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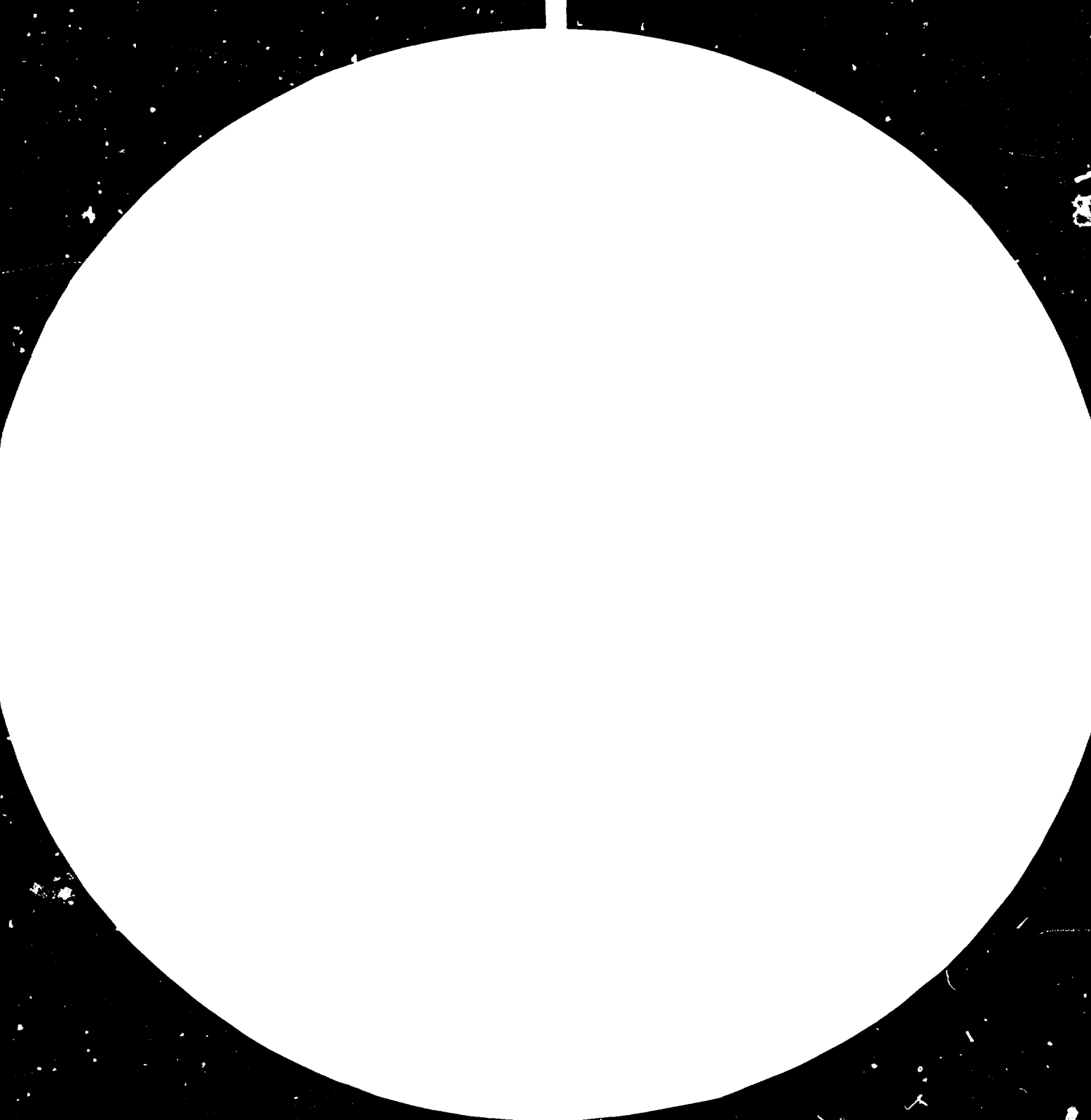

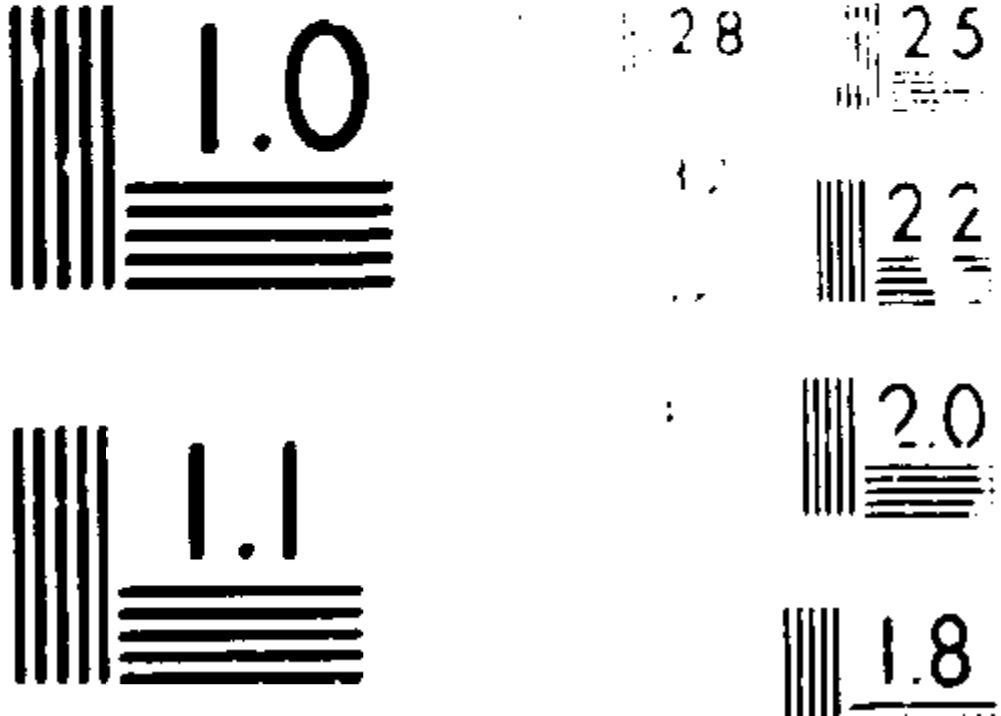
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POTENTIAL CASES FOR LTA USES*

by

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POTENTIAL CASES FOR LTA USES

INTRODUCTION

1. During the past few years, a number of situations have been analysed where alternative modes of transport and communication could provide a better internal rate of return on investment.

2. Specific bottle-necks and particular characteristics in the transportation sector have been looked at and alternative evaluations with a cost/benefit analysis for other advantageous modes suggested. After a short survey in several countries, some specific situations in different parts of the world where airships may provide a favourable transportation alternative may be enumerated. There are a number of places where an airship might have an impact and provide an advantage for the execution of development plans.

3. To maintain the analysis initiated by the countries represented at the UNIDO meeting in Vienna the following will be considered:

I. GEOPHYSICAL DESCRIPTIONS AND POTENTIAL CASES FOR LTA USES IN SEVERAL COUNTRIES

Brazil

Geophysical description

4. The Federal Republic of Brazil is the fifth largest country in the world. It lies in central and north-eastern South America. To the north are Venezuela, Colombia, Guyana, Surinam and French Guyana; to the west lie Peru and Bolivia, with Paraguay, Argentina and Uruguay to the south.

5. The climatic conditions vary from the tropical rain forest of the Amazon Basin to the savannah grasslands of the central and southern Uplands.

6. Agricultural production provides nearly half of Brazil's export earnings, and in 1977 Brazil became the world's second largest exporter of agricultural products.

7. The principal agricultural foreign exchange earners are coffee, sugar and soya beans while other crops include cocoa, sisal, tobacco, maize and cotton.

8. Brazil has an important industrial development and has been able to export steel since 1979.

9. Other industries are the automobile industry, the building industry and other related secondary supply industries.

10. Brazil possesses vast mineral reserves particularly in Minas Gerais and the Amazon area, the leading export products being iron ore. There are important deposits in Amazonia and iron ore is estimated to be the largest in the world with over 18,000 million tons of ore having 66 percent of iron content. Production should reach about 12 million tons in 1982 rising to 22 million tons in the following five years. There are new mineral discoveries including phosphate, uranium, manganese, titanium, copper and coal, while constantly new deposits of gold are being found all over the country yielding a 300 ton export per year.

11. Due to the vast distances, transportation remains a major problem in Brazil. There have been plans to expand the road system into the Amazon, where the well-known difficulties for road construction in the tropical rain forest are to be encountered. Consequently, the Government has promoted the use of aircraft as well as the aircraft industry.

12. As in other Amazon countries, the airship has been given strong consideration since it can fly over most of the Brazilian territory, weather permitting.

13. The transport services are currently limited by jungles, rivers and mountains and therefore, over large areas, the aeroplane or the airship would be the only means of transport in Brazil. There is a large domestic network of internal air services. Highways are a major mode of transport in the east, accounting for over 70 percent of freight and 90 percent of passenger traffic in 1975. Bus services play an important role in public transport over long distnaces. Rivers are a very important means of transport and there is a network of over 42,700 kilometres of navigable waterways. The Amazon is navigable for over 3,600 kilometres as far as Iquitos in Peru. Ocean-going ships can reach Manaus 1,600 kilometres up-stream and from there boats up to 10,000 tons can operate. There are important plans in Brazil to expand the transportation systems and especially those modes which require low energy consumption.

Potential case for LTA use

14. The Federal Republic of Brazil is the fifth largest country in the world. It lies in central and north-east South America. The climate varies from tropical rain forests of the Amazon Basin to the savannah grasslands of the southern highlands.

15. The principal airship activities are centered at the Centro Tecnico Aereo Espacial in Sao Jose dos Campos. This is a section of the Ministry for Aeronautics.

16. In 1978, a feasibility study was commissioned on the uses and advantages which airships may provide for transportation in Brazil. Brazil has an advantage over many countries through the existance of a hangar of over 300 metres long, 50 metres wide and 50 metres high for the contstruction of dirigibles. This hangar dates back to the days of the regular flights across the Atlantic of the Graf Zepellin. At Pernambuco there is still a mooring mast available. In a way, the Brazilians are already in an advantageous position to start building airships through having these facilities.

Egypt

Geophysical description

17. Egypt occupies an almost unique place in the world as a region, where in all probability the earliest development of civilization and organized government took place. It occupies the northern corner of the African continent, with an extension across the Gulf of Suez into the Sinai region which is usually, but not always, regarded as lying in Asia. The area is approximately 997,000 square kilometres, of which only three and a half per cent can be said to be permanently settled, the remainder being desert or marsh.

18. Egypt consists essentially of a narrow valley from 3 to 15 kms. wide, through which runs the river Nile. The land is generally flat and the geographical accidents which deserve mentioning are the cascades on the Upper Nile which separate Egypt. These cascades are a natural barrier to travel up-stream.

19. The side strip of the Nile valley is isolated to the south by the cataracts, and the deserts and swamps of Sudan, to the north by the Mediterranean Sea, and to the east and west by desertic plateaus about which a little more should be said. The area immediately to the east of the Nile valley, called the Eastern Highlands, is a complex region with peaks that rise up to 1,800 to 2,000 metres and much broken up by deep valleys that make travelling difficult. The area is very arid and therefore remains sparsely populated by a few partly nomadic shepherds. There are several monasteries and a number of small towns associated chiefly with the exploitation of petroleum, iron, manganese and granite.

20. Difficult land-ward communications mean that contact is mostly by sea, except in the case of the iron fields. The area which is separated from the eastern highlands by the Gulf of Suez is structurally very similar, but the general plateau level is tilted, with the highest point being 2,180 metres above sea level in the extreme south. Towards the north, the land gradually slopes down towards the low-lying sandy plains of the Sinai desert. West of the Nile are the vast expanses known as the Western Desert, or Moush, which is by no means uniform in height and where the land surface is much lower than east of the Nile, rarely exceeding 300 metres above sea level.

21. The main feature of the Egyptian climate is that it is almost uniformly arid. Alexandria in the western part receives 200 millimetre of rain annually, whilst over most of the south it is less than 80 millimetres. During summer the temperature may reach 38 to 43°C, and at times even 49°C in the southern and western desert.

22. The Mediterranean coast has a cooler climate with temperatures rising to a maximum of 32°C. Winters are generally warm with occasional rain and cold spells, but no snow. Due to the large expanse of desert behind the coast, hot dry sand storms called "khamsin" are fairly frequent particularly in spring and can cause much damage to crops. Temperatures have been known to rise by 20 degrees C. within two hours during such storms with wind velocities of over 150 kms./hour. Another unusual condition is the occurrence of early morning fog in lower Egypt during spring and early summer.

23. The Egyptian agriculture is dominated by the river Nile and the necessity for irrigation. Its contribution to the GDP has remained fairly constant around 30 per cent with industry accounting for 10 to 20 per cent, while agriculture still employs about 40 per cent of the labour force and accounts for over 60 per cent of the total export earnings.

24. The bulk of agricultural production is intended for the market place and not for subsistence. Nearly 3/4 of agricultural income comes from field crops, the remainder is from fruit, vegetables, livestock and dairy products. Long staple cotton is a most important field crop, but the area under cultivation declined from 2 million acres in 1968 to just over one million in 1979 since farmers have found it an unprofitable crop.

25. Rice is another important crop, and after cotton is almost as important as fruit as a foreign currency earner in the agricultural sector. Other grain crops include wheat, maize, millet and barley. Population growth has resulted in Egypt becoming a net importer of cereals, mostly wheat. Another high-yeild crop is sugar cane which is nurtured by an expanding sugar industry that supplies the bulk of national requirements.

26. Egypt produces about 1/3 of the world's crop of long staple cotton of 1-1/8 inch and longer.

27. The Government is aiming to expand both the Mediterranean and Red Sea port capacity as well as reviving Port Said, Ismailia and Suez to cope with traffic passing through the re-opened Suez Canal.

28. River transport is being expanded to relieve the traffic load on roads and railways for internal distribution. Navigable waterways total about 3,100 kms. of which half is the Nile and the rest canals.

29. Egypt was one of the first countries to have a railway which was constructed in 1851 and a good network was built up during the early stages of its development. Now with over 4,000 kms. of track, modernization is urgently needed. A project using loans of up to $165 million from various sources is being undertaken to modernize the railway system and expand its carrying capacity.

30. Good roads connect Cairo with Alexandria and the canal towns, and with those of upper Egypt. There are plans to expand industrial output both locally and through joint ventures with foreign companies.

31. Egyptair, the State airline, operates a network of domestic and international flights.

Potential case for LTA use

32. The principal centres of the country, Cairo (El Quhira) and Alexandria (El Iskandariya) receive fruits and vegetables from farms in the countryside, principally situated along the river Nile and its delta or through imports.

33. Perishable goods produced in most of the oases which are situated at a distance of approximately 250 miles around the cities, cannot reach the market. They are consumed locally, and therefore the oases' potential are not fully utilized, since there is no market for their produce. The produce cannot reach the consumer centres because of the road and trucking system and would spoil before reaching the cities. Airplane transport costs cannot justify the cargo.

34. If an airship could carry produce in less than three hours and in amounts of about 10 tons at a time, then these oases would have a market and would consequently expand their production. In time, the construction of a good road or railway would be justified and paid with the income from the produce.

35. The embankment in Aswan has formed a large lake, rich in fish. The fishing operation extends to over 300 kilometres from Aswan, where the railroad ends.

36. Fishing on the lake is done with small boats which are supplied with ice by a mothership, which also collects the catch and brings it to the railroad station for transport to the markets. The spoilage is great and the ice supply operation is costly.

37. Airships could supply both the boats with ice (an operation which in all probability would become superfluous), and it could collect the fish for transportation to the railraod station within hours of the catch. Because the time from collection to delivery at the railroad station is short, spoilage would decrease in all probability justifying the operation as outlined.

India

Geophysical description

38. India is one of the largest countries in the world with an area over 3.2 million square kms., including the Indian portion of Jammu and Kashmir. It has three well marked regions. The Himalayan chain to the north, the plateaus of the peninsula and in between the great plains of the Indus and Ganges basins.

40. The whole peninsula is fundamentally of ancient and largely crystalline rock which have been worn down through geological ages and now form a series of plateaus, mostly sloping eastward and drained by the great rivers Manhady, Krishna and Godabari flowing towards the Bay of Bengal.

41. The west coast is fringed by a narrow alluvial plain, while the east coast is generally wider, especially where it broadens onto the highly productive deltas of the great eastward flowing rivers.

42. The Hindu Gangetic plain, between the Sivaliks valleys and northern most plateau edges of the Deccan, is really one of the great plains of the world, consisting entirely of alluvion and presenting an appearance of monotonous flatness from the air. However, this general flatness conceals a great deal of variety. The fine muds and clays of the Ganga-Putra delta

contrast for instance with the sands of the Rajasthan desert at the western extremity of the Indian portions of the plains. Almost everywhere there is a contrast of flood plains alongside the rivers with dry belts of older alluvion well above the reach of even the highest floods.

43. The climate of India is dominated by the monsoon. This is the seasonal reversal of wind which brings the change from dry weather to wet. In the north of India there are not two seasons but three: a cold season, lasting from December to February which brings average temperatures of 10 to 15°C. followed by a season of the dry north-east monsoon when the pressure from the north-west may bring rain to the Punjab and indeed farther down to the plains to the east, and finally, the hot season of the north when temperatures rise from 32 to 35°C. on the average and rain is very rare. The monsoon in June and July brings with it rain and lower temperatures until September and October.

44. In the Ganges delta, to take another region as an example, the cool season is less cool than in Delhi (19°C. on an average for January in Calcutta), and the hot season is less hot (30°C. in May as an average), but the rains are much heavier. In places like Bombay, the temperatures are never as high as in Delhi.

45. The dry season decreases southwards until, in Kerala, in the far south-west, it lasts for only a month or two. The scene of contrast in the Indian climate is best expressed by drawing attention to the tremendous differences between the desert of Rajasthan and the less dry sands of Ramanathapuran in south-east Tamilnadu and the green landscape of the north-eastern Deccan and Kerala.

46. When colonial rule ended in India the British left behind a railroad network which is the biggest in the world after that of the USA. The network has more than 6,000 kms. of track and carries more than 2,000 million MT of goods and about 3,000 million passengers annually, representing over 140,000 million passenger kms. However, the Indian railways have been hit by various problems.

47. Road transport is increasing at the expense of the railroads and the railway freight traffic has stagnated at 200 million MT a year since 1965.

The railway was particularly bedeviled by labour unrest in the years before the State of Emergency in 1979 was declared. The high cost of fuel had a strong impact on the use of railroads which, to a certain extent, were transformed from diesel to electric engines.

48. India's road network is more extensive and increased from 400,000 kms. in 1961 to over 1,25 million kms. in 1976 of which about 520,000 kms. were surfaced. In terms of maintenance, Indian roads are less impressive than the railways, but road traffic has grown whereas the railways have stagnated.

49. India's shipping ports are also impressive, but facing many of the same trasportation problems found all over the world.

Potential case for LTA use

50. India is a very large country with particular characteristics such as large plains, mountains only in the north and a delta in the north eastern part of the country.

51. The large relatively flat plains are crossed by many roads, making road construction rather simple and which is often accomplished manually with a great display of human manpower. Here the employment situation receives an important backing. Thus in conclusion, airships would not, at first glance, be a national priority.

52. The current cost of construction varies between the equivalent of $100,000 and $150,000 depending on type and characteristics.

53. However, the transport policy of the Government of India is stated in a document published by the Planning Commission in May 1980:

> "The central issue of the transport policy is to allocate rationally and at a minimum resource cost the total available resources for investment between the various modes of transport to match with growing requirements of the economy."

54. The sole criteria for determining an optimal intermodal mix however, is not merely minimization of resource cost. The Government's socio-economic considerations play an important role in determining future policies.

55. In terms of reference, they specify the need for generating maximum employment. Transport is one of the principal energy consumers and therefore it is one of the basic objectives to promote, in the light of operational capabilities, those modes which have relatively high energy efficiency per unit of transport output.

56. In table I different energy yields per gallon of fuel for different transportation modes are given.

57. From an airshipman's view, there are also situations apparent in India where at first glance the airship could provide an important development input.

(a) In the north-east delta area where the collection of fish has currently a problem of high spoilage before reaching the consumer;

(b) In the north there are isolated valleys behind a relatively low mountain chain and where the construction of roads to cross them would be expensive and difficult. If these mountains, which are less than 2,000 metres at the highest point, could be crossed by an economic mode of transportation and connect with the road system in the plains, then an important development effort could be made to integrate these fertile regions with India's economic life stream;

(c) India used to be an important exporter of shrimp to the United States but this has been curtailed because the shrimp did not arrive in an acceptable condition at the US ports. The reason for this seems not to be the fishing operation itself. India is currently not engaged in deep sea fishing which is apparently being done by Japanese fleets operating in Indian continental waters. Apparently the shrimp for export is fished in an area extending approximately 300 kilometres around Bombay. The shrimp boats leave in the morning and fish during the day,

Energy efficiency for freight transport modes

MODE	TON-MILE/GALLON 1/	TON-MILE/GALLON 2/
Heavy duty truck	44	75
Railway	156,8	334,5
Waterway	255	--
Airplane	3.27	17.2
Airship 3/	50	--
Pipeline	187.1	--

Compiled by the Transportation Research Board, Washington, D.C. 1977.

1/ Data as average from the estimates made by R.A. Rice; W.E. Mooze; E. Hirst US DOT.

2/ Data from an estimate made by NASA/DOT engineering estimate.

3/ Estimate by G.R.A. Cahn Hidalgo.

returning in the evening to their villages. The catch has spent the whole day on the fishing boat and is unloaded in the evening. The following morning it is collected for transport to the freezing plants, where it arrives in a doubtful condition. There is thus a need to shorten the time from fishing to delivery at the processing plants. One solution would be to collect the fish in transit during the day and deliver them over these relatively short distances directly from the boat to the freezing plant, spending only hours in transit.

(d) The congestion of people in India is well known and implies also a congestion of boats in some parts of the sea. At the continental drilling platforms there is a certain amount of anxiety cause through potential collisions. The oil company in India, as well as the Coast Guard, are most interested in having a survey platform in the neighborhood to protect and warn shipping of possible danger. This could be a specific patrol and survey airship with, of course, a number of additional protective duties.

Indonesia

Geophysical description

58. Indonesia covers the same area as the former Dutch East Indies and Timor and was incorporated into Indonesia in 1976. The country lies along the Equator, between the south eastern tip of the Asian Mainland and Australia.

59. With an overall distance of over 4,800 kms. from east to west, and 2,000 kms. from north to south, Indonesia stretches over an area almost as big as Europe west of the USSR.

60. However, since nearly 4/5 of the area between the outer extremities consist of sea, the total land surface of Indonesia covers only 1,904 million square kms. making it the 14th largest territoral unit in the world.

61. The territory is divided between some 13,000 islands of varied size and character. The largest exclusively Indonesian island is Sumatra, cov-

ering 473,000 square kms. This is exceeded by the Indonesian 2/3 of Borneo having 539,999 square kms. and now called Kalimantan. All other islands cover smaller territories ranging form the largest of 412,000 square kms. to small groups of 100,000 square kms. each.

62. The differences in size of the islands reflect the fundamental differences in geological structure. There are pronounced mountain ranges facing the deep seas along the outer edges of the shelves and extensive lowland tracts facing the shallow inner seas, with coast lines showing all the characteristics of recent submergence.

63. In contrast to these larger islands of western and eastern Indonesia, most of those lying between the two shelves, including Sulawesi and the new Nusantenggara and Maluku groups, rise steeply from deep seas on all sides and have only extremely narrow coastal plains.

64. The archipelago is of widespread volcanity, much of it still active. The highest mountain is over 3,000 metres in altitude with the volcano Punjakjayam reaching 5,000 metres.

65. The most extensive lowlands occur along the eastern coast of Sumatra and along the southern coast of Kalimantan and Irian Java. Half of these islands however are covered with tidal swamps which make them unusable to date even though it would be technically feasible to have them drained and used for agriculture.

66. The better soil fertility is in the eastern 2/3 of Java and nearby Bali. The remaining islands have also rather rich soils, but can only be reached with difficulty and are therefore often only covered by tropical vegetation.

67. There are considerable, but not spectacular, petroleum reserves mostly in Eastern Sumatra and parts of Kalimantan, and the more easily accessible, but much less valuable tin deposits in the Suda Shelf Island of Bangka, Belitung and Sing Kap.

68. The climate of the greater part of Indonesia is maritime equatorial with consistently high temperatures. There is heavy rain fall at all seasons though in many parts of western Indonesia there are distinct peak periods of exceptionally heavy rain when either the north-east or the south-

west monsoon winds blowing in-shore. Noon temperatures vary around 26.5°C. while the average rainfall rises from 16 to 17.5cm annually. Nearly all of Indonesia, in its natural state, supports a very dense vegetation, but there are significant variations between the tidal swamps, normal lowlands, the lower slopes and higher areas. The natural forest becomes progressively thinner as one progresses eastward from central Java to Timor and over much of Nusa Tenggara where the vegetation is better described as a savannah.

69. The estimated population in 1979 was of 150.8 million inhabitants making it the fifth most populous country of the world. As a result of the combination of rich soil, less dense vegetation, a high proportion of low lying land and the absence of extensive and unhealthy tidal swamps together with its central position within Indonesia as a whole, Java, together with the neighbouring islands of Maduran and Bali, have since historic times proved to be by far the most favourable area for settling. The main problem is communication and distribution of goods.

70. This situation is reflected in an exaggerated form in the astonishing fact that these three islands, which in total comprise less than 1/13th of the total area of Indonesia, contain almost 2/3 of its population. Thus, whereas the average density of Indonesia as a whole according to the 1971 census was of 58 persons per square km., the corresponding figure for Java and Madura was 565 and for the rest of Indonesia only 22.

71. Djakarta is the capital with a population of 4.5 million inhabitants while the larger towns outside Java, including Midan have 680,000 and Paliendang in Sumatra with 883 000 inhabitants.

Potential case for LTA use

72. Indonesia is a country composed of an archipelago stretching along the Equator between the Indian and Pacific Oceans and between Asia and Australia, It consists of 13,667 islands, some large others small, extending over a distance of 3,200 miles from east to west and 1,200 miles from north to south. The coastline has 1.5 times the length of the Equator. Indonesia includes an area of 7.3 million square kilometres, of which 5.4 million are water. This precludes the potential use of airships - to extend and improve the fishing operations and to consolidate the communication system.

73. Most of Indonesia's population, (76 percent) reside on two of the islands, while the other islands remain only sparsely populated. Transportation is an important factor which determines this poor distribution pattern. In other words, there is a strong need to improve inter-island communication.

74. On one of the principal islands, Kalimantan (ex-Borneo), the communication problems are similar to those encountered in the Amazon Basin of Latin America. Road building has similar handicaps and the development programmes encounter similar needs.

75. Indonesia is currently developing an aircraft industry which will construct medium-sized aeroplanes and helicopters with the aid of a German assistance programme. Thus, there naturally exists the fallacy that the arrival of airships could dilute their efforts and energies which are presently directed towards this industry.

76. However, the place for airships is perfectly well determined and it will displace little, but rather complement and enhance the use of other economic modes.

77. The military sector of Indonesia has recognized the advantages of using airships within the islands, and have prepared a small feasibility and application study for the use of airships as a mode of transportation.

Paraguay

Geophysical description

78. The Republic of Paraguay is a land-locked state in central South America. Bolivia lies to the north, Brazil to the east and Argentina to the south and west.

79. The climate is sub-tropical with temperatures ranging from an average maximum of 34°C. in January to an average minimum of 14°C in June.

80. The area lies in the sub-tropical region of the Amazon and is mainly covered by rain forest. An important river system crosses the country, flowing into the Paraguay river across which the largest dam has been built for the power station in Yacitará.

81. Agriculture, livestock and timber account for more than 30 percent of Paraguay's gross domestic product. Due to limitations in the purchase of meat and timber from other countries, agricultural products such as cotton and soya bean have become increasingly important as Paraguay's leading exports since 1976. Other crops are cassava, sugar, maize, tobacco and rice and the Government is trying to diversify the production by encouraging fruit and vegetable growing.

82. The principal industries are cotton ginning, timber, leather processing and the manufacture of vegetable oils.

83. Paraguay is self-sufficient in electric energy and exports this commodity to Brazil through Itaipú. The Paraguayan economy has been the fastest growing in Latin America since 1977. In 1979 the GDP growth was over 9.5 per cent and this was equalled in 1980.

84. The economic expansion is largely due to the activity generated by the current hydro-electric projects and large inflows of capital from increased investments in industry as well as good performance in agriculture and industry.

85. In 1980, there were 441 kilometres of railway in use and 15,500 kilometres of roads, of which 1,456 kilometres were paved. The Pan-American Highway runs for over 700 kilometres through Paraguay and the Transchaco Highway extends from Asunción to Brasilia.

86. The river Paraguay is navigable from Asunción to Concepción and beyond for small vessels, with considerable traffic along the river Paraná through Argentina to the Atlantic Ocean.

87. The country is otherwise flat and without any important elevations that could hamper airship operations.

Potential case for LTA use

88. Paraguay is a land-locked country in central South America, north of Argentina. It lies in the wet tropical Amazon area and is covered to a large extent by rain forest. It is crossed by a number of large rivers

which provide a good method of transport. The climate is tropical with an average temperature of 34°C. in the summer.

89. The use of airships has been considered for some years in Paraguay. In 1971 the first plans were made for airship transportation but unfortunately, the ideas developed at that time were for the use of remote-controlled airships which were unfeasible and the project was consequently dropped.

90. The idea of using airships has however survived and was taken up again by ALADI, a Government association for free trade between Argentina Brazil, Bolivia, Paraguay and Uruguay. ALADI represents the interests of its five associates and has received a mandate to investigate and promote the use of airships for transportation of agricultural produce in Paraguay and Uruguay and possibly Bolivia.

Peru

Geophysical description

91. Peru faces the Pacific Ocean along the west coast of South America. It has a coast line of over 2,500 kms. and a continental shelf rich in fish from which is derived an immediate interest for the use and protection of this privileged position.

92. The country is divided into three distinctively different zones. The coast, which is desertic by nature, is like a fertile valley when irrigated and has a width varying from about 50 kms. to over 150 kms. It is limited by the Andes, a high mountain range which appears as the backbone of the country. In the mountains there exists a number of valleys with an autochthonous population very different in character from the coastal inhabitants. Beyond the Andes is the third zone, the Amazon jungle, which is a rich rain forest intersected by a navigable river system. The principal river, the Amazon, which communicates with over 25,000 kms. of inland waterways, down to the Atlantic Ocean, is navigable from Iquitos with ships of up to 10,000 tons.

Potential case for LTA use

93. In Peru a number of projects have been actively going on and are at various stages of implementation.

94. Airships would have applications in two areas of Peru: on the coast for fishing and related operations, and in the Amazon, which is void of infrastructure, for transportation. It is practically impossible to economically maintain roads in the Amazon jungle, as will be seen from the case study in Chapter II.

95. The cost of road construction in the Amazon jungle varies between $116,000 to over $270,000 per kilometre. However, there are also projected roads such as the link from the river Putumayo to the river Napo with an estimated cost of $1,140,000 per kilometre.

96. The lack of stone in the area, as well as the rising groundwater and flooding during the rainy season requires the construction of costly works of art.

97. Road maintenance costs can vary from $800 to over $1,800 per kilometre per month.

98. Consequently there are great expectations in Peru for the use of airships which could operate without the construction of a major infrastructure.

99. A step has been taken for the development and use of airships with the simplest possible and most needed applications over the sea for fishing. By taking this approach, Peru will be able to eventually train the required crews for larger airships used for overland operations.

100. As mentioned, Peru has a continental shelf rich in fish. Currently a number of oceanographic studies as well as protection operations are being carried out with ships, aeroplanes and helicopters. The cost of this kind of operation is over $4,000 per hour. These expenses could be reduced through the use of airships which would be able to perform a number of currently

performed operations at a fraction of the present cost. It is expected that an airship would cost between $300 to $400 per hour to operate. Peru plans to start airship operations by early 1982.

The Philippines

Geophysical description

101. The combined surface area of the 7,100 islands making up the Philippines amounts to 300,000 square kms. With the intervening seas, most of which are territorial waters, the country extends over a considerable area. Of many islands only some 880 are inhabited and 462 have an area of only 1 square mile or more, though the two largest, namely Luzon in the north with 104,000 kms. and Mindanao in the south with 94,000 kms. account for 66.5 percent of its territory. Nearly all the larger islands have interior mountain ranges, reaching heights of 1,100 to 2,400 metres. Apart from narrow strips of coastal plain, few have any extensive lowlands. This is the greatest natural liability from which the country suffers and it is largely because of the central plains of Luzon by representing the exception, that this island has assumed the dominant role in the life of the country as a whole.

102. Because of its mountainous character and its alignment across the south-west monsoons and the north-east tradewinds, the Philippines show considerable regional variation in the total amount of seasonal rainfall.

103. In general, the western side of the country gets most of the rains during the period of the south-west monsoons, from late June to late September whereas for most of the eastern side the wettest period of the year is from November to March. This difference can be seen by comparing Manila on the west side of Luzon with an annual total of 210 cms. which receives 110 cms. in July-September and only 50 cms. from December to April. Surigao in the north-east of Mindanao receives to the contrary annual total of 356 cms. of which 223 cms. are between November and March.

104. During the last few years considerable expense has gone into building up an infrastructure. It was estimated that about $1,000 million would be needed by 1980 to provide better transportation. Over 1 million road vehicles

of all types were registered for the first time in 1978 but despite marked achievements of road construction, the road network is still inadequate. In 1977, 1/3 of the highway system comprised newly improved sections constructed since 1965. Renewed interest has been shown in the railway system. There are plans to expand the current network and the line south from Manila is to be extensively renovated at the cost of $33 million.

105. The Government is building up a cargo fleet for the grain and sugar trade and is replacing many old vessels of the present national fleet.

106. The airport programme centres on improving the existing airports rather than building new ones. Emphasis has been placed on the international airports of Paktan, Selbú, Laog, Tagloban, Port of Princesa, Samwanga and Dawau in co-ordination with the tourist programme. Manila now possesses an international airport designed to cope with the traffic expected up to the end of the century.

Potential case for LTA use

107. The Philippines is also a country composed of islands. As a matter of fact, there are over 7,100 islands around the two largest, Luzon and Mindanao.

108. For many years the authorities of the country have been planning to use airships for inter-island communication. In this respect a very positive attitude has been developed.

109. The situation existing in the Philippines is somewhat similar to the one in Indonesia and Hawaii. In this latter state, a feasibility study has been proposed for inter-island transport and communication. However, in the Philippines the airship operation is limited to only a part of the year when it is free of typhoons.

Summary

110. Similar to the potential uses as outlined for the seven developing countries mentioned are those of a number of states in Latin America, Africa and Asia.

111. The needs of North America and Europe are different due to the existence of a good communication system. Here the requirements are mainly for heavy lifters for transporting those items which do not fit the conventional modes of transport, either because of their size or their shape.

112. The potential applications in developing countries are for what the term says: Development, either of the coastal areas for fishing and related operations, or for developing new territories.

113. It is expected that future technical development of adequate airships and landing systems would satisfy the requirements.

II. CASE STUDY ON THE TRANSPORT OF MATERIALS TO THE OIL FIELDS IN THE NORTH-EASTERN PERUVIAN AMAZON

Advantages to be derived from the use of dirigibles

Background information

114. Most of the heavy and bulky materials are transported by barge from Iquitos to the base camps located on the Pastaza River (Nueva Andoas), the Corrientes River (Puerto Lopez) or the Tigre River (Puerto Marsella).

115. Sometimes for reasons of urgency the materials are transported by helicopter. Normally personnel and lighter materials travel by plane, hydroplane or helicopter.

116. From the base camps further distribution takes place by helicopter and when feasible by tractor-trailers or trucks to the production areas at Campamento Sud, La Forestal, Shiviyaco, Huaviri, Bartra and others.

117. The distances from the distribution centres vary from a minimum of 5 and 10 kilometres to over 100 kilometres. The roads are mostly of red clay, with major irregularities and gradients.

118. The soil in the lower Amazon Basin is clay which mixes easily with water. It is hard to compact and is prone to cake-up forming slippery surfaces when wet, rendering truck operations rather difficult. There is an extended rainy season in this tropical zone, located within 3^{o} of the equator.

119. The production areas require continued and uninterrupted flow of supplies; thus transport is imperious. Materials must arrive and be available at all times notwithstanding weather conditions. Consquently, large and costly stocks are kept at each drilling location for reasons of production continuity.

120. This fact is, together with others, an important reason to consider the use of dirigibles as an alternative mode of transport.

121. In the area under consideration, the construction of simple roads costs on an average over $105,000 per kilometre. The maintenance costs are over $15,000 per km/year. The road network of greatest importance for present operations comprises approximately 120 kilometres. Thereby, this part of the road system alone represents an investment in infrastructure of over $12,6 million with a yearly maintenance cost of over $1,800.000.

122. At this stage, and in a first approach for a cost/benefit evaluation, only a limited area of operation is being considered. Furthermore, only one type of transportation vehicle is taken into account for cost comparisons, namely the seven ARDCO tractor-trailers.

123. For a more comprehensive survey, all other conventional means should be included in the calculations. However, the cost structure will change little.

Cost of operation of ARDCO tractor-trailers

124. For the cost calculations a number of assumptions have been made based on the information received in the field. The maximum speed indicated for the tractor-trailers is 20 km/hr. This speed however can only be attained on roads of optimal condition. The speed is reduced drastically when the road conditions change. The field personnel report that most of the time the condi-

tions are "fair" or "poor". Consequently only 1/3 of the maximum has been considered as an average speed of operation in the comparative evaluation. By the same token, the load carrying capacity is reduced from a maximum of 6 tons on roads in good condition to less than 2 tons on roads in fair or poor condition. An average of 4 tons has been considered.

125. It is usual to consider 365 working days per year for transport operations in the jungle. Of these, 2/3 are taken as productive while the remaining days may be required for maintenance and repair or, represent waiting time due to poor weather conditions which make the roads impassable. The return trips are made mostly with less than half loads, thus a 75 per cent load factor has been assumed. (η = 75%)

(a) Basic assumptions:

Acquisition cost per unit: $90,000

Useful life (replacement with spare parts): 3 years

Working days per year: 365 of which 2/3 productive i.e. 243 days

Average operating speed: 1/3 of maximum (20 km/hr)

: 6.6 km/hr.

Hours of operation per day: 10 hr/day i.e. 2,430 hrs/yr
plus loading time

Production: 2,430 hrs/yr x 6.6 kms/hr = 16.038 kms/yr

x 4 tons = 64.152 tons-km

(b) Cost of operation, 7 units:

CO = Capital investment plus Personnel plus Fuel and Oil
plus Maintenance plus Overhead

CO/yr = $673.630

(Amortization over 3 yrs; Personnel $/hr 2.08; fuel $/km .30

(c) Cost of operation per unit:

$/year	96.233
$/hr of operation	39.60
$/km	6.00
$/ton-km	1.50

Cost of roads

126. The cost of construction of 120 kms. have been estimated at $12.6 million which for oilfield production operations should be amortized over 15 years at 15 percent representing a cost of $/yr 2.116.175 or $/km-yr 17.635 The maintenance cost is $/yr 1.800.000 or $/km-yr 15,000.

Cost of operating dirigibles

127. The cost calculations presented here are for two sizes of non-rigid dirigibles. It should be remembered that larger airships would provide better economic results. However, they would not be practical at this time in the north-east Amazon project for operational reasons. The final selection of the most appropriate airships will consider a number of factors in addition to size and cost, including handling aspects of the dirigible and training of personnel.

128. Dirigibles have a normal life expectancy, as indicated by the manufacturer, of up to 20 years. However, in order to remain objective in its investment policies and in view of the climate and heavy operational demand, this oil company considers 8 years as being the useful life span with full amortization over that period of time.

(a) Characteristics of the airships 1/

Useful load cap.	6 tons	12 tons
Length (m)	82 tons	112 tons
Max. diameter (m)	16.5	19
Max. speed km/hr	111	111
Cruising speed km/hr	92	92

1/ The characteristics are only indicative. The final design will be given by the constructor.

(b) Cost of construction

Construction $	2,600.000	3,200.000
Extra equipment 5%	130.000	160.000
Total cost	2,730.000	3,360.000

(c) Direct operation cost

	$	$
Amortization (8 yr, 15%)	724.262	748.716
Crew	74.000	74.000
Helium purifying equipment (8 yr, 15%)	16.713	16.713
Helium loss (10%/yr)	2.132	3.707
Fuel oil	136.080	222.264
Maintenance	78.000	78.000
	10.000	10.000
Sub-Total	1,041.187	1,143.450

(d) Indirect operating costs

	$	$
Mooring and installations	20,000	20,000
Communication equipment	5,000	5,000
Indirect personnel	20,000	25,000
Overheads	50,000	10,000
Contingencies	25,000	25,000
Sub-Total	120,000	125,000

(e) Total operating cost 1,161.187 1,268.460

(f) Unit costs

For 3,000 hrs/yr	$/yr	1,161.187	1,268.460
	$/hr	307.06	422.82
	$/km	4.20	4.59
η = 75%	$/ton-km	.93	.51

Cost of operation of helicopter

129. The Peruvian Air Force has a monopoly on operating helicopters in north-east Peru. Consequently, the oil companies must rent the aircraft together with its pilot from the Air Force.

130. In 1980 the rent for a two-twelve-twin cell was $1,300 per hour.

131. The cargo capacity under normal conditions is 1,660 kgs. but in the hot and humid Amazon region it is approximately 1,250 kgs.

132. The maximum speed is 190 kms/hr and cruising speed is approximately 170 kms/hr;

Economics resulting from the use of dirigibles

133. (a) Cost of operations of 7 ARDCO tractor-trailers:

The 7 ARDCO tractor-trailers can transport per year:

TR = 7 x 16.038 kms/yr x 4 ton = 449.064 tons/km

The cost of transporting 449.064 tons/km is:

(i) Not including a proportion of road maintenance costs:

OC = 449.064 tons-km x $/tons/km 1.50 = $673.596

(ii) Including road maintenance costs: 2/

OC' = OC + 2/3 x $1,800.000 = $1,873.596

(iii) Including road maintenance and amortization costs: 3/

OC" = OC' + 2/3 x $2,116.179 = $3,284.382

2/ 2/3 of the transport on roads is carried by the 7 ARDCO tractor-trailers.

3/ An helicopter is more manoeuverable than a dirigible. To compensate for the extra handling time required, only half the operational normal cruising speed and 3/4 of the load capacity have been considered.

(iv) Total real cost of transport by ARDCO truck:

$/tons/ms 7.31

This cost is comparable to those of the helicopter.

(g) Cost of transporting the same amount of cargo by dirigible:

Operating the dirigible at half its cruising speed and at 75 per cent of the load capacity.

(i) A dirigible with a 6 ton payload capacity would require 1,815 hours of operating time to transport the same amount of merchandise ($449.064 tons/km/year) that could be transported in one year by the seven currently existing ARDCO tractor-trailers.

(ii) The cost of operating an airship with a 6 ton payload capacity for the required 1,815 hours would be $702,513. In addition, there would still remain 1,185 hours of free operating time for the airship. This time could be used for transporting other merchandise which is now carried by less efficient modes, such as the expensive helicopter.

(iii) The case for an airship with a 12 ton payload capacity is similar and would require only 907 operating hours to carry the 449.064 tons per km/year and thereby still have 2,093 hours of time for additional operations.

Conclusions

134. The cost of infrastructure in this part of the Amazon can be so immense that the use of surface transport becomes incongruent when compared to air transport.

135. The real costs of transportation are illustrated in Table III which provides a base for second thought when developing a new region in this part of the world. In addition to cost, the time and investment factor deserve strong considerations.

136. By venting these ideas, the use of airships becomes more evident from additonal uses in the Amazon, such as patrol and construction of pipelines, as well as supply to outposts.

Table 2: Summary of comparative operating costs

VEHICLE	ARDCO TRUCK	DIRIGIBLE I	DIRIGIBLE II	HELICOPTER
Load Capacity	4 ton	6 ton	12 ton	1,25 ton
Est. unit cost	$90,000	$2,730.000	$3,360.000	-
Cruising speed km/hr	6.6	92	92	190
Operation:				
$/yr	96.233	1,161.187	1,268.460	-
$/hr	39.60	387.06	422.82	1,300
$/km	1/ 6.00	2/ 4,20	2/ 4.59	6.84
$/ton-km	3/ 1.50	.93	.51	7.29

1/ Operating 2,430 hrs/yr at 75% load factor

2/ Operating 3,000 hrs/yr at 75% load factor

3/ Only one tractor-trailer, without cost for roads.

Table 3: Summary of transportation and comparison

TRANSPORTATION MOVE	DIRIGIBLE I	DIRIGIBLE II	HELICOPTER	ARDCO TRACTOR-TRAILER
Maximum load capacity	6 ton	12 ton 1/	1,250 2/	6
Load capacity in operating with 75% load factor	4,500 kgs.	9,000 kgs.	937 kgs.	4 3/
Cargo transported ton/km/year	449.064	449.064	449.064	449.064
Hours of operation hr/year	1,815	907	2,819	2,430
$ Cost per hour of operation	$387,06	$422,82	$1,300	$39.60 4/
				$1,351.59 5/
Total cost of transport	$702.514	$383.498	$3,664.700	$96,228 4/
				$3,284.364 5/

NOTES: 1/ Designed for this load capacity under prevailing climate in the Amazon.

2/ Maximum capacity is 1,660 kg. which adjusted to climate results 1,250 kg.

3/ Average operations laod

4/ Without cost for road.

5/ Including costs of roads.

Helicopter unit cost

	$/hr	1,300	
	$/km	6.84	(without loading time)
η = 75%	$/ton-km	7,29