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Transportation and Telecommunications

Brazil

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NATIONAL INTELLIGENCE SURVEY

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This chapter was prepared for the NIS by the Defense Intelligence Agency. It includes a contribution on airfields from the Defense Mapping Agency, Aerospace Center, and a contribution on merchant marine from the Department of the Navy. Research was substantially completed by May 1973.

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BRAZIL

CONTENTS

This chapter supersedes the transportation and telecommunication coverage in the General Survey dated January 1970.

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FIGURES

Transportation and Telecommunications

A. Appraisal (C)

The development of transportation (Figure 12) and telecommunication (telecom) systems in Brazil has been hampered by the great size of the area, unevenly distributed population centers, and a diversified terrain which in many places is unfavorable for highway and railroad construction (Figure 1). The overall inadequacy of the transportation and telecom facilities, most of which are located within a 300-mile belt paralleling the coastline, has been accentuated by an expanding economy and population.

Brazilian railroad and highway systems compare favorably with those of most other Latin American countries. The highway system, the most important means of domestic transportation, handles nearly 70% of all freight traffic. Railroads are used mainly for long-haul of bulk freight and commuter passenger traffic in the large cities.

Navigable waterways provide the major and often the only means of access to sparsely settled and underdeveloped sections, especially the vast western interior. In the east and south, waterways are important adjuncts to the rail and highway systems. The long coastline and the large number of population and economic centers along the littoral emphasize the importance of Brazilian seaports and merchant marine. Brazilian merchant ships handle the bulk of the coastal traffic, but a major share of the international cargoes, except for bulk petroleum, are carried in foreign-flag vessels. All the important ports, situated south of the "bulge," primarily serve their immediate geographic regions, which usually coincide with areas of densest population and greatest industrial and commercial activity. Most maritime activities are adequate for requirements of the economy. The petroleum pipeline system is confined to the industrialized and populated areas near the coast. Pipeline facilities are rapidly being expanded.

The civil air system provides good domestic and international service and to some extent compensates for the general inadequacy of surface transport by serving many areas not easily accessible by such means. Brazil's civil air fleet is one of the largest in the world.

Although it is underdeveloped, the rapidly expanding telecom system serves most population centers. The open-wire telephone network is gradually being replaced as the leading traffic carrier by the trunk radio-relay system. Domestic service is also provided by telegraph and radiocommunication networks. There are adequate wire, cable, and radio facilities for international communications.

Government ownership of transportation systems is concentrated in the railroads and merchant marine. Regulatory control over many facilities and modes is exercised through the Ministry of Transportation and Public Works and the Ministry of Air. Telecom facilities are owned and operated by the government and a number of private companies; responsibility for their operation is vested in the Ministry of Communications.

Development of the transportation systems is based on the government's 25-year National Transportation Plan, adopted in January 1965. The plan puts heavy emphasis and financial commitments on highway construction projects. It also provides for replacing old and obsolete equipment and facilities with new acquisitions. Improvements to the telecom system are based on a 10-year plan and emphasize expansion of the trunk radio-relay system and local telephone facilities. Lack of financial resources and planning problems are the principal barriers to completion of projects and goals.

There are several highway and railroad connections with Uruguay, one railroad to Bolivia, two highways to Paraguay, and one rail and one highway connection with Argentina. Waterway connections are made with nearly all neighboring countries by means of the Amazon River and Rio de la Plata[1] systems. Brazil has numerous civil air and telecom connections with neighboring and other foreign countries

[1]For diacritics on place names see the list of names on the apron of the Terrain and Transportation map and the map itself.

FIGURE 1. In opening up new territories, in this instance westward from Sao Paulo, Brazil is confronted with difficult terrain and tortuous roads and with plateaus over which it is possible to build highways having technical characteristics comparable to the best in the world (U/OU)

B. Strategic Mobility (C)

The capability of transportation and telecom facilities to support major military movement and resupply operations varies from good in some areas to nearly impossible in the north and west. Most of the rail lines are located within a 300-mile belt paralleling the coastline in an area containing most of the major population centers and extensive agricultural, livestock, and mining industries. The rail network requires general repair and improvement but could support sustained military use. Three international rail connections are made with Uruguay and one each with Argentina and Bolivia; railroads serve all major ports.

Military traffic could move with ease on the relatively dense network of good roads in the east and south. However, there are only a limited number of good connecting routes between developed areas. Movement in underdeveloped regions would be restricted by the low density of roads, lack of alternate routes, and low construction standards that generally prevail. In rural areas, most surfaced roads have pavements of light construction and would require considerable maintenance effort if subjected to heavy military traffic.

Climate and terrain would also affect military movement via highways. Heavy rains cause washouts, landslides, and flooding, often requiring extensive repairs. Unpaved roads are often impassable in the rainy season, and dusty at other times. The precipitous coastal escarpment limits movement inland. Sharp curves and steep grades prevail in the rugged highlands and deeply dissected plateaus. Much of the interior is covered by vast marshes and tropical rain forest. Because of the great number of streams the highways have many long bridges, which are vulnerable to interdiction. In mountainous areas, roads constructed along hillsides are highly vulnerable to hostile action because reconstruction is difficult or impossible. Roads in defiles are also vulnerable, but less repair effort is required to enable traffic to proceed over the rubble.

Inland waterways, including the Amazon, a complete system of transportation within itself, offer support to military operations in areas where other modes of transportation are undeveloped. In the east and south, waterways supplement the highway and rail system. Coastal vessels navigate the lower reaches of rivers which enter the Atlantic and on upper reaches of the Amazon and Rio de la Plata systems. Brazil has six major maritime ports and large numbers of smaller ocean and inland waterway facilities. If the numerous dry-cargo ships were utilized, the merchant fleet has an extensive potential for short-haul (48 hours' steaming) troop lift and for logistics support of Brazilian military operations. The capability to support military operations over a protracted period at greater distances also is considerable. However, such military support potential could be diminished at the outset of an emergency by the unavailability of those ships engaged in international trade in distant waters. The military-lift and supply-transport capability of the 133 dry cargo ships and two combination passenger/cargo ships is about 781,800 cargo deadweight tons. Of these ships, 39 have heavy-lift booms (40 or more tons), and 27 have large hatches (more than 50 feet in length). Three units have both large hatches and heavy-lift booms. Ships having service speeds of 18 knots or more number 30 (26 dry cargo and 4 refrigerator). The tanker fleet of 42 ships has an estimated lift capability of about 4,459,000 U.S. barrels of petroleum and related products. The 1,000-passenger total capacity of the two passenger ships could be increased considerably under emergency conditions.

The 2,411 airfields in Brazil are fairly well distributed and would be of considerable use in widespread military operations. The 30 major fields used by the Brazilian Air Force have a variety of aids such as instrument landing systems, area surveillance radar, VHF omni-directional range, and approach control towers; they also have refueling, meteorology, repair, and cargo-handling facilities. Airfields at Rio de Janeiro and Campinas can support heavy bomber operations; Augusto Severo, Brasilia, Campo Grande, Guararapes, Pinto Martins, and Val de Caes can support operations of jet fighters and medium to heavy bombers; and Campos dos Afonsos, Congonhas, Cumbica, Gravatai, Ponta Pelada, Salgado Filho, and Santa Cruz can support aircraft of 30,000 to 50,000 pounds. In an emergency the civil airfleet could significantly augment the Brazilian Air Force transport capability. A special unit of the air force is responsible for mobilizing civil aviation when the need arises.

The improving telecom system would provide major support to military operations in the southern third of the country and in the coastal area. In the interior, unprotected open-wire lines, remote radio-relay sites, and lack of alternate routes contribute to a high vulnerability factor. Dense jungle and mountainous terrain severely limit the usability of wireline facilities.

C. Railroads (C)

The railroad network, the second largest in Latin America, is far superior in both extent and condition to the networks of all bordering countries except Argentina. However, it consists of a number of systems under different ownerships and having varying track gages. In addition, the network is hampered by uneconomic business practices and line locations. Consequently, the network is barely adequate for current needs.

Totaling 19,935 miles, the network consists predominantly of meter-gage (3′3⅜″) lines plus a limited mileage of 5′3″ broad gage, standard gage (4′ 8½″), and narrow gage less than 3′3⅜″. Efforts are being made to eliminate the few remaining miles of the narrowest gages. Distribution of the route mileage by gage is as follows:

Gage	Route miles	Percent of total
5′3″	2,085	*10.5*
4′8½″	121	*0.6*
3′3⅜″	17,586	*88.2*
Less than 3′3⅜″	143	*0.7*

Electrified lines total 1,621 miles and comprise about 8% of the network. Power, which is drawn from the public net, is primarily 3,000-volt direct current, but there is some 1,500-volt and 600-volt direct current. All electrification uses overhead catenary and chiefly serves suburban areas of the large cities. The 455 miles of double track and 133 miles of multiple track are located primarily on electrified lines in the Santos, Sao Paulo, and Rio de Janeiro areas. Because of terrain, a section of line between Santos and Sao Paulo has funicular and rack rail.

Most rail lines are located within a 300-mile belt paralleling the coastline. The greatest density is in the southeast, and there are smaller concentrations in the far south and northeast. The area served by the railroads includes the major population centers and extensive agricultural, livestock, and mining industries. International connections consist of three with Uruguay and one each with Argentina and Bolivia. Except for the single-gage connection with Bolivia, all border crossings are made by short sections of dual-gage track.

The network consists of 26 rail systems, all of which are ultimately responsible to the Ministry of Transportation and Public Works through the National Railroad Department (DNEF). The 26 systems are owned, operated, or controlled by various administrations. The Federal Railroad Network, Inc. (RFFSA), a federal-government-controlled holding company, controls 14 systems accounting for about 78% of the national route mileage. In 1968 the RFFSA systems were incorporated into four regions and 14 divisions. The regions are as follows:

Northeast Regional System (SRN)
Central Regional System (SRC)
South-Central Regional System (SRP)
Southern Regional System (SRS)

All divisions are operating except the fourteenth. Its services were discontinued in early 1971 and all equipment and personnel were transferred to Division 11.

The Sao Paulo State Railroad Corp. (FEPASA), a state-government-controlled holding company, controls six rail systems accounting for about 17% of the total route mileage. Created in 1971, FEPASA incorporated the following systems:

Mogiana Railroad Company (CMEF)
Paulista Railroad Company (CPEF)
Araraquara Railroad (EFA)
Campos do Jordao Railroad (EFCJ)
Sorocabana Railroad (EFS)
Sao Paulo and Minas Railroad (EFSPM)

The remaining six systems, accounting for 5% of the total route mileage and administered by various government enterprises or private firms, are as follows:

Amapa Railroad (EFAP)
Madeira Mamore Railroad (EFMM)
Perus-Pirapora Railroad (EFPP)
Tocantins Railroad (EFT)
Votorantim Railroad (EFV)
Vitoria to Minas Railroad (EFVM)

Because of competition from a paralleling highway, EFMM equipment is being shipped to Sao Paulo, and the track is to be dismantled.

Despite major track improvements, much of the meter-gage trackage is in only fair condition. Adequate for normal traffic, the trackage is not suitable for handling the heavier axle loads at higher speeds essential for efficient and profitable operation. The broad-gage trackage, though relatively small in extent, is in better condition. The standard-gage and less-than-meter-gage trackage is in poor to fair condition.

Track standards vary widely. Rail weights range from 64 to 115 pounds per yard on the broad gage, from 40 to 115 pounds on the meter gage, and from 25 to 50 pounds on the gages narrower than 3′3⅜″; all standard-gage rail weighs 90 pounds per yard. Most rail is of the standard T-section type. Eventually, most rail is to be welded, and welding plants are being constructed and used. Ties are spaced from 1,710 to

3,170 per mile and are primarily of untreated native hardwood or treated softwood. Steel and concrete ties are used on some RFFSA, FEPASA, and private lines and more are to be installed on new high-density lines. RFFSA plans to build a concrete-tie plant in the State of Pernambuco. Many ties are in fair or substandard condition, and ballast is generally poor because of improper maintenance. Crushed stone is the most widely used ballast and is usually laid to a depth of 6 to 12 inches; other materials used are gravel, sand, earth, and cinders. Maximum axleload limits range from 9 to 30 short tons. Except for 8% to 10.2% grades on the funicular and rack sections, the steepest grade is 4%. The minimum radius of curvature on main lines is 164 feet. Many lines in the southeast extend from the coastal area into the highlands and have numerous sharp curves and steep grades.

The rail network has over 6,000 bridges (each 16 feet or more in length) and over 200 tunnels. A 6,595-foot concrete rail-highway bridge over the Rio Paraguay at Porto Esperanca is the longest bridge; the longest tunnel, about 5 miles in length, is located between Lajes and Vacaria in southern Brazil. Most bridges are either of steel or reinforced-concrete construction, and tunnels are concrete lined.

Train movements are controlled primarily by the manual block system, but the use of centralized traffic control (CTC) and automatic block systems is increasing, particularly in suburban areas of large cities and on major new lines. Communications are primarily by telephone and telegraph; however, RFFSA is installing teletype on major lines.

Much of the rail network is located in mountainous or hilly terrain which adversely affects operations. Major natural traffic interruptions are floods, washouts, and landslides. The many operating problems, all of which are being studied and corrected, include: multiple, nonstandardized administrations, operating procedures, track gages, maintenance practices, and equipment; the lack of mechanization; existence of uneconomic lines; and poor track condition and alignment.

Because of recent purchases of motive power and rolling stock from Eastern and Western Europe, Japan, the United States, and domestic sources, the equipment inventory has become more adequate. Both archaic and ultramodern locomotives and rolling stock are in operation, and condition ranges from poor to excellent. Steam locomotives are quite old and are being phased out of service under continuing dieselization and electrification programs. Because of these programs, many diesel and electric locomotives are less than 10 years old. Most track maintenance machinery has been purchased in the last 15 years; however, most is not yet used effectively.

Brazil is one of five Latin American countries producing rolling stock and one of three building locomotives. Additional rolling stock and an increasing number of locomotives are to be made in Brazil. Freight cars are being exported to Bolivia and Uruguay.

The 1970 equipment inventory for the entire rail network was as follows:

Locomotives:	
Steam	597
Diesel	1,508
Electric	246
Total	2,351
Railcars	461
Passenger cars:	
Coach	3,114
Pullman	280
Dining	193
Mail/Baggage	606
Miscellaneous	418
Total	4,611
Freight cars:	
Box	27,454
Gondola	15,093
Flat	6,705
Stock	3,584
Miscellaneous	6,546
Total	59,382

Wood, coal, fuel oil, diesel oil, and electricity are used for motive power. Only RFFSA locomotives use coal; RFFSA uses mainly electricity and diesel oil; FEPASA, mainly electricity. Nearly all coal and wood are obtained locally; some fuel oil and diesel oil supplies are imported. The 1970 motive-power fuel consumption was as follows:

	RFFSA	FEPASA	Others	Total
Wood (*cu. yd.*)	178,000	41,000	17,000	236,000
Coal (*short tons*)	33,605	...	...	33,605
Fuel oil (*short tons*)	84,423	...	862	85,285
Diesel oil (*short tons*)	252,052	61,708	62,756	376,516
Electricity (*1,000 kw.-hr.*)	246,850	285,327	2,496	534,673

... Not pertinent.

Water generally is of excellent quality and the supply is adequate. In some areas, such as the northeast, seasonal drought conditions could affect the availability of water. There are no water treatment plants, but treatment compounds are used to a limited extent.

The most important of 15 major repair facilities are at Sao Paulo, Jundiai, Bauru, and Rio de Janeiro. Locomotives and rolling stock are repaired in all 15 shops, and maintenance is generally good. Most yard facilities are adequate to handle the traffic. The new hump yard at Sao Paulo has the track capacity to accommodate over 2,000 cars. Adequate transloading facilities are located at points where different gages meet. In 1971, FEPASA inaugurated Brazil's first truck-changing facility, at Porto Passagem.

Railroads are the principal long-distance bulk-freight carrier, but their share of the country's total freight movement is about 17% compared to 69% for highways and 14% for coastal maritime transport. Most suburban passenger traffic is via rail. In 1970 the rail lines carried a total of 83.6 million short tons of freight and accounted for 21 billion short-ton-miles. During the same period over 332 million passengers were carried and 7.7 billion passenger-miles were produced. Suburban lines transported 83% of the rail passengers. The general traffic pattern over the past few years indicates that freight traffic is increasing each year and passenger traffic is decreasing. The principal freight commodities hauled in 1970 were iron, coal, cement, coffee, corn, steel, sugar, wheat, gasoline, lumber, fertilizer, limestone, manganese, diesel oil, slag, and fuel oil. These commodities represented over 80% of the total volume of freight-car loadings; iron alone represented almost 46% of the total volume. In 1971, RFFSA began containerized freight shipments on a limited scale, and the line plans major usage of containers between Rio de Janeiro and Sao Paulo. The regular rail shipment of automobiles between Sao Paulo producers and Rio distributors also began in 1971. An extensive Vitoria to Minas railroad modernization plan included installation of Brazil's first automatic car identification system.

Railroad income has not kept pace with rising costs, so the lines operate at a deficit, which is offset by subsidies paid by federal and state governments. The deficits, which are a large drain on the federal treasury, should decline because freight rates have been increased each year. In 1967, revenue for all the rail systems equalled about 49% of total expenditures; in 1969 the figure was 53%, and in 1970 it was 56%. The administrations are working to eliminate the deficits by 1975.

Most railroads are overstaffed and some effort has been made to reduce the number of employees. Reductions totaled 15,000 between 1965 and 1967 and 11,500 between 1967 and 1969. Rail employment totaled 169,714 in 1970. Brazil has no organized trade schools, but employees receive on-the-job training. In the past this has not produced highly efficient and competent workers, and efficiency and productivity are low. To ameliorate the situation, a massive training program began in 1971. Most employees belong to the National Federation of Railroad Workers, which is affiliated with the National Confederation of Land Transport Workers.

A 10-year railroad plan (1967-76) envisions eventual consolidation of all the railroads into one system based on four trunk lines, which are to radiate from Brasilia to the State of Rio Grande do Sul, to the State of Bahia and the north, to Belem, and to Cuiaba. The national pattern is to be completed by 29 secondary trunk routes and 52 interconnecting lines.

The rail network is undergoing considerable change including discontinuing service on uneconomic lines; standardizing operating and administrative procedures, maintenance, equipment, and, eventually, track gages; mechanizing maintenance and freight handling; reducing overstaffing; adopting realistic freight rates and passenger fares; and applying modern business techniques. Extensive track-renewal projects provide for heavier loads, greater speeds, and more trains per day. Included are line relocations to achieve shorter distances, utilization of heavier rail, reduction of sharp curves and steep grades, and modernization and reequipment of facilities.

Important projects due for completion by 1980 are FEPASA's merger, reorganization, expansion, and eventual consolidation with RFFSA; completion of a rail-highway bridge (Figure 2) over the Rio Sao Francisco between Propria and Porto Real do Colegio to connect the northeastern and southern rail regions; completion of a Rio de Janeiro–Sao Paulo rapid-transit line; construction of a link between Sao Paulo and Belo Horizonte to provide direct access between Rio, Belo Horizonte, Brasilia, Sao Paulo, and Rio; completion of a southern trunk line to provide direct access between Rio Grande and Brasilia; completion of a rack-rail line on the Santos–Jundiai Division; completion of the Aguas Claras–Sepetiba ore line; further expansion of the Vitoria to Minas Railroad to double track; and completion of a rail beltway around Sao Paulo. Brazil is consulting with Paraguay regarding construction of lines to connect the two countries and with Bolivia regarding expansion of its lines. Brazil may offer financing for these new lines.

Replacing old equipment and increasing inventories are other important aspects of railroad improvement. Current equipment orders include more than 1,230 locomotives, 12 train sets, 22 railcars, 8,750 freight cars, and 110 passenger cars. Brazil is to produce 112 locomotives, 3,192 freight cars, and 58 passenger cars.

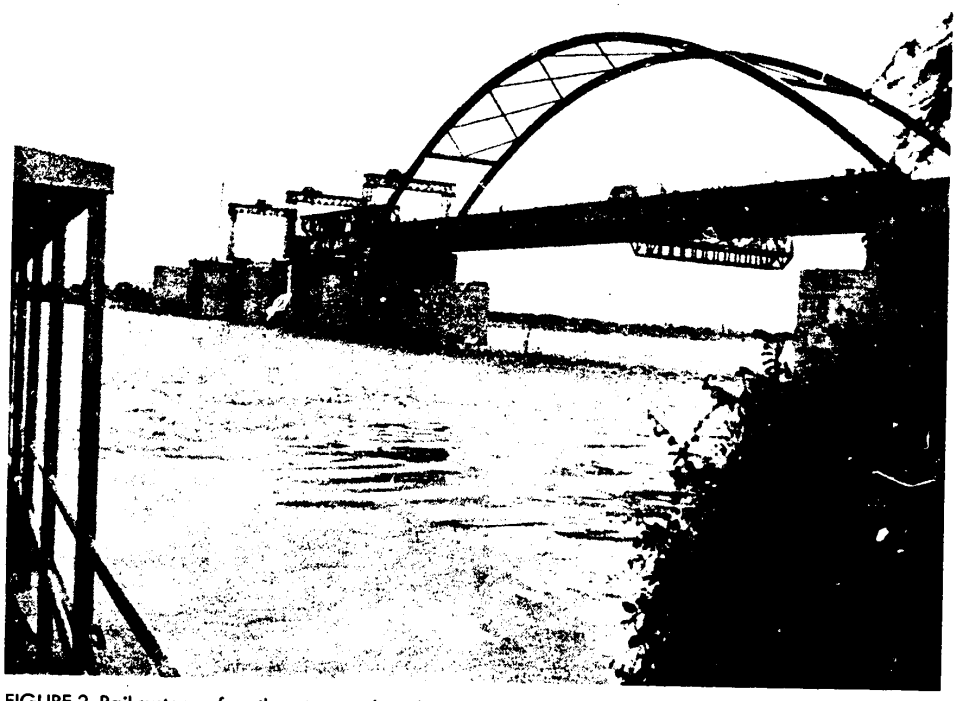

FIGURE 2. Rail systems of northeastern and southern Brazil will be connected by this 2,763-foot rail-highway bridge over the Rio Sco Francisco between Propria and Porto Real do Colegio (U/OU)

Figure 3 lists selected characteristics of the major routes.

D. Highways (C)

Highway transport handles about 69% of the total freight moved. However, because of the long distances and few alternative routes, the predominance of unsurfaced roads suitable only for light traffic, and poor original construction of important highways, the road network is inadequate for the growing needs of the country.

The highway system is unevenly distributed; nearly 75% of the road mileage is located within a 300-mile belt paralleling the coast from the border of Uruguay to the mouth of the Amazon River, and vast regions of the interior have no roads. The road density of Brazil, 0.18 mile of road per square mile of area, compares favorably with Argentina (0.12:1) and Venezuela (0.098:1). Brazil has six highway connections with Uruguay, one with Argentina, and two with Paraguay, and construction projects underway are to provide one connection with Bolivia and one with Peru.

The highway network of about 591,000 miles consists of 32,000 miles of national highways, 75,000 miles of state highways, and 484,000 miles of provincial roads. The 31,000 miles of paved highways consist principally of bituminous and bituminous-treated surfaces. About 50% of the national system and 18% of the state roads are paved; provincial roads are predominately unsurfaced earth roads.

Surface widths on national and state highways range from 10 to 50 feet. The standard width for paved highways is 23 feet, but some sections range from 15 to 30 feet. Four-lane divided highways, usually with 23-foot-wide surfaces on each roadway, are located in the vicinities of Sao Paulo, Rio de Janeiro, Belo Horizonte, and Porto Alegre. Divided highways also connect Santos with Sao Paulo and Sao Paulo with Rio de Janeiro (Figure 4). The base course for bituminous and concrete surfaces is generally

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FIGURE 3. Characteristics of selected rail lines (C)
(3'3⅜" gage and single track except as noted)

ORGANIZATION AND TERMINALS	ROUTE MILES	MAXIMUM GRADE		MINIMUM RADIUS OF CURVATURE	MAXIMUM AXLELOAD	MAXIMUM INTERVAL BETWEEN PASSING TRACK	REMARKS
		Going	Coming				
		Percent		*Feet*	*Short tons*	*Miles*	
Rede Ferroviaria Federal S.A. (RFFSA):							
Sistema Regional Nordeste (SRN):							
1st Division—Maranhao-Piaui:							
Sao Luis-Teresina	281	*3.5* (Direction *na*)	.....	591	*na*	16	Diesel and steam operated.
Teresina-Luis Correia	213	*1.6*	*na*	427	*na*	45	
2nd Division—Cearense	.....	**2.0*	.....	*334	13.2	.....	Diesel operated.
Fortaleza-Oiticica	311	.....	.....	.....	.....	20	
Camocim-Sobral	80	.....	.....	.....	.....	17	
Fortaleza-Sousa	359	.....	.....	.....	.....	24	
3rd Division—*Nordeste* (Northeast)	.....	**2.5*	.....	*328	13.2	.....	Diesel and steam operated. Some steel ties on division.
Recife-Natal	262	.....	.....	.....	.....	14	
Cabedelo-Paula Cavalcante	32	.....	.....	.....	.....	12	
Itabaiana-Mossoro	395	.....	.....	.....	.....	27	
Recife-Salgueiro	378	.....	.....	.....	.....	17	
Recife-Maceio	216	.....	.....	.....	.....	10	
Rio Largo-Porto Real do Colegio	167	.....	.....	.....	.....	14	Rail-highway bridge under construction to Propria across Rio Sao Francisco; rail ferry used in interim.
4th Division—*Leste* (East):							
Salvador-Propria	343	*1.5 (est.)* (Direction *na*)	.....	328	*na*	21	Diesel, electric, and steam operated. Double track to MP 8; electrified to Alagoinhas (MP 77). Rail-highway bridge under construction to Porto Real do Colegio across Rio San Francisco; rail ferry used in interim.
Mapele-Monte Azul	531	*3.6* (Direction *na*)	.....	361	*na*	25	Diesel, electric, and steam operated. Electrified to Santo Amaro (MP 35).
Sao Francisco-Paulistana	406	*na*	*na*	*na*	*na*	21	Diesel and steam operated.
Sistema Regional Centro (SRC):							
5th Division—*Centro-Oeste* (Central West):							
Angra dos Reis-Goiania	911	*3.5*	*3.2 (est.)*	312	*na*	24	Diesel, electric, and steam operated. Electrified (1,500- and 3,000-v.d.c. overhead catenary) for 216 miles Lidice (MP 28)—Lavras (MP 244); dual gage (3'3⅜" and 2'6") 9 miles Lavras-Botelho (MP 253).

Garcas de Minas–Belo Horizonte	185	*2.0*	*2.6*	361	*na*	13	Diesel, electric, and steam operated. Electrified 97 miles Divinopolis (MP 88)–Belo Horizonte.
Roncador–Brasilia	153	*0.5*	*1.1*	1,126	*na*	43	Diesel and steam operated.
6th Division—Central							Diesel, electric, and steam operated.
Rio de Janeiro–Monte Azul	844	Remarks	Remarks	Remarks	*na*	20	5′3″ gage; 32 miles dual gage (5′3″ and 3′3⅜″): Paraiba do Sul (MP 117)–Fernandes Pinheiro (MP 127); Conselheiro Lafaiete (MP 288)–Doutor Joaquim Murtinho (MP 297); Ferrugem (MP 388)–Horto Florestal (MP 401). Double or multiple track to Barra do Pirai (MP 68); electrified to Tres Rios (MP 123) and Barreiro (MP 381)–Belo Horizonte (MP 398). To Conselheiro Lafaiete maximum grade is 2.3% (direction *na*), minimum radius of curvature is 377 ft.
Barra do Pirai–Sao Paulo	243	*0.5* (Direction *na*)	.....	2,230	*na*	8	5′3″ gage. Electrified to Barra Mansa (MP 28) and Mogi das Cruzes (MP 212)–Sao Paulo; latter 31 miles double track. Construction of high-speed line by Japanese under consideration. Extensive usage of concrete ties on line.
7th Division—Leopoldina	.....	.....	.....	.....	22.0	.....	Diesel and steam operated. Some steel ties on division.
Rio de Janeiro–Vitoria	396	*2.7*	*3.0*	269	.....	19	Multiple track, including electrified track to Duque de Caxias (MP 12), which is operated by 6th division only.
Rio de Janeiro–Caratinga	419	*3.7*	*3.3*	164	.....	19	
Tres Rios–Manhuacu	247	Remarks	Remarks	Remarks	.....	15	Recreio (MP 82)–Manhuacu (MP 247) maximum grade going is 2.6%, coming 3.0%, minimum radius of curvature is 249 ft.
Sistema Regional Centro-Sul (SRP):							
9th Division—Santos–Jundiai:							
Santos–Jundiai	46	*8.0* and *10.2*	.....	1,146	30.8	8	5′3″ gage. Electric, diesel, and steam operated. Double track except for about 6 miles of multiple track in Sao Paulo area. Electrified Paranapiacaba (MP 19)–Jundiai. Funicular or cable-operated Piassaguera (MP 12)–Paranapiacaba; electrified rack RR. under construction to supplement funicular section.
10th Division—*Noroeste* (Northwest):							
Bauru–Corumba	821	*1.0* (Direction *na*)	.....	3,281	Remarks	24	Diesel and steam operated. Maximum axleload 19.8 short tons for diesel, 17.6 short tons for steam.

Footnotes at end of table.

FIGURE 3. Characteristics of selected rail lines (C) *(Continued)*

ORGANIZATION AND TERMINALS	ROUTE MILES	MAXIMUM GRADE		MINIMUM RADIUS OF CURVATURE	MAXIMUM AXLELOAD	MAXIMUM INTERVAL BETWEEN PASSING TRACK	REMARKS
		Going	Coming				
		Percent		*Feet*	*Short tons*	*Miles*	
Sistema Regional Sul (SRS):							
11th Division—Parana-Santa Catarina:							
Itarare–Marcelino Ramos	536	*3.2*	*na*	295	22.0	13	Diesel and steam operated. Section of newly inaugurated Southern Trunk providing shorter rail route to Sao Paulo–Rio de Janeiro–Brasilia area and N.
Paranagua–Ponta Grossa	167	Remarks	Remarks	Remarks	.....	11	Diesel, electric, and steam operated. Electrified 32 miles Veu da Noiva (MP 41)–Portao (MP 73). Newly reconstructed section Engenheiro Bley (MP 116)–Ponta Grossa has maximum grade of 1.0%, minimum radius of curvature of 1,644 ft.; this section forms part of newly inaugurated Southern Trunk (see above).
Engenheiro Bley–Lajes	231	*1.3* (Direction *na*)	.....	1,129	.....	12	Diesel and steam operated. Section of newly inaugurated Southern Trunk (see above).
Sao Francisco do Sul–Porto Uniao	260	*3.0*	*na*	331	.....	15	Diesel and steam operated.
12th Division—Teresa Cristina:							
Imbituba–Ararangua	90	**1.0*	.....	*328	17.6	9	Steam operated.
13th Division—Rio Grande do Sul							Diesel and steam operated.
Porto Alegre–Uruguaiana	446	**3.9*	.....	*410	19.8	13	At Uruguaiana dual-gage track (3′3 3/8″ and 4′8 1/2″) crosses Rio Uruguai via international rail-highway bridge to Paso de los Libres, Argentina.
General Luz–Lajes	247	*1.5* (Direction *na*)	.....	1,004	.....	*na*	Section of newly inaugurated Southern Trunk (see above), containing long tunnels and bridges.
Santa Maria–Marcelino Ramos	320	.....	.....	.....	.....	18	
Rio Grande–Cacequi	298	.....	.....	.....	.....	18	
Basilio–Jaguarao	69	.....	.....	.....	.....	14	Dual-gage track (3′3 3/8″ and 4′8 1/2″) crosses Rio Jaguarao via international rail-highway bridge to Rio Branco, Uruguay; transloading facilities at both stations.
Entroncamento–Santana do Livramento	98	.....	.....	.....	.....	25	Dual-gage (3′3 3/8″ and 4′8 1/2″) connection at Santana do Livramento with Rivera, Uruguay; transloading facilities at both stations.
Alegrete–Quarai	73	.....	.....	.....	.....	15	Dual-gage track (3′3 3/8″ and 4′8 1/2″) crosses Rio Quarai via international bridge to Artigas, Uruguay; transloading facilities at Quarai and Artigas.

Ferrovia Paulista S.A. (FEPASA):							
Companhia Mogiana de Estrada de Ferro (CMEF):							
Campinas–Araguari	449	*1.5* (Direction *na*)	.....	382	20.9	26	Diesel and steam operated.
Companhia Paulista de Estrada de Ferro (CPEF)	.....	**2.0*	.....	*988	26.4	.....	5′3″ gage. Diesel, electric, and steam operated. Some steel ties used in CPEF network.
Jundiai–Colombia	315	*1.0* (Direction *na*)	.....	3,760	.....	11	Double track to Campinas (MP 28); electrified to Rincao (MP 178).
Itirapina–Panorama	332	.....	.....	.....	.....	43	Electrified to Cabralia Paulista (MP 129).
Estrada de Ferro Araraquara (EFA):							
Araraquara–Rubineia	268	*1.0* (Direction *na*)	.....	2,604	30.8	19	5′3″ gage. Diesel operated.
Estrada de Ferro Sorocabana (EFS)	.....	**2.1*	.....	*785	19.8	.....	Diesel and electric operated.
Sao Paulo–Bauru	247	*2.1*	*2.1*	.....	.....	11	Double track to Ipero (MP 87); electrified to Rubiao Junior (MP 171). To MP 87 minimum radius of curvature is 1,146 ft.
Ipero–Itarare	165	.....	.....	.....	.....	9	Electrified to Itapetininga (MP 37).
Botucatu–Presidente Epitacio	357	.....	.....	.....	.....	14	Electrified to Ibirarema (MP 137).
Diverse Administrations:							
Estrada de Ferro Vitoria a Minas (EFVM)	.....	.....	.....	.....	.....	.....	Diesel operated.
Vitoria–Nova Era	337	*1.0*	*0.5*	663	26.4	17	Line carries heavy mineral ore traffic.
Nova Era–Belo Horizonte	114	*na*	*na*	*na*	*na*	14	Dual gage (3′3 3/8″ and 5′3″) for last 3 miles.

NOTE—Unless specified, electrification is 3,000-v. d.c., overhead catenary.
na Date not avilable.
*Maximum grade or minimum radius of curvature for pertinent division or system. Specific line grades and grade direction *na*.

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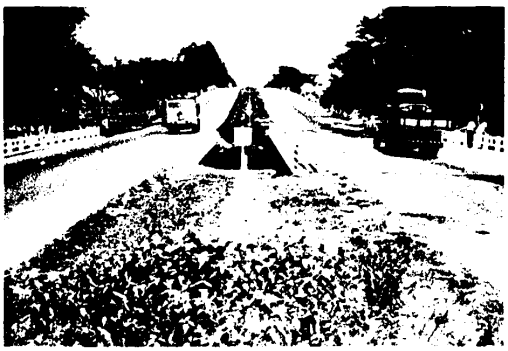
Highway through rugged terrain between Sao Paulo and Santos



Four-lane highway between Sao Paulo and Rio de Janeiro

FIGURE 4. Highways serving Sao Paulo (U/OU)

crushed stone and ranges in thickness from 3 to 27 inches. Shoulders are from 3 to 16 feet wide and are usually gravel, stone, or earth; on some sections they are bituminous surface treated.

Brazilian highway design standards vary. A minimum radius of curvature of 100 feet is permitted on low-class roads in mountainous terrain, but a 1,870-foot radius is required for high-class roads in flat terrain. Maximum grades vary from 3% to 8%. Construction standards are usually enforced for new projects, especially those financed by international lending agencies.

More than 55% of the highway bridges are constructed of reinforced concrete, and most of the remainder are of timber or masonry; there are very few steel bridges. Concrete beam is the principal structural type for spans of 100 feet and under, and concrete arches of the open-spandrel type are most commonly used for longer bridges. Standard concrete highway bridges are designed to support a column of 24-ton loads or a 34-ton single load. Most bridges on federal highways are in good condition. Timber bridges on many roads throughout the country are in various stages of deterioration.

The 20 tunnels on the highway system, which are located near Rio de Janeiro and Sao Paulo, are concrete lined, ventilated, and in fair to good condition. The numerous fords are on state highways and local roads or on pioneer federal highways. There are about 500 ferry crossings.

Within the Ministry of Transportation and Public Works a permanent government agency known as *Grupo de Estudas Para Integracao de Politica de Transports*—GEIPOT is responsible for planning and advising the minister on national transport. Its duties include coordinating and integrating transport policy with the national economic and social plans.

The National Highway Department (DNER), under the Ministry of Transportation and Public Works, administers the national highway network. Maintenance and construction are accomplished through 20 district offices. In each state is a state highway department (DER) responsible for its highway network. Government policy is to transfer maintenance and construction functions gradually from DNER to the DER's, thus enabling DNER to concentrate on planning and overall supervision. Maintenance operations are performed by the national and state highway department personnel and by contract. Most construction projects are accomplished by private contractors, but some is done by army engineers, especially in remote areas.

Highway construction and maintenance operations are hampered by heavy rains which cause floods, landslides, and cave-ins, sometimes necessitating extensive repairs. Terrain obstacles include the precipitous coastal escarpment, rugged highlands, deeply dissected plateaus, vast marshes, jungles, and dense forest. A shortage of modern equipment for mechanized road operations is being alleviated through loans and planning.

There are adequate domestic supplies of portland cement, stone, gravel, timber, and asphalt. However, much of this material must be transported great distances. Some steel and a few types of construction equipment are produced domestically, but most equipment is imported from the United States, Western Europe, and Japan. Imports include dump trucks, graders, bulldozers, compaction machines, and asphalt mixers and spreaders.

Large increases in transport volumes, both in passenger and freight, have resulted in pressures to improve and extend the highway network. The basis for all highway development is the 25-year National Transport Plan, adopted in 1965 and updated periodically. DNER continually reviews the program to ensure that established priorities are currently valid. Revenues from road-user taxes cover about 70% of the cost of construction, maintenance, and administration; the remainder is borrowed from international financing organizations.

Among the more important projects are the Central-West Development Program and the Program for the Sao Francisco Valley. The Central-West Development Program encompasses the States of Mato Grosso and Goias and calls for building 1,000 miles of basic roads and paving 1,300 miles more in a region which has a huge economic potential and occupies an important area for agricultural expansion. The Sao Francisco Valley program calls for building 1,000 miles of basic roads and paving another 1,000, thus assuring this area of more favorable conditions for producing and circulating its wealth.

In addition to these first-priority projects, reconstruction and improvement are nearing completion on two major north-south highways, both of which are over 2,000 miles in length. The inland route connects Jaguaribe, on the Uruguay border, to Fortaleza, in the northeastern State of Ceara. The other route runs along the coast and links Osorio, in Rio Grande do Sul, to Natal, in Rio Grande do Norte. Both roads interconnect Brazil's major cities.

The highway plan for development of the Amazon calls for constructing, by 1974, some 10,000 miles of roads, 2,200 of which will be paved. The most spectacular of these projects is the Trans-Amazonian Highway being constructed from Joao Pessoa and Recife on the Atlantic coast to the Peru border. Major projects scheduled for completion by 1975 include improving the road from Brasilia to Porto Velho via Cuiaba; surfacing the newly completed road from Manaus to Porto Velho, building a road from Santarem to Cuiaba; and paving the road from Belem to Brasilia.

Traffic is interrupted on highways in hilly and mountainous eastern Brazil by landslides, rockslides, and washouts, and in the rest of the country by the effects of flooding during heavy rainfall, which occurs generally from September through May for most of the country. Earth roads are often impassable during the rainy season. In some locations on federal highways, and more commonly on state highways and local roads, use of fords and ferries is restricted. Traffic flow is impeded on secondary and tertiary roads by narrow timber bridges, and in hilly and mountainous regions by steep grades and sharp curves.

Highway transport firms are privately owned, and most freight and passenger operations are performed by one-vehicle owners. A great amount of trucking is accomplished by farmers, ranchers, manufacturers, and service industries. Several large bus companies operate in the larger metropolitan areas, and numerous small lines serve the smaller towns.

Users are free to select the mode of transport which best suits their requirements. Entry into the interstate road transport industry requires DNER approval, but granting of licenses is almost automatic. Intrastate trucking operations are licensed by the DER's in the same way. Bus companies must apply to DNER or to DER's, prove public need, and file tariffs and timetables for each route.

Highway freight traffic grew by about 11% each year during the sixties and increased its share of the total freight movement from 62% in 1961 to 69% in 1970. For the same period the highway share of passenger traffic rose from 74% to 91%. The principal goods hauled are coffee, farm produce, processed foods, and lumber. In addition, large quantities of other building materials and machinery are moved along the highways.

In 1970 the inventory of 3,451,000 vehicles consisted of 2,694,000 passenger cars, 59,000 buses, and 698,000 trucks, including pickups and vans.

Vehicle production is growing at the rate of 20% a year. Over 500,000 vehicles were produced in 1971, and a capacity of 1 million vehicles per year is expected to be achieved by 1975. Brazil is self sufficient in the production of passenger cars. Trucks, buses, construction machinery, and spare parts are also produced, but some are also imported.

Figure 5 lists characteristics of selected highways.

E. Inland waterways (C)

Brazil's major inland waterways are the Amazon, the Rio Sao Francisco, the Lagoa dos Patos, the Rio Parana, the Rio Paraguay, and the Uruguay. With their tributaries they are navigable for a total of about 31,000 miles and provide the principal surface routes of transportation and communication through extensive sparsely settled and generally undeveloped or otherwise inaccessible sections of the country. The principal commodities shipped are timber, nuts, cocoa beans, mate, bituminous coal, and various mineral ores. Trends point to increased utilization of the waterways as arteries of freight and passenger transportation in the future.

The inland waterways may be divided geographically into the following general groups:

Northwestern group:	
Rio Araguari	Rio Madeira
Amazon	Rio Purus
Rio Negro	Rio Tocantins
Northeastern coastal group:	
Rio Para	Rio Itapicuru
Rio Gurupi	Rio Parnaiba
Rio Turiacu	Rio Acu
Rio Mearim	Rio Paraíba
Eastern group:	
Rio Sao Francisco	Rio Mucuri
Rio Paraguacu	Rio Doce
Rio Pardo	Rio Paraiba do Sul
Rio Jequitinhonha	
Southeastern coastal group:	
Rio Itajai	Rio Jaguarao
Lagoa dos Patos-Rio Guaiba	Rio Iguacu
Rio Jacui	Rio Tiete
Lagoa Mirim-Canal de Sao Goncalo	
Southern and Southwestern groups:	
Rio de la Plata	Rio Parana
Uruguay	Rio Paraguay

The Amazon River system, with its tributaries, provides Brazil with over 20,000 miles of seasonally navigable waterways; standard oceangoing cargo vessels ascend to the port of Manaus on the Rio Negro, about 1,100 miles from the Atlantic mouth. Significant among the national government's plans for Amazon Basin development is a project to expand Santarem into a deepwater port. Santarem lies at the junction of the Amazon and the Rio Tapajos and is the starting point of a transjungle highway to Cuiaba, about 1,000 miles southward, on a Rio Paraguay tributary.

Of the northeastern coastal waterways, the Rio Parnaiba, potentially the most important, has the longest extent of navigability, about 680 miles. Navigation locks under construction at the Boa Esperanca hydroelectric dam will increase the navigability of the Rio Parnaiba and facilitate transportation to the central and eastern parts of the country. Navigability of the other streams in the northeast area varies from 11 miles to 300 miles.

In the eastern area, the Rio Sao Francisco is navigable for about 1,000 miles, serving a valley of several hundred thousand square miles; portions totaling about 800 miles are being dredged and regulated to eliminate shallows, waterfalls, and rapids. A new river port is planned at Pirapora, in the State of Minas Gerais, near the headwaters of the Rio Sao Francisco where it approaches the Pan American Highway leading into the new Brazilian capital of Brasilia. Most of the other eastern waterways are short,

FIGURE 5. Selected highways (C)

ORIGIN AND DESTINATION	DISTANCE	SURFACE TYPE	SURFACE WIDTH	SHOULDER WIDTH	REMARKS
	Miles		*Feet*	*Feet*	
Uruguay border near Chui to Rio de Janeiro via Porto Alegre, Curitiba, Sao Paulo.	1,298	Bituminous.....	Mostly 21 to 23 .. (see remar'cs)	3 to 10	Sao Paulo-Rio de Janeiro route is 4 lanes wide, many segments consisting of 2 roadways divided by median strip.
Uruguaiana to Porto Alegre.....	408	....*do*.....	23.....	6	
Foz do Iguacu to Curitiba.....	420	....*do*.....	23.....	3 to 6	
Sao Paulo to Brasilia.....	715	....*do*.....	23.....	3 to 10	First 60 miles is a 4-lane divided highway.
Rio de Janeiro to Brasilia via Belo Horizonte.....	785	....*do*.....	20 to 25.....	4 to 10	First 70 miles is a 4-lane divided highway.
Road junction 85 miles N. of Rio de Janeiro to Salvador.	940	....*do*.....	20 to 25.....	4 to 6	
Belem to Brasilia.....	340 (*approx.*)	Remarks.....	Remarks.....	*na*	Originally completed in 1959 as unpaved "pioneer" road, 26 ft. wide, with sharp curves, steep grades, single-lane timber bridges. Road now being reconstructed with improved alignment, 2-lane bituminous pavement, 2-lane concrete bridges. Completion scheduled for 1975.

na Data not available.

swift-flowing streams with navigability ranging from 50 to 75 miles.

The most important and most developed waterway in Brazil is the 166-mile-long Lagoa dos Patos-Rio Guaiba in the southeastern part of the country; it carries a greater volume of traffic than any other waterway. With the ocean ports of Porto Alegre and Rio Grande at the northern and southern ends of Lagoa dos Patos, respectively, this waterway provides an outlet for the rich wheat- and cattle-producing region known as the "bread basket" of Brazil. Lagoa Mirim-Canal Sao Goncalo, with 158 miles of navigability, serves both Brazil and Uruguay. The other streams in the southeast have from 17 miles to about 500 miles of navigability. The Rio Guaiba has been improved with dams and locks and accommodates large river steamers for a distance of 177 miles. The Rio Tiete and the Rio Jacui are under extensive development. A project has been undertaken to connect the Rio Ibicui, a tributary of the Uruguay, with the Rio Jacui by means of a 95-mile-long canal, providing the State of Rio Grande do Sul with an east-west waterway.

In southern and southwestern Brazil, the Rio de la Plata system is dominant. The Uruguay and its tributaries provide about 1,250 miles of navigable routes; its upper reaches form most of the boundary between Brazil and Argentina. The Uruguay is navigable most of the year for about 700 miles within Brazilian territory where it is utilized in the transport of agricultural products to railroad centers along the river and in the rafting of timber downstream.

The Rio Parana, main artery of the Rio de la Plata system, forms part of the boundary between southeast Paraguay and Brazil. The upper third of the Parana, known as the Alto Parana, lies mostly within Brazil; two sections, roughly 80 miles and 300 miles long, are navigable. The nonnavigable portion between these two sections includes Salto das Sete Quedas, giant waterfalls at Guaira on the Paraguay border. Waterborne operations on the lower 80-mile section are made difficult by numerous rapids and dangerous whirlpools. Navigation locks are under construction on the Alto Parana. The chief cargo carried on the Brazilian portion of the Rio Parana consists of forest products and yerba mate.

The Brazilian section of the Rio Paraguay forms part of the border with Bolivia and is navigable for over 600 miles except during the low-water period, from November to February. Corumba, on the Rio Paraguay just across from the extreme southeastern part of Bolivia, lies about 150 miles upstream from the Paraguay border. The center of most of the area's commercial activity, Corumba is concerned with the transport of agricultural and mineral products and general merchandise in domestic and international trade. The Rio Paraguay also serves as an outlet for Bolivian products. Ladario, roughly 20 miles east-southeast of Corumba, is the site of a small naval installation where the Mato Grosso Flotilla is based. A drydock here is operational only in the rainy season.

Of the major inland waterways, the southeastern group carries about 65% of the cargo volume and the Amazonian group almost 20%.

The waterways of Brazil are navigable by a variety of craft. Many of the streams entering the Atlantic are capable of carrying standard ocean-type cargo vessels considerable distances inland. Manaus, Belem, and Sao Luis are served by such vessels as are the coastal ports of Rio Grande and Pelotas in southern Brazil. Coastal-type vessels navigate throughout the lower reaches of most coastal streams entering the Atlantic Ocean directly and on the upper reaches of the Amazon and the Rio de la Plata systems. River craft utilize the middle and upper reaches of most navigable streams in Brazil. Small native craft ply the upper reaches of the coastal streams as well as the tributaries of the Amazon, the Rio Sao Francisco, and the Rio de la Plata systems.

Navigation is interrupted by silting, rapids, falls, and floating debris. Sandbars and other obstructions formed by sediment and debris during high water often interrupt or limit navigation when flood waters recede. Rapids constitute seasonal interruptions in many of the waterways and permit only sectional navigation in others.

Structures on the inland waterways include bridges, overhead and submarine cables, navigation locks, and an increasing number of dams. Most new dams include plans for navigation locks. There are about 80 bridges over the navigable waterways, probably the most important being the international highway structure over the Rio Parana at Foz do Iguacu between Brazil and Paraguay.

The more than 700 ports and landings situated on the inland waterways range from maritime ports to small landings at villages in remote interior areas. Craft operating on the waterways include a large portion of the Brazilian merchant marine, privately owned river craft, and foreign-flag vessels operating in Brazil. A greater volume of cargo is handled by privately owned nonsubsidized companies than by the large federally controlled river services. The principal river service in the Amazon Basin is provided by the federally subsidized Navigation Services of the Amazonian Region and Administration of the Port of

Para (Belem), which has a fleet of over 100 units, including modern cargo-passenger vessels, paddle-wheel steamers, tugs, barges, and launches. The Rio Sao Francisco fleet includes 15 river steamers, about 50 diesel-powered barges, numerous manually propelled barges, and a number of cargo vessels of 20 to 30 tons carrying capacity. On the Lagoa dos Patos system, 20 companies provide service, including nine that have a combined fleet of over 100 craft that operate on the Rio Taquari and Rio Jacui. Service on the Rio Paraguay is provided by the government subsidized Navigation Service of the Prata Basin, which has a fleet of tugs, barges, river steamers, and other miscellaneous craft. Many of the craft are obsolete, and the fleet is generally inadequate. Coastal vessels also operate on the inland waterways, chiefly on the Amazon and Lagoa dos Patos systems.

A Presidential Decree of 1966 placed control of the inland waterways under the National Department of Ports and Navigable Routes (DNPVN), a dependency of the Ministry of Transportation and Public Works. The DNPVN has two groups concerned with waterways, the Directorate of Navigable Routes and the National Institute of Water Routes Investigations. Regional Directors act as field representatives for the National Director.

Developmental policy for inland waterways originates from the Ministry of Transportation and Public Works. Numerous federal and state improvement programs that have been implemented include canalizing important streams; rehabilitating ports, some of which are to have specialized terminals for handling regional agricultural and mineral produce; expanding shipyards and ship-repair centers; and replacing antiquated river-fleet units with modern craft.

The port of Santarem, situated at the junction of the Amazon and the Rio Tapajos, has received a large sum to be used in constructing piers for deep-draft vessels. In northeast Brazil, a dam and hydroelectric plant were constructed at Barragem de Boa Esperanca on the Rio Parnaiba; locks at the site are to be completed in 1973. In eastern Brazil a $55 million regularization project was begun in February 1972 on the Rio Sao Francisco; emphasis is on its middle 280-mile sector in the State of Minas Gerais. In southeast Brazil the Rio Tiete, Rio Taquari, and Rio Jacui are the targets of major improvements. Developments on the Rio Tiete, which is now being dredged, consist of a dam and navigation locks at Bariri and Barra Bonita, completed since 1970; a dam under construction at Promissao (plans for navigation locks are under study); and a dam at Ibitinga where work on navigation locks nears completion. The Bariri locks opened 125 additional miles of navigation in this system. The Rio Taquari is being dredged to permit barges with 10-foot draft to navigate as far as Porto Mariante, a wheat and soya bean production center about 64 miles upstream from Porto Alegre; navigation locks are under construction at the Bom Retiro do Sul dam on the Rio Taquari. Two locked dams adjoining hydroelectric plants have been completed on the Rio Jacui, and a dam-lock installation has been projected for construction at Santo Amaro do Sul on the same stream. These three installations will increase Rio Jacui navigability to 150 miles upstream from Porto Alegre.

An east-west waterway for the State of Rio Grande do Sul, connecting the Rio Ibicui, tributary of the Uruguay, with the Rio Jacui by means of a 95-mile-long canal, is in the final planning stage.

In southwest Brazil navigation locks are under construction at the hydroelectric plant dam near Jupia on the Rio Parana; when the dam and 4-million-kilowatt hydroelectric plant at Promissao, some 30 miles upstream from Jupia, are completed in 1973, navigation locks are to be installed, making the Rio Parana navigable in Brazil for almost 450 miles. Work being done on the Rio Parana and Rio Tiete are to create a navigable waterway of about 870 miles between Salto das Sete Quedas at Guaira on the Rio Parana and Sao Paulo on the Rio Tiete. Studies are in progress to develop the northwestern and northeastern rivers to coordinate traffic with the major highways connecting commercial and industrial centers with remote regions.

Characteristics of principal inland waterways are given in Figure 6.

F. Pipelines (C)

The pipeline systems of Brazil are confined to the highly industrialized centers and the oil producing areas near the Atlantic seaboard. Control is exercised by the government through its petroleum monopoly, PETROBRAS, Petroleo Brasileiro—and the Sao Paulo-state-owned Santos-Jundiai Railway Company. Since industrial growth has been a recent phenomenon, the petroleum facilities are relatively new and rapidly expanding.

About 65% of Brazilian crude oil requirement is imported; the remaining 35% is produced from domestic oilfields, primarily in the state of Bahia. Oil discoveries in the States of Sergipe and Maranhao, though encouraging, are expected to do little more than keep abreast of increasing domestic needs. Because of the great distances between the oilfields

FIGURE 6. Characteristics of principal inland waterways (C)

NAME	TYPE	NAVIGABLE LENGTH	SAFE DRAFT		REMARKS
			Low water	High water	
		*Miles**	*Feet*		
Amazon River	Natural stream	1,967	12	*na*	Navigable by coastal-type vessels throughout and by standard ocean-type vessels upstream about 1,100 miles to Manaus. With tributaries provides NW. Brazil with more than 20,000 miles of seasonally navigable waterways; empties into Atlantic Ocean through numerous delta channels. Important navigable tributaries: Rio Negro, Rio Madeira, Rio Purus, Rio Tocantins. Chief cargoes carried downstream: crude petroleum, petroleum products, rubber, timber, cattle, oil-bearing nuts, cotton, rice, cacao. Chief cargoes carried upstream: processed foodstuffs, building materials, oilfield equipment, manufactured goods.
Rio Sao Francisco	Partially improved stream	1,005 (126–879)	3	5	Navigable between mouth, near Piacabucu, and mile 126, and between mile 348 at Santa Maria da Boa Vista and mile 1,227 at Pirapora. Navigation interrupted between mile 126 and 348 by impassable rapids and falls. Small steamers navigable from river mouth to mile 126; river steamers and diesel-powered barges operate regularly between Juazeiro, mile 429, and Pirapora, mile 1,227, both RR. centers. Depth over bar at mouth 9 ft. at low water. River flows WNW. for about 350 miles from Atlantic Ocean, thence S. in irregular course. Cargo carried consists chiefly of mineral and agricultural products.
Lagos dos Patos-Rio Guaiba	Improved lake channels	166	13.5	16	Most important and most developed waterway in Brazil. Navigable channel 1,800 ft. wide, 26 ft. deep at low water, leads from sea 10 miles to lake. Lake encumbered by numerous shoal areas to Porto Alegre on Rio Guaiba. Channel in Rio Guaiba dredged to 18 ft. Joined by Rio Jacui just upstream from Porto Alegre. S. end of Lagoa dos Patos connected with Lagoa Mirim by 43-mile-long Canal Sao Goncalo, which serves as outlet for Brazilian and Uruguayan hinterlands; canal navigation limited to river craft and steamers by normal controlling depths of 10 ft. in dredged channel at entrance to Lagoa Mirim. Cargoes carried: grain, fruit, sugar, other agricultural products, coal, hides, lumber, petroleum products, manufactured goods.
Rio Uruguai	Natural stream	694	Remarks		Serves Brazil primarily as transport route for rafting timber from upper reaches downstream and for local transport of agricultural products, salt, ranch supplies, and other consumer goods. Borders Argentina for 445 miles in W. part of State of Rio Grande do Sul. Provides connections with Argentina and Uruguay. 445-mile section between Brazil and Argentina (mile 310 to mile 755) navigated by 10-ton-capacity launches and tugs with steel barges up to 72-ton capacity in tow. Borders of Uruguay, Brazil, Argentina meet at mile 310. Water levels vary markedly; between mile 310 and mile 575, at Porto Xavier, controlling depth is 6 ft.,

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				safe draft, 5 ft.; in upper reaches, mile 575 to mile 1,004, Marcelino Ramos, in SE. Brazil (upper limit of navigation), safe draft is 2 to 3 ft., navigable mostly by rafts, tugs, launches. International RR. and highway bridge between Brazil and Argentina at Uruguaiana, mile 362.
Rio Parana	....do	432 (82 + 319 + 41)	- - - Remarks - - -	Provides transport route to 6 Brazilian states and trade route to Argentina, Paraguay, Bolivia. Enters Brazil near Foz do Iguacu, mile 1,048, at Paraguay-Argentina frontier with Brazil. Forms 127-mile border with Paraguay, from mile 1,048 to mile 1,175 at Guaira, site of rapids and falls, Salto das Sete Quedas. Navigable by 300-ton-capacity river vessels between mile 1,048 and mile 1,130 at Porto Mendes, flowing through deep gorge; normal controlling depth 36 ft., safe draft, 6 ft. Not navigable for 45-mile stretch mile 1,130–mile 1,175, at Guaira. Mile 1,175–mile 1,494, at Jupia, depths are 25 ft. at low water, but few shallow passages limit navigation to shallow-draft vessels. Navigable by heavy towed barges from mile 1,494, site of Jupia hydroelectric plant dam (navigation locks under construction), to mile 1,525, site of Ilha Solteira, larger hydroelectric plant dam under construction. Cataracts, Cachoeira Urubupunga, at mile 1,500, were eliminated by rise in water level produced by Jupia dam. Typical log rafts used on Alto Parana have draft of about 3 ft. International highway bridge at Foz do Iguacu, RR. bridge at Jupia; highway bridge planned to span Rio Parana near mile 1,381. 6 miles below Presidente Epitacio. Cargo consists chiefly of lumber, logs, yerba mate, construction materials, general consumer products.
Rio Paraguay	....do	678	- - - Remarks - - -	Important to development of vast Mato Grosso area. Forms boundary between Brazil and Bolivia mile 770–mile 800 and between Brazil and Paraguay mile 572–mile 770. Navigable for 678 miles by launches and small shallow-draft craft from mile 572 at Paraguay border to Caceres at mile 1,250; open to international navigation from mile 924, at Corumba, southward. Steamers of 1,000-ton capacity navigate to Cuiaba via tributary, Rio Cuiaba, at high-water stages; barges used during low-water period. Vessels of 2,000-ton capacity navigate to Corumba, mile 924, except at low water when safe draft is about 4.5 ft. Corumba–mile 1,046, safe draft usually 3 to 3.5 ft.; low water, Nov.–Feb., above Corumba. RR. bridge spans river at Porto Esperanca, mile 845. Corumba is most important commercial port in upper Rio Paraguay basin. Eventual connection of Rio Paraguay headwaters with Rio Guapore, navigable tributary of Amazon River, envisioned in national transportation plans. Chief cargoes carried downstream: manganese ore, dried beef, hides, sugar cane, rubber, agricultural produce. Chief cargoes carried upstream: sugar, salt, petroleum products, staple food items, general merchandise.

na Data not available.
*Lengths are for Brazilian sections of the rivers.

and the processing centers, there is double handling of crude by pipelines and tankers.

Crude-oil pipelines are utilized for transporting crude oil from domestic fields to export marine terminals and from import marine terminals to refineries in industrialized areas. The products pipelines are used for transport of imported and locally refined products. There are 1,087 miles of pipelines in operation; 773 miles are used for crude oil, 290 miles for refined products, and 24 miles for natural gas.

In the State of Bahia 144 miles of crude-oil and 24 miles of natural-gas pipelines connect the oilfields with each other and with the marine terminal at Madre de Deus and the Mataripe refinery. Production in the Bahia area is about 140,000 barrels a day. The refinery has a crude-distillation capacity of 45,000 barrels, leaving 95,000 barrels a day for shipment to other parts of the country.

The first pipeline and marine oil terminal in the State of Sergipe was inaugurated in December 1966. This 30-mile pipeline taps the Carmopolis oilfield (about 18 miles north of the port of Aracaju) and adds a minimum of 16,000 barrels a day to Brazil's crude-oil production. Long-term expansion to 100,000 barrels a day is planned for the area.

The state of Sao Paulo, Brazil's largest industrialized area, imports all of its petroleum products through marine terminals at Santos and Sao Sebastiao. Crude oil is delivered to four refineries by 277 miles of pipeline; refined products are distributed by an additional 187 miles of pipeline.

The longest single pipeline in Brazil covers a distance of 227 miles between Rio de Janeiro and Belo Horizonte. This line, which formerly transported refined products from the Duque de Caxias refinery in Rio de Janeiro, has been converted to transport crude oil from the Rio de Janeiro marine terminal to the new Gabriel Passos refinery in Belo Horizonte. A 91-mile pipeline carries fuel oil to the important industrial area of Volta Redonda and to the marine terminal of Santa Cruz. An additional 48 miles of crude-oil and products pipelines also connect the refinery in Rio de Janeiro with local port facilities and POL storage terminals.

The only gas pipelines in the country are those in the state of Bahia, where the gas is probably being injected into the Candeias oilfield to increase oil production.

Details of principal pipelines are given in Figure 7.

G. Ports (C)

Brazil has six major ports and 25 significant minor ports. Rio de Janeiro and Santos (Figure 8), both on the southeastern Atlantic coast, are the principal maritime centers. The other four major ports are Recife, Salvador, Porto Alegre, and Rio Grande. Four of the significant minor ports, Belem, Sao Luis, Fortaleza, and Areia Branca, are on the less populated north coast. Manaus, almost 1,100 miles upstream from the mouth of the Amazon River, is the trading center for a vast hinterland and exports rubber and other agricultural products and receives general cargo for distribution through a flourishing international free zone. On the more densely populated east coast are the following significant minor ports:

Natal	Ilheus	Paranagua
Cabedelo	Tubarao	Itajai
Maceio	Vitoria	Florianapolis
Aracaju	Angra dos Reis	Tramandai
Aratu	Sao Sebastiao	

Characteristics of the minor ports are consistent with the type of commodity produced and the imports needed in the respective areas. Belem, the most important commercial port on the north coast and headquarters of the Fourth Naval District, exports rubber, cacao, timber, and hides. Belem yards have two large floating drydocks and four marine railways and perform major hull and routine machinery repairs to naval and merchant ships. Most of the port activities at Fortaleza have been transferred recently to nearby Mucuripe from which cotton, ores, and salt are shipped. Areia Branca is being converted into a salt-distribution port because of its proximity to large salt flats. Natal ships salt, cotton, sugar, and ore; the floating drydock at the naval base repairs ships up to 2,000 tons. Cabedelo's principal shipments are sisal, sugar, and cotton. At Maceio a sugar terminal under construction has alongside depths suitable for large oceangoing vessels. Aracaju is undergoing dredging and extension of berthing space. Aratu, about 15 miles north of the major port of Salvador, is the site of new industrial plants and a naval base, which has the second largest drydock in Brazil. Ilheus is Brazil's leading cacao export port. The new port of Tubarao, owned and operated by a large mining company and completed in 1966, is designed especially for the shipment of iron ore and the receipt of coal; in 1970 it shipped over 22 million tons of iron ore, and the expansion of port facilities continues with the construction of an additional ore berth at depths suitable for vessels of 400,000 d.w.t. Vitoria has become a general-cargo and grain-handling port since most of its ore handling operations have been transferred to Tubarao. Angra dos Reis, about 75 miles south of Rio de Janeiro and site of the large Verolme shipyard, ships coffee, bananas, and rum and receives wheat, coal, and salt. The petroleum terminal built by

FIGURE 7. Principal pipelines (C)

LOCATION/TERMINALS					
From	To	LENGTH	DIAMETER	PRODUCTS TRANSPORTED	REMARKS
		Miles	*Inches*		
Bahia (state):					
Agua Grande oilfield	Madre de Deus	*37	12	Crude	Transports crude to Madre de Deus marine terminal. Has 78,000 bbl./day capacity; 1 pumping station.
Do	Candeias	30	6 5/8	*do*	
Do	Taquipe	12	12	*do*	
Buracica	Candeias	34	8–12	*do*	Connects Buracica and smaller oilfields with Candeias terminal. Has 2 pumping stations; capacity of 120,000 bbl./day.
Candeias	Madre de Deus	*4	18	*do*	
Do	*do*	*4	6 5/8	*do*	
Do	Mataripe refinery	3	6 5/8	*do*	Transports crude from Candeias to Mataripe refinery, which has capacity of 45,000 bbl./day.
Dom Joao	Candeias	6	6 5/8	*do*	Connects Dom Joao and 2 other oilfields with Candeias terminal.
Miranga	Aqua Grande	14	8	*do*	Completed 1965; has 1 pumping station.
Sergipe (state):					
Carmopolis	Atalaia Velha	30	18	*do*	50,000 bbl./day capacity; future expansion to 75,000 and then 100,000 bbl./day.
Sao Paulo (state):					
Ilha do Barnabe	Sao Paulo refinery	43	12 3/4	*do*	Transports crude from port of Santos via 2 pumping stations to Sao Paulo area.
Sao Bernardo do Campo	Capuava refinery	7	12 3/4	*do*	Branch line of Ilha do Branabe–Sao Paulo line from point 33 km. from Santos.
Sao Sebastiao	Cubatao refinery	75	22	*do*	Transports crude to Cubatao refinery; has 2 pump stations.
Do	Paulinia refinery	140	24	*do*	Transports crude to Paulinia refinery; has 100,000 bbl./day capacity.
Paulinia	Barueri	60	10–14	Refined	2 parallel lines scheduled for completion in 1972.
Santos	Cubatao	12	22	Crude	Transports crude from marine terminal in port of Santos to refinery; has 1 pumping station.
Alamoa pumping station	Sao Caetano pumping station	35	18	Refined	Serviced by 3 pumping stations.
Do	*do*	35	10 3/4	*do*	2 parallel lines serviced by 2 pumping stations.
Do	Cubatao refinery	15	14	*do*	
Do	*do*	10	8	*do*	
Do	*do*	9	6 5/8	*do*	
Capuava refinery	Utinga pumping station	5	6 5/8	*do*	
Ilha do Barnabe	Cubatao refinery	12	8	*do*	
Kilometer 41	Sao Paulo (Piratininga thermal powerplant).	6	18	*do*	Branch line of 18-inch Alamoa–Utinga line from a point 41 km. from Santos.

Footnote at end of table.

FIGURE 7. Principal pipelines (C) (Continued)

LOCATION/TERMINALS		LENGTH	DIAMETER	PRODUCTS TRANSPORTED	REMARKS
From	To				
		Miles	*Inches*		
Rio de Janeiro (state):					
Duque de Caxias refinery	Ilha d' Agua	12	26	Crude	2 identical parallel lines transport crude to refineries in Rio de Janeiro.
Do	Japeri	26	12	Refined	Carries fuel to Japeri for further transport to Volta Redonda and Santa Cruz.
Japeri	Volta Redonda	40	10	*do*	Scheduled for completion in 1972.
Do	Santa Cruz	25	8	*do*	*Do.*
Do	*do*	12	14	*do*	2 identical parallel lines transport refined products to Rio de Janeiro.
Rio de Janeiro	Belo Horizonte refinery	227	18	Crude	Transports crude to refinery near Belo Horizonte. Has 70,000 bbl./day capacity and 2 pump stations. To be increased to 100,000 bbl /day and 3 pump stations.
Rio Grande do Sul (state):					
Tramandai	Porto Alegre	64	18	*do*	Transports crude to refinery at Canoas, via Porto Alegre. Initial capacity 45,000 bbl./day; can be increased to 100,000 bbl./day.
Porto Alegre	Canoas refinery	19	10–12	*do*	

*Estimated.

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PETROBRAS at Sao Sebastiao accommodates 150,000-ton tankers, and expansion is nearing completion to handle 300,000-ton supertankers; the port supplies crude petroleum to three large refineries in the State of Sao Paulo. Paranagua ranks just below Santos in the shipment of coffee and receives large quantities of wheat, petroleum, and cement; a container terminal is under construction. Itajai is a commercial center for industrial interests inland; its principal exports are tobacco, rice, timber, and marble. Florianapolis, headquarters of the Fifth Naval District, is decreasing in importance as a commercial seaport. Tramandai, a new petroleum terminal owned and operated by PETROBRAS is capable of mooring 200,000-ton tankers bringing crude oil to refineries located inland.

Maritime ports are vital to the Brazilian economy because of the marked concentration of agricultural, mining, and industrial activities in or near the coastal areas. Coastwise shipping accounts for a large volume of maritime traffic. Crude petroleum, petroleum products, and wheat composed the bulk of coastwise cargo handled in the period 1962 through 1970. Coastwise traffic, concerned principally with the export of coffee, iron ore, sugar, cacao, and cotton and the import of crude petroleum and petroleum products, machinery, wheat, fertilizers, chemicals, and pharmaceutical products, more than tripled in 1970.

Movement of cargo through Brazilian ports increased about 6% in 1969 and 12% more in 1970. The greatest increases were in the ports of Vitoria, Tubarao, Maceio, Recife, and Paranagua.

A national program of port expansion and modernization, in progress since 1964, calls for constructing new piers and wharves, dredging channels and harbors, acquiring cargo-handling equipment and harbor craft, and constructing warehouse and containerization facilities. Almost all Brazilian ports have benefitted from this program.

Brazil has 10 principal shipyards and numerous boatyards. Six of the principal yards, including the Japanese-Brazilian yard, Ishikawajima (Ishibras), are in the Rio de Janeiro area. Under construction by Ishibras and scheduled for completion in 1973 is a new drydock capable of holding ships up to 400,000 tons. The principal naval base at Rio de Janeiro has extensive shipbuilding and ship-repair facilities. The Dutch-Brazilian yard, *Verolme do Brasil*, which has two shipbuilding docks, is located at the port of Angra dos Reis; in 1971 it delivered a 53,500-d.w.t. bulk-cargo carrier, the largest ship ever built in South America. One of the largest drydocks in Brazil is at the naval base in Aratu.

Brazilian ports are administered by the National Department of Ports and Navigable Routes (DNPVN) under the Ministry of Transportation and Public Works; authority, however, is delegated in various ways. The port of Rio de Janeiro is administered by the federal government through a special port agency; 11 ports, including Recife, Porto Alegre, and Rio Grande, are administered by state concessions; three ports, including Salvador and Santos, are administered by private "dock company" concessions; five ports, including Manaus, are under direct control of the DNPVN; two, Aracaju and Maceio, are under a combination of the DNPVN and the respective state governments; and two, Fortaleza and Belem, are under "mixed economy societies." Special petroleum, iron-ore, coal, and fertilizer terminals are administered by owner companies. A large dredging company (*Companhia Brasileira de Dragagem*) owned and operated by the DNPVN renders service to numerous ports, as required. Administration of the various ports is subject to change as new needs arise.

Ports are being improved in direct ratio to the accelerated industrial and commercial growth of the country and as a result of recent studies showing that some facilities were unable to handle international and domestic trade adequately.

Details of the major ports are given in Figure 9.

H. Merchant marine (C)

Few countries depend so heavily on waterborne shipping, both foreign and domestic, as does Brazil. A long coastline, a concentration of population and economic activity along the seaboard area, and inadequately developed land transport have stimulated development of a necessary, extensive, and increasingly efficient maritime system.

Most coastal shipping is handled by Brazilian-flag ships operating in liner (scheduled) service. In 1960 the cargo in this traffic amounted to 7.86 million metric tons; by 1970 the volume had increased to 14.29 million metric tons. The rise was due to a great increase in coastwise carriage of oil and ore, which more than offset a drop in the volume of general cargo carried. Coastal service continues to be vital to the five northern States of Para, Maranhao, Piaui, Ceara, and Rio Grande do Norte and important to the central region and to Rio Grande do Sul in the south. However, it is doubtful that the former volume of general trade, which had been lost through inefficiency and erratic sailing schedules, can ever be completely regained. The two main streams of coastal

Rio de Janeiro, including naval base at upper right

FIGURE 8. Rio de Janeiro and Santos, major ports (U/OU)

traffic are from the southern states to the central region and from the north and northeast states to the central region.

Brazilian foreign trade, which is preponderantly seaborne, amounted in 1971 to a total value of about US$2.900 billion in exports (principally coffee, cocoa, sugar, iron ore, cotton, and manufactures) and US$3.250 billion in imports (principally petroleum, wheat, machinery, and chemicals). Major trading partners are the United States, West Germany, the United Kingdom, Italy, the Netherlands, Argentina, and Venezuela. In 1970, Brazilian-flag ships carried 10.4%, by volume, of Brazil's exports and 20.6%, by volume, of her imports. Brazilian companies, operating with chartered foreign-flag ships as well as their own vessels, accounted for 21.7% of the volume of Brazilian exports and 56.5% of the volume of her imports. Freight charges on these cargoes returned

Santos

US$254 million to Brazil and surpassed coffee exports and the mining of iron ore as a national source of income, according to an announcement by the Minister of Transportation and Public Works. However, the continuing need to charter foreign tonnage to supplement Brazilian ships in their world-wide service was also cited as contributing as much as 50% to the annual deficit in the "services" sector of the balance of payments. During 1970, the state-owned shipping entity, *Lloyd Brasileiro*, operated in international traffic with 30 of its own ships and 20 chartered foreign-flag vessels. During 1969, 11 Brazilian companies operating in foreign trade chartered 357 foreign-flag ships for that trade, the charter fees amounting to US$118.1 million. Since 1969, the percentage of the total fleet deadweight tonnage involved in foreign trade has increased from about 50% to over 75%.

FIGURE 9. Major ports (C)

NAME; LOCATION; ESTIMATED MILITARY PORT CAPACITY*	ACTIVITIES	HARBOR	BERTHS
Rio de Janeiro..... 22°54′S., 43°14′W. 51,000	Largest and most complex port; cultural, commercial, and industrial center. Cargo handled at record high in 1970. Receipts—grain, coal, crude and refined petroleum products, salt, fruit, manufactured goods. Shipments—iron and manganese ores, other minerals, coffee, cocoa, cotton, canned meats, hides. Principal shipbuilding and ship repair center; 8 graving docks, largest 760 x 131 ft.; 2 shipbuilding docks, largest 1,148 x 213 x 28 ft.; 2 floating drydocks, largest 626 x 85 ft., lifting capacity 11,000 tons; 2 marine railways, largest hauling capacity 55 tons. Principal naval center, Hq. of Brazilian Navy and 1st Naval Dist.; extensive operational, logistical, training facilities with supporting activities, important shipyard.	Natural, well-protected, coastal, in Baia de Guanabara, one of finest natural harbors in world; divided into 3 sections: Niteroi, in E. part, 15 sq. miles; Governador in NW. part, 20 sq. miles; Rio, in SW. part, 15 sq. miles, principal cargo transfer area and site of 2 largest shipyards. General depths about 50 ft.; alongside depths, 23 to 42 ft.; depths leading to berths exceed depths in berths.	Alongside—For 12 large, 19 standard, 15 small ocean-type cargo vessels; 9 standard, 20 small coaster-type cargo vessels; 46 lighters; 1 standard ocean-, 10 standard coaster-type tankers; 2 large ocean-type tankers (offshore pipelines); 3 small aircraft carriers; numerous berths for other types of naval vessels. Fixed mooring—For 5 large ocean-type cargo vessels. Anchorage—Large numbers of all classes.
Santos..... 23°57′S., 46°20′W. 30,000	Principal port of Sao Paulo, most highly industrialized state and rich coffee-growing area; leading coffee export port of world. Movement and handling of cargo continually increasing. Has container-handling area. Construction and improvement of port facilities on left bank of estuary under way. Receipts—grain, chemicals, coal, fertilizers, machinery, crude and refined petroleum products. Shipments—coffee, sugar, bananas, citrus fruits, hides, textiles. Limited hull, boiler, engine repairs; 4 marine railways, largest 412 ft. long, hauling capacity 600 tons. Minor naval communications facility and school.	Natural, coastal, in Santos estuary; area about 2½ sq. miles; general depths 20 to 42 ft., excellent protection; depths leading to berths exceed depths in berths.	Alongside—7 large, 29 standard, 3 small ocean-type cargo vessels; 7 small coaster-type vessels; 6 lighters; 2 large, 4 standard, 1 small ocean-type and 1 standard coaster-type tankers.
Porto Alegre..... 30°04′S., 51°11′W. 31,000	Chief port and principal administrative, commercial, industrial, transportation center of State of Rio Grande do Sul; chief industrial activity processing agricultural products; major center of transshipment in Lagoa dos Patos system, one of Brazil's most important inland waterways and largest in volume of cargo handled. Receipts—wheat, fruits, machinery, timber, sugar, meat, coal, coke, fertilizers, iron and steel, salt, refined petroleum products. Shipments—lumber, wheat, meat and meat products, rice, tobacco, iron and steel products. Minor repairs and small-boat construction; 2 marine railways, largest hauling capacity 600 tons; 3 building ways, largest 490 ft. x 177 ft.	Natural, river harbor on Rio Guaiba; area about 2½ sq. miles; excellent protection; channel has controlling depth of 15½ ft.	Alongside—For about 90 small coaster-type cargo vessels, 44 lighters.

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Recife 8°03′S., 34°54′W. 12,000	Chief port and principal commercial, industrial, transportation center of region; closest deepwater Brazilian port to Africa and Europe, on sealanes connecting main South Atlantic ports of South America with North America, Europe, North Africa. Cargo handled annually increasing; new construction of facilities and purchase of new handling equipment. Receipts—grain, refined petroleum products, cement, hardware, chemical products, coal. Shipments—sugar, cotton, coffee, hides and skins, vegetable oil, alcohol, leather, timber. Minor hull and machinery repairs; 2 marine railways, largest hauling capacity 1,500 tons. Hq. of 3rd Naval Dist., secondary naval base with landing, shipyard, ordnance, supply, communications, training, medical, miscellaneous facilities.	Improved, natural coastal; area about 1 sq. mile; afforded good protection by island, breakwaters, reef; controlling depth 33 ft. (33 ft. MHWN) at entrance.	Alongside—For 5 large, 8 standard, 4 small ocean-type cargo vessels; 2 small coaster-type vessels; 9 lighters (5 standard ocean-type tankers, alternative berths). Fixed mooring—For several standard ocean-type cargo vessels. Anchorage—Large numbers of all classes, 1 to 5 miles SE. of harbor entrance.
Rio Grande 32°02′S., 52°05′W. 9,800	Deepwater terminal for Lagoa dos Patos waterway system; petroleum refining and distributing center for Rio Grande do Sul (state); other industrial activities include meat packing, fish and vegetable canning, brewing, textiles, cigarettes, footwear, animal products, pharmaceuticals. Receipts—crude petroleum, salt, wheat, chemicals, iron and steel products, coal, cement, paper. Shipments—wheat, frozen meats, agricultural products, rice, wool. Minor hull and machinery repairs: 2 marine railways, each has hauling capacity of 1,200 tons.	Improved, natural harbor, well protected, at N. end of channel connecting Atlantic Ocean with Lagoa dos Patos; area 1 sq. mile; 2 parts—Porto Novo, depths 19 to 29 ft., Porto Velho, depths 11 to 18 ft. Dredged channel extends length of Porto Novo, least depth 26 ft.; connecting channel has depth of 33 ft.	Alongside—For 11 standard ocean-type cargo vessels; 1 standard, 9 small coaster-type cargo vessels; 1 lighter; 1 small ocean-type, 1 standard coaster-type tankers. Anchorage—Large numbers of all classes in roadstead outside harbor.
Salvador 12°59′S., 38°31′W. 8,000	Capital and principal commercial center of Bahia (state); port serves primarily as exporting port for agricultural and mining hinterland. Port expansion and development program under way. Receipts—general cargo, coal, grain, refined petroleum products, iron and steel products, machinery, paper products. Shipments—cacao, manganese and iron ores, wax, coffee, sugar, hides, tobacco, grain, hemp. Limited floating and engine repairs to naval and commercial small ships. Hq., 2nd Naval Dist. and secondary naval base; components include ship repair, supply, training, medical, miscellaneous facilities.	Improved natural, coastal harbor; area about 500 acres; 2 breakwaters afford only fair protection; general depths 7 to 34 ft.; depths leading to berths exceed depths in berths.	Alongside—For 3 large, 5 standard ocean-type cargo vessels; 1 small coaster-type cargo vessel; 6 lighters; 1 standard ocean-type tanker. Anchorage—Large numbers of all classes outside breakwaters in Baia de Todos os Santos.

*The estimated military port capacity is the maximum amount of general cargo—expressed in long tons—that can be unloaded onto the wharves and cleared from the wharf aprons during a period of one 24-hour-day (20 effective cargo-working hours). The estimate is based on the static cargo-transfer facilities of the port existing at the time the estimate is prepared and is designed for comparison rather than for operational purposes; it cannot be projected beyond a single day by straight multiplication.

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In July 1972, the Brazilian merchant fleet consisted of 213 ships of 1,000 gross register tons (g.r.t.) and over, totaling 1,609,602 g.r.t. or 2,363,393 deadweight tons (d.w.t.), as follows:

Type	No.	G.R.T.	D.W.T.
Dry cargo	133	694,292	929,088
Tanker	42	542,177	881,696
Naval tanker*	3	8,867	13,855
Bulk cargo	18	183,273	285,916
Combination tanker/ore carrier	2	121,220	210,839
Refrigerator	6	21,288	21,985
Liquefied-gas carrier	5	15,277	11,444
Passenger	2	20,894	6,970
Combination passenger/cargo	2	2,314	1,600
	213	1,609,602	2,363,393

*Known to be used commercially.

Among the merchant fleets of South America, the Brazilian fleet is both the largest and the most modern. The largest ship in the fleet is a 116,195-d.w.t. tanker (Figure 10). Additional characteristics are given in the following tabulation:

	Percent of D.W.T.
Age (*years*):	
Under 10	65
10 to 19	23
20 and over	12
	No. of ships
Size (*d.w.t.*):	
Under 10,000	133
10,000-19,999	63
20,000-99,999	13
Over 100,000	4
Service speed (*knots*):	
18 and over	30
14.1 to 17.9	63
Under 14	120
Power/fuel:	
Diesel	168
Steam/oil	44
Steam/coal	1

Fleet ownership is divided among 44 government and private beneficial owners (entities assuming profit or loss from operations). The largest of these is the Government of Brazil, which owns and operates 91 ships under five semiautonomous entities known as *autarquias*. Aside from the government, only eight owners have more than four ships. These owners and the government operate 92% of the total fleet deadweight tonnage, and the remaining 8% is distributed among 35 owners. Four private owners and two government *autarquias* each operate more than 100,000 d.w.t. of shipping. The largest of these, PETROBRAS, provides 96% of the fleet's total tanker deadweight tonnage through its operating arm, *Frota Nacional de Petroleiros*—FRONAPE which owns and operates 858,258 d.w.t. Two small Brazilian-flag tankers, each under 1,500 d.w.t. are foreign owned, one by the Shell-Royal Dutch Group of London and the other by Standard Oil of New Jersey. Two ships are registered under the Liberian flag.

In January 1971, in addition to merchant ships of 1,000 g.r.t. and over, there were about 90 merchant ships between 100 g.r.t. and 999 g.r.t., totaling 36,000 g.r.t. Of these, about 80 are dry-cargo ships, most operating in the coastal and river trade. In 1971, Brazil's fishing fleet consisted of more than 300 vessels, including about 25 oceangoing ships between 100 and 400 g.r.t. and totaling about 5,000 g.r.t.

The Brazilian merchant marine program has long supported the modernization and expansion of a chronically aged and inefficient merchant fleet. This program, pursued sporadically since long before World War II, was stepped up at the war's end with the acquisition by the government of 20 oceangoing freighters and 12 C1-M-AV1 type U.S.-built coastal freighters. It was further implemented in 1956 with the addition of 12 more of the same type coastal vessels. In the intervening period, PETROBRAS and FRONAPE began operations with a fleet of about 20 tankers and four river vessels. However, the combined efforts of government and private capital were not sufficient to sustain the growth of the fleet through new acquisition or to renovate the many older units then in operation. In response to a critical need for financing, and in order to diminish the outward flow of foreign exchange due to Brazilian cargo being carried in foreign ships, a fund and tax plan was promulgated in 1958.

The fund for merchant fleet renovation and expansion was tied closely to a strong plan for improving the domestic shipbuilding and repair industry. Government loans administered through the Merchant Marine Commission (CMM) from the Merchant Marine Fund (FMM) and for up to 85% of a ship's price are made available to offset the difference in construction cost between Brazilian and foreign yards. The FMM has been made partially self-sustaining by imposition of the Renovation Tax for the Merchant Marine, also promulgated in 1958 as a part of the FMM. This tax consists of a charge of 20% against cargo owners on freight receipts generated both in international and coastwise trade. Money from the tax is deposited with the National Bank of Brazil and is earmarked for purchasing, building, and modernizing ships.

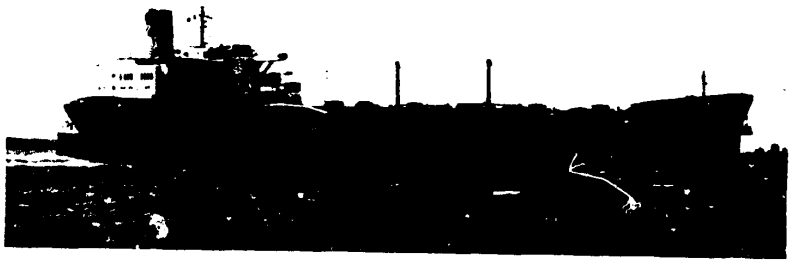


FIGURE 10. The *Horta Barbosa* (62,619 g.r.t., 114,800 d.w.t.), shown here, and the *Hamilton Lopes* (62,619 g.r.t., 116,195 d.w.t.), government-owned tankers, are the largest ships in the Brazilian merchant fleet. Both ships were acquired in 1969. (U/OU)

At the outset of the program, before it could get underway domestically, orders were placed abroad for new ship construction and used tonnage was acquired to replace the oldest vessels. The bulk of these orders were planned to extend from 1958 through about 1961, when the domestic shipbuilding industry was scheduled to begin phasing into large-scale production for the Brazilian merchant fleet. Tankers were purchased mainly from Dutch, Japanese, and Danish yards, and most new freighters came from Polish and Finnish yards. New tonnage in dry-cargo and combination passenger/cargo ships was virtually offset by scrapping old tonnage, but tanker tonnage increased by 30%.

Between 1960 and 1968 the government program resulted in the construction for Brazilian owners of 61 ships of 527,000 d.w.t. in Brazilian shipyards. The program was reaffirmed and accelerated in 1967-68, and by September 1969 an additional 65 ships of 1,275,000 d.w.t. were on order from Brazilian yards for Brazilian owners. By January 1972, 90 Brazilian-built ships aggregating 782,787 d.w.t. and representing 35% of the total fleet deadweight tonnage were in service under the Brazilian flag. Domestic construction has produced 61% of the dry cargo deadweight tonnage.

As of 30 April 1972, 68 ships aggregating 2,626,890 d.w.t. were on order for the domestic fleet. This included 40 dry cargo, 11 tankers, eight bulk carriers, and nine combination tanker/ore carriers. The largest ships on order were five 131,000-d.w.t. and one 265,300-d.w.t. combination tanker/ore carriers.

There is no inclusive body of law encompassing the maritime sector in Brazil. Authority is based on executive decree and regulation except when based on, or flowing directly from, specific articles of the constitution. In general, the government's policy has been to encourage the growth of the merchant fleet so as to enable it to carry at least half of Brazil's foreign trade and all of the coastwise trade.

The specific goal of government policy is the reservation of the majority of trade between Brazil and each of her trading partners individually to the ships of the countries involved through bilateral negotiation and agreement. Under such agreements, 40% of the trade would be carried by Brazilian ships and 40% by those of the trading partner. The remaining 20% would be available to third country ships. The amount of Brazilian trade carried by Brazilian ships has steadily increased as a result of this policy and of the government's direct supervision of shipping conference arrangements. The increased proportion of domestic cargos carried also is a result of the use of more modern ships in the Brazilian fleet and the allocation of overseas lines to Brazilian companies previously restricted to coastal operations, diverting Brazilian tonnage to that trade. Some shipping lines of countries not party to the bilateral arrangements, especially those of Scandinavian flags, have withdrawn their ships from the Brazil-North American trade due to the steadily decreasing amount of that trade carried by them.

Government policy with regard to cabotage, or coastal trade, restricts such operations to the nation's own ships or to those chartered by Brazilian companies when Brazilian ships are not available. A principal policy objective has been to reestablish confidence in this means of transport, which has long suffered from lack of dependable service. Lines serving the coastal trade are now required to maintain regular schedules of service. All ships in this trade, including foreign

charters, are under explicit governmental regulation and regardless of flag are controlled as if they were Brazilian owned.

In chartering foreign-flag ships for both coastwise and high-seas services, Brazilian lines utilize ships only with the case-by-case approval of the government and may only charter deadweight tonnage up to the level of new tonnage on order for their own account. Chartered tonnage, as well as Brazilian-flag tonnage, is taxed at the rate of 20% of the freight payment, the money going to the fund for merchant marine renovation. This money is returned to the owners in proportion to tonnage under construction to their order.

The government extends direct aid to Brazilian shipping in several forms. Operating deficits of government-owned ships are absorbed, both for cabotage and international operations. New-construction loans are made for up to 85% of construction cost and are to be repaid out of revenue at 6% interest over 15 years. Indirect aid to the merchant marine is extended through selectively granting duty-free imports, giving preferential treatment in carrying certain exports and imports, and by participating in the ownership and operation of merchant ships.

Brazil is party to the following international conventions or acts: The Inter-Governmental Maritime Consultative Organization (IMCO); International Convention for the Safety of Life at Sea, 1960; International Regulations for the Prevention of Collisions at Sea, 1960; and International Convention on Load Lines, 1966. Maritime Affairs are administered by the National Merchant Marine Superintendency (SUNAMAM) under the Ministry of Transportation and Public Works, which in 1969 succeeded the Merchant Marine Commission. SUNAMAM consists of five departments (Engineering, Finance and Control, Plans and Studies, Navigation, and Administration). It has regional agencies within Brazil and in Hamburg and New York.

SUNAMAM executes national maritime policy and participates in its formulation; regulates Brazil's overseas and domestic maritime trade; assigns routes to Brazilian companies; administers public resources as applied to merchant fleet renovation and subsidies; fixes certain tariff limits; negotiates working conditions and wages of stevadores and other port workers; participates in international conventions and effects their implementation by Brazil; authorizes the charter of foreign ships by Brazilian companies; regulates the administration of national shipbuilding programs and the allocation of contracts for new construction; and authorizes expenditures on the merchant fleet outside Brazil.

All water transportation undertaken for Brazilian account or under the Brazilian flag, whether by governmental agencies or by private concerns, is regulated by the decrees of SUNAMAM. The Superintendent of the Merchant Marine is appointed directly by the President of the Republic.

On 1 January 1971, 6,367 seafaring personnel were employed on Brazilian merchant ships of 1,000 g.r.t. and over, 7% less than those employed afloat at the beginning of 1970. The decrease reflects both a desire to reduce manning levels and the greater use of automation in the more modern fleet. No official government steps have been taken toward preserving jobs threatened by automation.

Maritime labor, both afloat and ashore, is unionized under the National Confederation of Maritime, River, and Air Transport Workers. Much of this union's militant and politically active leadership was removed after the 1964 Revolution. The union is now rigidly controlled by and subject to the political vigilance of Brazilian naval authorities. Strikes are outlawed by the government.

Merchant marine training is accomplished through the Merchant Marine Academy at Rio de Janeiro, which is under the administration of the Brazilian Navy. The academy accommodates about 600 students and provides undergraduate and postgraduate instruction in deck, engineering, and steward departments. All graduates of the Academy are commissioned in the Naval Reserve.

I. Civil air (C)

Civil aviation has a vital role to play in the present and future development of the Brazilian economy. International air services greatly strengthen the nation's ties with many of the major centers of the Western world. In addition, domestic air services are especially important in the undeveloped northern and central areas of the country where many settlements are separated by hundreds of miles and where surface transportation is inadequate or completely lacking. However, in spite of its importance, domestic air traffic has not increased as expected. A fleet modernization plan has helped, but additional planning and development are needed to provide a strong and reliable domestic air network. A major problem which must be solved is that of too many airlines serving the same points.

Sixteen foreign airlines serve Brazil; these together with the Brazilian airlines provide regularly scheduled services between Brazil and 39 cities in 31 countries. Brazil's *Empresa de Viacao Aereo Rio-Grandense, S.A.*—VARIG and *Aerolineas Argentinas* of Argentina are the only Latin American airlines providing a direct link between southern Africa and South America.

Brazil, which has over 3,700 registered aircraft, has one of the largest civil airfleets in the world. However, in the last few years the number of major (20,000 pounds gross weight or over) civil-transport aircraft has declined because of permanent grounding, storage, or sale of obsolescent aircraft and bankruptcy encountered by some small companies. The following 110 civil aircraft of at least 20,000 pounds gross weight are registered and operating in Brazil:

4 Aerospatiale Caravelle 6R	15 Douglas DC-3
2 BAC 111-400	4 Douglas DC-6C
4 BAC 111-500	1 Douglas DC-8
4 BAC Viscount 827	2 Fairchild C-82A
11 Boeing 707-320C	4 Fairchild-Hiller FH-227B
2 Boeing 707-420	6 Handley Page Herald
8 Boeing 727-100	10 Hawker Siddeley HS-748
3 Boeing 727-200	10 Lockheed L-188 Electra
6 Boeing 737-200	14 NAMC YS-11A

An estimated 36,000 persons are engaged in civil aviation activities, including about 3,250 commercial pilots and 16,700 private pilots. About 900 pilots are rated in heavy multiengine aircraft. Skilled maintenance personnel number about 6,500.

Three of the four major scheduled airlines in Brazil are privately owned. In addition there are about 70 air taxi and charter operators. VARIG, Brazil's chosen instrument for long-distance international flights and the largest airline company in Latin America, serves 59 domestic points and links Brazil with 22 cities in 20 countries. VARIG's routes extend two-thirds of the way around the world; a gap between Rome and Tokyo prevents VARIG from becoming a round-the-world airline. The company employs nearly 11,000 persons, including about 2,200 skilled maintenance personnel and 500 pilots. VARIG is a private enterprise, 70% owned by its employees. Its fleet consists of nine Boeing 707-320C's, two Boeing 707-420's, four Boeing 727-100's, one Douglas DC-8, 10 Hawker Siddeley HS-748's, and 10 Lockheed L-188 Electras.

Brazil's second major carrier, *Servicos Aereos Cruzeiro do Sul S.A.*—CRUZEIRO, serves 35 domestic points and six regional cities. About 85% of the company's stock is held by its employees. CRUZEIRO employs about 4,400 persons, including 185 pilots and 1,800 skilled maintenance personnel. Its fleet consists of four Aerospatial Caravelle 6R's, four Boeing 727-100's, eight Douglas DC-3's, two Fairchild C-82's, and eight NAMC YS-11A's.

SADIA S.A. Transportes Aereos—TRANSBRAZIL S.A. Linhas Aereas, a subsidiary of the privately owned Sadia Corporation, serves 19 domestic points and employs about 1,000 persons, including at least 35 pilots. Its fleet consists of four BAC 111-500's and six Handley Page Hearlds.

Viacao Aerea Sao Paulo, S.A.—VASP is the only major Brazilian air carrier that is not privately owned; over 90% of the company is owned by the State of Sao Paulo. VASP employs about 4,200 persons, including 170 pilots and 2,000 skilled maintenance personnel, and has an operating fleet consisting of two BAC 111-400's, four BAC Viscount 827's, six Boeing 737-200's, seven Douglas DC-3's, four Douglas DC-6's, six YAMC YS-11A's, and three Boeing 727-200's.

VARIG, CRUZEIRO, and VASP have joined a pool to provide high-frequency scheduled services via the *Ponte Aerea* (Air Bridge) between Rio de Janeiro and Belo Horizonte, Rio de Janeiro and Sao Paulo, and Rio de Janeiro and Brasilia.

Brazil's largest air-taxi operator is *Lider S.A. Transportes Aereos*—Lider Taxi Aero, which operates one Lear Jet 24, eight Aero Commanders, three Beech Barons, and three Cessna Skylanes. It employs 130 persons, including 40 pilots. From headquarters at Belo Horizonte, Lider provides services over an extensive network throughout Minas Gerais, as well as to Rio de Janeiro, Sao Paulo, and Brasilia. The balance of air-taxi and charter services fly light single- and twin-engine aircraft from Brazil's major cities to outlying areas.

In addition to the services operated by the scheduled airlines and charter carriers, the *Correio Aereo Nacional*, the airmail and general carrier division for the Brazilian Air Force, transports mail throughout the interior, linking about 100 small communities and villages where regularly scheduled private air transport is unavailable. Passenger and cargo are carried on a space-available basis.

The Directorate of Civil Aviation, under the jurisdiction of the Ministry of Aeronautics, is responsible for the control and coordination of all civil aviation activities. The Ministry of Aeronautics is concerned with all aspects of civil and military aviation and subjects civil air operations to strong military influence. Also attached to the ministry is the Committee for Studies Concerning International Air Navigation, an intergovernmental agency dealing with international aviation policy matters. The Study Committee for Airline Authorizations advises the

Director General of Civil Aviation on problems relating to the regulation of aspects of the domestic activities of national operators and the concession of new domestic airline services.

A variety of training activities is conduct ' in Brazil. The major facility for aeronautical sciences, technology, and research is the Aerospace Technical Center, which provides work in airframe and airport design and training in airline management and operations. An advanced flying school and training center at Porto Alegre is maintained by VARIG and provides flying and maintenance courses for VARIG personnel. An additional VARIG training facility at Santos Dumont airport in Rio de Janeiro houses simulators for training flight crews in its Boeing 707, Hawker Siddeley 748, and Lockheed Electra aircraft. CRUZEIRO operates a training school subsidized by the government. A number of Brazilian personnel have been trained overseas; VASP pilots, for example, have been trained in the BAC 111 aircraft by personnel of Allegheny Airlines.

Most of the civil aircraft are overhauled in Brazil. SADIA and VASP have maintenance bases at Sao Paulo; VARIG's is at Porto Alegre, and CRUZEIRO's is at Rio de Janeiro. VARIG is capable of overhauling most of its aircraft. The British-owned Rolls Royce maintenance facilities in Sao Paulo overhaul and repair engines for VASP and SADIA and for several foreign airlines. *Companhia Electromecanica*—CELMA overhauls piston and jet engines for the Brazilian Air Force, Brazilian commercial lines, and several foreign companies. The company is government controlled and is reportedly one of the most efficient in Latin America. Among the foreign overhaul facilities used by Brazilian airlines are the Frankfurt, West Germany, shops of Lufthansa, which provides VARIG with modifitations on its Boeing 707's.

The Brazilian Government actively encourages development of civil aviation. Subsidies are granted to all the major air carriers and to at least 14 charter companies and air taxis operating in the interior. Subsidies are available for international routes, for interior "social-service" routes, for equipment, and for defraying increased operating costs not covered by charges or other government aid. Private flying is encouraged through an extensive system of government-subsidized-and-regulated aeroclubs. This support is considered essential for development of air transport as well as a means of establishing a semitrained reserve for the Air Force.

Brazil is a member of the International Civil Aviation Organization (ICAO) and is represented on the ICAO council. VARIG and CRUZEIRO are full members of the International Air Transport Association (IATA) and VASP is an associate member. Brazil has international agreements or arrangements covering the exchange of air service with at least 31 countries.

J. Airfields[2] (C)

The air facilities system of Brazil consists of 2,411 airfields, 375 sites, and 18 seaplane stations. Of these, 40 civil, 16 joint military/civil, and 14 military are significant. Most of the airfields are located within a 300-mile wide band along the east coast. In the interior the greatest concentration of fields is found in the States of Minas Gerais and Sao Paulo in the southeast and in the southern region near the Uruguay border. The Amazon Basin has relatively few airfields, but the number is considered sufficient for this underdeveloped area. Inaccessible terrain dictates that many fields be located along waterways. Continued expansion of the economy and development of the interior will require more and longer paved runways and at least minimum support facilities.

Galeao Airfield at Rio de Janeiro and Vira Copes at Campinas have concrete runways of 10,000 feet which can support sustained heavy bomber operations. Galeao is Brazil's most important airfield. Navigational and communications aids include instrument landing system (ILS), area surveillance radar (ASR), VHF omnidirectional range (VOR), and approach control towers. There are complete refueling, meteorology, repair, and cargo handling facilities. Vira Copos has VOR, nondirectional radio beacon (NDB), approach control tower, and complete field facilities. Augusto Severo, Brasilia, Campo Grande, Guararapes, Pinto Martins, and Val de Caes have paved runways of 7,000 to 9,000 feet and facilities to support jet fighter and medium to heavy bomber operations. Campo dos Afonsos, Congonhas, Cumbica, Gravatai, Ponta Pelada, Salgado Filho, and Santa Cruz could support continuous operation of USAF fighter aircraft in the 30,000- to 50,000-pound class and medium transports.

The 116 airfields having hard-surface runways are in fair to good condition. Weight bearing capacity, in general, is consistent with length of runway and significance of field. Some shorter runways are rated as strong as others of greater length. For example,

[2]For detailed information on individual air facilities in Brazil, consult Volume 4, *Airfields and Seaplane Stations of the World*, published by the Defense Mapping Agency, Aerospace Center, for the Defense Intelligence Agency.

Congonhas, which has 5,700 feet of concrete, is rated at 660,000 pounds for aircraft with twin dual-tandem landing gear, as is Galeao, which has 10,827 feet. The more important fields have adequate to good taxiway and apron systems consistent with existing traffic and aircraft types. Smaller fields having paved runways have few or no taxiways and one or two small gravel or asphalt aprons. Cargo-handling equipment varies from crude to sophisticated according to need. Airline operations number from one or two flights per week from fields in outlying areas to 1,700 scheduled international and domestic departures from the Galeao/Santos Dumont complex at Rio de Janeiro.

The 2,295 temporary- and natural-surface runways are suitable for light-transport and liaison aircraft. Surfaces are gravel, clay and sand, graded earth, and grass, condition varying from poor to good depending on location, weather, and maintenance. Many fields lie along river lowlands and are not usable during the rainy season. Airstrips are built for the express purpose of road construction and continue to be used as towns are built along the roads. Practically all *fazendas* (ranches) have their private strips.

The larger seaplane stations are located near cities along the north and east coasts; operations consist of patrol and rescue work. Support facilities are adequate to good. Operating areas are just inside the mouths of large rivers or bays for sheltered anchorage. Inland seaplane stations with few facilities other than fuel and anchorage are located along the Amazon River and its major tributaries.

The 375 sites are former usable airfields; most have returned to natural state and have little or no potential without clearing and grading.

Maintenance is fair to good for major fields supporting military, international, and domestic air traffic. Marginal runway, taxiway, and apron weight capacity for the volume and type of traffic on many fields keep them in constant need of repair. Minor fields of temporary or natural surface receive little or no maintenance. Support and service facilities are available according to field significance. Only a few major fields have hydrant refueling, most using trucks and hose carts.

Expansion and improvement are concentrated primarily on existing fields serving major population centers and are the direct results of increased heavy-jet traffic. Improvement includes cargo- and passenger-handling facilities, installation of hydrant refueling, and addition of new runways and taxiways. Control and navigation aids are being upgraded, but nondirectional radio beacons remain the primary facility. Extensive installation of VOR, ILS, and ASR is planned. Thus far only Galeao, Salgado Filho, and Brasilia have ILS. The Rio de Janeiro and Sao Paulo areas have surveillance radar. Santa Cruz military is the only field having precision approach radar. An air force base to support Mirage fighters is under construction at Anapolis. Both military and joint military/civil fields have potential for expansion and support of sustained operations; however, irregular allocation of funds will probably continue to hamper progress.

Characteristics of selected airfields are listed in Figure 11.

K. Telecommunications (C)

The telecommunication (telecom) system compares favorably with other systems in South America but is below the standards of the United States and Western European countries. Despite extensive recent construction, most telecom facilities still are concentrated in the southern third of the country and in a relatively narrow strip of land bordering the Atlantic Ocean. Immense sections of the interior are served only by scattered radiocommunication stations and a tenuous tropospheric-scatter system. Rio de Janeiro is the dominant center of telecom services, especially in the field of international operations. The important cities of Sao Paulo, Recife, Salvador, Porto Alegre, Belo Horizonte, and Brasilia continue to develop as regional centers. The trunk radio-relay system is replacing the open-wire telephone and telegraph networks as the primary traffic-carrying medium. Although nearly all modern telecom media are found in Brazil, they are not yet sufficiently developed to fulfill normal requirements of the government, the military services, and the public. The rapidly expanding population and related economic growth place constant pressures on an already overtaxed system.

Telecom facilities are owned and operated by the government and a number of private companies. Supreme authority for the administration of all telecommunications is vested in the Ministry of Communications. Two autonomous bodies, the Brazilian Telecommunications Enterprise (EMBRATEL) and the Brazilian Post and Telegraphs Enterprise (ECT), operate all interstate and international facilities. In addition, there are nearly 900 small telephone companies operating under state, municipal, or private ownership. Most broadcast facilities are privately owned. Both the National Telecommunications Department (DENTEL) and the National

FIGURE 11. Selected airfields (C)

NAME AND LOCATION	LONGEST RUNWAY: SURFACE; DIMENSIONS; ELEVATION ABOVE SEA LEVEL	ESWL*	LARGEST AIRCRAFT NORMALLY SUPPORTED	REMARKS
	Feet	*Pounds*		
Augusto Severo 5°55′S., 35°15′W.	Asphalt 7,441 x 200 161	56,607	C–135	Joint. Alternate for Boeing 707.
Brasilia 15°52′S., 47°55′W	Asphalt 9,789 x 150 3,478	56,607	C–135	Joint. International airport. Civil airport, air force base.
Campo Fontenelle (Pirassununga) 21°59′S., 47°20′W.	Asphalt 6,560 x 150 1,962	31,000	C–118	Military. Training school for cadet pilots.
Campo Grande AB 20°28′S., 54°40′W.	Concrete 7,438 x 141 1,834	56,607	C–135	Military. International airport. Brazilian Air Force and national airlines use field.
Cumbica 23°23′S., 46°29′W.	Concrete 6,444 x 148 2,503	56,607	C–135	Military. 4th Air Zone Headquarters.
Dois de Julho 12°55′S., 38°20′W.	Asphalt 7,621 x 150 43	48,184	C–121	Joint. One of more important fields along coast. Good refueling base. Quick turnaround. Capable of heavy-jet support.
Galeao 22°49′S., 43°15′W. N. of Rio de Janeiro	Concrete 10,827 x 150 16	56,607	C–135	Joint. International airport. Used by USAF regularly. Complete facilities.
Gravatai 29°57′S., 51°08′W.	Concrete 6,562 x 170 26	59,893	C–118	Joint. One of the better jet bases with modern buildings and facilities. Used by Brazilian Air Force.
Guararapes 8°08′S., 34°55′W.	Concrete 8,205 x 161 36	56,607	C–135	Joint. International airport. Capable of sustained 707 traffic.
Pampulha 19°51′S., 43°57′W.	Concrete 8,326 x 154 2,589	48,184	C–121	Joint. One of Brazil's better fields. Brazilian Air Force personnel school located here.
Pinto Martins 3°47′S., 38°32′W.	Asphalt 8,366 x 164 82	56,607	C–135	Joint. Sustained jet operation capability.
Ponta Pelada 3°08′S., 59°59′W.	Asphalt 6,562 x 147 276	48,184	Constellation	Civil. International airport. Primary field in Amazon Basin.
Salgado Filho 30°00′S., 51°10′W. N. of Porto Alegre	Concrete 7,474 x 138 13	56,607	Boeing 707	Civil. International airport. Main base for VARIG, principal airline of Brazil. Alternate for military traffic for Gravatai.
Santa Cruz 22°56′S., 43°43′W.	Concrete 6,360 x 160 10	56,607	C–135	Military. First Fighter Group stationed here.
Tiririca 2°35′S., 44°14′W.	Asphalt 7,710 x 148 177	48,184	C–121	Joint. Limited medium jet transport capability.
Val de Caes 1°23′S., 48°33′W.	Asphalt 8,285 x 147 52	56,607	C–135	Joint. International airport. Sustained jet operation capability.
Vira Copos 23°00′S., 47°18′W. S W. of Campinas	Concrete 10,630 x 148 2,126	56,607	Boeing 707	Civil. International airport. Brazil's second largest field. Complete facilities.

*Equivalent Single-Wheel Loading: Capacity of an airfield runway to sustain the weight of any multiple-wheel landing-gear aircraft in terms of the single-wheel equivalent.

Telecommunications Council (CONTEL) function as advisory and policy making bodies.

The backbone of the domestic telecom system is a far-reaching network of interconnected high-capacity radio-relay systems and low-capacity tropospheric-scatter links. From dual centers in Rio de Janeiro and Sao Paulo, trunk radio-relay routes extend southwest to Curitiba and Porto Alegre, west to Campo Grande, north to Brasilia and Belem, and northeastward to Belo Horizonte and Salvador, and then along the coastline to Recife and Fortaleza. Most of these routes are operating in the 4 and 6 gigahertz (GHz) range and have ultimate capacities of 960 telephone channels and one TV channel, but current capacities are probably only a fourth of this total. Complementing the trunk routes are extensive very-high-frequency (VHF) and ultra-high-frequency (UHF) radio-relay networks in operation in most Brazilian states and having tie-ins to the national routes in the state capitals. The tropospheric-scatter network provides capacities of 60 and 120 channels and ties together widely scattered localities in northwestern Brazil from Manaus south to Campo Grande. An extensive open-wire telephone network, which is carrier equipped along many important routes, is supplemented by a parallel telegraph wireline network. The old domestic radiocommunications network has been largely relegated to an emergency role. Most urban telephone systems are automatic, and increasing numbers of circuits between medium and large cities are being connected to transit switching centers to facilitate expansion of direct-distance dial operations. The number of telephones has nearly doubled since 1965 to an estimated total of 2,300,000 sets. Domestic telegraph services in the larger cities are fully automated. The telex (teleprinter-subscriber) network has about 3,500 subscribers, and there are plans to extend this service fourfold by 1976.

A wide variety of modern and increasingly automated services is available for international communications. The Intelsat satellite ground station at Tangua, 50 miles east of Rio de Janeiro, has replaced high-frequency (HF) radiocommunications as the primary means of contact with other countries. The ground station has 106 channels in operation and has direct connections to 12 similar ground stations in the Americas and Europe. Modern HF radiocommunications originate from three sites in the Rio de Janeiro area. Most of the traffic from these stations, and from smaller installations in Manaus and Porto Alegre, is destined for Latin American countries and the United States. Wirelines provide important links with neighboring Bolivia and Paraguay. Work on Brazil's first coaxial submarine cable is now underway; known as BRACAN-1, this cable is to carry 160 telephone channels between Recife and the Canary Islands where it will interconnect with the worldwide telephone cable system.

The general inadequacy of the public system in the past led to development of many special networks by military, industrial, and governmental organizations. The military forces operate extensive and physically separate networks. Federal and state police communication systems are constantly being expanded and modernized. Other important private systems are operated by railroad, airline, electric power, and mining companies.

Radio and TV broadcast facilities are highly developed. AM coverage is good throughout the eastern half of Brazil, but FM broadcasts are limited to larger urban centers. In mid-1973 about 900 AM and 150 FM stations were in operation. The majority of the radiobroadcast transmitters are low powered and provide programs intended for local audiences; the more powerful and influential stations are making increased use of networks to expand coverage. Extensive radio-relay routes, using circuits in newly constructed domestic systems, provide nationwide transmission of TV programs. There are 56 TV stations originating programs and about 100 additional low-powered repeater stations. Color TV broadcasts, using the phase alternating line (PAL) system, were begun in March 1972. As of mid-1973 the number of radiobroadcast receivers was estimated at 12 million sets; the number of TV receivers, at 7 million.

The Brazilian telecom equipment industry produces all but the most sophisticated types of apparatus in quantities sufficient to meet the nation's requirements. Complete items still imported consist mainly of microwave UHF and VHF equipment, forward-scatter UHF equipment, and television transmission apparatus. However, substantial quantities of components for both wire-line and radio equipment made in Brazil continue to be imported. The principal source for wire-line components and equipment is Sweden; West Germany is a distant second. Radio equipment and components are supplied, in order of importance, by the United States, Japan, West Germany, the United Kingdom, and Italy.

Because of limited training facilities, there is a shortage of skilled labor to install and operate the many new telecom systems being constructed. EMBRATEL conducts a 5-month telecom course, and

a new training center was recently opened by the Brazilian Telephone Company. Many of the personnel must acquire their knowledge and skills from on-the-job training.

Among the most important long-range plans to improve the telecom system are: 1) implementing a domestic communications satellite network in 1973-75; 2) constructing a second antenna at the Tangua ground station for international service; 3) introducing several more high-powered AM broadcast transmitters at the *Radio Nacional* station in Brazilia; and 4) constructing high-capacity radio-relay routes into neighboring countries as part of the Inter-American Telecommunications Network.

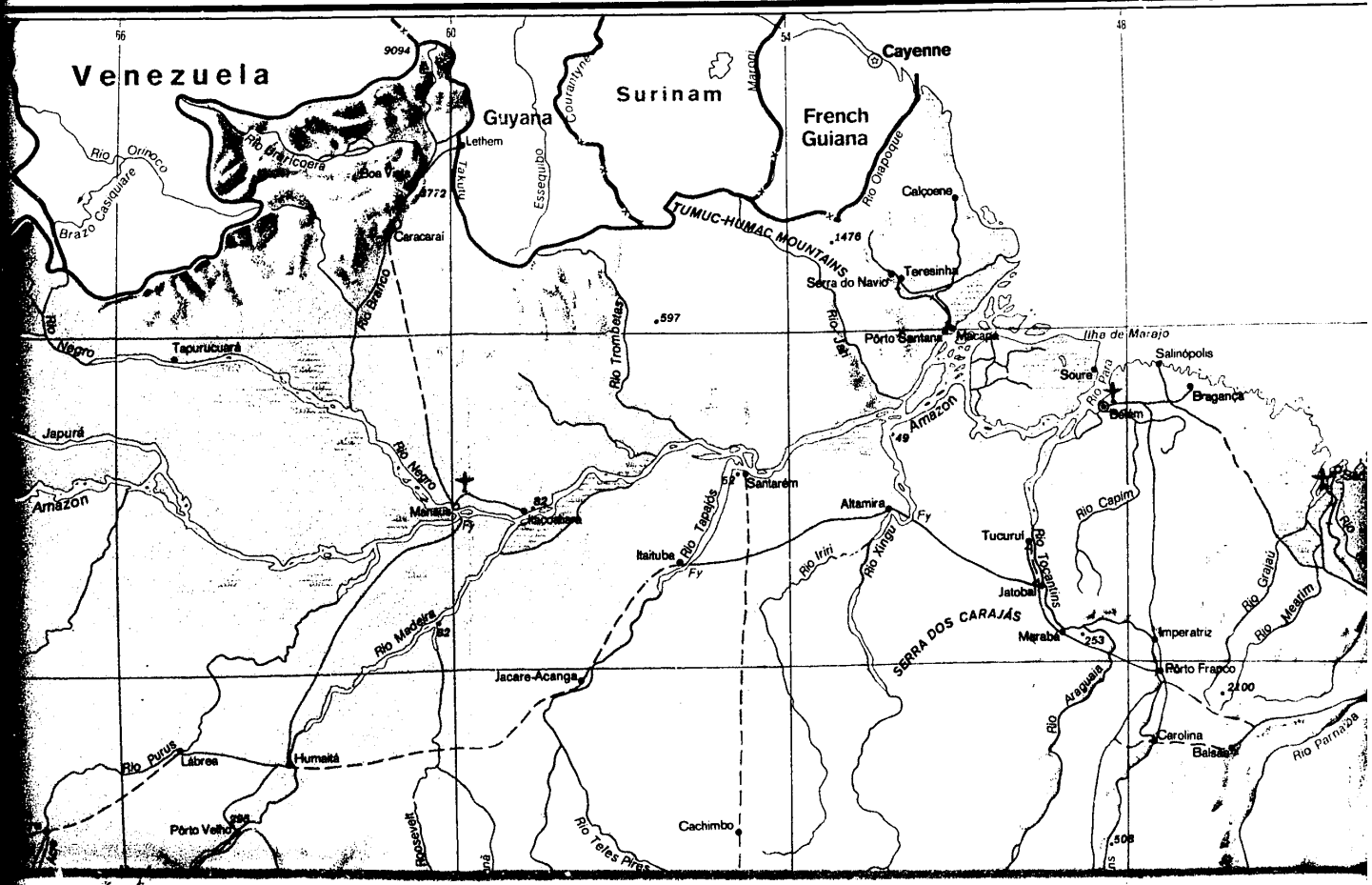
Glossary (u/ou)

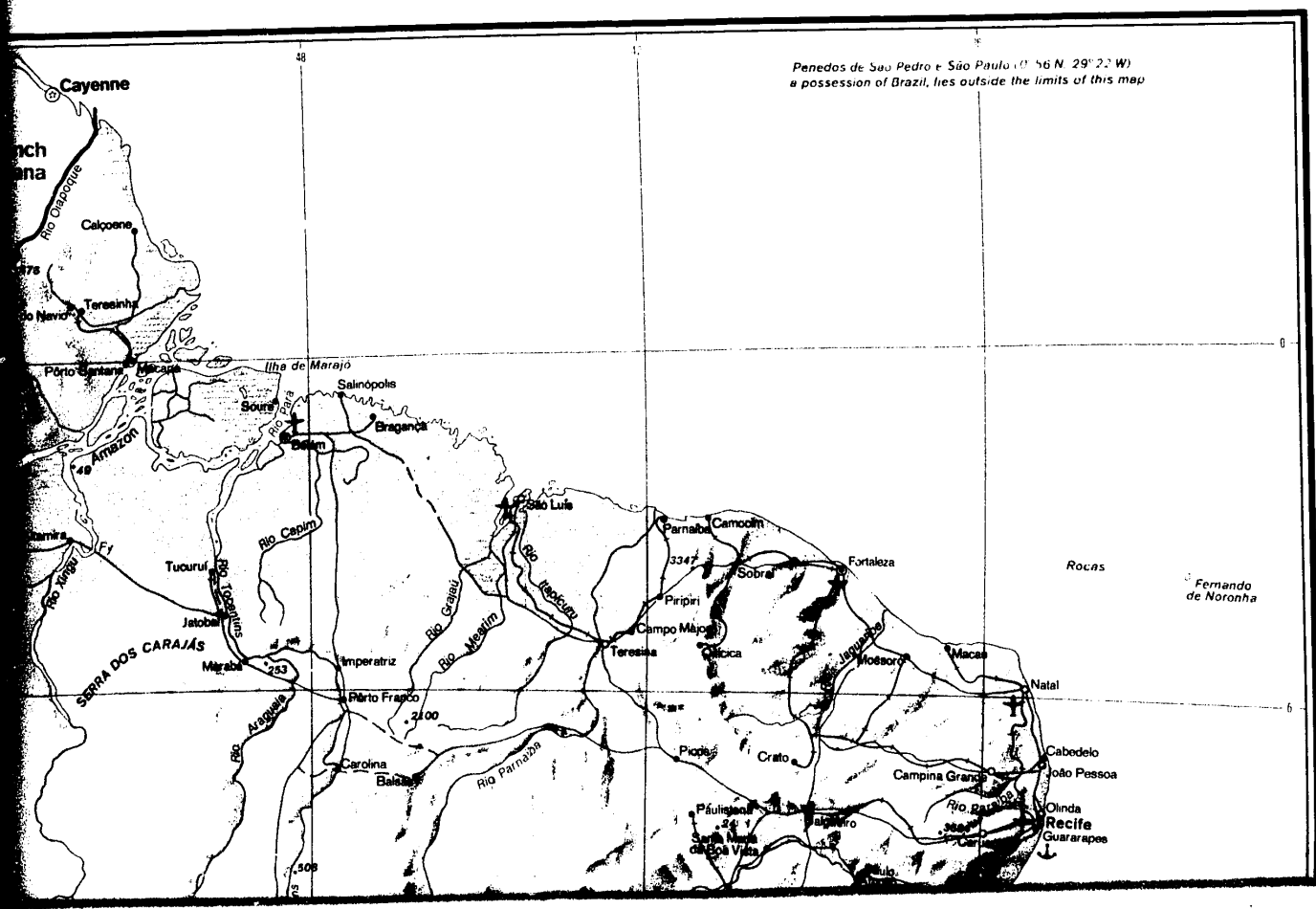
ABBREVIATION	PORTUGUESE	ENGLISH
CELMA	*Companhia Electro mecanica*	
CMEF	*Companhia Mogiana de Estradas de Ferro*	Mogiana Railroad Company
CMM		Merchant Marine Commission
CONTEL		National Telecommunications Council
CPEF	*Companhia Paulista de Estradas de Ferro*	Paulista Railroad Company
CRUZEIRO	*Servicos Aereos Cruzeiro do Sul S.A*	
DENTEL		National Telecommunications Department
DER	*Departamento de Estradas de Rodagem*	State Highway Department
DNEF	*Departamento Nacional de Estradas de Ferro*	National Railroad Department
DNER	*Departamento Nacional de Estradas de Rodagem*	National Highway Department
DNPVN	*Departamento Nacional de Portos e Vias Navegaveis*	National Department of Ports and Navigable Routes
ECT		Brazilian Post and Telegraphs Enterprise
EFA	*Estrada de Ferro Araraquara*	Araraquara Railroad
EFAP	*Estrada de Ferro do Amapa*	Amapa Railroad
EFCJ	*Estrada de Ferro Campo do Jordao*	Campos do Jordao Railroad
EFMM	*Estrada de Ferro Madeira Mamore*	Madeira Mamore Railroad
EFPP	*Estrada de Ferro Perus-Pirapora*	Perus-Pirapora Railroad
EFS	*Estrada de Ferro Sorocabana*	Sorocabana Railroad
EFSPM	*Estrada de Ferro Sao Paulo e Minas*	Sao Paulo and Minas Railroad
EFT	*Estrada de Ferro Tocantins*	Tocantins Railroad
EFV	*Estrada de Ferro Votorantim*	Votorantim Railroad
EFVM	*Estrada de Ferro Vitoria a Minas*	Vitoria to Minas Railroad
EMBRATEL	*Empresa Brasileira de Telecomunicacoes*	Brazilain Telecommunications Enterprise
FEPASA	*Ferrovia Paulista, S.A*	Sao Paulo Railroad Corp.
FMM		Merchant Marine Fund
FRONAPE	*Frota Nacional de Petroleos*	
GEIPOT	*Grupo de Estudos Para Integracao de Politica de Transports*	
PETROBRAS	*Petroleo Brasileiro*	
RFFSA	*Rede Ferroviaria Federal, S.A*	Federal Railroad Network, Inc.
SADIA	*SADIA S.A. Transportes Aereos*	
SRC	*Sistema Regional Centro*	Central Regional System
SRN	*Sistema Regional Nordeste*	Northeast Regional System
SRP	*Sistema Regional Centro-Sul*	South-Central Regional System
SRS	*Sistema Regional Sul*	Southern Regional System
SUNAMAM		National Merchant Marine Superintendency
VARIG	*Empresa de Viacao Aereo Rio-Grandense, S.A.*	
VASP	*Viacao Aerea Sao Paulo, S.A*	

Places and features referred to in this General Survey (u/ou)

	COORDINATES			COORDINATES			COORDINATES	
	°	′S.	° ′W.	°	′S.	° ′W.	°	′S. ° ′W.
Abuña	9	42	65 23	Itajaí	26	53	48 39	Rio Itapicuru (*stream*)
Alagoinhas	12	07	38 26	Itapetininga	23	26	48 03	Rio Jacuí (*stream*)
Alemóa	23	56	46 22	Itapetinga	15	15	40 15	Rio Jaguarão (*stream*)
Alegrete	29	46	55 46	Itararé	24	07	49 20	Rio Jequitinhonha (*stream*)
Amazon Basin (*drainage basin*)	2	30	60 00	Itirapina	22	15	47 49	Rio Largo
Amazonia (*region*)	4	00	60 00	Jacarepaguá	22	55	43 21	Rio Madeira (*stream*)
Amazon River (*stream*)	0	10	49 00	Jaguaribe	7	08	34 53	Rio Mearim (*stream*)
Angra dos Reis	23	00	44 18	Japeri	22	39	43 40	Rio Mucuri (*stream*)
Água Grande (*oilfield*)	12	22	38 21	João Pessoa	7	07	34 52	Rio Negro (*stream*)
Aracaju	10	55	37 04	Juàzeiro	9	25	40 30	Rio Pará (*distributary*)
Araguari	18	38	48 11	Juiz de Fora	21	45	43 20	Rio Paraguaçu (*stream*)
Araranguá	28	56	49 29	Jundiaí	23	11	46 52	Rio Paraguai (*stream*)
Araraquara	21	47	48 10	Jupiá (*rr sta*)	20	47	51 39	Rio Paraíba (*stream*)
Aratu	12	49	38 27	Ladário	19	01	57 35	Rio Paraíba do Sul (*stream*)
Araxá	19	35	46 55	Lagoa dos Patos (*lagoon*)	31	06	51 15	Rio Paraná (*stream*)
Areia Branca	4	57	37 08	Lagoa Mirim	32	45	52 50	Rio Paraopeba (*stream*)
Artigas, Uruguay	30	24	56 28	Lajes	27	48	50 19	Rio Pardo (*stream*)
Asunción, Paraguay	25	16	57 40	Lavras	21	14	45 00	Rio Parnaíba (*stream*)
Atalaia Velha	10	58	37 04	Lídice	22	51	44 12	Rio Purus (*stream*)
Baía de Guanabara (*bay*)	22	50	43 10	Luís Correia	2	53	41 40	Rio Quaraí (*stream*)
Bariri	22	04	48 44	Maceió	9	40	35 43	Rio São Francisco (*stream*)
Barra Bonita	22	29	48 32	Madre de Deus	12	44	38 37	Rio Tapajós (*stream*)
Barra do Piraí	22	28	43 49	Manaus	3	08	60 01	Rio Taquari (*stream*)
				Mambucaba	23	15	44 03	Rio Tiete (*stream*)

ATES		COORDINATES	
° ′W.		° ′S.	° ′W.
8 39	Rio Itapicuru (*stream*)	2 52	44 12
8 03	Rio Jacuí (*stream*)	30 02	51 15
0 15	Rio Jaguarão (*stream*)	32 39	53 12
9 20	Rio Jequitinhonha (*stream*)	15 51	38 53
7 49	Rio Largo	9 29	35 51
3 21	Rio Madeira (*stream*)	3 22	58 45
4 53	Rio Mearim (*stream*)	3 04	44 35
3 40	Rio Mucuri (*stream*)	[illegible] 05	39 34
4 52	Rio Negro (*stream*)	3 [illegible]	59 55
0 30	Rio Pará (*distributary*)	1 40	49 15
3 20	Rio Paraguaçu (*stream*)	12 45	38 54
6 52	Rio Paraguai (*stream*)	27 18	58 38
1 39	Rio Paraíba (*stream*)	6 58	34 51
7 35	Rio Paraíba do Sul (*stream*)	21 37	41 03
1 15	Rio Paraná (*stream*)	33 43	59 15
2 50	Rio Paraopeba (*stream*)	18 50	45 11
0 19	Rio Pardo (*stream*)	15 39	38 57
8 00	Rio Parnaíba (*stream*)	3 00	41 50
4 12	Rio Purus (*stream*)	1 54	53 29
1 40	Rio Quaraí (*stream*)	30 12	57 36
5 43	Rio São Francisco (*stream*)	10 30	36 24
8 37	Rio Tapajós (*stream*)	2 24	54 41
0 01	Rio Taquari (*stream*)	19 15	57 17
[illegible]	Rio Tietê (*stream*)	20 40	51 35





Barragem de Boa Esperança (*dam*)	6	43	43	47
Barra Mansa	22	32	44	11
Barreiro (*rr sta*)	19	59	44	02
Barueri	23	31	46	53
Bauru	22	19	49	04
Belém	1	27	48	29
Belo Horizonte	19	55	43	56
Bom Retiro do Sul	29	37	51	56
Botelho	21	21	48	46
Botucatu	22	52	48	26
Brasília	15	47	47	55
Buenos Aires, Argentina	34	36	58	27
Buracica (*oilfield*)	12	19	38	24
Cabedelo	6	58	34	50
Cabo	8	17	35	02
Cabrália Paulista	22	28	49	20
Cacequi	29	53	54	49
Cachimbo	8	57	54	54
Caioba (*oilfield*)	25	42	48	32
Camaçari	12	36	38	12
Camaquã	30	51	51	49
Camocim	2	54	40	50
Campinas	22	54	47	05
Campo Grande	20	27	54	37
Canal de São Gonçalo (*navigational canal*)	32	10	52	38
Candeias (*oilfield*)	12	42	38	33
Capuava	23	56	47	58
Carmópolis	10	39	36	59
Caratinga	19	47	42	08
Catalão	18	10	47	57
Chuí	33	41	53	27
Colômbia	20	10	48	40
Congonhas	20	30	43	52
Conselheiro Lafaiete	20	40	43	48
Corumbá	19	01	57	39
Coxilha de Santa	31	15	55	15
Cubatão	23	53	46	25
Cuiabá	15	35	56	05
Curitiba	25	25	49	15
Diamantina	18	15	43	36
Divinópolis	20	09	44	54
Dom João (*oilfield*)	12	37	38	39
Doutor Joaquim Murtinho (*rr sta*)	20	33	43	49
Duque de Caxias	22	47	43	18
Engenheiro Bley	25	37	49	45
Entroncamento	29	51	54	56
Exu	7	31	39	43
Fernandes Pinheiro	22	04	43	13
Ferrugem (*rr sta*)	19	57	44	01
Florianópolis	27	35	48	34
Fortaleza	3	43	38	30
Foz do Iguaçu	25	33	54	35
Garças de Minas (*rr sta*)	20	11	45	40
General Luz (*rr sta*)	29	55	51	22
Goiânia	16	40	49	16
Guaira	24	04	54	15
Guaratinguetá	22	49	45	13
Guarulhos	23	28	46	32
Horto Florestal (*rr sta*)	19	55	43	55
Ibirarema	22	49	50	06
Ibitinga	21	45	48	59
Ilha d'Água (*isl*)	22	49	43	10
Ilha do Barnabé (*isl*)	23	55	46	20
Ilha do Governador (*isl*)	22	48	43	12
Ilhéus	14	49	39	03
Imbituba	28	14	48	40
Ipanema, Praia de	22	59	43	12
Iperó	23	21	47	41
Itabaiana	7	20	35	20
Itabira	19	37	43	13

Itaituba				
Mapele	12	47	38	26
Marcelino Ramos	27	28	51	54
Mariana	20	23	43	25
Mariante	29	42	51	58
Mataripe	12	41	38	35
Miranga (*oilfield*)	12	23	38	11
Mogi das Cruzes	23	31	46	11
Monte Azul	15	09	42	53
Montevideo, Uruguay	34	53	56	11
Mossoró	5	11	37	20
Mucuripe	3	3	38	29
Natal	5	47	35	13
Niterói	22	53	43	07
Nova Era	19	45	43	03
Nova Iguaçu	22	45	43	27
Oiticica	5	03	41	05
Olinda	8	01	34	51
Osasco (*rr sta*)	23	32	46	46
Osório	29	54	50	16
Ouro Prêto	20	23	43	30
Panorama	21	21	51	51
Paraíba do Sul	22	09	43	17
Paranaguá	25	31	48	30
Paranapiacaba	23	47	46	19
Paso de los Libres, Argentina	29	43	57	05
Paula Cavalcante (*rr sta*)	7	09	35	08
Paulínia	22	45	47	10
Paulista	7	57	34	53
Paulistana	8	09	41	09
Pelotas	31	46	52	20
Petrópolis	22	31	43	10
Piaçabuçu	10	24	36	25
Piassaguera (*rr sta*)	23	50	46	23
Piedade, Serra da (*ridge*)	7	21	37	20
Pirapora	17	21	44	56
Pirassununga	21	59	47	25
Poços de Caldas	21	48	46	34
Ponta Grossa	25	05	50	09
Portão (*rr sta*)	25	29	49	18
Pôrto Alegre	30	04	51	11
Pôrto Esperança	19	37	57	27
Pôrto Flores	25	37	54	36
Pôrto Mendes	24	30	54	20
Pôrto Passagem (*rr sta*)	21	01	48	09
Pôrto Real do Colégio	10	11	36	49
Pôrto União	26	15	51	05
Pôrto Velho	8	46	63	54
Pôrto Xavier	27	54	55	08
Presidente Epitácio	21	46	52	06
Propriá	10	13	36	51
Promissao (*dam*)	21	06	50	10
Quaraí	30	23	56	27
Recife	8	03	34	54
Recôncavo *basin*	12	29	38	13
Recreio	21	32	42	28
Resende	22	28	44	27
Ribeira	24	40	49	01
Rincão	21	35	48	05
Rio Açu (*stream*)	5	06	36	40
Rio Araguari (*stream*)	1	15N.	49	55
Río Branco, Uruguay	32	34	53	25
Rio de Janeiro	22	54	43	14
Río de la Plata, Argentina (*estuary*)	35	00	57	00
Rio Doce (*stream*)	19	37	39	49
Rio Grande	32	02	52	05
Rio Guaíba (*estuary*)	30	15	51	12
Río Gurupi (*stream*)	1	13	46	06
Rio Ibicui (*stream*)	29	25	56	47
Rio Itajaí (*stream*)	26	54	48	33

Rio Tocantins (*stream*	
Rio Turiacu (*stream*)	
Rivera, Uruguay	
Roncador	
Rubião Júnior (*rr sta*)	
Rubinéia	
Salgueiro	
Salto das Sete Queda	
Salvador	
Santa Cruz	
Santa Cruz, Bolivia	
Santa Maria	
Santa Maria da Boa	
Santana do Livramen	
Santarém	
Santarém	
Santiago, Chile	
Santo Amaro	
Santo Amaro do Sul	
Santos	
São Bernardo do Cam	
São Caetano do Sul	
São Francisco (*rr sta*)	
São Francisco (*draina*	
São Francisco do Sul	
São José dos Campos	
São Luís	
São Paulo	
São Sebastião	
Sepetiba (*bay*)	
Sobral	
Sorocaba	
Sousa	
Tanguá	
Taquipe (*oilfield*)	
Teresina	
Tramandaí	
Três Corações	
Três Rios	
Tubarão	
Uruguaiana	
Uruguay River (*stream*	
Utinga (*rr sta*)	
Val-de-Cães	
Vassouras	
Véu da Noiva (*rr sta*)	
Vila Militar	
Vitória	
Volta Redonda	

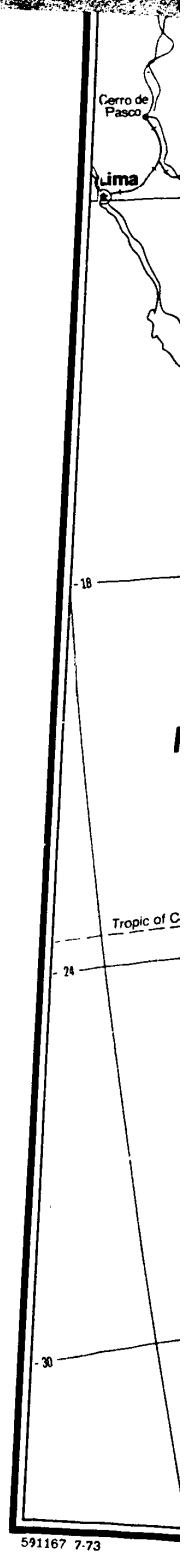
Se

Augusto Severo	
Brasília	
Campo Fontenelle (Pir	
Campo Grande AB	
Cumbica	
Dois de Julho	
Galeao	
Gravataí	
Guararapes	
Pampulha	
Pinto Martins	
Ponto Pelada	
Salgado Filho	
Santa Cruz	
Tirir.cal	
Val de Caes	
Vira Copos	

Mapele	12 47	38 26
Marcelino Ramos	27 28	51 54
Mariana	20 23	43 25
Mariante	29 42	51 58
Mataripe	12 41	38 35
Miranga (*oilfield*)	12 23	38 11
Mogi das Cruzes	23 31	46 11
Monte Azul	15 09	42 53
Montevideo, Uruguay	34 53	56 11
Mossoró	5 11	37 20
Mucuripe	3 43	38 29
Natal	5 47	35 13
Niterói	22 53	43 07
Nova Era	19 45	43 03
Nova Iguaçu	22 45	43 27
Oiticica	5 03	41 05
Olinda	8 01	34 51
Osasco (*rr sta*)	23 32	46 46
Osório	29 54	50 16
Ouro Prêto	20 23	43 30
Panorama	21 21	51 51
Paraíba do Sul	22 09	43 17
Paranaguá	25 31	48 30
Paranapiacaba	23 47	46 19
Paso de los Libres, Argentina	29 43	57 05
Paula Cavalcante (*rr sta*)	7 09	35 08
Paulínia	22 45	47 10
Paulista	7 57	34 53
Paulistana	8 09	41 09
Pelotas	31 46	52 20
Petrópolis	22 31	43 10
Piaçabuçu	10 24	36 25
Piassaguera (*rr sta*)	23 50	46 23
Piedade, Serra da (*ridge*)	7 21	37 20
Pirapora	17 21	44 56
Pirassununga	21 59	47 25
Poços de Caldas	21 48	46 34
Ponta Grossa	25 05	50 09
Portão (*rr sta*)	25 29	49 18
Pôrto Alegre	30 04	51 11
Pôrto Esperança	19 37	57 27
Pôrto Flores	25 37	54 36
Pôrto Mendes	24 30	54 20
Pôrto Passagem (*rr sta*)	21 01	48 09
Pôrto Real do Colégio	10 11	36 49
Pôrto União	26 15	51 05
Pôrto Velho	8 46	63 54
Pôrto Xavier	27 54	55 08
Presidente Epitácio	21 46	52 06
Propriá	10 13	36 51
Promissao (*dam*)	21 06	50 10
Quaraí	30 23	56 27
Recife	8 03	34 54
Recôncavo (*basin*)	12 29	38 13
Recreio	21 32	42 28
Resende	22 28	44 27
Ribeira	24 40	49 01
Rincão	21 35	48 05
Rio Açu (*stream*)	5 06	36 40
Rio Araguari (*stream*)	1 15N.	49 55
Río Branco, Uruguay	32 34	53 25
Rio de Janeiro	22 54	43 14
Río de la Plata, Argentina (*estuary*)	35 00	57 00
Rio Doce (*stream*)	19 37	39 49
Rio Grande	32 02	52 05
Rio Guaíba (*estuary*)	30 15	51 12
Rio Gurupi (*stream*)	1 13	46 06
Rio Ibicui (*stream*)	29 25	56 47
Rio Itajaí (*stream*)	26 54	48 33
Rio Tocantins (*stream*)	1 45	49 10
Rio Turiacu (*stream*)	1 36	45 19
Rivera, Uruguay	30 54	55 31
Roncador	17 22	48 15
Rubião Júnior (*rr sta*)	22 53	48 29
Rubinéia	20 13	51 02
Salgueiro	8 04	39 06
Salto das Sete Quedas (*waterfall*)	24 02	54 16
Salvador	12 59	38 31
Santa Cruz	22 56	43 41
Santa Cruz, Bolivia	17 48	63 10
Santa Maria	29 41	53 48
Santa Maria da Boa Vista	8 49	39 49
Santana do Livramento	30 53	55 31
Santarém	2 26	54 42
Santarém	3 43	45 00
Santiago, Chile	33 27	70 40
Santo Amaro	12 32	38 43
Santo Amaro do Sul	29 56	51 54
Santos	23 57	46 20
São Bernardo do Campo	23 42	46 33
São Caetano do Sul	23 36	46 34
São Francisco (*rr sta*)	12 09	38 25
São Francisco (*drainage basin*)	10 30	36 24
São Francisco do Sul	26 14	48 39
São José dos Campos	23 11	45 53
São Luís	2 31	44 16
São Paulo	23 32	46 37
São Sebastião	23 48	45 25
Sepetiba (*bay*)	23 00	43 48
Sobral	3 42	40 21
Sorocaba	23 29	47 27
Sousa	6 45	38 14
Tanguá	22 44	42 43
Taquipe (*oilfield*)	12 26	38 25
Teresina	5 05	42 49
Tramandaí	29 58	50 08
Três Corações	21 42	45 16
Três Rios	22 07	43 12
Tubarão	20 17	40 14
Uruguaiana	29 45	57 05
Uruguay River (*stream*)	34 12	58 18
Utinga (*rr sta*)	23 37	46 32
Val-de-Cães	1 23	48 29
Vassouras	22 25	43 40
Véu da Noiva (*rr sta*)	25 26	48 54
Vila Militar	22 52	43 24
Vitória	20 19	40 21
Volta Redonda	22 32	44 07

Selected airfields

Augusto Severo	5 55	35 15
Brasilia	15 52	47 55
Campo Fontenelle (Pirassununga)	21 59	47 20
Campo Grande AB	20 28	54 40
Cumbica	23 23	46 29
Dois de Julho	12 55	38 20
Galeao	22 49	43 15
Gravatai	29 57	51 08
Guararapes	8 08	34 55
Pampulha	19 51	43 57
Pinto Martins	3 47	38 32
Ponto Pelada	3 08	59 59
Salgado Filho	30 00	51 10
Santa Cruz	22 56	43 43
Tirirical	2 35	44 14
Val de Caes	1 23	48 33
Vira Copos	23 00	47 18



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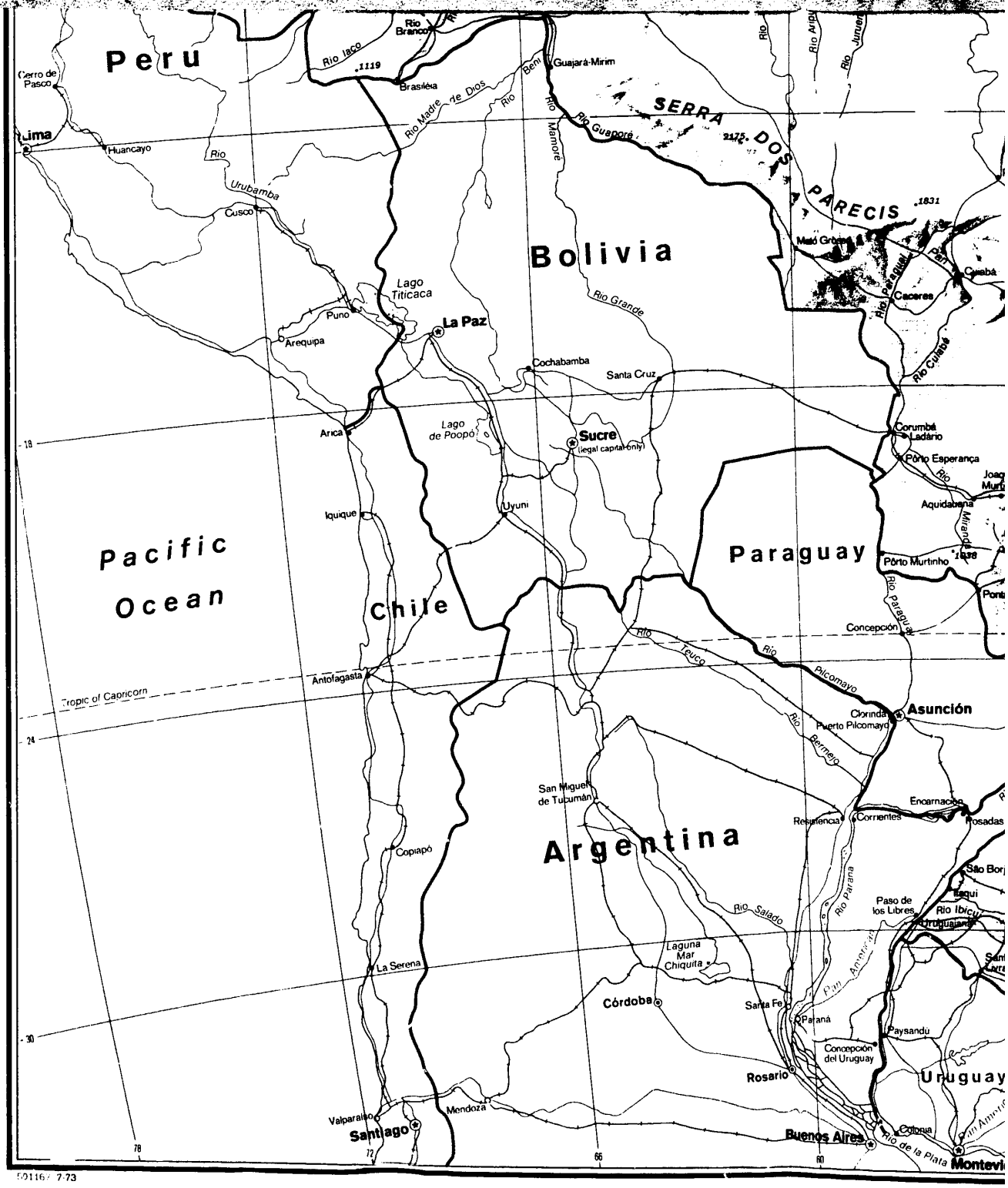

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Terrain and Transportation Figure 12