increases of productivities result from improved handling methods, experienced work and will reach their level in 1995.

4.2 Daily capacity

The daily capacity is based on 21 operation hours which include the regular breaks but exclude unforeseen delays of 20 % and time for mooring etc. of 10 % of operation time. Further it is considered that each vessel will be worked with 4 gangs, which will not create problems regarding berth manoeuvring spaces if only one vessel will be at the same time at berth.

According to the projected effective productivities the following daily capacities result:

commodity	1985	1990 (tons/day)	1995	2000
iron	2,100	2,500	3,500	3,500
paper	2,500	2,700	2,800	2,800
bagged fertilizer	1,600	2,100	2,600	2,600
bulk silicate *	1,600	2,100	2,100	2,100

* The same capacity can be reached if the shore crane of the Muelle 70 will be fitted with 5-to bucket and working 20 moves per hour.

Gang structure

The gang structure recommendable for the break bulk handling is shown in the following table:

Table: Gang structure for bulk handling ship/shore

Function	Indirect Handling				Direct Handling			
	Iron	Paper	Bagged Cargo port pallets	Bagged Cargo palletized preslung	Iron	Paper	Bagged Cargo port pallets	Bagged Cargo palletized preslung
on ship (stevedore)								
hatchforeman	1	1	1	1	1	1	1	1
signalman	1	1	1	1	1	1	1	1
winchman	2	2	2	2	2	2	2	2
forklift driver	1	1	1	1	1	1	1	1
workers	4	2	8	2	4	2	8	2
total aboard	9	7	13	7	9	7	13	7
on shore (port author.)								
on pier								
gangforeman	1	1	1	1	1	1	1	1
tally/checker	1	1	1	1	1	1	1	1
forklift driver	1	1	1	1	1	1	1	1
workers	2	2	2	2	4	4	10	4
total on pier	5	5	5	5	7	7	13	7
transport								
truck driver	1	1	1	1	-	-	-	-
storage area								
gangforeman	1	1	1	1	-	-	-	-
forklift driver	1	1	1	1	-	-	-	-
workers	2	2	2	2	-	-	-	-
total at yard	4	4	4	4	-	-	-	-
total stevedore	9	7	13	7	9	7	13	7
total port auth.	10	10	10	10	7	7	13	7
total operation	19	17	23	17	16	14	26	14

4.3 Berth requirements

The expected amount of break-bulk cargo considers that in future bulk fertilizer will be handled exclusively at Moîn. Thus the following tonnages are tobe handled at Limôn:

commodity	1985	1990 (tons/year)	1995	2000
iron	63,500	79,000	82,000	85,000
paper	130,000	145,000	138,500	131,000
bagged fertilizer	800	1,000	1,500	2,000
bulk silicate	47,000	66,000	65,500	61,000
total	241,300	291,000	287,500	279,000

This leads to following operation-day requirements:

commodity	1985	1990 (days)	1995	2000
iron	30.2	31.6	23.4	24.3
paper	52.0	53.7	49.5	46.8
bagged fertilizer	0.5	0.5	0.6	0.8
bulk silicate	29.4	31.4	31.2	29.0
total operation days	112.1	117.2	104.7	100.9

The berthday requirements read as follows:

commodity	1985	1990 (days)	1995	2000
plus 20 % unforeseen delays	22.4	23.4	20.9	20.2
plus 10 % dead-time at berth	11.2	11.7	10.5	10.1
berthday requirements	145.7	152.4	136.1	131.2

The number of berths required for the break bulk handling is listed on the following page, also the utilization of 360 commission days, based on the economical utilization of 60 %:

commodity	1985	1990	1995	2000
berthday requirements	146	152	136	131
required berths	0.7	0.7	0.6	0.6
berths provided	1	1	1	1
utilization %	41	42	38	36

The berth requirements will be fulfilled by providing one berth which will then give sufficient spare capacity for general cargo operation if required. As suitable berth we recommend the Muelle 70, which should operate only one vessel per time because of the narrowness of space of 17 m. The operation of two vessels situated in front of each other would suffer from the overtraffic on the berth and consequently decrease the productivity. (see Drawing E-2, Volume IV).

4.4 Storage requirements

The required storage space to be provided for the break-bulk cargo depend on following premises:

- The rate of indirectly and directly delivered cargo which should be regarded as 100 % in future*), because the ship service time has priority and therefore the goods must be transported to a stacking area, where it is loaded to vehicles for oncarriage.

- The dwell-time of cargo in the port was approx. 15 days in 1978 (Transmar Study), but should be decreased to 10 days by operational and tariff means.

- The necessary space required to store the cargo depending on the storage factor and highstacking will be

  2.0 m^2/ton for iron
  1.0 m^2/ton for paper and bagged fertilizer.

Above rates include 35 % manoeuvring space for covered areas and 60 % for open areas because the loading zones must be greater outside the shed.

The average amount flowing through the port per 10 days will be as listed on the following page:

---

*) except bulk silicate which will be handled 100 % directly due to its nature

commodity (tons)	1985	1990	1995	2000
iron	1,760	2,190	2,280	2,360
paper	3,610	4.030	3,850	3,640
bagged fertilizer	20	30	40	60
bulk silicate	1,300	1,830	1,820	1,690
total	6,690	8,080	7,990	7,750

As it cannot be expected, that the commodities will be handled continuously like general cargo, additional spare area must be provided against traffic peaks. This rate should be calculated at 50 %.

Thus the following storage space will be required in future:

commodity	required space in m^2				
	type of area	1985	1990	1995	2000
iron	open	5,280	6,570	6,840	7,080
paper	covered	5,415	6,045	5,775	5,460
bagged fertilizer	covered	30	45	60	90
bulk silicate	no space required because direct handling				
total space	covered	5,455	6,090	5,835	5,550
total space	open	5,280	6,570	6,840	7,080

Delivery of transit cargo and gang structure

The gang structure is the transit operation will be similar to that of general cargo, i.e. 1 gangforeman, 1 forklift driver and 2 workers. (see also chapter E-5). The delivery of cargo during the 10 days dwell-time will also be the same, namely 7.8 days. Operation from Monday to Saturday will be performed.

Thus the following daily tonnages have to be delivered/received on average:

commodity (tons/d)	1985	1990	1995	2000
iron	226	280	292	303
paper	463	517	494	467
bagged fertilizer	3	4	5	8
total	692	801	791	778

The productivity per ganghour should be 25 tons for iron and paper and 20 tons for bagged fertilizer, which in this figure will be negligible because of the small amount.

Thus following ganghours are required per day:

ganghours	28	32	32	31
gangs per day	4	4.6	4.6	4.5
1. shift	2	3	3	3
2. shift	2	2	2	2

It is recommended to perform the delivery continuously during the day and to allocate the relating vehicles by preplanning the operation together with the consignee, who should be forced by policy and tariff to announce the arrival of vehicles 24 hours prior loading. Regarding the railcar disposition, this has to be undertaken by the central disposition.

4.5 Operation system

The operation system will be the same as indicated for general cargo, i.e. the use of trailers for the transport to the storage area, if the distance will be too far. This applies mainly for the operation on the Muelle 70, where break-bulk vessels should be berthed.

Regarding the operation of bulk silicate it would be advisable also to use the shore crane of the Muelle 70. It must be fitted with a bucket grab of approx. 5-ton capacity and would speed up the operation or substitute the gangs required.

4.6 Equipment

The necessary equipment is based on the gangs working per shift in the port on break bulk plus a 20 % spare portion.

Equipment	stevedore		port authority			total	
	ship	pier	transport	unloading	transit operation	in operation	incl. spare equipm.
forklifts	4	4	---	4	3*)	15	18
trucks	---	---	4	---	---	4	5
trailers	---	---	12	---	---	12	15

*) Note: In 1985 only 2 are required.

Furthermore two mobile cranes should be used to support the iron loading in transit operation if requested. Suitable adaptable forklift gear for paper handling must be purchased (4 sets) and a bucket for bulk silicate, which will be fit to the shore crane of the Muelle 70. Further handling equipment such as slinging gear see chapter G-4.

5. General cargo

5.1 Productivity

By implementation of a port pallet system as it is designed today the effective productivity per ganghour will be 10 tons, which is a world-wide standard. This figure may vary depending on the kind of cargo and represents an average figure.

5.2 Daily capacity

The daily capacity per vessel will be 21 operation hours multiplied with 10 tons/ganghour = 210 tons/gang/day.

Due to the new berth in front of the bodega at berth No. 10 sufficient operation space will be available to work a vessel with four gangs. The same applies for the Muelle 70 if only one vessel will be berthed, The target of the port should be to work a vessel with a maximum number of gangs to reduce the ship's turnaround time.

For the average 4 gangs per general cargo vessel will be calculated, which result in 840 tons per vessel per day. Also this value is world wide acceptable.

5.3 Berth requirements

The requirements for cargo operation days per year are listed below based on the daily capacity:

year	expected tonnage	effective operation days
1985	135,000	161
1990	115,000	137
1995	137,000	163
2000	127,000	151

To calculate the total berthday requirements the unforeseen delays of 20 % have to be added plus time for mooring etc. of 3 hours per vessel. The delays caused by breaks are already included in the daily capacity.

To estimate the number of expected general cargo vessel will be difficult because of the changes of trade due to containerization, but it should be considered not being quite different from today. Today the average shipment per vessel is approx. 1000 tons.

Thus the following vessels carrying general cargo could be expected:

1985 : 135 ships
1990 : 115 ships
1995 : 137 ships
2000 : 127 ships

Based on the rate of unforeseen delays and additional deadtime per vessel the following berthday requirements result:

year	effective operation (d)	unforeseen delays (d)	deadtime (d)	berthday requirements (d)
1985	161	32	17	210
1990	137	27	14	178
1995	163	33	17	213
2000	151	30	16	197

The number of berths required for this demand based on 360 commission days and 60 % utilization will be:

year	berthdays	required berths	utilization (%)
1985	210	0.97 = 1	58
1990	178	0.82 = 1	49
1995	213	0.99 = 1	59
2000	197	0.91 = 1	55

Thus one berth will meet the demand regarding general cargo. The allocation and disposition of the general cargo vessel have to be performed together with the container berth and Muelle 70. (See drawing E-2).

5.4 Storage requirements

For general cargo two kinds of cargo could be expected.
First the conventionally shipped cargo has to be handled in the port as transit cargo. Additionally cargo generated by the container traffic, the so-called LCL-cargo(LCL = less than container load). This type of goods requires stripping and stuffing of containers and warehousing.

5.4.1 Conventional general cargo

For the stacking and storing of general cargo the space could be determined by the following premises:

1) the use of port pallet system of 120 + 180 cm each (2.16 m^2) loaded on average with 700 kg and stacked two pallets high.

2) required traffic and manoeuvring space in the storing areas additional space of 35 %,

3) the future general cargo traffic flows indirectly to 100 % and the dwell-time of cargo will be on average 10 days.

Thus each ton of cargo requires 1.54 m^2 space plus 0.54 m^2 for traffic space, totally 2.08 m^2 per ton. We use 2.1 m^2/ton.

The total cargo will never stay in port at the same time except a port congestion happens. Thus the port should achieve by handling methods and traffic policies a smooth transit flow of cargo and not to exceed the average dwell-time of 10 days. That means per year 36 changes of storage cargo will occur.

The rate for covered and open storage requirements for general cargo will be 20 % open storage and 80 % covered. (see also Transmar Study 1978).

Storage requirements for general cargo

year	cargo (1000 t)	cargo per 10 days (t)	required storage area(m^2)	storage area	
				open (m^2)	covered (m^2)
1985	135	3,750	7,880	1,580	6,300
1990	115	3,190	6,700	1,340	5,360
1995	137	3,810	8,000	1,600	6,400
2000	127	3,530	7,410	1,480	5,930

The new shed of the Proyecto Alemàn already provides 5,400 m^2 which will cover the storage requirements of covered area at approx. 80 %,

Included in the above calculated figures are the areas to be provided for dangerous cargo which will be dealt separately.

5.4.2 Portion of LCL-containers/trailers

5.4.2.1 General

When calculating the necessary storage area requirements for general cargo, also the LCL-containers/trailers have to be taken into consideration. LCL ("less than container load") means that the container will be packed or unpacked in the port, whereas a FCL-container ("full container load") will directly be transported to/from the consignee.

This leads to the result that a LCL-container/trailer needs storage space for the container/trailer and for the general cargo. It can be taken as a fact that 100 % of the cargo to /from LCL-containers has to be stored in covered storage areas.

5.4.2.1 Actual situation

The present situation in Limón shows that only a few containers and trailers are packed and unpacked in the port. Due to the situation that nearly 90 % of all containers/trailers are destinated to San José and only 10 % to the vicinity of Limón, the shipping lines prefer at present to seal the containers/trailers upon arrival (import) and to transport them directly to bonded yards in San José. There, customs clearance can be performed. The same procedure applies to the export of containers and trailers. This situation will also be valid in future, so that only a very low percentage of LCL-cargo has to be considered.

5.4.2.2 Storage area requirements

Discussions with the shipping lines led to the result that a portion of at maximum 7 % of containers/trailers have to be considered as LCL-cargo. This portion applies only to the loaded/discharged containers without banana containers and empties.

Based on Annex E-1 and the trailer calculation (Chapter F - 3) the following number of containers,trailers have to be taken into account:

year	40'-cont.	20'-cont.	trailers	tonnage	LCL-percentage (7%) in tons
1985	8,717	3,810	8,741	350,443	24,530
1990	11,244	5,200	9,588	432,988	30,310
1995	14,244	5,963	11,765	545,008	38,150
2000	17,197	9,034	14,000	664,988	46,550

Following space is needed for the storage based on the assumptions under 4.1:

year	cargo per 10 days (t)	required covered area (m^2)
1985	681	1,430
1990	842	1,770
1995	1,060	2,230
2000	1,294	2,720

5.4.3 Receipt and delivery of transit cargo (including LCL-cargo)

The delivery and receipt of transit cargo should be performed during 2 shifts only (6:00-14:00/14:00-22.00 h)which imlies 14 hours operation from Monday to Saturday. The consignees should give notice to the port one day before loading for gang allocation. During the dwelltime period of 10 days only 7.8 days result for delivery, each day with 14 hours work. The delivery/receptions productivity we calculate on average at 10 tons/ganghour.

year	tons per 10 days	tons per day	tons per hour	requ. gangs	provided gangs per shift
1985	4,431	568	40	4	4
1990	4,032	517	37	3.7	4
1995	4,870	624	45	4.5	5
2000	4,824	619	44	4.4	5

5.5 Operation system and gang structure

5.5.1 General

As outlined in the organisational part of this study the port cargo operation should be split into ship operation performed by private stevedores and shoreside handling by the port authority.

The shoreside handling of general cargo should be designed in the following manner depending on the location of the vessel.

Berth No. 10 (in front of the shed on the Proyecto Alemán)

The cargo set on the quay wall will be transported by forklifts to its storing location. For that reason each gang must include one forklift plus one additional on standby if the distance will become too great. The economical transportation distance should be calculated at 70-100 m, above that rate the forklift does not fulfill its design as a liftoperator. Above 100 m the use of a trailer is more economical, because its lower investments while fulfilling the same purpose. It should be noted, that this relates to a longterm operation and for occasional happenings a second forklift could meet the requirements.

Berth No. 11 (container pier) and Muelle 70

As the distance to the storage areas excludes the economical use of forklifts, trailers should transport the goods to their storage location. Then the cargo set down on the quay will be loaded by a forklift on the trailer, transported to the shed or open area and unloaded there by another forklift. Each gang requires then three trailers (one on loading, one on transport and one on unloading), one truck and two forklifts.

The operation system for export cargo will be performed vice versa as mentioned above. Although direct handling should be avoided and hardly happen due to the nature of trade, it might occur on special request. Therefore, a short scheme for the operation will be given hereafter.

Imports directly

The goods set on the quay are loaded by forklifts on the trailers or truck. Savings of a second forklift for unloading at storage area and transportation devices result. But the productivity will be lower, if not flatcars or covered railcars with openable roofs or full length side doors are supplied.

Exports directly

The same as imports handled directly or direct unlading of transport vehicles by ship's gear, if the vehicles are suitable for such an operation and the nature of goods is adequate.

5.5.2 Gang structure for general cargo

The gang structures figured below are based on following assumptions:

1. Operation system as explained above and by ship's gear.
2. The use of port pallet system or unitized general cargo suitable for forklift operation.
3. All general cargo imported or exported is handled indirectly although direct handling may occur on special request and therefore listed for comparison, but will not be the normal case.

The table on the following page indicates the requirements of personnel without the supervisory staff, which depend on the vessels and show as follows:

- Shipside/stevedore : 1 general ship foreman per vessel
- Shoreside/port authority : 1 jetty foreman per vessel,
  who are supervising, guiding and preparing the operation as partners.

The gang structure for the delivery and reception of transit cargo looks as follows:

	port pallets	unitized
gang foreman	1	1
forklift driver	1	1
workers	4	2
total	6	4

5.6 Equipment

For the handling of general cargo in ship/shore operation and transit delivery following forklifts, trucks and trailers are required, considered all gangs involved are working at the same time and 20 % spare capacity.

type of equipment	ship/shoreside	transit delivery	total
port authority			
forklifts	10	6	16
trucks 1)	5	--	5
trailers (15 t)	15	--	15 2)
stevedores			
forklifts	5		5

Note: 1) - This equipment is only required if general cargo will be handled at berth No. 11 or on Muelle 70, therefore the trucks for ro/ro should be used.

2) - The trailers must be provided in any case for operation peaks and fast ship dispatch, although low utilization.

For further handling equipment see chapter E-10.

6. Banana handling at Moín

Bananas are the main export products beside coffee. Therefore, special attention has been drawn to the facilitation of banana handling. The costs of loading should be optimized, the handling procedures minimized to raise the quality of the fruits. Special concern in the following chapter has been made to calculate the two possibilities of trade development. Case A, in which the bananas will be shipped conventionally without substantial changes, and case B - the consultant's opinion - that in future the bananas will be containerized up to an amount of 100 % in the year of 2000.

Furthermore, the acceptable staytime of vessels in port has been investigated according to the different aspects of producers, shippers and port operator, who has to provide the adequate facilities.

6.1 Operational aspects

6.1.1 Operation system

A predetermination of the operation system for banana loading has been decided by purchasing four elevators or gantries. This operation system offers several advantages:

- flexibility, because the gantries are movable on rails and could be set aside if the berths will not be used for banana vessels. Thus other commodities could be handled with sufficient berth space;

- fast hatch preparation, because the gantries could be shifted very quick from hatch to hatch. (see fig. E-6.1 on the next page). The elevator boom will be put into the hatch and required deck. Thus a time-consuming shifting and rigging of roll lanes is not necessary. Only the lanes from the boom output to a particular place in the deck have to be provided;

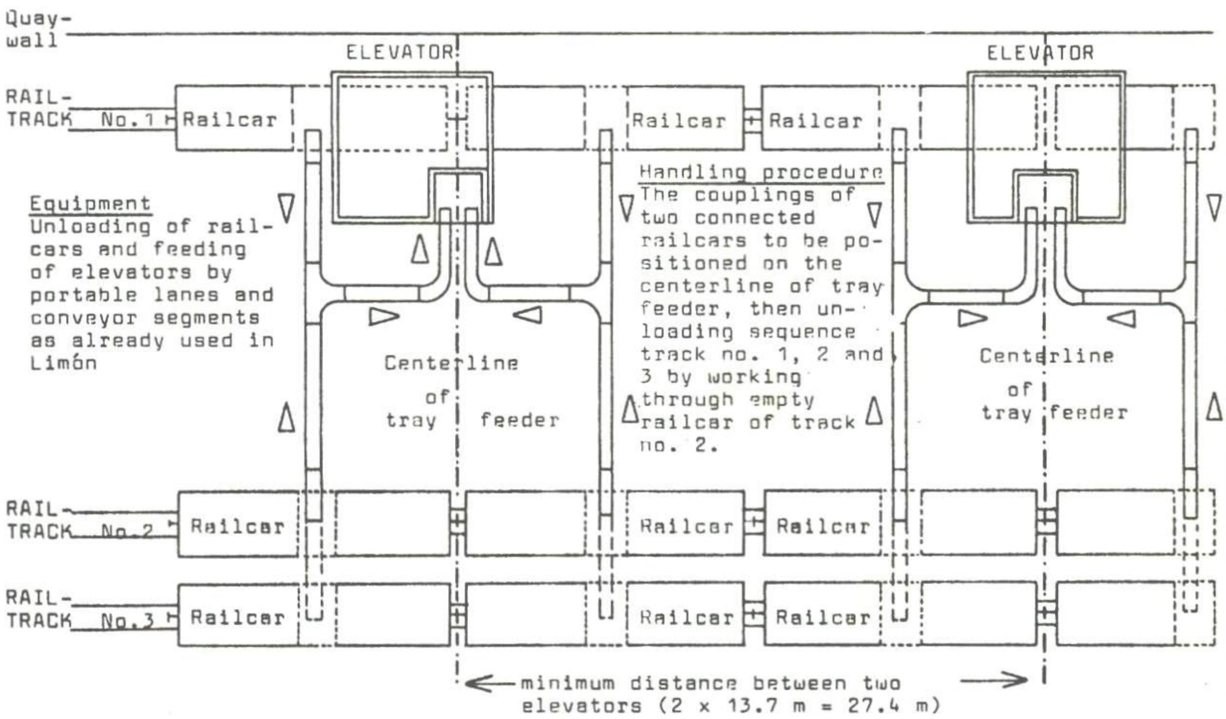
- higher productivity because the theoretical capacity is named at 4,500 boxes per hour; we will calculate with 3,800 and 3,200 (pessimistic assumption) boxes per hour as productivities;

- no further investments are necessary.

6.1.2 Gang structure Moín

For the gangs which load bananas with gantries the following gangstructure is recommendable. As the gantry will be fed by two lanes coming each from a different railcar, the following figures have to be doubled.

Figure E-6.1: Operation system for banana loading at Moín; General scheme of equipment and handling procedure



Ashore:

6 men working per railcar
1 man controlling 1. lane curve
1 man controlling 2. lane curve - each with a switch control
1 man controlling the tray feed - to stop the flow
1 man checking and tallying

10 men per lane or for two lanes
20 men for carton feeding ashore.

Aboard:

6 men working in the hatch per lane
1 man output control
1 man lane control - emergency switches available

8 men per lane or for two lanes
16 men aboard.

The elevator needs to be manned with
1 man driver and operator
1 man mechanical assistance to the driver

2 men totally per gantry

Following supervision staff is required:

1 man general gang foreman
1 man foreman abroad
1 man foreman ashore
1 man signalman aboard
3 men shunting advice and technical preparation

7 men
======

Thus the total required workforce amounts to

45 men,

of which 29 are provided by Japdeva and 16 by stevedores.

6.1.3 Man productivity

The present conveyor system at Limón reaches a maximum productivity of 2,500 boxes per hour with 45 men (Estibasa S.A.) which relates to a man productivity per hour of 56 boxes.
The gantries will work with 3,800 boxes per hour and 45 men, i.e. a man productivity of 84 boxes per man/hour.
Thus the productivity per manhour is 1.5 times higher if gantry loading system is used.

6.1.4 Hatch preparation

Presently following hours are consumed at Limón prior to loading:

3 hours preparation of hatches after mooring,
1 hour taking equipment from the vessel after completion

4 hours total preparation.

The gantry system provides a faster preparation, because the transloading equipment is taken aboard by the elevator itself.

1 hour preparation of hatches after mooring,
0.5 hour taking equipment from the vessel after completion.

1.5 hours total preparation.

The time saving per vessel thus amounts to

2.5 hours.

6.2 Equipment supply

6.2.1 Elevator productivity

As the elevators have not been used so far, only theoretical reflections could be made and then evaluated by practical and experienced means.

The theoretical productivity is mentioned at 4,500 boxes per hour. From the practical experience only 80 % of it should be calculated. Thus a productivity per elevatorhour could be considered at 3,800 boxes.

The elevators presently are in a condition which do not allow any operation. After being overhauled, tested and then continuously maintained this productivity could be realized. But for comparison we will calculate additionally the productivity of 3,200 boxes per hour (approx. 70 %). Actually the productivity will be in the range of 3,200 to 3,800 boxes per hour, should reach the 80 % of theoretical capacity.

6.2.2 Number of elevators per banana vessel

The elevator loading system requires a distance between two elevators of 27.40 m, due to the length of railcars. This implies that the operation of two connecting hatches will not be possible, if the hatch openings do not have the distance from each other of 27.40 m. (see also figure E-6.1).

Furthermore, our research of several banana vessels of different age and type found out that the hatch capacities vary substantially. Taking the biggest hatch as guideline, normally only another hatch has approx. the same capacity and the leaving two or three hatches each hold only a portion between 80 % and 40 % of the biggest hatch. Another aspect is that the two biggest hatches are normally connected, i.e. are located beside each other. (see annex E-6/3). Taking the above metioned facts into consideration, it seems not worth to work a banana boat with four elevators, the time saving will be little, because the loading time depends only on the biggest hatch.

Thus as maximum number of elevators per vessel we regarded as 3 elevators. This is supported by the fact, that presently at Limòn, berth No. 1, the average amount of gangs per banana vessel is 3.3.

With three elevators, disposed correctly in the preplanning, the loading requirements will be fulfilled.

Three elevators are usable with modern ships, having three holds forward and one after. This type of vessel could be regarded as the proto type of a modern banana-vessel.

Although vessels with 4 holds forward and one hold aft exist, they have not been proved workable efficiently and the trend is directed to the 4-hold vessel.

For the older type of vessels with 2 holds forward and 2 holds aft the use of three elevators is limited due to the small distances between the hatches and will not be necessary because of the relative small capacities.

The average shipments per banana vessel in 1978 for the different companies and future development displays as follows:

Companies	1978	1985	1990	1995	2000
Cobal	56,000	80,000	150,000	150,000	150,000
SFCO	144,000	150,000	150,000	150.000	150.000
Bandeco	93,000	100,000	100,000	--	--

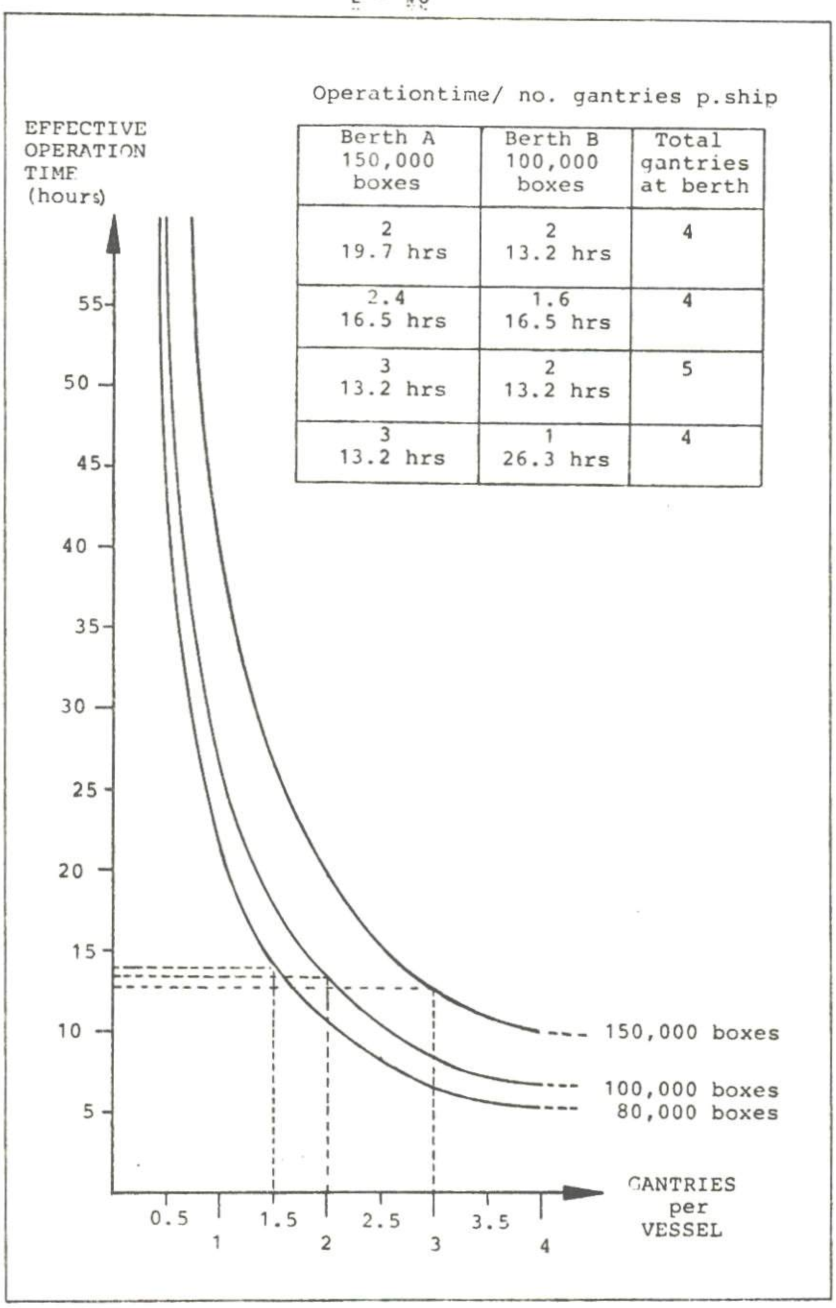
The growth of shipment is not only restricted to the age and the size of vessels, but also by the production of bananas. The cutting and packing capacities of the banana companies lie at about 150,000 boxes per day. This situation will not change in future.

In 1990, Cobal needs to replace their old vessels by modern ones due to the age and because of their increasing exports.

The calculation of the effective operation time (hours) per vessel dependent on the shipment and the numbers of elevators per vessel is listed below for high and low elevator productivity;

	Size of shipment (boxes)					
	150,000		100,000		80.000	
elevators per vessel	productivity (%) 3,800 b/hr	3,200 b/hr	productivity (%) 3,800 b/hr	3,200 b/hr	productivity (%) 3,800 b/hr	3,200 b/hr
1	39.5	46.88	26.3	31.3	21.1	25.0
1.5	26.3	31.3	17.5	20.8	14.0	16.7
2	19.7	23.4	13.2	15.6	10.5	12.5
2.5	15.8	18.8	10.5	12.5	8.4	10.0
3	13.2	15.6	8.8	10.4	7.0	10.0
3.5	11.3	13.4	7.5	8.9	6.0	7.1
4	9.9	11.7	6.6	7.8	5.3	6.3

The table shows clearly that from the operational view the increase of elevators per vessel would hardly be possible. This means for example that 150,000 boxes must be delivered in the port by the railway and producers in a time span of 11.3 hours (3.5 gantries per vessel, high productivity). This additional fact leads us to the recommendation to work small shipments (100,000 boxes) with two elevators at maximum, bigger ones (150,000) with 3 elevators.



Operationtime/ no. gantries p.ship

Berth A 150,000 boxes	Berth B 100,000 boxes	Total gantries at berth
2 19.7 hrs	2 13.2 hrs	4
2.4 16.5 hrs	1.6 16.5 hrs	4
3 13.2 hrs	2 13.2 hrs	5
3 13.2 hrs	1 26.3 hrs	4

The diagram displays how the staytime of vessel with different shipment vary in dependance of the elevators used per ship.

The determination, how many gantries are provided to the ships, has to be made by the port authority. At present four gantries are available and consequently 2 elevators are allocated per berth. This would result in the fact that a vessel with 100,000 cajas will be completed earlier than one with 150,000 cajas. Only in the case that one ship is in port, a third (or fourth) elevator could be supplied.

Another determination of gantries per vessel could be to decide that vessels should have approx. the same staytime in port, no matter how big the shipment is. This would encourage banana companies to ship bigger amounts of exports per vessel. In this case a theoretical allocation of 1.6 elevators to a shipment of 100,000 boxes and 2.4 elevators to 150,000 boxes would lead to the same operation time of 16.5 hours per vessel.

In case of 4 elevators the annual capacity is

73.9 million boxes with high productivity

and

62.1 million boxes with low productivity.

With 5 elevators the same reads:

92.4 million boxes with high productivity

and

77.8 million boxes with low productivity.

Then the following elevator utilizations result:

Elevator utilization in %

year	boxes for export million	4 gantries		5 gantries		6 gantries	
		3,800 b/hr	3,200 b/hr	3,800 b/hr	3,200 b/hr	3,800 b/hr	3,200 b/hr
1985	37.7	51	61	41	48	not applicable	
1990	37.7	51	61	41	48	34	40
Case A (low containerization of banana)							
1995	41.1	56	66	44	53	37	44
2000	44.9	61	72	49	58	41	48
Case B (high containerization of banana)							
1995	28.2	38	45	31	36	not applicable	
2000	--	0	0	0	0	not applicable	

6.2.4 Determination of necessary elevators

For economical reasons and for a better and more attractive outfit of the berths we suggest to supply a fifth elevator with the completion of construction.

Thus the overall berthtime per vessel will be lower than 24 hours; the total savings of waiting times at anchor will cover more than twice the investments. This especially in case of low productivity of the gantries.

The sixth elevator would be necessary in 1990 if the containerization did not follow our opinion (case B). Therefore, the trade situation must be analysed carefully and in 1988 the decision should be made. In case of high containerization the operation should continue with 5 elevators after 1990. (see also annex E- 5).

6.3 Berth requirements

6.3.1 Expected banana volumes

Based on the traffic forecast of this study and the share of exports for the banana exporting companies the following table shows the amount of boxes and conventional ship containers to be handled at Moín.

year	SFCO		Bandeco		Cobal		Total	
	million boxes	40' containers (pcs)	million boxes	40' containers (pcs)	million boxes	40' containers (pcs)	million boxes	40' containers (pcs)
1985	26.8	1,654	6.0	via Limón	4.8	276	37.7	1,930
1990	29.9	3,142	2.3	via Limón	5.5	552	37.7	3,694
Case A (low banana containerization)								
1995	29.9	3,142	--	via Limón	11.2	1,158	41.1	4,300
2000	29.9	3,142	--	via Limón	15.0	1,544	44.9	4,686
Case B (high banana containerization)								
1995	20.5	via Limón	--	via Limón	7.7	via Limón	28.2	via Limón
2000	--	via Limón	--	via Limón	--	via Limón	--	via Limón

Note: the container figures base on 1,000 boxes per 40'-container and that the same amount of exported containers has to be imported empty.

The table shows that Bandeco will fully containerize bananas first and that SFCO and Cobal will ship a certain amount of containers conventionally on their vessels. This applies for case A.

6.3.2 Development and size of shipment of bananas via Moín

Standard Fruit Company (SFCO)

1985 150,000 boxes per vessel
1990 150,000 boxes per vessel
1995 150,000 boxes per vessel
2000 150,000 boxes per vessel

This is the modern type of vessels with 3 hatches forward and 1 hatch aft, workable with 3 elevators.

Bandeco

1985 100,000 boxes per vessel
1990 100,000 boxes per vessel
1995 Bandeco will use contai-
2000 ner vessels only

Bandeco will not renew their old fleet due to containerization programme.

Cobal

1985	80,000 boxes per vessel	Cobal will increase the shipment due to new plantations and later renew the fleet to modern type of vessels, because at present they use the oldest ships.
1990	150,000 boxes per vessel	
1995	150,000 boxes per vessel	
2000	150,000 boxes per vessel	

The figures above apply to both cases, A and B, but in case of high banana containerization the ships calling at Moín will be substantially container vessels by and by after 1990.

Thus container vessels then will call at Limón.

6.3.3 Number of expected vessels for banana berths at Moín

Based on the average shipments and amounts of exports per banana company the following figures of vessels per year are expected. The conventionally carried containers are considered to be additional loads to the conventional banana boxes.

year	SFCO		Bandeco		Cobal		Total	
	vessels per year	boxes per vessel	vessels per year	boxes per vessel	vessels per year	boxes per vessel	vessels per year	boxes p. vessel
1985	179	9	60	--	61	5	300	6
1990	199	16	23	--	37	15	259	14
Case A (low banana containerization								
1995	199	16	--	--	75	15	274	16
2000	199	16	--	--	100	15	299	16
Case B (high banana containerization								
1995	137	--	--	--	51	--	188	--
2000	--	--	--	--	--	--	--	--

The table shows that the number of vessels expected at Moín will remain constant up to the year 2000. It will decrease up to 1990 because of the fact that Bandeco's vessels will call at Limón and because Cobal will carry bigger shipments on their ships. This although the total exports will increase.

In case of high banana containerization the number of banana vessels will decrease constantly up to zero in the year 2000.

6.3.4 Vessels staytime at berth

The staytime of banana vessels at the berth is determined by the following points:

1. the effective operation time to load the banana boxes, plus the operation time to handle the carried conventional containers,
2. unforeseen delays caused by weather influences, random breaks and maintenance and repair occasions,
3. time needed for mooring and unmooring, preparation of hatches before and after loading and clearance by authorities.

Following assumptions based on the evaluation of the present situation were made:

- effective operation time will be 21 hours a day
  (3 x 8 hrs = 24 hrs - 3 x 0.5 break - 3 x 0.5 hrs shiftchange = 21 hrs)
- containers handled by ship's gear are calculated on 5 moves per hour
- unforeseen delays at berth etc. are calculated on 20 % of effective operation time including container handling
- time for mooring, preparation and clearance 3 hours per vessel because the preparation of hatches worked by elevators will take not more than 1 hour, mooring should be calculated at 1 hour, the preparation for sea after loading will be congruent with the waiting for documents.

Thus two other facts have to be considered, which will influence the stay time, specifically the operation time:

the productivity of gantries
and
the number of gantries per vessel.

In the chapter "elevator supply at Moin" we defined the productivity with 3,800 boxes/hour as high and 3,200 boxes/hour as low.

The gantry supply to vessels is determined by
the provision of 5 gantries in 1985;
6 gantries in 1990 in case A and
5 gantries in case B.

Thus the following staytime of vessels result, which are shown in the following tables:

Staytime at berth per vessel (hours)

(figures in brackets for productivity 3,200 b/h)

year	SFCO		Bandeco		Cobal		Total
	gantries per ship	vessel at berth(hrs)	gantries per ship	vessel at berth(hrs)	gantries p.vessel	vessel at berth(hrs)	gantries available
1985	3	23 (26)	2	20 (24)	2	18 (21)	5
Case A (low banana containerization)							
1990	3	25 (28)	2	20 (24)	3	25 (28)	6
1995	3	25 (28)	--	--	3	25 (28)	6
2000	3	25 (28)	--	--	3	25 (28)	6
Case B (high banana containerization)							
1990	2.4	30 (33)	2	20 (24)	2.4	29 (33)	5
1995	2.4	25 (29)	--	--	2.4	25 (29)	5
2000		fully containerized					5

The table shows that with the recommended elevators at berth the staytime will be around 1 day per vessel.

The following table gives a split up of the average staytime per vessel for the future years:

Breakdown of average staytime in port (hours per vessel):

(figures in brackets for productivity 3,200 b/h)

year	effective elevator operation	container operation (conventional)	deadtime 1)	staytime at berth total	waiting time at anchor 2)	total time in port
1985	13.2(15.6)	1.2	7.1(7.8)	21.5(24.6)	0.9(2.0)	22.4(26.6)
Case A (low containerization of bananas)						
1990	13.2(15.6)	2.8	8.4(9.4)	24.4(27.8)	1.0(2.0)	25.4(29.8)
1995	13.2(15.6)	3.2	8.3(9.2)	24.7(28.0)	1.2(2.2)	25.9(30.2)
2000	13.2(15.6)	3.2	8.2(9.2)	24.6(28.0)	2.0(3.1)	26.6(31.1)
Case B (high containerization of bananas)						
1990	16.5(19.7)	2.8	9.2(9.8)	28.5(32.3)	2.3(3.6)	30.8(36.9)
1995	16.5(19.7)	--	8.5(9.0)	25.0(28.7)	0.5(0.6)	25.5(29.3)
2000		trade fully containerized				

1) deadtimes include 3 hours for mooring, hatch preparation and clearance; furthermore, breaks, loss by shiftchanges and unforeseen delays.

2) waiting times are based on the Erlang-distribution ($E_2/R_2/2$).

6.3.5 Berth occupancy and berth requirements

Based on the foregoing chapters and figures the following berthdays per banana company result:

year	SFCO No. of vessels	SFCO berth-days	Bandeco No. of vessels	Bandeco berth-days	Cobal No. of vessels	Cobal berth-days	total berthdays No. of vessels	total berthdays berth-days
1985	179	172 (195)	60	51 (59)	61	46 (54)	300	269(308)
Case A (low containerization); 6 gantries;								
1990	199	205 (234)	23	20 (23)	37	38 (43)	259	263(300)
1995	199	205 (234)	--	--	75	77 (86)	274	282(320)
2000	199	205 (234)	--	--	100	102 (115)	299	307(349)
Case B (high containerization); 5 gantries;								
1990	199	243 (275)	23	20 (23)	37	44 (51)	259	307(349)
1995	137	143 (164)	--	--	51	53 (61)	188	196(225)
2000				nil				

Note: Figures in brackets for low gantry productivity 3,200 b/hr.

This table shows that two berths are sufficient, SFCO-vessels could be handled easily at one berth only, because even with low gantry productivity the berthday will not exceed 286 operation days.

But the relatively low utilization of the second berth by Bandeco and Cobal allows to handle SFCO-vessels also at the second berth, if two vessels of Standard Fruit Company should be in port at the same time.

This situation hardly will occur because the production and cutting capacity will not meet the loading requirements of 300,000 boxes per day.

6.3.6 Berth utilization

The final determination, the berth utilization, has to be calculated on the availability of berthdays. As two berths are already under construction, the total availability per year we calculate

2 berths x 360 working days = 720 berthdays.

Furthermore, the information is required about the use of operation days. The operation days we calculated at

2 berths x 286 op.days/year[1]= 572 days.

Thus the following utilization is valid for the banana loading berths

---

1) operation Monday noon to Saturday which result in

5.5 days/week x 52 weeks/year - 286 days/year

Utilization of 2 banana berths

year	total berthday	utilization in % of operation days (572 days)	utilization in % of annual availa-bility (720 days)
1985	269 (308)	47 (54)	37 (43)
Case A (low containerization), 6 gantries;			
1990	263 (300)	46 (52)	37 (42)
1995	282 (320)	49 (56)	39 (44)
2000	307 (349)	54 (61)	43 (48)
Case B (high containerization), 5 gantries;			
1990	307 (349)	54 (61)	43 (48)
1995	106 (225)	34 (39)	27 (31)
2000	no utilization - trade fully containerized		

Note: in brackets the figures for low gantry productivity 3,200 b/hr.

The berth utilization never will exceed the available operation days, which means that loading of banana could be performed from Monday to Saturday. Regarding the annual utilization the figure will never exceed 48 %, even in case of low gantry productivity.

The above mentioned utilization furthermore results in very short waiting times for banana vessels, and reserve capacity for the port to absorb traffic peaks.

A detailed calculation of berth utilization, waiting time of vessels at anchor for different numbers of available gantry cranes and gantry productivity are given in annex E-5/1 to E-5/3.

7. Petrol liquid bulk at Moín (RECOPE)

The import of oilproducts has to be handled at the oilpier and the operation performance should be in the responsibility of RECOPE, because of the very specialized handling procedure.

Special importance should be drawn to the security and safety requirements for tanker handling and the port must supervise that RECOPE will fulfill all the requirements.

7.1 Size of expected vessels

After completion of the oilpier and its water access tankers are expected which carry approximate shipments of 40,000 tons petrol products.

7.2 Rate of discharge

The pipeline and discharging facilities will have a capacity of 8,000 barrels per hour, which is similar to approx. 1,020 tons per hour for common oil products.

Although discharging depends on the capacity of shippumps it is assumed that the vessels will have sufficient equipment to meet the pipeline's capacity.

7.3 Ineffective operation time

The rate of 1,020 tons per hour will not be the average discharging rate because the operation will suffer by delays for switching valves and draining the ship's tank, furthermore time will be consumed for ballasting.

For above mentioned purposes 20 % of the effective operation time will be calculated for delays. Furthermore, each vessel needs time for manoeuvres and discharging preparation. For the berthing and unberthing manoeuvres with tugboat assistance we calculate 2 hours and for preparation of gear another 2 hours, i.e. per vessel 4 hours.

7.4 Staytime of vessels at berth

The breakdown of the time consumption at berth shows as following:

shipment	40,000	tons
effective operation time	39.2	hours
delays during operation	7.8	hours
manoeuvres, preparation	4.0	hours
time at berth	51.0	hours or 2.13 days.

The average time a tanker spends at berth will be 51.0 hours or 2.13 days.

7.5 Berth occupancy

The following table calculates the berthday requirements and the utilization based on 360 operation days per year.

year	imports (1,000 t)	No. of vessels	berthday requirements	utiliza- tion (%)
1985	965	24	51.12	14
1990	1,170	29	61.77	17
1995	1,350	34	72.42	20
2000	1,500	38	80.94	22

The berth utilization for the oilpier regarding tanker handling will be rather low and increase from 14 % to 22 % in the period from 1985 to 2000.

7.6 Operation system

The handling and operation of the petrol bulk cargo should be in the responsibility of RECOPE because of the highly specialized handling techniques and equipment.

Berthing priority for tankers should be given to RECOPE by the port enabling them to minimize the staytime of vessels in the port to reduce the transportation costs of the imported petrol products.

7.7 Equipment

As the whole handling should be performed by RECOPE, they also should maintain the cargo facilities like oil discharging tower, pipeline and valves. Furthermore, RECOPE must provide the security measures required by international institutions like the "International Chamber of Shipping" and "Oil Companies International Marine Forum" laid down in the "International Safety Guide for Oil Tankers and Terminals".

8. Chemical liquid bulk at Moín

According to information of a private company "Quimicos Holanda" the discharge, storing and reloading of chemical liquid products should be handled at Moín.

The expected cargo amount was indicated at approx. 9,000 tons per year, imported by 4 or 5 ships per year.

8.1 Productivity

The effective handling rate is expected to be 100 tons/hours.

8.2 Daily capacity

The operation of liquid chemical bulk should be performed continuously during the day which means 24 hours as the goods are pumped ashore or aboard respectively.

Thus the daily capacity will be 2,400 tons effectively. Keeping in mind, that any operation will suffer from unforeseen delays such as bad weather, draining of tanks, switching valves, 20 % delays will be calculated.

8.3 Berthday requirements

4 or 5 vessels will be expected per year, we will use the pessimistic premise, i.e. 5 vessels, each carrying 1,800 tons import cargo. Considering that the same amount will be reexported with the same amount of shipment, totally 10 vessels are expected to handle 1,800 tons each.

Calculation of berthday requirements

vessels	10
shipment	1,800 tons
productivity (effective)	100 tons/hour
daily capacity	2,400 tons/day
operation time (effective)	0.75 days/vessel)
	(or 18.00 hours/vessel)
20 % unforeseen delays	0.15 days/vessel
	(or 3.60 hours/vessel)
gross operation time	0.90 days/vessel
	(or 21.60 hours/vessel)
time for mooring, preparation	0.13 days/vessel
	(or 3.00 hours/vessel)
total time at berth	1.03 days/vessel
	(or 24.60 hours/vessel)
annual required berthdays	10.30 days
	(246 hours)

Thus the berthdays required for the total handling of the imports and reexports of chemical products amount to

10.3 days per year,

which is similar to a berth utilization of 3 % per year of 360 operation days.

8.4 Storage requirements

According to the company's information, the area necessary for the installation of tanks etc. will be 2,000 m^2 in the beginning and 6,000 m^2 for future extension. Thus the total landspace reserved for the plant amounts to 8,000 m^2.

8.5 Operation system

The implementation of such a plant would be the beginning of the industrial zoning. Because the handling of chemical liquids is such a particular operation like RECOPE's petrol imports, the operation should be guided and performed by the private importer under the control of the port authority as far as public security is concerned.

8.6 Equipment

The good's nature requires pipe installations and shorepumps for reloading.

The berth, where the operation will take place, should be provided with a fixed pipe fitting or pipe connection making the operation safe without environmental negative influences.

9. Fertilizer handling at Moín

During the consultant's review in Costa Rica intentions were brought up to install a fertilizer bulk terminal at Moín. Beside the scientifical research of the commodities which should be handled there, the operational requirements have been investigated. In Annex E-8 an interims information concerning unloading and handling of fertilizer and liquid bulk in the port of Moín, which was submitted to MOPT in February 1980, is enclosed.

9.1 Discharging methods for fertilizer in bulk

a) The most common way of discharging bulk-fertilizer is using grabs and hoppers. A mobile crane or gantry crane equipped with a grab discharges the bulk-cargo into a simple hopper. Using mobile crane/s this hopper/s is also mobile, whereas in case of operation of a gantry crane the hopper is fixed with the portal of the crane. Through this hopper the granulated cargo proceeds on to a conveyor belt located on the pier parallel to the vessel and leading from there to the storage area. In order to enable a utilization of the pier not only for liquid and dry cargoes in bulk but also for general cargo or the like, it is recommended to locate the pier conveyor which is permanently fixed at the inn er side of the pier construction. However, if the discharging operation would be performed by means of shop's gear the mobile hopper/s would have to be located just behind the fender line because of the limited outreach of the gear with the consequence that a travelling conveyor would be necessary. This conveyor belt should be covered - protecting the fertilizer against wind and rain.

b) An alternative method for the discharging would be a continuously running bucket elevator, elevating the granulat out of the cargoholds on to the conveyor belt. This kind of handling works nearly free of dust but needs a lot of maintenance, the installation is comparably expensive and the rest of cargo in each cargohold is very difficult to discharge.

c) The most simple installation (one conveyor belt system and two hoppers) on the pier is necessary when using ship's gear for discharging.
However, only vessels fitted with cranes and/or derricks usable for grabs can be chartered for the transport, and the productivity depends largely on the speed of this ship's gear.

If the charterer can not guarantee an acceptable ship's gear the most economical solution is the grab discharging. The grab can be operated by a slewing crane (mobile crane) or by a gantry crane.
To reach a productivity of about 200 - 250 t/h it is necessary to carry at least 6.5 to on each crane cycle (about 35 - 40 crane cicles per hour are possible with a fast running gantry crane). That means a grab-capacity of about 6 m^3 = 5.5 t per load. Therefore the crane capacity should be 12 tons.

A gantry crane of this capacity (12 t) with an outreach of 15 m from the pier (see section: design vessel) and a possible speed of 40 moves per hour including a simple hopper will cost about the same as two mobile cranes.

The life time of such a gantry is much longer than for mobile cranes. Comparing a mobile crane of only 125 t/h capacity with, the price will be about half of the gantry.

That means for the same productivity of 250 t/h there are two mobile cranes necessary but the life time of mobile cranes is counted not more than 5 - 10 years in the average.

The most economical solution (next to discharging by ship's gear) seems to be the gantry crane. This crane could be installed on the southern end of the oil pier-travelling on rails from the southern end of the oil tower - 100 m southward so that there are still about 50 m in the south of the pier free for the planned/expected ro-ro traffic. The pier conveyor belt (capacity should be about 400 m^3/h) must reach over the same length.

This, however, assumes that before allocation and installation of fertilizer handling equipment a closer statical check up of the pile head connection and of the bearing capacity of the pier slab should be carried out in order to secure that the pier can carry the newly assigned statical and dynamical loads.

The weighing-machine (which is strongly recommended in order to avoid discrepancies between the manifested and the outturned weights) should be positioned before entering the storage facilities. After weighing the distribution to the different storage boxes should be done by conveyor belts also to insure the maximum filling of the boxes. For the given storage capacity of some 20,000 tons (8 commodities) a covered area of about 5,600 m^2 is necessary. The measurements of this stoarge area, i.e. two sheds, should be about 90 m in length and 27 m width each, 12 m height to the ridge of the roof with a central traffic way between the sheds for the conveyor belt. For the given additives of maximum 1000 t the storage boxes should be not too small to ensure an acceptable filling of it as well as the possibility of a proper discharge by bulldozers or the like. In a long storage shed like this also one traffic way and one delivering conveyor belt could be saved. Heating installations (by hot air) should be planned in order to decrease the humidity inside of the storage shed with regard to the hygroscopic property of the fertilizers and consequently enable a medium storage period.

The blending and bagging building should join this storage shed at one end, connected by the sideward delivering conveyor belt.

9.2 Capacity calculation

Working days

365 calendar days ./. 3 holidays
./. 22 rainy days = 340 working days

Berth occupancy

Optimum feasible berth occupancy is calculated to be 40 % for unscheduled arrivals.

Working time

The maximum achievable working time amounts to 20 hours per wwd (weather working day) equivalent to 24 hours less 4 average hours for berthing and unberthing, shifting as well as mealtimes.

Number of gangs

The calculation is based upon one gang working with shore crane. This could be equivalent to approximately 2 gangs working with ship's gear.

Productivity

The hourly productivity has to be adapted to the usual discharging time of the design vessel. This amounts to 3,000 tons per day = 150 t/h. (As this represents an average figure and the productivity decreases considerably during trimming the balance of the cargo as well as cleaning within the hatch the design productivity should be minimum 200 t/h in order to achieve the above mentioned average production).

The berth throughput capacity is calculated to be:
340 x 20 x 1 x 150 = 1,020,000 t/y.

Berth utilization

The yearly imports are estimated at 100,000 t in the beginning with an upward trend to some 150,000 t. This would result in a berth utilization of 10 to 15 % only. In view of this low utilization factor the berth would have enough vacant capacity for other commodities.

9.3 Design vessel for fertilizers in bulk

9.3.1 General

In view of the relatively small quantities of different commodities to be imported as well as the short distance between the port of loading (US Golf Coast) and Moin as the port of discharge there is very limited room only for utilizing the economies of scale in bulk shipping. The advantage of savings in seafreight by the employment of medium-sized bulk carriers would be compensated by the disadvantages resulting from - the uneconomical relation between the (long) loading/discharging days on one hand and the (short) seatransport days on the other - the capital investment for a larger stock of the different commodities in relation to the limited number of shipments.

9.3.2 Size of shipment

Consequently the size of the design vessel should not be adapted to the demand for imports for one or even two or three months (22,500 up to 67,500 t) but to the largest consignment to be shipped during high season in order to avoid uneconomical costs necessary for separating consignments of some 1000 tons paying deadfreight respectively.

Consequently it is recommended to take a vessel (bulk carrier type) of some 6,500 to 7,000 t net load equivalent to approximately 7,500 t tdw as a design vessel for the fertilizer imports. Depending on the charter market the average size of vessel may be smaller - probably some 5,000 tdw - the discharging installation, however, consequently has to be adapted to the design vessel.

9.3.3 Design vessel

This vessel has on an average the following main dimensions:

GRT	5 000	
DWT	7 500	
Length	135.00	m
Beam	17.50	m
Draft	8.00	m

Source: EAU (Linear-/Multipurpose Vessels respectively)

9.3.4 Discharging of a "Design vessel"

Cargo to be handled 6,500 - 7,000 tons
2 hatches - 2 holds
Total time for discharge : 40 (weather working hours)
= 5 1/2 shifts à 7.5 hrs.

a) By gantry cranes

	Crane Driver	Fore-man	Hatch Signal Man	Bulldozer Driver	Trimming-men
1st shift	1	1	1	-	-
2nd shift	1	1	1	-	-
3rd shift	1	1	1	1	2
4th shift	1	1	1	1	2
5th shift	1	1	1	1	2-4 depending on
6th shift	1	1	1	1	2-4 type of vessel

After discharging 2 men and 1 bulldozer/shovel loader for one shift for cleaning pier and conveyor belt is necessary.

b) By ship's gear - equivalent to 2 mobile cranes

	Crane Driver	Fore-man	Hatch Signal Man	Bulldozer Driver	Trimming-men
1st shift	2	1	2	-	-
2nd shift	2	1	2	-	-
3rd shift	2	1	2	-	-
4th shift	2	1	2	2	4
5th shift	2	1	2	2	4
6th shift	2	1	2	2	4-8

9.3.5 Discharging areas (piers)

Advantages	Disadvantages
Oil Pier	
No special pier-construction required	Collision with other berth occupancies (Tanker, ro-ro vessels)
Possibility of limited area for storage/bagging etc. near to the pier	Dust and corrosion on the banana-pier
	No independent management/cargo handling
	Spark-proved discharging facilities (see chapter: safety regulations)
New pier south of the banana pier	
Lee-side of the banana pier	New pier construction necessary
Independent management / cargo handling possible	Only limited extention area near to the pier available
"Industrial zone" in vicinity.	

9.3.6 Safety regulations / special requirements for fertilizer handling

Except the spark-proved electric equipment on the oil pier (or the total "switch-off" - probably combined with the tanker discharging installations - of this equipment) there are no special requirements for a safety cargo handling of the given eight commodities.

9.4 Delivering

The delivering capacity has to be adapted to the planned maximum tonnage of 22 500 t (15 % of 150 000 t/year). Monthly working days are calculated to be 25 (30 days ./. 4 sundays, ./. 1 holiday).
In this case the necessary demand (high season) is 900 t/day.

One delivering conveyor belt - operated by two men - has a productivity of 40 t/h (800 bags) bagged cargo loaded on to wagons or lorries. Consequently 22.5 working hours are required. In view of the fact that a continuous loading of trucks is impossible because of their unscheduled arrivals and the time lost by shunting of the trains a maximum feasible utilization of 15 hours per day = 2 shifts à 7.5 hours per belt can be achieved. The idle time during the 3rd shift can also be used for maintenance and repairs.

Therefore two delivery ramps - each equipped with a car loading conveyor belt - should be planned.

So the possibility is given to handle in two shifts à 7 1/2 working hours with three "gangs" (3 x 40 x 22 1/2 = 900 t per day) the above mentioned tonnage or even to cover eventually peaks during the "high season" in working with four gangs in two shifts - and slow down in the rest of the year.

Taking into consideration that under normal circumstances a changing of wagons by the railway company twice a day is possible there is a demand of 361 m (for 23 railcars) railtrack parallel the loading track (see plan).

If more than 900 t daily are to be delivered a changing of railcars 3 times a day is necessary.

The shunting of the railcars can be done by a so-called railcar pusher or by a special installed single pull railcar shunting system (winch).

The notice for changing railcars should be given at least 1 hour in advance (time for loading of 4 railcars on two conveyor belts) to the railway company to ascertain this changing without having idle times in delivering.

The railtracks in the vicinity of the delivery ramps should be paved on the same level than the adjoining street for the dispatch of railcars or lorries.

Note:

The bagged cargo can also be delivered palletized instead of the described operation with conveyors, this method however requires a larger storage area for bagged cargo and the investment/maintenance of pallets and forklifts.

9.5 Additional data

Additional data such as type, size and capacity of mobile and gantry cranes as well as preliminary layout and cross section of a fertilizer plant in Moin are given in Annex E-6 at the end of this chapter and in drawing K-2.1.

10. Equipment

10.1 General

As already outlined in the chapters E-2 to E-9 a certain amount of equipment will be required making the port efficient to handle the expected cargo volume.

The table 10-1 shows the cargo lifting year which should be made available.

The table 10-2 gives a breakdown of the cargo handling rolling stock which will be necessary in the future years.

It should be noted that the nature of cargo may require alterations or new cargo lifting gear if changes in commodities arise. The trailers and trucks for break-bulk and general cargo are necessary because of the finger pier of Muelle 70 and the shipside operation will take place at a distance from the storage area which does not allow to use forklifts economically for transportation.

In case B (high containerization of bananas) this equipment could be saved if the breakbulk and general cargo operation will be transferred totally to berth No. 10 and No. 11.

Table E-10.1: Cargo lifting equipment and other equipment (Port of Limón)

number of units	type of gear	capacity 1,000 kg	remarks
8,000	port pallets	2	120x180 cm
	chains		
20		5	length 6 m
15		8	length 6 m
6		15	length 6 m
	wire ropes		
50		2	length 10 m
50		2	length 7 m
20		3	length 10 m
20		3	length 7 m
10		4.25	length 7 m
	polyester belts		all 6 m long
100		2	
50		3	
100		1.5	
6	car gear	2.5	
3	truck gear	15	
18	barrel gear	4	for 8 barrels
8	paper clamps	3	
10	pallet gear	2	
20	nets	3	
1	grab for shore crane of Muelle 70	5	for bulk silicate
10	safety nets pier/ship		10x8 m
40	canvas covers for storage area		10x10 m
	adaptable gear for forklifts		
8	paper clamps		

Table E-10.2: Breakdown of operation equipment necessary to achieve efficient port capacity including landside handling, Port of Limón
(number of units of indicated type)

type of equipment	1985	1990	case A 1995	case A 2000	case B 1995	case B 2000	remarks
container gantry cranes	1	2	2	2	3	4	
straddle carriers	5	7	8	9	13	22	
banana elevators	5	6 (case A) 5 (case B)	6	6	5	*	at Moin
railcar pusher	3	3	3	3	3	3	for railcar shunting at Limón
forklifts							specification of lifting capacity see table below
break bulk (Muelle 70)	13	14	14	14	14	14	
general cargo (berth 10)	16	16	16	16	16	16	
empty container	2	2	2	2	3	4	
total	30	32	32	32	33	34	
trucks							five of these trucks will be used also for general cargo operation and require adaptability for Ro-Ro trailers and general cargo trailers.
Ro-Ro (berth 10)	5	5	5	5	5	5	
break bulk (Muelle 70)	5	5	5	5	5	5	
total	10	10	10	10	10	10	
trailer							the trailers could also be used for container transport in case of LCL handling, the 15 trailers for general cargo are required if berth 11 will be used for general cargo vessels
break bulk	15	15	15	15	15	15	
general cargo	15	15	15	15	15	15	
total	30	30	30	30	30	30	
mobile cranes	2	2	2	2	2	2	

forklift specification	1985	1990	case A 1995	case A 2000	case B 1995	case B 2000
3 tons	23	25	25	25	25	25
7.5 tons	5	5	5	5	6	7
15 tons	2	2	2	2	2	2
total	30	32	32	32	33	34

* In the year 2000 no more elevators will be required.

10.2 Equipment policy

The equipment required for operation includes already 20 % maintenance and repair downfall. To reach this optimum rate of breakdowns it is necessary to implement some important measurements.

- To purchase a certain type of equipment from one manufacturer only and make him guarantee the supply of spareparts over a reasonable time span and at reasonable prices.
  This would increase the starting investments but pay out by improved maintenance and repair situation and thus consequently lower breakdown times (see also chapter G-2.2.5).

- To establish a permanent maintenance and repair service for the rolling stock. Programs must be worked out which guarantee a regular maintenance after a certain amount of running hours.
  Therefore it is required to establish a record card for each unit of equipment having the control over the condition.
  Such performance requires a well equipped workshop with experienced mechanicians.

- To provide a suitable workshop where the maintenance and repair could be performed at any weather condition in a sufficient manner.

- To train the equipment drivers permanently that they will be able to realize defects, that they control the main running conditions and care for the proper handling.

All these measures will doubtless lead to lower breakdown times and save enourmous costs which could arise by lower port throughput due to failing equipment, longer ship service time due to lower productivities and higher investments in shorter periods because the lifetime decreases in case of improper maintenance and handling.

10.3 Maintenance and repair performance

The proper maintenance and repair starts with the handling of the equipment by the driver. Before using its vehicle he should control the main functions and conditions as water, fuel, grease. Any improperties must be reported immediately to avoid higher damages.

Between the shifts the used rolling stock should be inspected, fueled etc. and the running hours controlled. The equipment pre-planning of the central disposition department should consider the regular maintenance based on the running hour events when preparing the operation. The workshop should work on the two shifts whereas it is not necessary to keep the full staff ready in the second shift. The main maintenance and repair work should be performed during the first shift. The second then will continue and being ready for immediate repair works.

Equipment which breaks down in the third shift will be due for repair the next morning. Thus the workshop has to be prepared for two kinds of work, the regular maintenance and immediate repairs. The coordination with the operation department will lead to a calculable breakdown time of 20 %.

10.4 Workshop facilities

The future port situation requires three workshops.

1) A workshop for rolling stock at Limôn adjacent to the container terminal,

2) a construction workshop responsible for super- and infrastructures and piers at Limôn. This function should be taken over by the workshop which still exists in the western port area,

3) a maritime workshop for floating equipment and nautical equipment at Moîn, the marine yard.
The facilities for cargo handling equipment at Moîn could be combined with the maritime workshop although personnel will be required exclusively for the maintenance and repair of the elevators and feeding equipment. (This facility has been described in Chapter F-8).

10. 5 Workshop for rolling stock at Limôn

The workshop for the rolling equipment will be situated best between the Proyecto Alemân and the Muelle 70 in front of the present shed No. 5 beside today's port entrance.

This central position allows a short distance to the piers and working areas, a fast return after shift end and the straddle carrier of the container terminal will not disturb the traffic of the port.

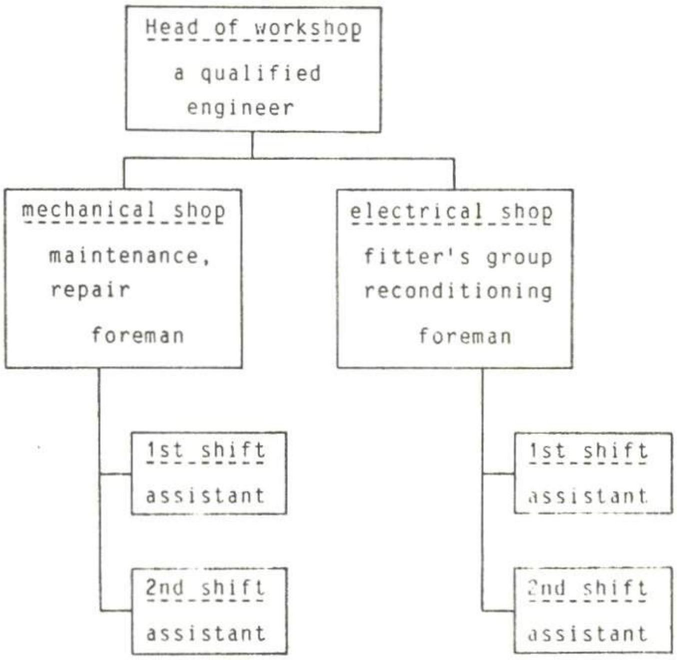
10.5.1 Workshop organization

The efficiency of a workshop depends directly on its organization and the flexibility of the staff. The head of the workshop should be a mechanical engineer which has experience with cargo handling equipment and its maintenance. The mechanical workshop should be supervised by a qualified forman with two assistants for the alternating shifts, they performed the equipment maintenance.

Additionally a fitter group, electricians will be guided by another foreman in the electrical workshop. He could delegate the supervision of the second shift to an assistant. The rehabilitation of spare parts should be in his charge possibly in conjunction with the fitter's shop of the construction workshop as described in 4.3 No. 2 to cover peak times.

The figure E-10.1 shows the organization chart of the workshop.

Figure E-10.1: Workshop organization for rolling stock



Note: The head of the workshop prepares the work programs in cooperation with the operation department.
The mechanical and electrical foremen cooperate directly during work-phases and daily programs.

10.5.2 Staff requirements

The workshop operation needs personnel which should be specialized on certain types of the equipment. Nevertheless they should be interchangeable up to a certain degree in case that operation peaks occur.

The specialisations are required for shore cranes, mobile cranes, trailers, trucks, forklifts and straddle carrier.

Following mechanics should be provided:

	1st shift	2nd shift
Forklifts	5	3
Trucks	3	1
Trailer	3 - 4	1 - 2
Mobile Cranes	3	2
1985 - 2000		
Straddle Carrier	8	4
Cranes	4	2
1995 - 2000 (Case B)		
Straddle Carrier	20 - 22	10 - 12
Cranes	8	4

10.5.3 Workshop design

The workshop should supply enough boxes for the different types of equipment that the maintenance and repair could be performed without disturbing each other.

Beside the store for spare parts (2 Floors), the workshops for the fitters and electricians, office rooms for the supervision staff and the head of the workshops should be installed in the first floor.
Parking space in front of the workshop will be available and beside an area should be created for equipment waiting for repair.

The rough layout of the workshop is shown in Drawing K-1.3.1; K-1.3.2.

10.5.5 Workshop outfit and equipment costs

The workshop and its parts for the different types of equipment are outlined below. Costs are given in US-Dollar and CIF Limón. (Cost based on 1979 prices, no foreign exchange factor included).

Straddle carrier workshop

A crane trolley of 5 tons capacity	$ 40,000.--
A service box for maintenance	$ 13,000.--
- work benches, small tooling machines, racks, boards and tools	$ 67,000.--
	$ 120,000.--
- case B additionally	$ 70,000.--

Forklift and truck workshop

A crane trolley of 3 tons capacity	$ 20,000.--
A rising platform	$ 40,000.--
- work benches, machines, tools	$ 67,000.--
	$ 127,000.--

Trailer workshop

Outfit and equipment	$ 7,000.--

Fitter's and electrician's shop

A crane trolley of 3 tons capacity	$ 20,000.--
outfit and equipment	$ 33,000.--
	$ 53,000.--

Store

Outfit and equipment	$ 33,000.--
Total workshop	$ 340,000.--
(in case B additionally)	$ 70,000.--

11. Total port operation and cargo assignment

The chapters E-2 to E-9 detail the particular anticipated situations regarding the special cargo commodity and indicate the necessary requirement for a higher port efficiency. The following last section of the Chapter E (anticipated port operation) will summarize the overall port situation.

11.1 Cargo volume

The table E-11.1 shows the future development of the cargo volume regarding the different commodities for the two cases "A" and "B" (low and high containerization of bananas).

11.2 Number of expected vessels

The table E-11.2 gives an outlook on the number and type of vessels which will call at Limón and Moín in future and displays that the arrivals will remain constant in future due to bigger shipments per vessel.

11.3 Berthday requirements

Based on the assumptions and measurements which are recommended in the concerning sections E-2 to E-9 the table E-11.3 indicates the berthday requirements for the port in total, Limón and Moín are listed also as subtitles. (Case A).

The data show a reasonable overall utilization of the port during the whole future period of approximately 50 %.

This will avoid possible congestion situation and benefit the Costa Rican economy to an extent that the progress will not be hindered by inadequate port infrastructure.

11.4 Cargo assignment and distribution of utilization to the different piers

11.4.1 Low containerization of bananas - Case A

Table E-10.4 shows the distribution of cargo to the different piers in the port and the required berthdays per commodity.

This table considers the case that the banana containerization will be low (Case A). The cargo assignment was chosen in a way to provide berthing space to container ships and banana vessels at priority. Therefore the utilization of berth No. 11 (container terminal) and the banana piers at Moín should be at approx. 40 %. The other berths for breakbulk and general cargo should not be utilized over 60 % to avoid longer waiting times for such kind of vessels (queueing).

Table E-11.1: Cargo volume in 1,000 tons to be handled at Limón and Moin

type of cargo	1985	1990	case A - low containerisation 1995	2000	case B - high containerisation 1995	2000
container	486.5	691.0	813.5	906.0	1,049.5	1,721.0
Ro-Ro	144.0	163.0	200.0	238.0	200.0	238.0
break bulk	241.3	291.0	287.5	279.0	287.5	279.0
general cargo	135.0	115.0	137.0	127.0	137.0	127.0
conventional banana	683.0	684.0	746.5	815.0	510.5	nil
petrol liquid bulk	965.0	1,170.0	1,350.0	1,500.0	1,350.0	1,500.0
chemical liquid bulk (*1	9.0	9.0	9.0	9.0	9.0	9.0
fertilizer bulk*2	80.0	100.0	150.0	150.0	150.0	150.0
total cargo Limón/Moin	2,743.8	3,223.0	3,693.5	4,024.0	3,693.5	4,024.0

Note: -*1 According data received from the private enterprise "Quimicos Holanda",
-*2 according data made available by the company "Abono Superior"

Table E-11.2: Number of vessels to be expected in Limóm and Moin

type of vessel	1985	1990	case A - low containerisation 1995	2000	case B - high containerisation 1995	2000
container	170	190	205	230	310	415
Ro-Ro	158	175	192	192	192	192
break bulk (*1	241	291	288	279	288	279
general cargo	135	115	137	127	137	127
subtotal Limón	704	771	822	828	927	1,013
conventional banana	300	259	274	299	188	nil
petrol tanker	24	29	34	38	34	38
chemical tanker	10	10	10	10	10	10
fertilizer bulk vessel (*2	14	21	21	21	21	21
subtotal Moin	348	319	339	368	253	69
total Limón and Moin	1,052	1,090	1,161	1,196	1,180	1,082

Note: (*1- each break bulk vessel is calculated at a shipment of 1,000 tons,
(*2- each fertilizer bulk vessel transports 7,000 tons

Table E-11.3: Case A - low containerisation of bananas.
Berthday requirements and utilisation for the whole port complex Limón/Moin
- based on 360 commission days per year and pier -

berth	type of cargo	1985	1990	1995	2000
Muelle 70	break bulk general cargo subtotal	146 62 208	152 36 188	137 69 206	131 79 210
Proyecto Alemán berth 10	Ro-Ro general cargo subtotal	61 148 209	68 140 208	79 126 205	94 112 206
Proyecto Alemán berth 11	container general cargo subtotal	173 - 173	133 - 133	153 18 171	166 7 173
total berthdayrequirements Limón utilisation Limón		590 55%	529 49%	582 54%	589 55%
banana piers	conventional bananas	269(308)	263(300)	282(320)	307(349)
oilpier	petrol liquids chemical liquids fertilizer bulk Ro-Ro subtotal	51 10 36 7 104	62 10 54 7 133	73 10 54 11 148	81 10 54 11 156
total berthday requirements Moin utilsation Moin		373(412) 35%(38)	396(433) 37%(40)	430(468) 40%(43)	463(505) 43%(47)
total berthday requirements port total utilisation Limon and Moin		963(1,002) 45%(46)	925(962) 43%(45)	1,012(1,050) 47%(49)	1,052(1,094) 49%(51)

Note: in brakes the figures for low banana gantry productivity of 3,200 boxes/hour

11.4.2 High containerization of bananas - Case B

In case that bananas will be containerized according to the consultant's alternative opinion (high containerization of bananas - Case B) the consultant will recommend constructional changes in the port, detailed in Chapter F. For these alternatives the next four tables indicate the cargo assignment and utilization for the piers.

It should be noted that the different development of containerization will start after 1990, i.e. both cases A and B the cargo assignment up to 1990 is identical.

Table E-11.5 considers the possibility to use Proyecto Alemân in its planned concept, operating with an economic utilization of about 60 per cent, and handling excess container traffic with a new to built container terminal, 1 berth (alternative B-1 (a)).

Table E-11.6 describes the cargo assignment after 1990 if a new container terminal will be built and the whole break bulk and general cargo operation will be transferred to the Proyecto Alemân (alternative B-1 (b)).

Table E-11.7 displays the situation if a new container terminal will be constructed at Limôn with an adjacent general cargo pier (alternative B-2).

Table E-11.8 shows the possibility to build a container terminal only for banana containers at Moîn (alternative B-3 (a)).

The last table E-11.9 gives a description of a concept of harbour operation for container handling in Moîn. By this, in Limôn only general cargo and break bulk will be handled in future, using berth 10 and 11.

Table E-11.4: Distribution of Pier Utilization and Cargo Assignment

- Case A -

1985

	Berth Unit	Container	Ro/Ro	Break Bulk	General Cargo	Bananas	Petrol Liquids	Chemical Liquids	Fertilizer	Total
LIMON	Proyecto Aleman Berth 10 + RoRo-Ramp	—	17	—	41	—	—	—	—	58
LIMON	Proyecto Aleman Berth 11	48	—	—	—	—	—	—	—	48
LIMON	Muelle 70	—	—	41	17	—	—	—	—	58
MOIN	Oilpier and RoRo-Ramp	—	2	—	—	—	14	3	10	29
MOIN	Banana Pier Berth 1+2	—	—	—	—	(43) 37	—	—	—	(43) 37
	Utilization required by commodity per berth units	48	19	41	58	(43) 37	14	3	10	

1990

	Berth Unit	Container	Ro/Ro	Break Bulk	General Cargo	Bananas	Petrol Liquids	Chemical Liquids	Fertilizer	Total
LIMON	Proyecto Aleman Berth 10 + RoRo-Ramp	—	19	—	39	—	—	—	—	58
LIMON	Proyecto Aleman Berth 11	37	—	—	—	—	—	—	—	37
LIMON	Muelle 70	—	—	42	10	—	—	—	—	52
MOIN	Oilpier and RoRo-Ramp	—	2	—	—	—	17	3	15	37
MOIN	Banana Pier Berth 1+2	—	—	—	—	(42) 37	—	—	—	(42) 37
	Utilization required by commodity per berth units	37	21	42	49	(42) 37	17	3	15	

1995

	Berth Unit	Container	Ro/Ro	Break Bulk	General Cargo	Bananas	Petrol Liquids	Chemical Liquids	Fertilizer	Total
LIMON	Proyecto Aleman Berth 10 + RoRo-Ramp	—	22	—	35	—	—	—	—	57
LIMON	Proyecto Aleman Berth 11	43	—	—	5	—	—	—	—	48
LIMON	Muelle 70	—	—	38	19	—	—	—	—	57
MOIN	Oilpier and RoRo-Ramp	—	3	—	—	—	20	3	15	41
MOIN	Banana Pier Berth 1+2	—	—	—	—	(44) 39	—	—	—	(44) 39
	Utilization required by commodity per berth units	43	25	38	59	(44) 39	20	3	15	

2000

	Berth Unit	Container	Ro/Ro	Break Bulk	General Cargo	Bananas	Petrol Liquids	Chemical Liquids	Fertilizer	Total
LIMON	Proyecto Aleman Berth 10 + RoRo-Ramp	—	26	—	31	—	—	—	—	57
LIMON	Proyecto Aleman Berth 11	46	—	—	2	—	—	—	—	48
LIMON	Muelle 70	—	—	36	22	—	—	—	—	58
MOIN	Oilpier and RoRo-Ramp	—	3	—	—	—	22	3	15	43
MOIN	Banana Pier Berth 1+2	—	—	—	—	(48) 43	—	—	—	(48) 43
	Utilization required by commodity per berth units	46	29	36	55	(48) 43	22	3	15	

*) Note: - Values are expressed in % of 360 commission days
- Values in brakes indicate the utilization of banana facilities for low gantry productivity (3,200 b/h)

Table E-11.5: Distribution of Pier Utilization and Cargo Assignment
- Case B (Alt. 1 a) -

1995	BERTH UNIT	CON-TAINER	RO/RO	BREAK BULK	GENERAL CARGO	BANANAS	PETROL LIQUIDS	CHEMICAL LIQUIDS	FERTILIZER	TOTAL
LIMON	PROYECTO ALEMAN BERTH 10 + RO/RO-RAMP	—	22	—	25	—	—	—	—	47
LIMON	PROYECTO ALEMAN BERTH 11	20	—	—	25	—	—	—	—	45
LIMON	MUELLE 70	—	—	38	9	—	—	—	—	47
LIMON	CONTAINER TERMINAL (NEW) 1 BERTH	24	—	—	—	—	—	—	—	24
MOIN	OILPIER AND RO/RO-RAMP	—	3	—	—	—	20	3	15	41
MOIN	BANANA PIER BERTH 1+2	—	—	—	—	(31) 27	—	—	—	(31) 27
UTILIZATION REQUIRED BY COMMODITY PER BERTH UNITS		44	25	38	59	(31) 27	20	3	15	

2000	BERTH UNIT	CON-TAINER	RO/RO	BREAK BULK	GENERAL CARGO	BANANAS	PETROL LIQUIDS	CHEMICAL LIQUIDS	FERTILIZER	TOTAL
LIMON	PROYECTO ALEMAN BERTH 10 + RO/RO-RAMP	—	26	—	25	—	—	—	—	51
LIMON	PROYECTO ALEMAN BERTH 11	20	—	—	25	—	—	—	—	45
LIMON	MUELLE 70	—	—	36	5	—	—	—	—	41
LIMON	CONTAINER TERMINAL (NEW) 1 BERTH	37	—	—	—	—	—	—	—	37
MOIN	OILPIER AND RO/RO-RAMP	—	3	—	—	—	22	3	15	43
MOIN	BANANA PIER BERTH 1+2	—	—	—	—	0	—	—	—	0
UTILIZATION REQUIRED BY COMMODITY PER BERTH UNITS		57	29	36	55	0	22	3	15	

Note: - Values are expressed in % of 360 commission days
- Values in brakes indicate the utilization for low gantry productivity (3,200 b/h)

Table E-11.6: Distribution of Pier Utilization and Cargo Assignment
- Case B (Alt. B - 1b) -

1995

	BERTH UNIT	CON-TAINER	RO/RO	BREAK BULK	GENERAL CARGO	BANANAS	PETROL LIQUIDS	CHEMICAL LIQUIDS	FERTILIZER	TOTAL
LIMON	PROYECTO ALEMAN BERTH 10 + RO/RO-RAMP	—	22	38	—	—	—	—	—	60
LIMON	PROYECTO ALEMAN BERTH 11	—	—	—	59	—	—	—	—	59
LIMON	MUELLE 70	—	—	0	—	—	—	—	—	0
LIMON	CONTAINER TERMINAL (NEW) 2 BERTHS	44	—	—	—	—	—	—	—	44
MOIN	OILPIER AND RO/RO-RAMP	—	3	—	—	—	20	3	15	41
MOIN	BANANA PIER 2 BERTHS	—	—	—	—	(31) 27	—	—	—	(31) 27
UTILIZATION REQUIRED BY COMMODITY PER BERTH UNITS		44	25	38	59	(31) 27	20	3	15	

2000

	BERTH UNIT	CON-TAINER	RO/RO	BREAK BULK	GENERAL CARGO	BANANAS	PETROL LIQUIDS	CHEMICAL LIQUIDS	FERTILIZER	TOTAL
LIMON	PROYECTO ALEMAN BERTH 10 + RO/RO-RAMP	—	26	33	—	—	—	—	—	59
LIMON	PROYECTO ALEMAN Berth 11	—	—	3	55	—	—	—	—	58
LIMON	MUELLE 70	—	—	0	—	—	—	—	—	0
LIMON	CONTAINER TERMINAL (NEW) 2 BERTHS	57	—	—	—	—	—	—	—	57
MOIN	OILPIER AND RO/RO-RAMP	—	3	—	—	—	22	3	15	43
MOIN	BANANA PIER 2 BERTHS	—	—	—	—	0	—	—	—	0
UTILIZATION REQUIRED BY COMMODITY PER BERTH UNITS		57	29	36	55	0	22	3	15	

Note: - Values are expressed in % of 360 commission days
- Values in brakes indicate the utilization for low gantry productivity (3,200 b/h)

Table E-11.7: Distribution of Pier Utilization and Cargo Assignment
- Case B (Alt. B - 2) -

1995	BERTH UNIT	CON-TAINER	RO/RO	BREAK BULK	GENERAL CARGO	BANANAS	PETROL LIQUIDS	CHEMICAL LIQUIDS	FERTILIZER	TOTAL
LIMON	PROYECTO ALEMAN BERTH 10+11+ RO/RO-RAMP	14	22	—	—	—	—	—	—	36
LIMON	CONTAINER TERMINAL (NEW) 1 BERTH	30	—	—	—	—	—	—	—	30
LIMON	GENERAL CARGO BERTH (NEW)	—	—	—	59	—	—	—	—	59
LIMON	MUELLE 70	—	—	38	—	—	—	—	—	38
MOIN	OILPIER AND RO/RO RAMP	—	3	—	—	—	20	3	15	41
MOIN	BANANA PIER 2 BERTHS	—	—	—	—	(31) 27	—	—	—	(31) 27
UTILIZATION REQUIRED BY COMMODITY PER BERTH UNITS		44	25	38	59	(31) 27	20	3	15	

2000	BERTH UNIT	CON-TAINER	RO/RO	BREAK BULK	GENERAL CARGO	BANANAS	PETROL LIQUIDS	CHEMICAL LIQUIDS	FERTILIZER	TOTAL
LIMON	PROYECTO ALEMAN BERTH 10+11 + RO/RO-RAMP	17	26	—	—	—	—	—	—	43
LIMON	CONTAINER TERMINAL (NEW) 1 BERTH	40	—	—	—	—	—	—	—	40
LIMON	GENERAL CARGO BERTH (NEW)	—	—	—	55	—	—	—	—	55
LIMON	MUELLE 70	—	—	36	—	—	—	—	—	36
MOIN	OILPIER AND RO/RO-RAMP	—	3	—	—	—	22	3	15	43
MOIN	BANANA PIER 2 BERTHS	—	—	—	—	0	—	—	—	0
UTILIZATION REQUIRED BY COMMODITY PER BERTH UNITS		57	29	36	55	0	22	3	15	

Note:-Values are expressed in % of 360 commission days
-Values in brakes indicate the utilization for low gantry productivity (3,200 b/h)

ANNEX E - 1 TO E - 8

Calculation of Container Handling in the Terminal

1985:	120,000t	SL/USL	= 6,667 cont.(35'/40')	+ 1,333 M/T
	252,000t	SL/USL (bananas)	= 15,460 cont. (35')	+ 14,127 M/T
	86,500t	other lines	= 3,810 cont. (20')	+ 762 M/T
			2,050 cont. (40')	+ 410 M/T
			27,987 cont. full	
			16,632 cont. M/T	
			44,619 cont. total	
1990:	152,000t	SL/USL	= 8,444 cont. (35'/40')	+ 1,689 M/T
	371,500t	SL/USL (bananas)	= 22,791 cont. (35')	+ 21,102 M/T
	118,000t	other lines	= 5,200 cont. (20')	+ 1,040 M/T
			2,800 cont. (40')	+ 560 M/T
			39,235 cont. full	
			24,391 cont. M/T	
			63,626 cont. total	
1995:	187,000t	SL/USL	= 10,389 cont. (35'/40')	+ 2,078 M/T
	412,500t	SL/USL (bananas)	= 25,306 cont. (35')	+ 23,228 M/T
	158,000t	other lines	= 6,963 cont. (20')	+ 1,393 M/T
			3,749 cont. (40')	+ 750 M/T
			46,407 cont. full	
		case A	27,449 cont. M/T	
			73,856 cont. total	
1995:		see case A	= 73,856 cont.	
	275.000t	bananas	= 15,805 cont. (40')	+ 15,805 M/T
			89,661 cont.	
		case B	15,805 cont. M/T	
			105,466 cont. total	
2000:	222,000 t	SL/USL	= 12,333 cont. (35'/40')	+ 2,467 M/T
	412,500 t	SL/USL (bananas)	= 25,306 cont. (35')	+ 22,839 M/T
	205,000 t	other lines	= 9,034 cont. (20')	+ 1,807 M/T
			4,864 cont. (40')	+ 973 M/T
			51,537 cont. full	
		case A	28,086 cont. M/T	
			79,623 cont. total	
2000:		see case A	= 79,623 cont.	
	857,000 t	bananas	= 49,253 cont. (40')	+ 49,253 M/T
			128,876 cont.	
		case B.	49,253 cont. M/T	
			178,129 cont. total	

Gantry-crane effectiveness

To evaluate the effectiveness of the distribution of container gantry cranes per berth following standards should be taken into consideration.
The daily capacity of a gantry must be multiplied with the effectiveness factor which is displayed hereafter:

cranes per 1 berth	effectiveness factor per crane
1	1.0
2	0.9
3	0.8
4	0.7

As calculated for Limón, the daily capacity of a container gantry crane will be 420 boxes per day.
If providing the required crane up to the year 2000 to only one berth, the berth capacity per day shows as following:

with 1 crane (1 x 1.0 x 420) = 420 boxes/day,
with 2 cranes (2 x 0.9 x 420) = 756 boxes/day,
with 3 cranes (3 x 0.8 x 420) =1,008 boxes/day,
with 4 cranes (4 x 0.7 x 420) =1,176 boxes/day.

Thus it is obvious the the daily capacity of a port would be greater if an additional berth will be supplied in case that more than 2 crane will be used.
In case of Limón (case B) the third gantry becomes necessary in 1994 and the fourth in 1997.
Then the second berth should be finished in 1994.
The following comparison will show the increase of daily capacity:

year	cranes	one berth	two berthes	increase
1994	3	1,008 boxes/day	1,176 boxes/day	17%
1997	4	1.176 boxes/day	1,512 boxes/day	29%

Storage Area Requirements

year	Shipp. Co.	Containers	% of affect	Cont. affect. area	Dwell-time	x-TEU	Subtotal (4x5x6)	Div.by 360	Total (7:8)	x peak factor	Grand Total (9 x 10)
1985	SL	8,000	10%	800	2	2	3,200	*/.360	9	1,8	16
	SL Ba	29,587	40%	11,834	2	2	46,936	*/.360	130	1.8	234
	o.Lines	4,572	100%	4,572	5	1	22,860	"	64	1.8	115
	o.Lines	2,460	100%	2,460	5	2	24,600	"	68	1,8	122
											TEU 487
1990	SL	10,133	30%	3,040	2	2	12,160	"	34	1.5	51
	SL Ba	43,893	60%	26,335	2	2	105,340	"	292	1,5	438
	o.Lines	6,240	100%	6,240	5	1	31,200	"	87	1,5	174
	o.Lines	3,360	100%	3,360	5	2	33,600	"	93	1.5	140
											TEU 760
1995 (A)	SL	12,467	40%	4,987	2	2	19,948	"	55	1.5	83
	SL Ba	48,534	60%	29,120	2	2	116,480	"	323	1.5	484
	o.Lines	8,356	100%	8,356	5	1	41,780	"	116	1.5	174
	o.Lines	4,499	100%	4,499	5	2	44,990	"	125	1.5	188
											TEU 929
1995 (B)		see 1995 (A)							619	1.2	743
	Ban.	31,610	100%	31,610	5	2	316,100	"	878	1.2	1,053
											TEU1,796
2000 (A)	SL	14,800	40%	5,920	2	2	23,680	"	66	1.5	99
	SL Ba	48,534	60%	29,120	2	2	116,480	"	323	1.5	484
	o.Lines	10,841	100%	10,841	5	1	54,205	"	151	1.5	227
	o.Lines	5,837	100%	5,837	5	2	58,370	"	162	1.5	243
											TEU1053
2000 (B)		see 2000 (A)							702	1.2	842
	Ban.	98,506	100%	98,506	5	2	985,060	"	2,736	1.2	3.283
											TEU 4.125

Calculation of Utilization of Straddle Carriers

year	containers (disch./load)	landside re-handling	subtotal (1+2)	re-stow moves 15 %	total (3+4)	peak-factor	grand-total (5+6)
1985	19,666	19,666	39,332	5,900	45,232	1.8	81,418
1990	38,975	38,975	77,950	11,693	89,643	1.5	134,465
1995 (A)	46,962	46,962	93,924	14,098	109,013	1.5	162.020
1995 (B)	78,572	78,572	157,144	23,572	180,716	1.2	216.860
2000 (A)	51,718	51,718	103,436	15,515	118,951	1.5	178.427
2000 (B)	150,224	150,224	300,448	45,067	345,515	1.2	414.618

year	ships with 150000 boxes	gantries per vessel	days at berth (1	ships with 100000 boxes	gantries per vessel	days at berth (1	ships with 80000 boxes	gantries per vessel	days at berth (1	Total ships	Total gan-tries	Total berth-days (1	Utilisation (1 (%) of operation 572 d	commission 720 d	Waiting time at anchor (1 co-efficient²	shipdays per year	hours per ship	Staytime in port per ship hrs	or d
1985	179	2.0	1.32 1.52	60	2.0	0.85 0.99	61	2.0	0.76 0.88	300	4	333 385	58 67	46 53	0.10 0.15	33.3 57.8	2.7 4.6	29.3 35.4	1.22 1.48
		2.4	1.14 1.31		1.6	1.04 1.21		1.6	0.91 1.05		4	322 372	56 65	45 52	0.09 0.13	29.0 48.4	2.3 3.9	28.1 33.7	1.17 1.40
		3.0	0.96 1.09		2.0	0.85 0.99		2.0	0.76 0.88		5	269 308	47 54	37 43	0.04 0.08	10.8 24.6	0.9 2.0	22.4 26.6	0.93 1.11
1990	236	2.0	1.40 1.60	23	2.0	0.85 0.99	nil	-	-	259	4	350 400	58 67	46 53	0.10 0.15	35.0 60.0	3.2 5.6	35.6 42.7	1.48 1.78
		2.4	1.22 1.38		2.0	0.85 0.99		-	-		5	307 349	54 61	43 48	0.08 0.11	24.6 38.4	2.3 3.6	30.8 36.9	1.28 1.54
		3.0	1.03 1.17		2.0	0.85 0.99					6	263 300	46 52	37 42	0.04 0.07	10.5 21.0	1.0 2.0	25.4 29.8	1.06 1.24

Case A - low containerisation of banana

Case A

year	ships with 150000 boxes	gantries per vessel	days at berth	ships with 100000 boxes	gantries per vessel	days at berth	ships with 80000 boxes	gantries per vessel	days at berth	Total ships	Total gantries	Total berth-days	operation 572 d	commission 720 d	co-efficient	shipdays per year	hours per ship	hrs	d
1995	274	2.0	1.40 1.60	nil	-	-	nil	-	-	274	4	383 437	67 76	53 61	0.15 0.24	57.5 104.9	5.0 9.2	38.5 47.5	1.60 1.98
		2.4	1.22 1.38		-	-		-	-		5	333 378	58 66	46 53	0.10 0.15	33.3 56.7	2.9 5.0	32.1 38.1	1.34 1.59
		3.0	1.03 1.17		-	-		-	-		6	282 320	49 56	39 44	0.05 0.08	14.1 25.6	1.2 2.2	25.9 30.2	1.08 1.26
2000	299	2.0	1.40 1.60	nil	-	-	nil	-	-	299	4	417 477	73 83	58 66	0.20 0.32	83.4 152.6	6.7 12.3	40.2 50.6	1.68 2.11
		2.4	1.22 1.38		-	-		-	-		5	363 412	63 72	50 57	0.12 0.18	43.6 74.2	3.5 6.0	32.6 39.1	1.36 1.63
		3.0	1.03 1.17		-	-		-	-		6	307 349	54 61	43 48	0.08 0.11	24.6 38.4	2.0 3.1	26.6 31.1	1.11 1.30

Case B - high containerisation of banana

Case B

year	ships with 150000 boxes	gantries per vessel	days at berth	ships with 100000 boxes	gantries per vessel	days at berth	ships with 80000 boxes	gantries per vessel	days at berth	Total ships	Total gantries	Total berth-days	operation 572 d	commission 720 d	co-efficient	shipdays per year	hours per ship	hrs	d
1995	188	2.0	1.22 1.42	nil	-	-	nil	-	-	188	4	229 267	40 47	32 37	0.02 0.04	4.6 10.7	0.6 1.4	29.8 35.5	1.24 1.48
		2.4	1.04 1.20		-	-		-	-		5	196 225	34 39	27 31	0.02 0.02	3.9 4.5	0.5 0.6	25.5 29.3	1.06 1.22
		3.0	0.85 0.99		-	-		-	-		6	160 187	28 33	22 26	0.01 0.02	1.6 3.7	0.2 0.5	20.6 24.4	0.86 1.02
2000	no banana movement because the trade is fully containerised									nil	no bananamovement, trade fully containerised								

Note: (1 - upper figure for gantry productivity 3,800 b/hr, lower figure for 3,200 b/hr

(² - rate of waiting time at anchor per berth time. The coefficient was taken from the Erlang-diagram $E_1/E_1/2$ for specialized berths.

Berth occupancy and utilisation - banana piers Moin ; gantry productivity 3,800 boxes/hr
Supply of gantries - 1985 4 gantries, 1990 4 gantries; 1995-2000 4 gantries.

Disposition of gantries per vessel		SFCO No. vessels per year	SFCO days staytime at berth	Bandeco No. vessels per year	Bandeco days staytime at berth	Cobal No. vessels per year	Cobal days staytime at berth	total berthdays	Utilisation in % 572 d	Utilisation in % 720 d
SFCO = 2, Bandeco = 2, Cobal = 2	1985	179	1.32	60	0.85	61	0.76	333	58	46
		total days 236		51		46				
SFCO = 2, Bandeco = 2, Cobal = 2	1990	199	1.40	23	0.85	37	0.76	350	61	49
		total days 279		20		51				
Case A - low containerisation of bananas										
SFCO = 2, Cobal = 2	1995	199	1.40	nil	nil	75	1.38	383	67	53
		total days 279		---		104				
SFCO = 2, Cobal = 2	2000	199	1.40	nil	nil	100	1.38	417	73	58
		total days 279		---		138				
Case B - high containerisation of bananas										
SFCO = 2, Cobal = 2	1995	137	1.22	nil	nil	51	1.22	229	40	32
		total days 167		---		62				
SFCO =, Cobal =	2000	NO BANANA MOVEMENT						NIL	NIL	NIL
		total days TRADE FULLY CONTAINERISED								

Calculation of staytime at berth for banana vessels at Moin
COMPANY Standard Fruit; Gantry productivity 3,800 boxes per hour; gantries per vessel 2

	banana boxes per vessel	container per vessel	effective operation time (hours) boxes	container	total	unforeseen delays (1	breaks etc. (2	deadtimes (3	Total time at berth hours	or days
1985	150,000	9	19.7	1.8	21.5	4.3	2.8	3	31.6	1.32
1990	150,000	16	19.7	3.2	22.9	4.6	3.0	3	33.5	1.40
Case A - low containerisation of bananas										
1995	150,000	16	19.7	3.2	22.9	4.6	3.0	3	33.5	1.40
2000	150,000	16	19.7	3.2	22.9	4.6	3.0	3	33.5	1.40
Case B - high containerisation of bananas										
1995	150.000	nil	19.7	nil	19.7	3.9	2.6	3	29.2	1.22
2000	no banana movement because the trade is fully containerised								nil	

Note: (1 - unforeseen delays are calculated at 20% of effective operation time and include all delays caused by weather conditions, shifting railcars, waiting for cargo etc.
(2 - include regular breaks during each shift of 8 hours, i.e. o.5 hrs per shift, and time losses between shiftchanges of o.5 hrs per shiftchange. Total 3hrs per 24 hrs or 13%.
(3 - include 3 hours per vessel for berthing and unberthing manoeuvres, hatch preparations and waiting for documents

Analysis of hatch capacity of banana vessels

Name of vessel Morillo ; built 1971 (year)

length o.a. 155.8 metres; width 21.3 metres

draught 9.2 metres;

Operation possible with 3 elevators at same time.

Number of hatches: 5 ; 4 hatches forward, 1 aft;

Total capacity appr. 213,000 boxes.

hatch No.	% of total capacity	capacity of biggest hatch (%)	hours to work	time needed to complete the vessel (hours) __ el.*	__ el.	__ el.
4	25.28	100	14.2	27.2	27.2	-
3	25.15	99	14.0			
2	23.43	93	13.2			
5	11.82	47	6.7			
1	10.51	42	5.9			

A/m completion time is valid for 213,000 boxes, for
150,000 boxes 19.2 hours are needed with 3 elevators,
19.2 hours with 2 elevators
and — hours with — elevators.

No. of totally used elevators	Total gantry hours used	gantry hours actually worked	Utilisation of gantries %
3	81.6	54	66
2	54.4	54	99
-	-	-	-

Note: (* - el. means elevator

Fertilizer handling at Moin

A: Weights and loads

1. gantry weight: about 3oo to
wheel load : about 25 to (distance between the wheels 1 m)

2. mobile crane weight: about 6o to
max. corner load: 6o to (average 42 to)

B: Energie consumptions

1. gantry (25o to/h) = approx. 22o KW
2. mobile crane (12o to/h) = approx. 25 KW for additional electric fast slewing equipment plus 3o - 35 litres diesel/hour
3. conveyor belt (1oo - 12o m) = 3o - 45 KW

C: Prices (roughly estimated)

1. gantry (25o to/h) = 2.25 Million DM (rigged in Central America)

2. mobile crane (12o to/h) = 1.1 Million DM (rigged in Central America)

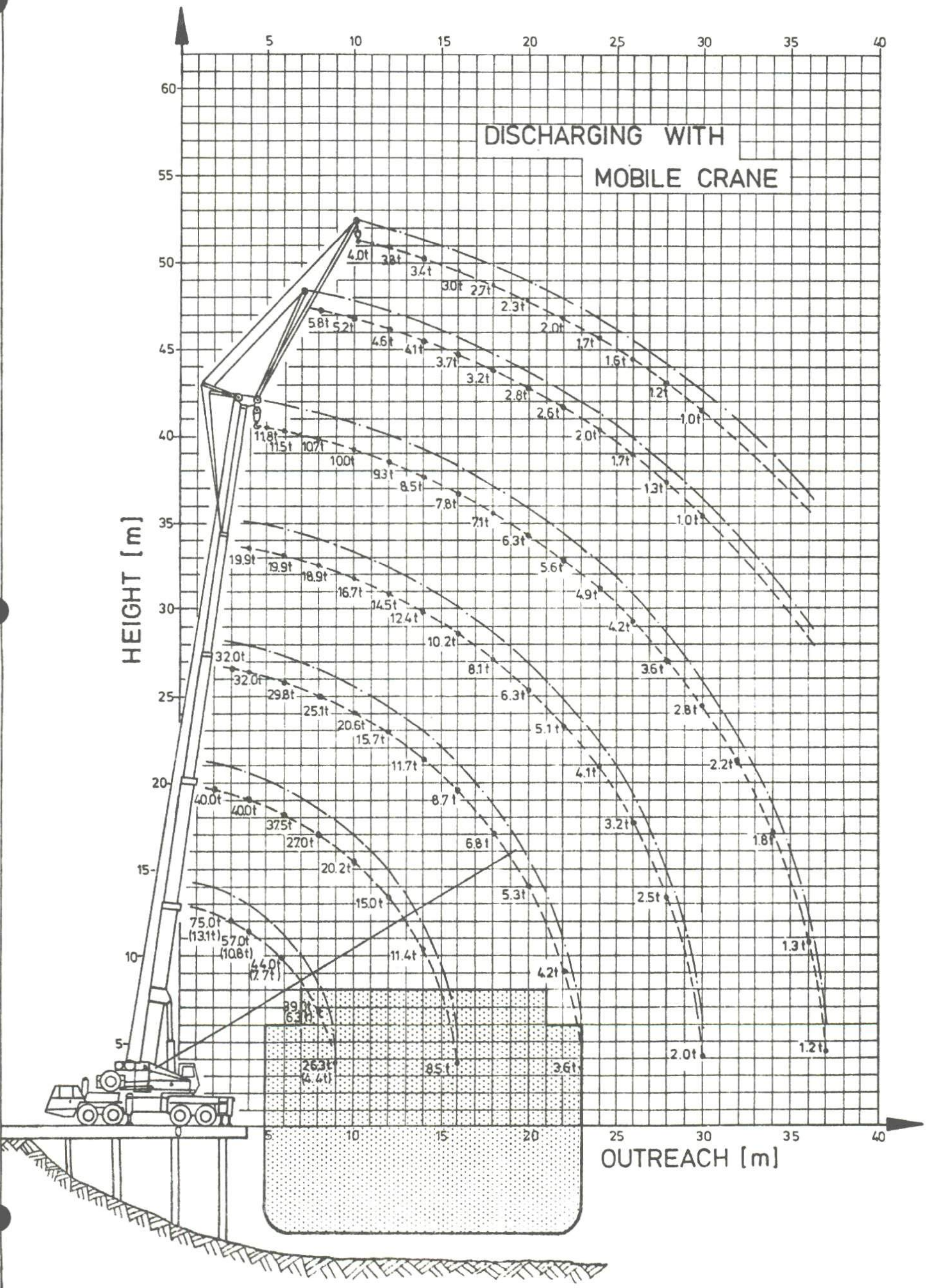
3. conveyor belt (1oo - 12o m) = 32o ooo DM (4oo m^3/h covered)

D: Life times

1. gantry crane: 25 years - 3o years
2. mobile crane: 5 years - 8 years
3. conveyor belt system: 12 years - 15 years

E: Repairs and Maintenance (per year)

1. gantry crane: approx. 2.5 % of investment
2. mobile crane: approx. 7 % - 1o % of investment
3. conveyor belt: approx. 1 % of investment


DISCHARGING WITH
MOBILE CRANE
HEIGHT [m]
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37.5t
27.0t
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11.4t
8.5t
75.0t
(13.1t)
57.0t
(10.8t)
44.0t
(7.7t)
39.0t
6.3t
26.3t
(4.4t)

Annex E - 8

(14 pages)

INTERIM INFORMATION

PORT OF MOIN

UNLOADING AND HANDLING

OF FERTILIZER AND LIQUID CHEMICALS

(February 1980)

TABLE OF CONTENTS

Fertilizer Unloading and Handling of Liquid Chemicals in the Port of Moin

1. General

According to the objectives of the Masterplan Study, one of the major activities during the reconnaissance and analysis phase in Costa Rica has been to gain as much information as possible enabling later to integrate the ideas of the planned industrial zone of Moin into the Masterplan concept and to determine the possible effects especially on berth utilization of the existant structures.

The Consultants have first been informed by CODESA (Corporación Costarricense de Desarrollo S.A.) about prospective private port customers for use of the rear part of the oilpier. Within this area and using the oilpier for unloading, granulated chemicals (fertilizer) and liquid chemicals shall be storaged, semiprocessed and stored for transshipment either by road / rail for distribution in Costa Rica (bagged fertilizer) or for reexport (liquid chemicals). These prospective customers are:

Abonos Superior, S.A.
Quimicos Holanda, Costa Rica, S.A.

Furthermore, the Consultants have been informed about the plans of these customers and are well aware of the importance of such plants to the Costa Rican commerce and agriculture.

During the interim discussion, held in December 1979 in San José, it was agreed upon to work out preliminary recommendations which should enable the Government of Costa Rica to have more knowledge on this matter while in the permission process to grant use of port facilities in Moin to these private customers.

2. Expertises on Fertilizer Samples of "Abonos Superior, S.A."

Fertilizer raw products shipped in bulk are in general dusty and absorb moisture very readily, which can create problems for unloading. Portions of the granulate material can be relatively fine (whether by abraison due to transport movements in the ship or due to its own consistence) and a great deal of dust is given off whenever a transfer of material takes place. It is therefore necessary to ensure that, for example, when material is discharged from a ship into a ground hopper, provision is made for the dispersal of the dust-laden air.

The material itself is non-toxic, but it can be a nuisance to the operator in constant close contact with it at the discharge point.

In order to get more informations and to base the recommendations for the best location for the unloading and transshipment plant on a sound basis,it was asked for physical and chemical analysis of the fertilizer samples intended to be handled in the Port of Moin. These samples have been handed over by Mr. Gurdian of Abonos Superior S.A.

Two independent chemical consultants have perfomed expertises, using said samples and their own experience in the fertilizer field.

Both analyses came to more or less the same conclusions, whereby one is based on scientifical laboratory research and the other mainly on practical points of view from own work in the field of fertilizer handling.

In Supplement 1 copies of the expertises are enclosed.

The analysis indicates that bulk handling of the special fertilizer products - handed over - will not have essential influences to the nearby banana handling with respect to dust pollution and toxical effects, although last doubts regarding dust pollution could not be eliminated:

1. Based on the samples, the dust development is relatively low and need not be regarded as serious if the following precautions are obeyed:

   - handling operation by bucket grabs and simple rubber protections
   - avoidance of long falling distances into hoppers and truck lorries.

2. Short-range pollution of liquified and agglomerated dust in the pier vicinity has to be expected which requires a permanent cleaning during and after ship's operation.

3. High corrosion effects to steel and concrete structures have to be expected which requires profound coating and protection of all steel and concrete structures and cathodic protection.

4. Environmental oecological influences are not serious.

5. Toxical effect of foodstuffs are negligible.

6. The danger of fire is low and negligible, except for ureanitrate which tends to spontaneous combustion if the water content exceed 10 %.

3. <u>Possibilities of Location</u>

In the present state of planning there are generally 2 possibilities for the handling and the location of private companies:

Alternative A: - Handling of fertilizers and liquid chemical products via the oilpier.

- Location of tank farm of Quimicos Holanda and the bulk blending plant of Abonos Superior in the area between oilpier, the planned marine yard and the envisaged road connection of the marine yard at the foot of the hill.

Alternative B: - Handling of fertilizers and liquid chemical products via the pier to be constructed in the direct vicinity of the second banana pier.

- Location of tank farm of Quimicos Holanda and the bulk blending plant of Abonos Superior in the area between the pier to be constructed, the envisaged railway connection of the banana pier and the Japdeva Terminal.

These two possible alternatives are shown in a plan which is enclosed as annex to this report.[1] Location of land indicated in this plan and the possible use by private companies serve only as an illustration and are as to now by no means binding in its local position and dimensions.

It shall be pointed out that planning and design concerning the layout of private companies (loading and unloading faciliites, conveyor belts, halls, tanks etc.) is not included in the scope of works for the masterplan.

4. Comparison of Alternatives

In order to compare both alternatives to finally decide upon the location of the private companies in the Port of Moín, the advantages and disadvantages of the alternatives shall be listed.

Alternative A (location behind the oilpier)

Advantages

- additional investments for a pier and land reclamation are not necessary;
- additional dredging activities are not necessary;
- due to the available area behind the oilpier, the private companies can start with the building of their landside investments without essential time-lays;
- improved utilization of the oilpier when berthing the bulk vessels for fertilizer and liquids;

Disadvantages

- priority decisions are necessary for the berthing at the oilpier as only one vessel at the same time can be operated; priority should be given to tankers and ro-ro vessels which will possibly cause waiting-times for the bulk vessels of the private companies;
- the area behind the oilpier will be fully occupied by the investments of the private companies, so that the port has no possibility to use this area in future for handling and storage of cargo;
- the two private companies are limited regarding their extensions to approx. one hectar in total for each company;
- the exact bearing capacity of the oilpierslab is not known and should be subject to further tests before placing additional loads. Reference is made to the findings of the Immediate Study.
- Last doubts regarding contamination of the bananas and their boxes, especially on berth number 1 could not be eliminated.
- The construction work for the breakwater and the marine yard may be hindered by the construction activities of the private factories and tanks;
- the landside connections for rail and road are limited within the area behind the oilpier;

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[1] Plan showing alternative location of fertilizer plant are not anymore included in this study. On drawing F-2.5 alternative A is shown.

- the operation, especially with regard to Abonos Superior, will be hindered by the location of the fixed-installed oil-discharging tower;
- the location of the private companies behind the oilpier would mean that private investments (factories, equipment, and private handling of cargo) would be allowed within the public port area. This fact does not cope with the organizational recommendations to have exactly defined responsibilities for the parties concerned regarding the handling of cargo within the entire port area. Such break in the overall organizational system may lead to the result that other companies will follow with similar requirements and such development would lead to an unintegrated split-up of the port area. A partly solution of this organizational problem would be that Japdeva invests in the handling equipment and performs the discharging of fertilizers, which will not exclude the construction of private facilities within the port area. This above-mentioned partly solution, however, will be theoretical as the private companies will reject such recommendation, as it directly influences the expected productivities and financial calculations.

Alternative B (location in the south of banana piers)

Advantages

- clear separation of public port activities and private handling activities; the southern area behind the two banana-piers can be declared as a start of a future industrial zone for private investments. This location would be a clear solution from the organizational point of view;
- an extension for the private companies is not limited;
- the port is able to use the area behind the oilpier for future handling and storage;
- there are no difficulties regarding berth priority at the oilpier;
- due to the available area there are no limitations for landside connections (road and rail);
- in case the fertilizer operation will produce dust, the main wind will not be in direction to the banana-piers;

Disadvantages

- an additional berth has to be built;
- additional dredging activities are necessary;
- the construction of the pier needs time which results in delays of the start of construction of the private facilities;
- as the factories cannot be located directly behind the pier, longer conveyor belts/pipes have to be installed;
- the oilpier as well as this new berth will not be sufficiently utilized;
- the back-up area for the factory/tanks may have difficult subsoil conditions at present;
- replacing of oilpipeline.

5. Final Evaluation

When finally evaluating the most important advantages and disadvantages of both alternatives it leads to the result that the first alternative is the cheapest one which also guarantees a better utilization of the oil-berth. It has to be taken into consideration, however, that the location of private companies with own areas, investments and performance of operation within the public port area (behind the oil-pier) does not correspond with the overall organizational recommendations for the port. From this organizational point of view, a location of private companies in the south of the two banana piers and a declaration of this area as a start of a future industrial zone for private investments would be a clearer solution.

But in case the following conditions are fulfulled:

- Japdeva has no objectives to have no space available behind the oilpier for future storage and/or handling of cargo;
- Japdeva has no objectives to locate private companies with their own investments in the public port area from the organizational point of view;
- the private companies accept the berthing priorities at the oilpier for tankers and ro-ro-vessels;
- the private companies, especially the company Abonos Superior must possibly accept operational restrictions as the last doubts regarding negative influences to banana-handling cannot be eliminated and the exact bearing capacity of the oilpierslab is not known at the time being

there are no more serious arguments against a location of the fertilizer company (Abonos Superior) and the liquid bulk company (Quimicos Holanda) in the port area behind the oilpier in Moin.

Supplement 1

CHEMISCH-TECHNOLOGISCHES LABORATORIUM
Dr. WOLFGANG MELZER
ÖFFENTLICH BESTELLTER UND VEREIDIGTER HANDELSCHEMIKER
DER FREIEN HANSESTADT BREMEN
Probenahmen, Begutachtungen, Lade- und Löschkontrollen
Untersuchung von Brennstoffen, Ölen, Schmiermitteln, Chemikalien
Erzen, Metallen, Trink- und Brauchwässern
Lebensmitteln
Gasfreiheitsprüfungen für Industrie und Schiffahrt
Bankverbindung:
Bremer Bank, Bremen, (BLZ 290 800 10) Kto.-Nr. 1028443

2800 BREMEN 1,
Dortmunder Straße 20
Postfach 10 33 46
Fernsprecher 5 17 24
Telegr.-Adr.: Melzerchemie
Telex: 0244385

15.2.80

Messrs.
Port and Transport
Consulting Bremen GmbH.
Postfach 10 79 65
2800 Bremen 1

E X P E R T I S E

Re: Fertilizer-reloading-point in the port of Moin/Costa Rica

We received 6 samples of fertilizers, on which has run a physical-chemical analysis. All obtained results are refering to the delivery-condition of the samples.
The samples have been marked as follows:

Sample 1 : Grace
Sample 2 : Sulpomag
Sample 3 : Muriate of Potash
Sample 4 : Triple Superphosphate
Sample 5 : Diammonium Phosphate
Sample 6 : Granulated Urea

The following tests have been run on the samples:

		1	2	3
Dust-Content (<0,8 mm)	:	0,09 %	0,55 %	0,44 %
Dust-Content after dumping (dumping-height 1 m)	:	0,10 %	0,57 %	0,52 %
pH-value (10 %-solution)	:	6,5	6,2	6,0
Acidity (ml 1 n NaOH/100 g)	:	630	20	2
Sulphate (SO_4^{2-})	:	13,29 %	n.t.	n.t.
Chloride (Cl^-)	:	n.d.	n.t.	n.t.
B.O.D. 5 days (biochemical oxygen demand)	:	n.t.	n.t.	n.t.
Hygroscopic components	:	0,97 %	0,39 %	0,10 %

- 2 -

		4	5	6
Dust-Content (<0,8 mm)	:	0,52 %	1,28 %	0,01 %
Dust-Content after dumping (dumping-height 1 m)	:	0,55 %	1,46 %	0,03 %
pH-value (10 %-solution)	:	3,5	7,0	6,0
Acidity (ml 1 n NaOH/100 g)	:	710	170	30
Sulphate (SO_4^{2-})	:	n.t.	n.t.	n.t.
Chloride (Cl^-)	:	n.t.	n.t.	n.t.
B.O.D. 5 days (biochemical oxygen demand)	:	n.t.	n.t.	no biodegrability
Hygroscopic components	:	1,69 %	3,95 %	0,55 %

n.d. = not detectable
n.t. = not tested

Nature of the samples at 76 % humidity in the air:

Sample 1	:	Significant agglomeration, change of colour (clear to dark ochre)
Sample 2	:	Significant incrustation and agglomeration
Sample 3	:	Slightly agglomeration
Sample 4	:	No change, since incrustation
Sample 5	:	Significant liquefaction
Sample 6	:	Total liquefaction

Nature of the samples at 80 % humidity in the air:

Sample 1	:	Beginning liquefaction
Sample 2	:	" "
Sample 3	:	" "
Sample 4	:	No change, since incrustation
Sample 5	:	Beginning liquefaction
Sample 6	:	Total liquefaction

Danger of fire and explosion

Sample 1	:	No danger, no combustible and oxidzible material
Sample 2	:	" " " " " " "
Sample 3	:	" " " " " " "
Sample 4	:	" " " " " " "
Sample 5	:	" " " " " " "
Sample 6	:	Low danger for Urea (stive-explosion), high danger for Urea-nitrate with min. 10 % water-content (Imco-class 4.1.)

General comments to these datas:

The dust content of all samples has been found in a very low range. It might increase for a small amount by mechanical strain of the fertilizer at discharging- and transport-procedures.
The figures of trial-dumpings are showing no significant development of dust.
The spreading of the dusts will not be influenced only by direction and velocity of wind but also by the atmospheric conditions. In this point it should be taken into consideration the high content of humidity in the air, which causes, with exception of sample No. 4, more or less an agglomeration or liquefaction of the fertilizers. Under these cirlumstances there is no large spreading of dusts to be expected. It has to be mentioned that exact figures only can be obtained by dust-detection with special-devices at the port of Moin/Costa Rica.
Due to the above named facts we would give at the moment no suggestion for special-equipment of dust reduction.
The corrosive effect of the fertilizers has to be regarded high at sample No. 1 and especially at sample No. 4 (Triple Superphosphate).
This effect is concerning steel as well as beton (concrete).
The contamination of seawater by contact with the fertilizers, under the aspect of envivonment-protection, is not very serious, because all these products are not containing heavy metals or

other hasardeous substances. For this reason there is also no <u>toxic</u> influence to foodstuffs, especially bananas. On the other side it has to be acknowledged that dust-contamination of foodstuffs at all events represents a depreciation, which will be regarded in a variable way by the foodstuff-law of the different countries. In Germany, for instance, foodstuffs contaminated with fertilizer-dust, would be rejected.
Concerning the distance between fertiliser reloading-point or other industrial establishment to points of human interest (residential areas, foodstuff reloading) there has been developed a couple of "distance- or protection-zone-lists" between industrial and residential areas (Reichow BRD 1948, USSR 1957, Polen 1967, Israel 1970) by a few countries.
As to other oecological aspects it should be taken into consideration, that green-areas are providing a large filter-effect. Especially trees and forests are very effective in the way of dust-filtering, where-as gaseous contaminations can not be reduced by cultivation-procedures.

HANS SCHWARZ
Dipl. Chem.
Von der Handelskammer Hamburg
vereidigter Sachverständiger
für Kali und andere Salze

2050 HAMBURG 80 (Bergedorf)
Fritz-Lindemann-Weg 36
Telefon 739 80 13
Labor:
2102 HAMBURG 93 (Wilhelmsburg)
Kalikai

Ref.: Fertilizer Transshipment Plant at Moin, Costa Rica

Since a transshipment plant for fertilizers is envisaged in a distance of only 1oo m from the banana pier the question of probable dust influence is of major importance.

According to the available samples the bulk materials to be handled at present are melting granulate materials producing a non-abrasive grain which is expected to have a low percentage of dust.
From the sieve analysis it can be seen that there is at least a percentage of 1 to 3 % below grain size of 2o and 28 Tyler mesh,resp.
Interesting would only be the existing percentage of dust (-6o Tyler mesh).
According to our experience melting granulate materials with few tenth percents of dust show a behaviour which can be very similar to that of fine salts with considerably more dust.

It can be expected that the dust percentage below 2o Tyler mesh of melting granulate materials consists mostly of relatively rough edge rubbles of irregular shaped granulate grains and therefore, might fall rapidly to the ground.

Concerning the reach of dusts it can be up to 2oo to 3oo m at corresponding wind conditions.
In this context, however, it has to be pointed out that in my opinion the dust development is in the first place a question of the handling method. If, for example, the contents of a crane bucket is dropped from deck height into the ship's space there is virtually no dust development at all.
Is the same quantity loaded by means of conveyor belt and downcomer extremely strong turbulences are produced by the air which is carried along in the downcomer so that also with granulate materials of o.3 to o.5 % of dust (-6o Tyler mesh) a dust could results which escapes immediately through the hatch and is carried away with the wind.

The best handling method seems by means of grab crane whith drops the bulk into a hopper with rubber rags in the connected downcomer which largely prevent backflow of incoming air.

All mentioned fertilizers melt or sinter under heat influence, do not contain inflammable components or decompose in the heat (2oo-3oo° C).
Ammonium sulfate and carbamide, however, combine then to ammonia gas whereas diammon phosphate can be regarded as fire protection agent.
Concerning the corroding effect an effective protective paint is absolutely necessary. For steel constructions and concrete parts (shed walls) we apply epoxy-coal tar resins with coating height of 3oo my.

-2-

Metal parts shall be cleaned by sand blasting (i.e. absolutely clean, nearly bright). Three-fold coating should be applied at a relative air humidity of less than 75 %. (!)
Contamination of seawater by one of the mentioned particles is of no importance, only the water would become more salty.

The bulks mentioned are mineral salts which also occur naturally in the same or similar form.
Actual "toxidity" is not the case.
Also large quantities of breathed-in dust particles (operating stall) are discharged with the urine within a short period of time so that there are no objections if smaller quantities of dust come into contact with food stuff.

In view of your particular question (banana handling) problems might occur, however, if the dust percentage of the handled fertilizers could settle on the fruits with the air humidities of 85 to 95 %.

All salts are hygroscopic to such an extent that when cooling the fruits afterwards in the ship's space a thin layer of concentrated salt solution is produced on the bananas' surface which possibly could diffuse into the fruits' interior and might affect the taste.
An exact statement on influence of salty dusts can only be made if the composition of grain sizes is known by use of extended characteristic curves.
If a grain fraction " -6o Tyler mesh " can be excluded, there are no objections against handling of bananas in the lee of a fertilizer transshipment plant.

Finally I want to note that according to my information bananas are delivered in perforated plastic bags which are packed in cardboard boxes provided with holes. In this case an influence of salt dusts could be excluded.

Supplement 2

ONE OF THE WILLIAMS COMPANIES
AGRICO INTERNATIONAL COMPANY
A DIVISION OF AGRICO CHEMICAL COMPANY
ONE WILLIAMS CENTER
TULSA, OKLAHOMA 74101
918 588 3029 TELEX 49[illegible]

CHARLES M GRAU
PRESIDENT

January 23, 1980

Diplomat Engineer Alfred Vetter
RHEIN-RUHR-GESELLSCHAFT-INGENIEUR-GES MBH
P.O. Box 281
4600 Dortmund
West Germany

Dear Mr. Vetter:

We are informed by Mr. Rodolfo Gurdian Montealegre, President of Continental Abonos, S.A., that you are concerned that particulate emissions from a fertilizer blending and storage facility his firm proposes to build at the port of Moin could contaminate bananas when they are being loaded at an adjoining pier some 50 to 100 meters away. Mr. Montealegre also informed us that your firm provides consulting services on port design and marine installation to the government of Costa Rica and that Continental Abonos is having difficulty in obtaining a permit because of your reservations.

Agrico Chemical Company is one of the largest phosphate rock miners and chemical fertilizer manufacturers and merchants in the world and with several huge plants operating in the United States and abroad, we and most of our competition continually strive to improve product quality including making it cleaner or more dust free and less friable. We are intimately familiar with port operations, blending plants and warehousing such as Continental Abonos proposes. We also make it a practice to stay aware of the newest techniques and equipment available in emissions control.

We think that a facility for receiving, blending, storage and shipping of granular fertilizers such as Continental Abonos plans to build, can be very important to Costa Rican commerce and agriculture. Accordingly, as a fertilizer company and as friends of Continental Abonos, we should like to express our support of their plans and to testify on their behalf.

Modern granulated fertilizers are vastly improved over materials produced even a few years ago. Products such as Agrico's granular Urea, DAP and MAP are manufactured to very stringent size specifications and treated during the manufacturing process with conditioning agents to help eliminate dust emissions. Engineering technology and design is available and economically feasible to aid in eliminating virtually all particulate emissions in receiving, blending and shipping operations. Environmental concern throughout the world has prompted these technical advances and created a real pride in the accomplishments of fertilizer producers and distributors.

Without question, because of the points I have mentioned, fertilizer plants can be good and acceptable neighbors, even in close proximity to food processing operations, or the loading of bananas.

I respectfully urge you to rule favorably for Continental Abonos, and to recommend that their permit be approved so that they may proceed with their very worthwhile plans.

Yours very truly,

C. M. Grau

C. M. Grau

jd

BANANA DEVELOPMENT CORP. OF COSTA RICA, S. A.
SAN JOSE, COSTA RICA

APARTADO: 4084
CALLE 28, AVE. CTRL. Y 2da.

TELEFONO: 22-92-11
CABLE: BANDECO
TELEX: CR-2175

AMPLIACION PUERTO DE LIMON
SUPERVISION DE LAS OBRAS
29 ENE. 1980
RHEIN-RUHR INGENIEUR-GESELLSCHAFT MBH

RECIBIDO 11 ENE. 1980

erhalten 26/1/80

Enero 7, 1980

Señor
Ing. León Venegas
Director General de Obras Portuarias
MINISTERIO DE OBRAS PUBLICAS Y TRANSPORTES
Presente

Muy estimado León:

Por este medio deseo manifestar que BANDECO en principio no objeta la descarga de fertilizante granulado que sabemos desea importar al país Abonos Superior, S.A., descarga que se pretende hacer en el muelle petrolero de Moín. Hasta donde sabemos, las materias primas que importa esa compañía para preparar las mezclas de fertilizantes vienen en forma granulada y, por lo tanto, no producen polvo contaminante que pueda dañar el banano que cargaremos en los puestos bananeros de ese puerto.

Consideramos de suma importancia que se le facilite a Abonos Superior, S.A. la posibilidad de realizar instalaciones graneleras para recibir fertilizante, ya que en esa forma esperamos se logrará bajar los precios de este insumo, el que, como usted sabe, es un factor que incide grandemente en el costo final de la caja de banano.

Sin otro particular, nos suscribimos

Atentamente,

BANANA DEVELOPMENT CORPORATION
OF COSTA RICA, S. A.

Lic. Hernán Robles O.
Gerente

HRO/mg

AMPLIACION DEL PUERTO DE LIMON
[illegible] DE LAS OBRAS -
29 ENE. 1980
RHEIN-RUHR
INGENIEUR-GESELLSCHAFT MBH

STANDARD FRUIT COMPANY

STANDARD FRUIT Co.
APARTADO 4595
SAN JOSE - COSTA RICA
CABLE: STANFRUCO

Dole
BANANAS

Enero 22 de 1980

RECIBIDO 23 ENE. 1980

Señor
Ing. León Venegas
Director General de Obras Portuarias
Ministerio de Obras Públicas y Transportes
Presente

Estimado señor:

Sirva la presente para manifestarle que nuestra Empresa no objeta la descarga de fertilizante granulado que desea traer Abonos Superior, S.A. por el muelle petrolero en Moín. Las materias primas que importa Abonos Superior, S.A. para preparar las mezclas de fertilizantes, vienen en forma granulada y no producen, por lo tanto, polvo contaminante que pueda dañar el banano que cargaremos en los puestos bananeros.

Queremos agregar, que consideramos de suma importancia se le facilite a Abonos Superior, S.A. el establecimiento de la instalación granelera para recibir fertilizante, lo cual determinará una reducción en los precios de este insumo.

Atentamente,

Mario Garnier Borella
SUB-GERENTE

ia

cc: Sr. S. Bacani
Sr. R. Gurdián
Archivo

COMPAÑIA BANANERA ATLANTICA LTDA.

SAN JOSE, COSTA RICA

TELEFONO 21-30-12 — APARTADO 10076 — TELEX: CR-2235 CABLES: COBAL

AMPLIACION DEL PUERTO DE LIMON
· SUPERVISION DE LAS OBRAS ·
RHEIN - RUHR 29 FEB. 1980
INGENIEUR - GESELLSCHAFT M B H

Enero 24, 1980.

RECIBIDO 28 ENE. 1980

Señor
Ing. León Venegas
Director General de Obras Portuarias
Ministerio de Obras Públicas y Transportes
Presente.

Estimado señor:

Sirva la presente para manifestarle que nuestra empresa no objeta la descarga de fertilizante granulado que desea traer Abonos Superior, S.A. por el muelle petrolero en Moín. Las materias primas que importa Abonos Superior, S.A. para preparar las mezclas de fertilizantes, vienen en forma granulada y no producen, por lo tanto, polvo contaminante que pueda dañar el banano que cargaremos en los puestos bananeros de Moín.

Queremos agregar, por otro lado, que consideramos de suma importancia que se le facilite el establecimiento de la instalación granelera para recibir fertilizante, pues en esta forma se logrará bajar los precios de este insumo, cuyo costo incide tanto en costo final de la caja de banano.

Muy atentamente,

Houston H. Lacombe
Gerente General.

HHL/dg.