

2.2.2 Road Sub-Sector

(1) Road Network

Road network consists of some 3,000 km of national roads, 3,100 km of provincial roads, and 28,000 km of district roads. Road length by class is summarized in Table 2-4.

Table 2-4 Road Length by Category
(Unit: km)

Road Category	Length	Pavement	
		Asphalt Bitumen	Gravel / Laterite
National Road	3,000	2,400	600
Provincial Road	3,100	100	3,000
Rural Road	28,000	-	28,000
Total	34,1000	2,500	31,600

Source: Kampuchea Needs Assessment Study, UNDP, August, 1989

The primary national road network radiates from Phnom Penh, which are numbered in clockwise like RN (Route Nationale) 1,2,3, etc., connecting the capital with the major centers of population and economic activity.

The Roads and Bridges Department (RBD) of the Ministry of Public Works and Transports (MPTW) is responsible for construction, operation and maintenance of the country's national roads and bridges, including large bridges on provincial roads, while the roads departments of the provinces are responsible for provincial roads and bridges.

(2) Inventory of National Roads

Table 2-5 gives "Inventory of National Roads in Cambodia", among which the national roads marked with (*) indicate the trunk national roads which are summarized in Table 2-6, and shown in Fig. 2-1 (1) and Fig. 2-1 (2).

Table 2- 5 Inventory of National Road in Cambodia

RN No.	Location	Length (km)	No. of lanes	Width (m)	Surface Type	Surface Condition (as of 1968)	Remarks (As of 1968)
1*	Phnom Penh-Kompong Trabeek-Svay Rieng-Viet Nam border	167	2	5-6	Asphalt	Good	Bridge under construction at Phnom Penh over Basak River; Ferry over Mekong River
2*	Phnom Penh-Junction to Provincial Route 38 Junction to PR 38-Chambak Chambak-RN 25 RN25-Takeo-Viet Nam border	20 25 29 <u>61</u> 135	2 2 2 2	N.A N.A N.A N.A	Asphalt Asphalt Asphalt Asphalt	N.A N.A N.A N.A	
3*	Phnom Penh-Ang Tasom-Kampot-Veal Renh (Jnc to RN 4) Veal Renh-Ang-Phsar Ream	202 40 <u>242</u>	2 2	5.5-6 N.A.	Asphalt Asphalt	N.A. N.A.	22 narrow metal bridges; maximum safe speed 60 kph Coincide with RN 4
4*	Sihanoukville(Kompong Thom)-Phnom Penh	226	2(4)	7	Asphalt	Good	
5*	Poipet (Thai border) Sisophon Sisophon-Battambang Battambang-Muong Russel-Pursat -Kompong Chhang-Phnom Penh	47 69 <u>291</u> 407	2 2	4-5 4-5 5-6	Asphalt Asphalt (partially laterite) Asphalt	Fair Fair Fair	5 narrow concrete, 4 narrow steel bridges; speed limit 30 kph; floods in rainy season. 5 narrow concrete, 13 narrow steel bridges; section subject to flooding
6*	Junc to RN 5 (Prek Kdam)-Skun-Prakham-Kompong Thom Kompong Thom-Stoung-Siemreap Siemreap-Sisophon (Jnc to RN 5)	135 146 <u>101</u> 385	2 2 2	5-6.5 5-6	Asphalt Asphalt Asphalt	Good N.A N.A	26 steel bridges. 21 bridges, 6 narrow concrete. 27 narrow wooden bridges; 4 km one-way; 5 km subject to flooding.
7*	Skun-Kompong Cham Kompong Cham-Kandoal Chum Kan Chum-Khy Krek-Dar Dar-Memot	44 43 36 11 <u>46</u> 180	2 2 2 2 1	5-6.5 4-5.5 N.A N.A N.A	Asphalt Asphalt Asphalt Asphalt Asphalt	Good Good N.A N.A N.A	10 km narrow.
10	Battambang-Snoeng-Pailin	83	2	5	Asphalt	N.A	Truck and loose surface, dry weather.
12	Kompong Thom (Junc to/RN 6)-Sre Sre-Chhep Kandal-Kompong Sralau (Laos border)	33 <u>181</u> 214	2 1	4-5 3-4	Laterite Gravel	Fair Poor	Truck and loose surface, dry weather.
13	Viet Nam border-Snuol-Kratie Kratie-Stung Treng Stung Treng-Laos border	101 114 <u>84</u> 299	1 2 2	N.A 5 N.A	Asphalt Asphalt Asphalt	Good N.A N.A	
14	Viet Nam border-0 Rang-Dak Dam (Viet Nam border)	103	-	N.A	Gravel	N.A	Loose surface, dry weather road.
15*	Chup (Jnc to RN 7)-Prey Veng-Prek Klisay (Junc to RN 1)	90	2	4-5	Asphalt	Fair	
16	Junc to RN 3-Kompong Trach-Kampot	91	2	5-6	Asphalt	Good	
17	Kompong Trach-Viet Nam border	16	2	4-5	Asphalt	Fair	
18	Kaong (Junc to RN 4)-Chikha	24	2	4-5	crushed rock/laterite	N.A	30 km gravel road 11 km laterite road
19	Junction RN 13-Bung Lung-Viet Nam border	198	1	3-4.5	Laterite	N.A	
21	Junc to RN 6 (Kompong Thom)-Bos Chek Prey-Jnc to RN 7 (Tracung)	56	2	4-5	Asphalt/ laterite	N.A	
25	Takeo (Junc to RN 2)-Ang Tasom (Junction RN 3)	10	2	6	Asphalt	Good	
26*	Oudong (Junc to RN 5)-Srang	61	2	4-6	Asphalt/ Laterite		
30	30 Phnom Penh (Junc to RN 2)-Prek Koy	25	1	N.A	Asphalt	N.A	
	Total	3,012					

Source: United Nations, Atlas of Physical, Economic and Social Resources, September 1968

Note: National Roads marked with (*) shows the relatively important roads which almost radiate from Phnom Penh

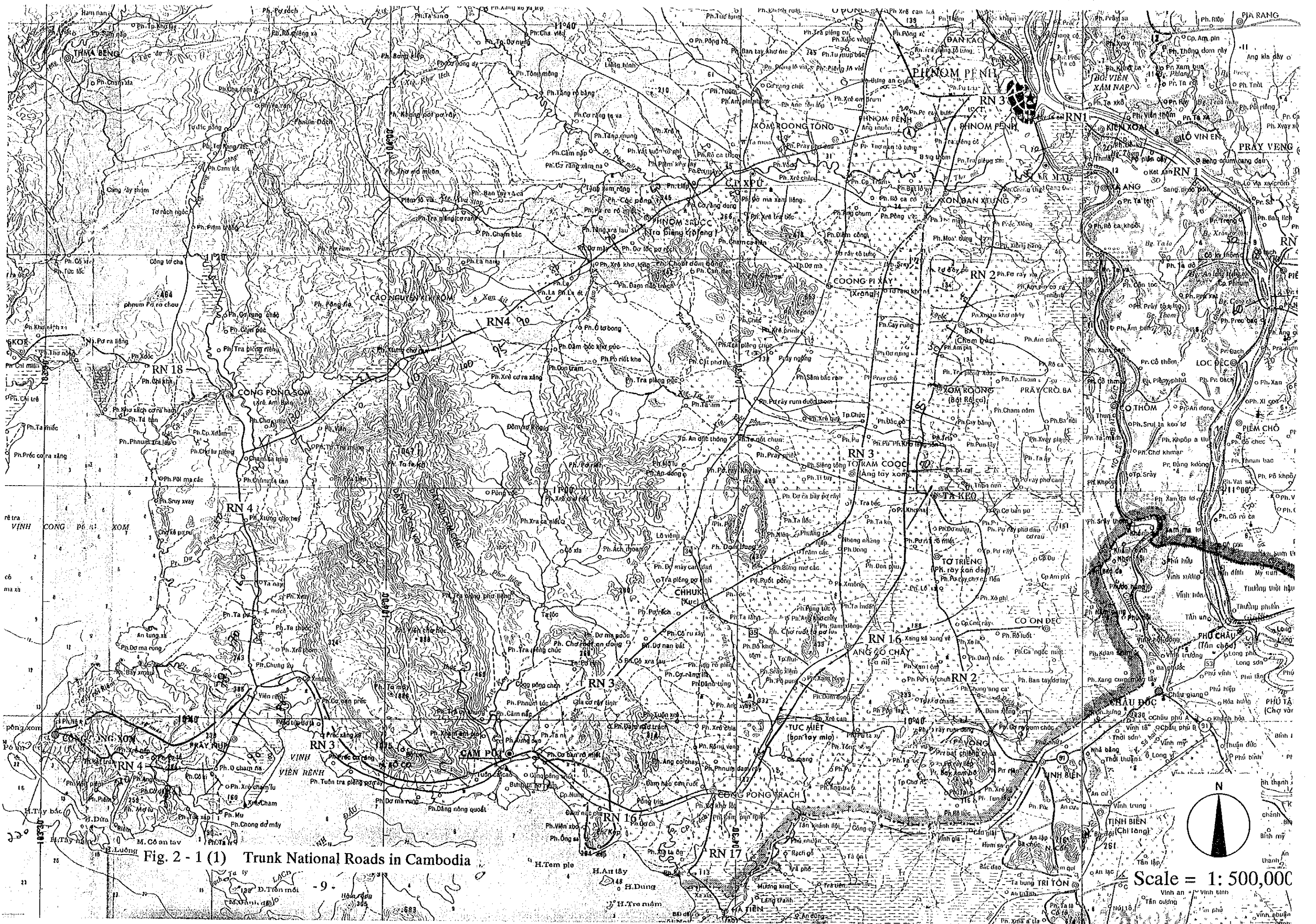
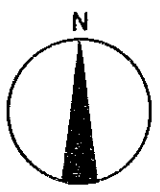


Fig. 2 - 1 (1) Trunk National Roads in Cambodia



Scale = 1: 500,000

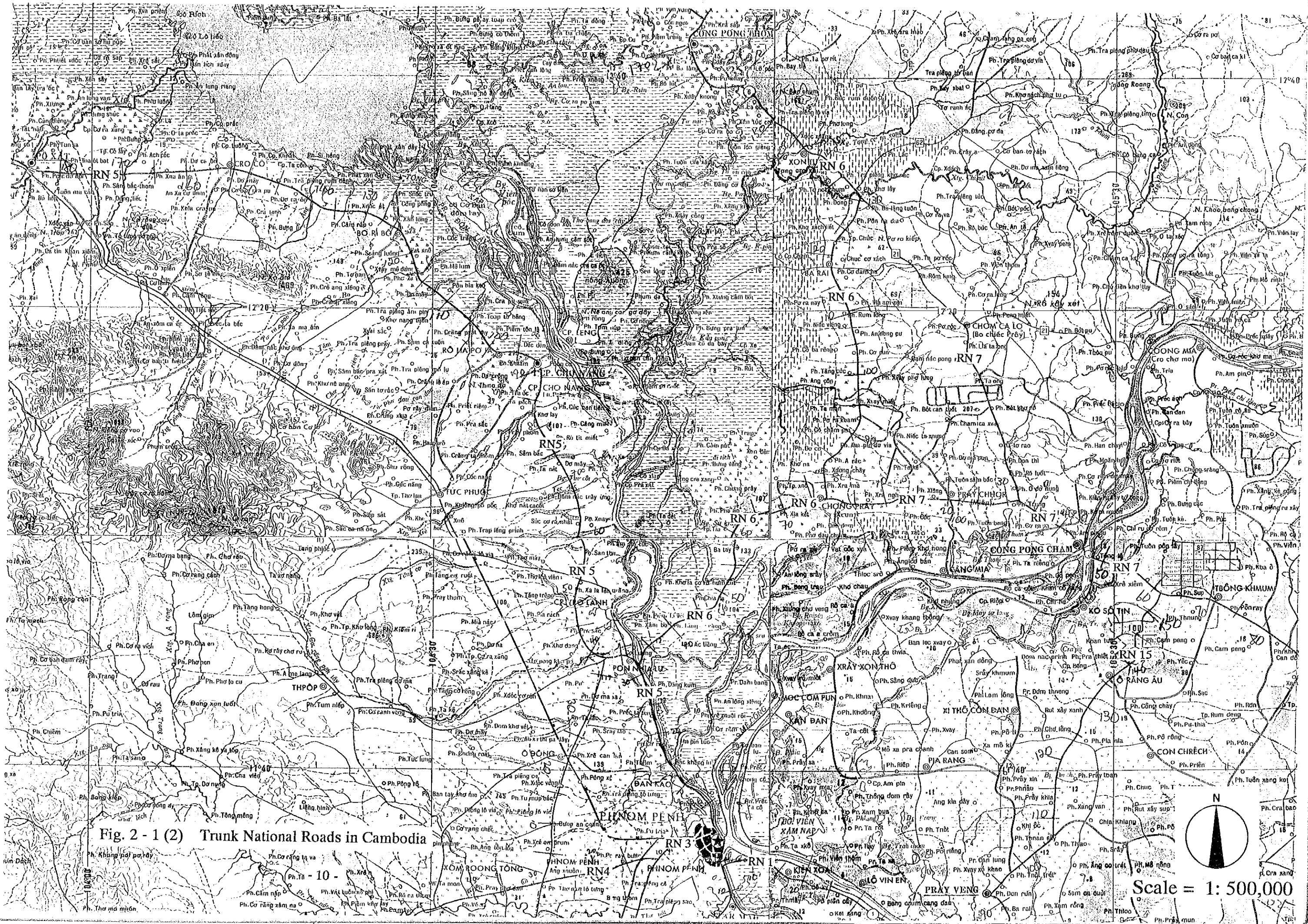


Fig. 2 - 1 (2) Trunk National Roads in Cambodia

Scale = 1: 500,000

Table 2-6 Trunk National Roads and Extension

National Road	Section
RN1	Phnom Penh ~ Vietnam Border ~ (Ho Chimin City)
RN2	Phnom Penh ~ Takeo ~ Vietnam Border
RN3	Phnom Penh ~ Kampot (Thailand Bay) ~ Veal Renh (Junc w/RN4)
RN4	Phnom Penh ~ Kompong Som (Sihanoukville)
RN5	Phnom Penh ~ Battambang ~ Poipet (Thai Border)
RN6	Prek Kaam (Junc. w/RN5) ~ Kompong Thom ~ Sisophon (Junc. w/RN5)
RN7	Skun (Junc. w/RN6) ~ Kompong Cham ~ Vietnam Border
RN13	Vietnam Border ~ Snoul ~ Kratie ~ Stung Treng Lao Border
RN15	Chub (Junc. w/RN7) ~ Kratie ~ Stung Treng ~ Lao Border
RN26	Udon (Junc. w/RN5) ~ Sran (Junc. w/RN4)

(3) Traffic on National Roads

The UNDP mission reported that the magnitude of traffic on RN1 in 1990 reached some 6,000 per day as shown in Table 2-7.

Table 2-7 Traffic Survey on RN1

Type of vehicle	Counted traffic in opposite direction	Traffic in both directions converted in one hour (1)	Daily traffic (1) x 6	Composition (%)
1. Bicycle	118 (20 km/h)	157	942	16
2. Motorcycle	111 (60 km/h)	444	2,664	43
3. Motorcycle & towed cart (10-15 persons)	74 (50 km/h)	247	1,482	25
4. Passenger car, Jeep, Van	29 (60 km/h)	116	696	12
5. Mini bus	2 (60 km/h)	8	48	1
6. Bus	5 (60 km/h)	20	120	2
7. Truck	3 (60 km/h)	12	72	1
Total of slow moving vehicles	(Total of 2. to 7.)		5,082	84
Total of fast moving vehicles	(Total of 1. to 7.)		6,024	100
Total			6,036	100

Source: Cambodian Infrastructure Survey Mission, UNDP 1990

Note: A preliminary traffic survey was conducted by counting on-coming traffic while traveling at an average speed at 60 kilometers per hour for 30 minutes.

The study team conducted a traffic survey by counting on-coming traffic on the trunk national roads, which is the same method of the UNDP mission. The result is shown in Table 2-8.

Table 2-8 Rough Estimate of Traffic on Main National Roads

National Road	Estimated Daily Traffic Aug. 1993
RN 1	6,000
RN 2	450
RN 3	450
RN 4	2,200
RN 5	6,500
RN 6	550
RN 7	540
RN 13	220
RN 15	330
RN 26	330

Source: Surveyed by the Study Team

(4) Registration of vehicles

According to the recent statistic shown in Table 2-9, the number of vehicle registered was some 34,500 and 54,000 in 1987 and 1988, respectively, which increased to some 70,200 in 1990, 161,200 in 1991, and 182,800 in 1992 when the full scale operation and deployment of UNTAC and other Agencies were made. At present the number is estimated roughly at about 240,000, which includes unregistered number, after the essential core of the UNTAC withdrew from Cambodia.

Table 2-9 Motor Vehicle Registration, 1990-92

Type of Vehicle	1990	1991	1992*	growth rate in % 1990/91
Private Cars	5,323	9,944	12,228	86.8
Trucks	2,165	5,175	5,355	139.0
Motorcycles	62,755	146,101	165,220	132.8
Total	70,243	161,220	182,803	129.5

Note: (*) First three months only.

Source: Cambodia, Agenda for Rehabilitation and Reconstruction, The World Bank, June 1992.

(5) Situation of road maintenance of main National Road by RBD

Except for the highway from Phnom Penh to Sihanoukville (RN4), which was built with the U.S. assistance in the 1960s, most of the road network was constructed in the 1920s and 1930s. They are suited only to light vehicle traffic with much of the network having pavement width of only 4 to 4.5 meters. It can be said that pavement structures of the primary road network are inadequate for the current traffic volumes and heavier axle loads. Furthermore, because of relatively low embankments built from inadequate compacted sand and clay, many roads are susceptible to flooding during the monsoon season, thus causing serious damage to pavement and embankment.

Road maintenance works are generally classified into:

- 1) Routine Maintenance including urgent repair and temporary recovery which may be effective for the longest one year,
- 2) Periodic Maintenance including recovery work of a limited section which effect will last for at longest about three years,
- 3) Rehabilitation comprising recovery of entire section,
- 4) Upgrading which entails an improvement of alignment, pavement geometric dimensions, etc.,
- 5) Reconstruction or new Construction.

Table 2-10 shows the record of road maintenance for main national roads by RBD for the period 1979 to 1991.

The major constraints on the rehabilitation and development of the country's road network, including bridges and ferries are the lack of funds, mechanized equipment, fuel and spare parts, and inadequate number of trained and experience personnel. Severe budget constraints, particularly after 1989, have hampered reconstruction and rehabilitation works. Mechanized work is often out of commission for extended periods because of inadequate workshops, tools and spare parts. Also due to the loss of many engineers and technicians in the 1970s, there is an urgent need to strengthen the technical as well as the managerial capacity of RBD and MPWT through substantial training inputs.

Table 2-10 Situation of Road Maintenance of Main National Road by RBD 1979 - 91

Year	Routine Maintenance	Periodic Maintenance					Sub-Total	Total
		Asphaltic Repair	Lateritic Repair	Repair of Shoulder	Repair of Subgrade			
1979	-	122	-	7	-	-	129	129
1980	-	4	-	-	-	-	4	4
1981	-	58	18	71	-	-	147	147
1982	-	69	99	17	-	-	185	185
1983	-	164	118	3	9	-	294	294
1984	-	124	71	-	-	-	195	195
1985	-	94	25	3	-	-	122	122
1986	-	57	15	3	-	-	75	75
1987	-	84	37	-	2	-	123	123
1988	-	48	80	-	6	-	134	134
1989	-	163	53	29	-	-	245	320
1990	-	86	74	4	-	-	164	314
1991	-	18	56	25	-	-	99	204
Total	330	1,091	646	162	17	-	1,916	2,246

Source: Data for 1979/88 are derived from "10 years Report by RBD".

Those for 1989/91 are from "Cambodia, Agenda for Rehabilitation and Reconstruction, The World Bank, June 1992"

Note: 1) Objected roads were RN1, 2, 3, 4, 5, 6, 7, 13, 15 and 26

(6) Rehabilitation Programme of Road Sub-sector (1992/93)

The Economic and Social Development Plan 1991/1995 places the highest priority on transport sector along with agriculture, mining/industry/energy and tourism sectors. Details of the investment required for the transport sector is given in Table 2-11.

Among the transport sector development plan, the roads sub sector which includes improvement for ferries facilities, provision of construction equipment, etc. has been given the highest priority as shown in Table 2-12.

Table 2-11 Investment for Transport Sector under the Economic and Social Development Plan 1991/95

(Unit: US\$ million)	
Sub-sector	Estimated Cost
(1) Master plan	0.2
(2) Rehabilitation of roads and bridges	290.9
a. Machinery for roads and bridges construction	
b. Roads rehabilitation	
c. Chroy Changvar bridge	
d. Ferries	
(3) Rehabilitation of railways	25.5
a. Locomotive	
b. Supply of equipment	
c. Track rehabilitation, Sisophon to Poipet	
(4) Navigation and ports	31.2
a. Master plan	
b. Dredge works for rivers	
c. Building facilities	
d. Control and sign for navigation	
e. Rehabilitation and supply of equipment and materials for 2 ports	
(5) Aviation	16.2
a. Upgrading aviation management	
b. Rehabilitation and upgrading of airports	
(6) Telecommunication	15.1
Total	379.1

Source: Interview with staff of RBD, August 1993

Table 2-12 Rehabilitation Programme of Road Sub-Sector

Item	Quantity
1. Rehabilitation of national roads	<u>2,460 km</u>
(1) RN1: P. Penh ~ Vietnam border	167
(2) RN2: P. Penh ~ Takeo ~ Vietnam border	120
(3) RN3: P. Penh ~ Kampot ~ Junc w/RN4	202
(4) RN4: P. Penh ~ Sihanoukville	226
(5) RN5: P. Penh ~ Pursat ~ Battambang ~ Sisophon	407
(6) RN6: Prek Kdam ~ Kg. Thom ~ Siem Reap ~ Sisophon	385
(7) RN6A: Chroy Chanvar ~ Junc. w/RN6	42
(8) RN7: Skun (Junc w/RN6)	180
(9) RN13: Kratie ~ Stung Treng	299
(10) RN14: Kusem ~ Sen Monorom	104
(11) RN15: Neak Loeng ~ Prey Veng ~ Chub	90
(12) RN17: Kampot ~ Kep	40
(13) RN19: Opon Mueon ~ Ratanakiri ~ Oyadar	198
2. Rehabilitation of provincial roads	<u>3,100 km</u>
3. Rehabilitation of district roads	<u>28,000 km</u>
4. Rehabilitation of urban streets in P. Penh and provincial cities	L.S
5. Rehabilitation of Chroy Chanvar Bridge	L.S
6. Provision of ferries	L.S
7. Provision of dredgers	L.S
8. Rehabilitation of cargo equipment of P. Penh Port	L.S
9. Provision of aggregate production plan and drilling machines, etc.	L.S
10. Provision of construction equipment for rehabilitation of national roads, improvement of motor pool and materials storage, and construction of workshop	L.S

Source: Interview with staff of RBD, August 1993

2.2.3 Organization and Budget of Implementing Agencies

(1) Organization

Throughout the transitional period after the election (July 1993) and establishing Constitution of the Kingdom of Cambodia (September 1993), the Government's control and social stability are being restored significantly. RBD will be strengthened absorbing the autonomous construction company, and reorganizing and strengthening the national road rehabilitation units. The Road Construction Center under jurisdiction of RBD is expected to play an essential role for the road recovery programmes. Organizations of MPWT and RBD are given in Fig. 2-2 and Fig. 2-3, respectively. Also, number of employees and technical staff of RBD are shown in Table 2-13 and Table 2-14, respectively.

(2) Budget

RBD's budget for 1992/93 was around Riel 700 million (US\$ 333 million equivalent). However, due to rapid privatization of public enterprises and increase of military expenditure etc., the Government's total revenue covers only 60% of that of expected. Under the circumstance, RBD's budget to be assigned to road repair and maintenance has been almost suspended to date. RBD's recurrent budget during the period of 1989-1992 is shown in Table 2-15.

Table 2-15 RBD's Budget (Unit: Riel)

	Expenditure			
	1989	1990	1991	1992*
RBD	25,078,406	171,913,223	273,210,979	403,175,206
Road Construction Company	10,600,560	11,500,000	40,000,000	58,000,000
Bridge Construction Company	33,319,500	198,693,699	292,449,426	137,737,500
Total	68,998,466	382,106,922	605,660,405	598,912,706

Source : Preliminary Study on the Project for the Improvement of the Road Construction Center, JICA, Mar, 1993

Note: 1) Figures of the year of 1992 indicate the total amount during the period of 9 months.

2) 1 US\$ = 2,100 Riel (Dec. 1992)

3) Road Construction Company was reorganized into RBD's recurrent Road Rehabilitation Units for National Road as of August 1993

Table 2-13 Number of The Employees of RBD

No.: Staff and Unit	Nos as of January 1993	Nos as of June 1993
I Recurrent Unit		
1 Director & 3 Deputy Directors	4	4
2 Administration Office	20	19
3 Personel Office	8	9
4 Accounting Office	14	14
5 Material Office	10	11
6 Planning Office	8	17
7 Technical Office	13	22
8 Warehouse Unit	42	34
9 Survey Unit	31	63
10 Technical School	17	19
11 RN1 Unit	65	68
12 RN2+3 Unit	91	94
13 RN4 Unit	75	85
14 RN5A Unit	85	82
15 RN5B Unit	55	51
16 RN6 Unit	84	91
17 RN13 Unit	224	110
18 Road Construction Unit	249	260
19 Sawmill Unit	26	26
20 Aggregate Production Unit	168	167
21 Workshop/Road Construction Center (ODEM)	120	124 ^{*1}
22 Study in the country & abroad	100	23
Total of I	1,509	1,393
II Autonomous Company		
1 Bridge Construction Company	350	299
2 Neak Loeung Ferry Company	145	135
3 Prek Kdam Ferry Company	80	79
4 Tonle Bet Ferry Company	52	52
Total of II	627	565
Grand Total (I + II)	2,136	1,958

Source : Interview with staff of RBD in August 1993

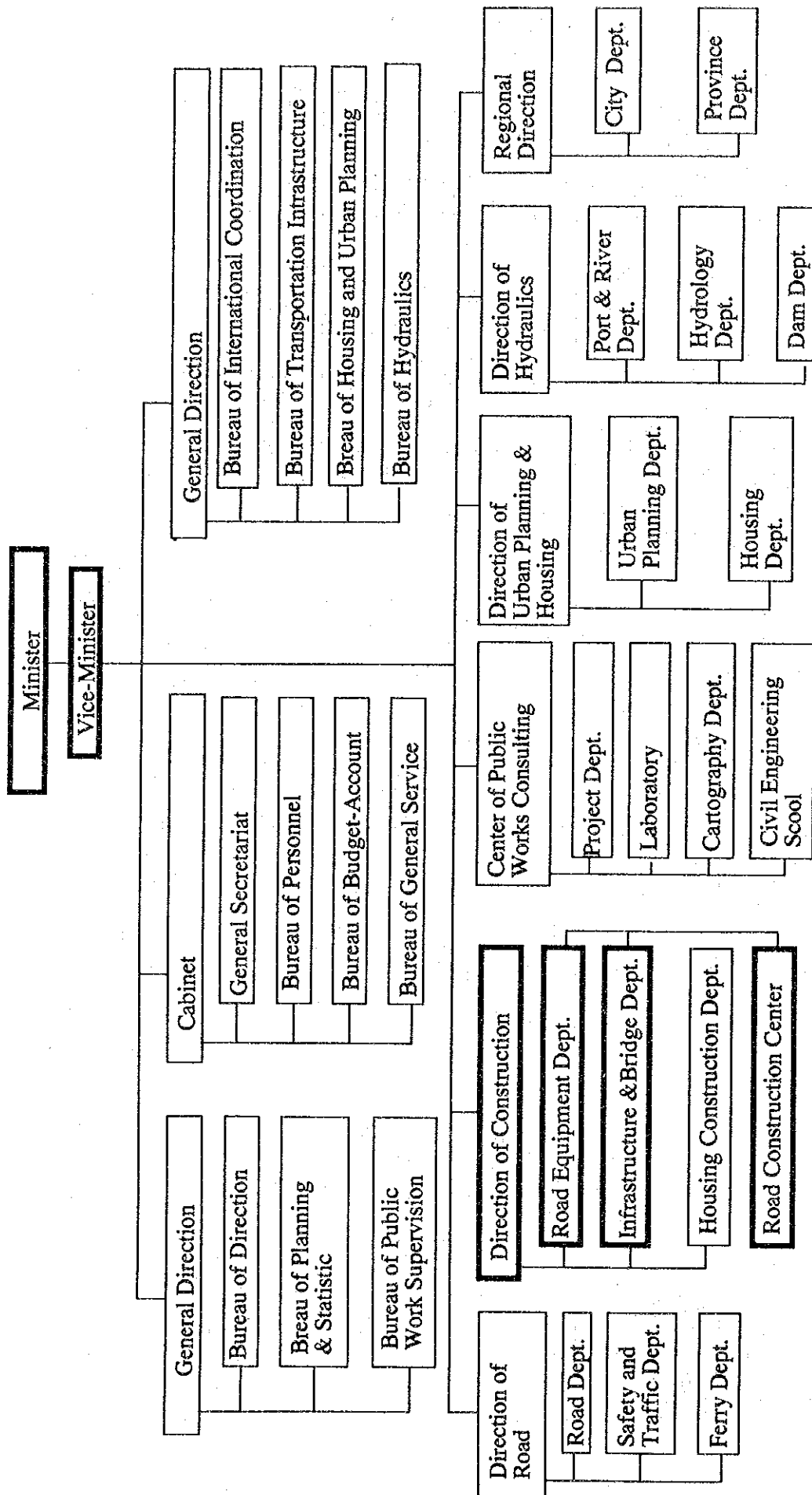
Note : *1 Data as of May 1993

Table 2-14 Technical Staff of RBD

(as of August 1993)

Item No.	Degree/Diploma	Country	Course	Nos		
1	Ph. Doctor	USSR	Roads and Bridges Equipment	1		
2	Engineer	USSR	Roads and Bridges Constructions	3		
			Roads and Bridges Equipment	3		
			Cars and Tractors	2		
			Construction Industry	1		
			Transportations Economics	1		
			Computer	1		
			Sub-total	11		
			Vietnam	Roads and Bridges Equipment	6	
		Mechanic		4		
		Transport Economics		1		
		Sub-total		11		
		Germany	Roads and Bridges Equipment	1		
		Hungary	Mechanic	1		
		Poland	Mechanic	1		
		Thailand	Mechanic	1		
			Total	27		
		Cambodia	-	50		
		Total of Items (1)+(2)				77
		3	Assistant Engineer		Industrial Pedagogy	2
					Construction Industry	1
Mechanic	4					
Transport Planning	1					
Roads and Bridges Construction	10					
Development	1					
Computer	1					
Sub-total	20					
Vietnam	Mechanic			1		
	Total			21		
Cambodia	-	160				
Total of Items (3)				181		
Total (1) + (2) + (3)				258		

Source: Interview with RBD staff in August 1993

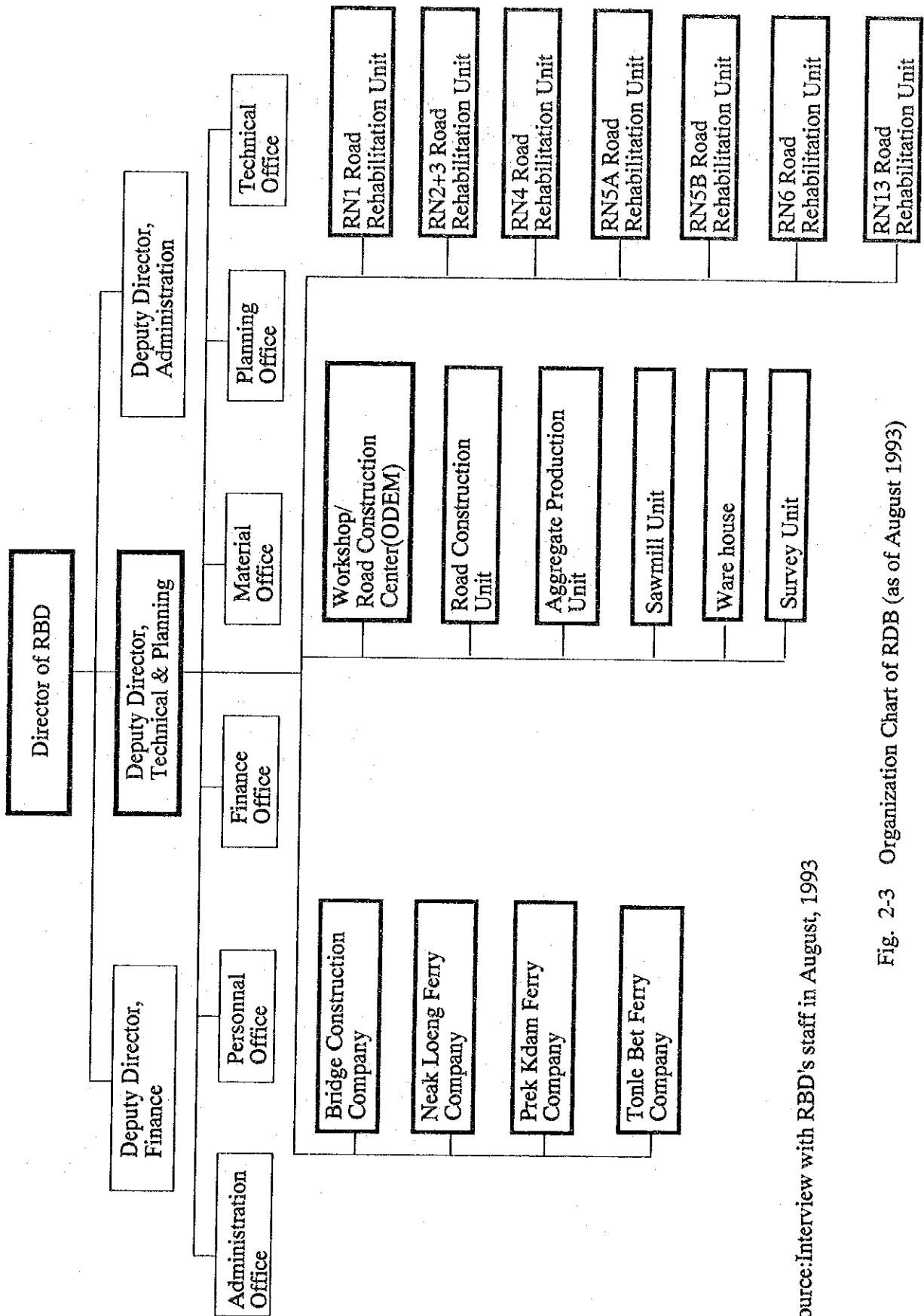


Source: Interview with staff of MOPW in August 1993.

Note 1: "Direction of Construction" corresponds to the existing Road and Bridge Department (RBD) with an addition of new mandate of "Housing Construction".

2: Proposed the MOPW as of August, 1993.

Fig. 2-2 Reorganized Structure of MPWT



Source: Interview with RBD's staff in August, 1993

Fig. 2-3 Organization Chart of RBD (as of August 1993)

2.2.4 Existing Condition of the Road Construction Center

(1) General

The Road Construction Center was established in the late 1950s as a construction equipment center (Office des Engins et Mécaniques: ODEM). In the middle of 1960s it was used as contractor's (USA) base camp for the construction project of RN 4. Most of the existing buildings were constructed in the period of 1975-1979 under the Administration of the Democratic Kampuchea (Pol Pot regime) for the purpose of maintenance and repair of agricultural equipment.

During the period 1979-1991 it was reorganized as an autonomous body, Heavy Equipment Repairing Company, where repairing works for the equipment of National Road Rehabilitation Units, Road Construction Company and other autonomous companies were executed on commercial basis. It also had responsibility of development of technical skill and training of the workshop staff. Considerable number of equipment were supplied by USSR, and four Russian were stationed for maintenance purpose until the end of 1991.

(2) Organization

Function of the existing Road Construction Center is limited to mechanical field to date. However, RBD's function now undertaken by the headquarter in Phnom Penh is going to shift to the Road Construction Center. Fig. 2-4 gives the organization and Table 2-16 shows strength of workshop of the Road Construction Center.

(3) Capacity of equipment and maintenance of the Road Construction Center

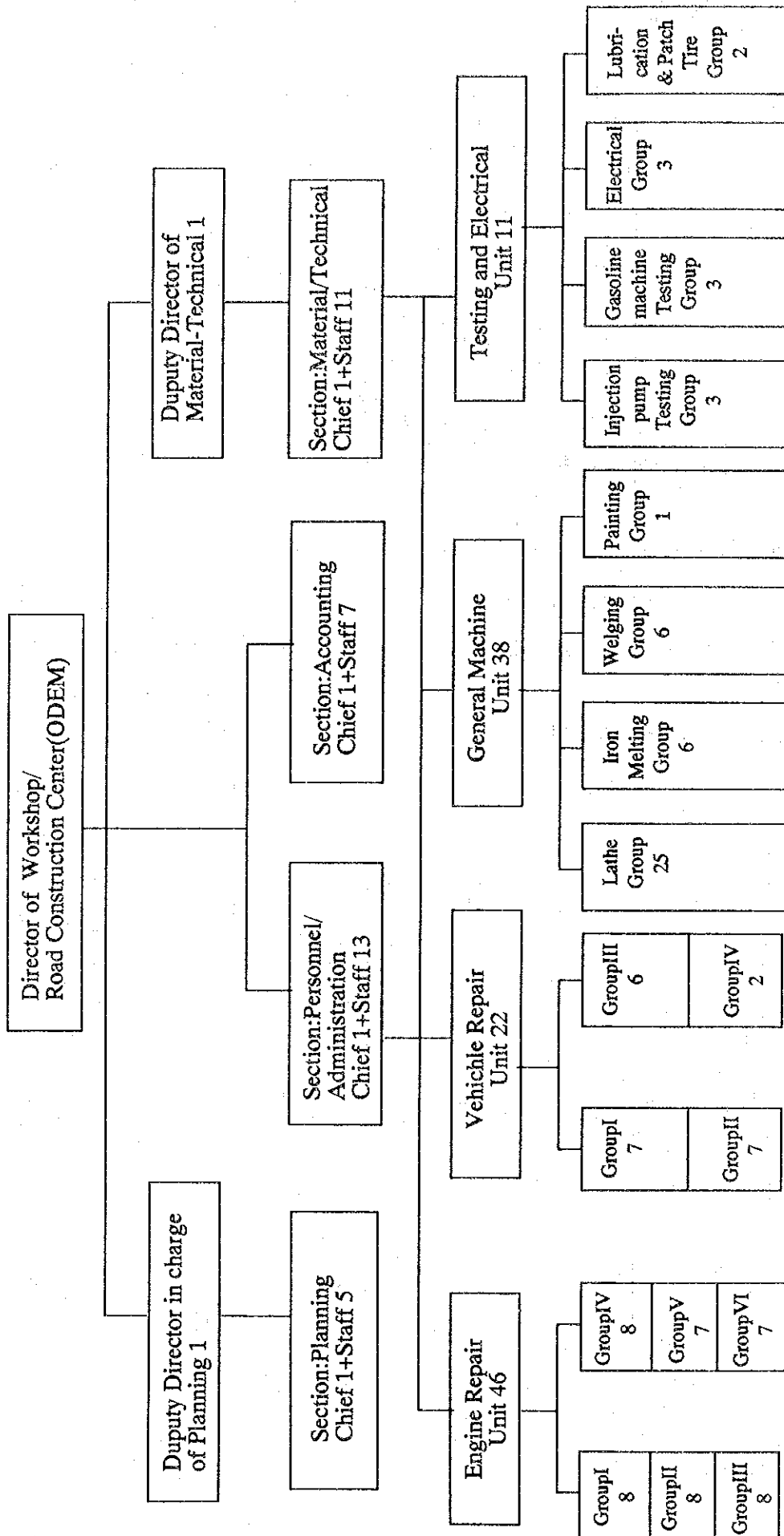
Table 2-17 shows the existing maintenance equipment installed at the workshop of the Road Construction Center. Almost all the equipment are regarded as scraps.

(4) Spareparts for the construction equipment provided by USSR

Although some 10,000 items of spareparts mainly for the equipment of USSR have been still stocked in the spareparts store adjacent to the existing Road Construction Center, there are no first-moving spareparts to be used for existing construction equipment.

Table 2-16 Strength of Workshop/Road Construction Center (ODEM)

No.	Position	Number			Number as of Dec., 1986		Number as of May, 1993		Vacancy Nos
		Simple Indirect	Indirect production	Direct production	Total	Assigned Nos	Deficit Nos	Assigned Nos	
1	Administration	34	17	0	51	44	7	18	33
	Leaders	3			3	3		2	1
	Personnel/Administration	11	3		14	14		3	11
	Guard		8		8	8		2	6
	Accounting	8			8	4	4	4	4
	Planning	6			6	3	3	4	2
	Material-Technical	6	6		12	12	0	3	9
2	Production	0	2	126	128	100	28	88	40
A	Carpenter	0	0	11	11	11	0		
B	Workshop	0	0	46	46	37	9		
	Engine Repair Unit								
	Group 1			8	8	8		Chief of Workshop (4)	
	Group 2			8	8	7	1	Vice Chief of Workshop (4)	
	Group 3			8	8	6	2	Mechanics (36)	
	Group 4			8	8	6	2	Technical Assistant (11)	
	Group 5			7	7	5	2	Technical Staff (1)	
	Group 6			7	7	5	2	Construction (2)	
C	Vehicle Repair Unit	0	2	20	22	19	3		
	Group 1			7	7	4	3		
	Group 2			7	7	4	3		
	Group 3			6	6	4	2		
	Group 4		2	0	2	7			
D	General Machine Unit	0	0	38	38	31	7		
	Lathe Group			25	25	21	4	Lathe Operator (14)	
	Iron Melting Group			6	6	6			
	Welding Group			6	6	3	3	Welding Operator (8)	
	Painting Group			1	1	1			
E	Testing and Electrical	0	0	11	11	2	9		
	Injection Pump Testing Group			3	3		3	Electrician	
	Gasoline Machine Test Testing Group			3	3		3		
	Electrical Group	0	0	3	3		3		
	Lubrication and Patch Tyre Group	0	0	2	2	2			
	Total	34	19	126	179	144	40	106	73



Source: Interview with RBD in Aug. 1993

Note: Figures shown in each section indicate personnel quota

Fig. 2-4 Organization Chart of The Workshop/Road Construction Center(ODEM)

Table 2-17 Maintenance Equipment of the Road Construction Center Workshop

No.	Model	Year	Origin	Usable	Repairable	Scrap
1	Lathe (3m)	1984	Soviet			0
2	Parlet lathe (1.2m)	1984	Soviet			0
3	Lathe (3.5m)	1960	Japan			0
4	Lathe (4m)	1974	China		0	
5	Milling (2m)	1970	China			0
6	Milling (2m)	1967	Germany			0
7	Milling	1970	India			0
8	Milling	1974	China			0
9	Milling	1970	Germany			0
10	Milling	1970	India			0
11	Shaper	1967	Sweden			0
12	Shaper	1986	France		0	
13	Drilling machine	1984	Soviet			0
14	Drilling machine	1970	China		0	
15	Bender	1970	Dutch			0
16	Bender	1970	Dutch			0
17	Bender	1970	Germany			0
18	Grinder	1970	Germany			0
19	Press	1970	Japan			0
20	Bench press	1984	N.A.		0	
21	Boring machine	1984	Soviet			0
22	Boring machine (inside)	1976	North Korea			0
23	Roller Grinder	1970	America			0
24	Roll	1970	Germany			0
25	Hack saw machine	1970	Germany			0
26	Generator 60 kVA	1984	Soviet			0
27	Generator 125 kVA	1984	Soviet			0
28	Generator 125 kVA	1984	Soviet			0
29	Generator 250 kVA	1984	Soviet			0
30	Portable gantry crane	1975	Cambodia		0	

Source : RBD's data

2.2.5 Existing Condition of Construction Equipment possessed by RBD

Inventory of the equipment possessed by the Road Rehabilitation Units of RBD, Autonomous Companies, Provincial Public Works are being prepared by RBD in relation to the re-organization of the Governmental agencies.

The latest inventory is not available yet. Inventory of the road rehabilitation units and autonomous companies as of April 1990, May 1992 and December 1992 are summarized in ANNEX 7. Total number as of December 1992 is estimated about 280, of which 200 are operable condition. Of the operable equipment about 55% are vehicles (dump truck, tanker, etc.).

Regarding origin of equipment and year of manufacture the inventory of the road rehabilitation units as of April 1990 was analyzed as follows:

Origin of equipment

Table 2-18 shows the origin of equipment of existing national roads rehabilitation units under the control of RBD. More than 80% of the equipment are origin of USSR or East European countries.

Year of manufacture

Year of manufacture of equipment possessed by the existing national road rehabilitation units is shown in Table 2-19. The equipment procured before 1986 counts 70 unit which are nearly grounded. Of a 120 unit which procured after 1985, 90% are USSR or East European origin. Procurement of their spare parts are actually impossible.

Table 2-18 Origin of Equipment possessed by National Road Rehabilitation Unit

Existing National Road Rehabilitation Unit	Total	Origin		
		USSR, East-European block countries	Japan, USA and West-European countries	Others
RN1+2+3+6	56	39	4	13
RN4+18	25	21	4	0
RN5A	25	18	7	0
RN5B	35	30	5	0
RN NE13+14+19	49	49	0	0
Total	190	157	20	13
Ratio	100%	82.6%	10.5%	6.8%

Source: RBD's data

Table 2-19 Year of Manufacture of the Equipment possessed by National Road Rehabilitation Unit

Existing National Road Rehabilitation Unit	Total	Year of Manufacture										
		before 1980	81	82	83	84	85	86	87	88	89	N.A
RN1+2+3+6	56	3	0	1	2	16	0	10	10	8	0	6
RN4+8	25	1	0	14	3	0	0	0	2	3	2	0
RN5A	25	1	2	2	0	0	2	1	2	5	8	2
RN5B	35	0	0	1	0	0	0	12	8	10	4	0
RN NE13+14+1	49	0	0	0	0	8	14	4	3	8	3	9
Total	190	5	2	18	5	24	16	27	25	34	17	17
Ratio	100%	2.6%	1.1%	9.5%	2.6%	12.6%	8.4%	14.2%	13.2%	17.9%	8.9%	9.0%

Source: RBD's data

2.3 Outline of Related Programme

2.3.1 Projects Assisted by Multilateral and Bilateral Agencies

Based on Paris Peace Accord in October, 1991, various international donor agencies and countries have assisted implementation of emergent recovery programmes of dilapidated socio-economic infrastructures, together with technical assistance. Ongoing emergent recovery programmes in road sector are summarized in the table and figure in ANNEX 8. Also, the following projects intend to realize not only short term recovery but also medium or long term objectives of transport sector.

- (1) Social rehabilitation assistance project/transport component, Asian Development Bank (ADB)

Project comprises power plant and distribution, transport, irrigation and flood control, fertilizer, and education and vocational training. Of a total of US\$ 67.7 million, US\$ 24 million will be allocated to the roads and bridges subsector. Procurement of consultant started in July 1993 to materialize individual programme. Implementation is anticipated in 1994.

- (2) Emergency rehabilitation project/transport, International Development Association (IDA).

Sectors to be covered by the project are agriculture, transport, electric power, education, health and administration. Of a total of US\$ 75.0 million US\$ 9.75 million will be allocated to transport sector. Also, some portion of the commodity loan will be allocated to this sector.

- (3) Rehabilitating some parts of national highway in Cambodia, United States Agency for International Development (USAID)

A total of US\$ 36 million will be allocated to the rehabilitation of RN3 and RN4. Engineering study is in progress.

2.4 Outline of the Request

During the civil war which started in 1970, socio-economic infrastructure was deteriorated seriously due to destruction and lack of repair or maintenance activities thereon. Now, as the Government's control and social stability are being restored significantly, the emergency recovery programme of infrastructure, particularly road is given the highest priority.

Most of the existing roads are in such conditions as deteriorated pavement, lack of width, embankment height, compaction, etc. In every rainy season several sections in flat area are affected by flood. Also, most of a total of 4,000 bridges, which had been well maintained in pre-war period, were either damaged or destroyed, and require urgent repair. The then Ministry of Communication, Transport and Posts (MCTP) has started the task of rehabilitation and reconstruction since 1979. However, due to the constraints such as lack of funds, mechanized equipment, fuel and spare parts, inadequate number of trained and experienced personnel, and aged workshop facilities, the recovery work has not progressed as expected.

Before 1975, when Cambodia had received assistance from USA and west-European countries, a lot of construction equipment of those countries origin were introduced in Cambodia. However, for the period of 1975-1979 under the regime of Democratic Kampuchea, due to improper operation and lack of maintenance, those equipment were completely deteriorated. Then in the period of 1979-1990, those of USSR origin were introduced. Now most of the existing equipment of the USSR origin start to meet serious difficulties such as expiration of economic life, lack of spare parts which new supply is actually impossible. Also, coupled with the aged workshop facilities and lack of experienced mechanics, the number of operable equipment is anticipated to decrease rapidly.

Under these circumstances, Cambodia made a request to the Government of Japan a grant aid for the projects of:

- (1) Supply of construction equipment for emergent recovery work of roads and bridges for National Roads,
- (2) Rehabilitation of workshops and related facilities for the maintenance of the construction equipment,
- (3) Establishment of road construction training center.

The Government of Japan decided to hold a basic design study and JICA made the Preliminary Study in November and December 1992. The requests confirmed in the Preliminary Study was the improvement of the Road Construction Center (ODEM), which comprises:

- (1) Rehabilitation of workshop
 - Supply of maintenance equipment (lathe, hydraulic press, etc.)
 - Rehabilitation/construction of facilities
 - Construction of equipment depot
- (2) Supply of construction equipment

The request confirmed at the basic design study is as follows:

- (1) Improvement of workshop facilities
 - Construction of new building for workshop - Workshop (A)
 - Rehabilitation of existing workshop - Workshop (B)
 - Rehabilitation of existing machine shop to operation quarter and warehouse
 - Rehabilitation of existing warehouse to the garage and parts storage
 - Construction of new building for administration office
 - Power supply facility, water supply facility, sewage facility, and ancillary facilities
 - Rehabilitation of equipment yard
 - Rehabilitation of in-site road
- (2) Supply of equipment
 - Maintenance equipment for workshop
 - Construction equipment

CHAPTER III OUTLINE OF THE PROJECT

CHAPTER III OUTLINE OF THE PROJECT

3.1 Objectives

Emergency recovery of dilapidated socio-economic infrastructure, particularly, road infrastructure is given the highest priority in the current economic recovery programme. However, due to lack of adequate fund, number of experience staff and technical skills, aged construction equipment, maintenance equipment and workshop facilities, the progress of the recovery programme is being seriously hampered. The Road Construction Center under the Project is intended to be the headquarter to proceed the recovery programme. It has a workshop to provide repair and maintenance service of the construction equipment used for the various recovery programmes. The main objective of the Project is to expedite the emergency road recovery programmes and also to put the first step in medium and long term reconstruction programme of the roads and bridges by strengthening the capacity of existing Road Construction Center.

3.2 Study and Examination on the Request

3.2.1 Appropriateness and Necessity of the Request

Security situation being improved significantly, the emergent recovery of road infrastructure is given the highest priority. Several emergent recovery programmes have being implemented by international funding agencies or countries. In connection with the road rehabilitation and reconstruction programmes, supply of appropriate type and number of equipment is considered essential for the smooth implementation. Also, coherent maintenance system with well organized workshop facilities is indispensable for the effective operation of these equipment. Due to aged facilities and poor equipment, RBD's workshops actually do not function now. The Project will enable to accelerate the road recovery programme and also save the scarce resources which are being input.

The Road Construction Center under the Project covers the important sections of the national roads, RN1, RN2, RN3, RN5, RN6, RN7, RN15 and RN26 in the capital area. Total length of the road sections is approximately 600 km, of which 100 km of lateritic roads and 500 km of asphalt surface roads, which is summarized in Table 3-1. Influence area covers Phnom Penh and the provinces of Kandal, Kompong Cham, Prey Veng, Takeo and Kompong Chhang where produce 50% of rice and 40% of fish to the total of Cambodia.

Table 3-1 Road Sections of Trunk National Roads under the Road Construction Center

National road	Selected section	Length (km)
1. Asphalt paved road (including deteriorated stretches which were changed to laterite surfaces)		
RN1	Phnom Penh ~ Neak Loeng	61
RN2	Phnom Penh ~ Takeo	76
RN3	Phnom Penh ~ Ang Tasom	75
RN5	Phnom Penh ~ Prek Kdam ~ Kg. Chhnan	91
RN6	Prek Kdam ~ Skun	42
RN7	Skun ~ Kg. Cham ~ Chub ~ Suoan	68
RN15	Chub ~ Prey Veng ~ Neak Loeng	97
Sub-total		510
2. Laterite road		
RN26	Junction w/RN5 ~ Junction w/RN4	40
Others	within metropolitan circle	50
Sub-total		90
Total		600

3.2.2 Study on the Implementation Programme

(1) Organization

Roads and Bridges Department (RBD) is being reorganized to the Construction Department absorbing housing construction section and extending its functions. As one of the drastic reforms that will make the Road Construction Center to play a key role in the implementation of the RBD's road recovery programmes, the equipment possessed by and personnel belonged to the Road Construction Company and Road Rehabilitation Units are being transferred to the Road Construction Center. Particularly, the road rehabilitation units will be reorganized to the Emergency Repair Unit for Trunk National Road, ERU, considering the extent of the area and road length to be covered.

On the other hand, in relation to the improvement of the central workshop under the Project, the extensive on-the-job training will become possible, which is expected to upgrade the technical skill of the staff. Furthermore, a mobile workshop which is to be introduced under the Project, will enable the Road Construction Center to provide a coherent equipment maintenance services together with those of central workshop.

RBD's management function, which is now limited to Phnom Penh, also is shifted to the Road Construction Center, and an effective management system which organizes the road maintenance work, equipment operation and equipment maintenance will be established in one place.

(2) Operation Cost

Operation cost after completion of the Project is estimated as shown in Table 3-2. Details of the calculation is shown in ANNEX 9.

Table 3-2 Operation Cost

Item	Operation Cost US\$
1. Operation cost for the equipment to be supplied	328,800
1.1 Fuel & Lubricant	226,646
1.2 Spare parts	7,732
1.3 Operator's wages	94,449
2. Operation cost for the workshop improved	21,600
3. Labor cost	315,700
Total	666,100

(3) Project Revenue

Through execution of the specified programme or projects financed by the international funding agencies or countries on force account basis, the operation cost of the Road Construction Center will be covered by revenue therefrom. Financial status of such projects and expected revenues are described below:

- 1) Special rehabilitation assistance project/transport component
 - Asian Development Bank (ADB)

A total of US\$ 24 million will be allocated to road and bridge sub-sector. The implementation will be on force account basis by RBD. Of which, US\$7.2 million (about 30%) and US\$ 720,000 (about 10%) are expected to be allocated to the equipment operation cost and administration cost, respectively.

- 2) Emergency rehabilitation project/transport
 - International Development Association (IDA)

A total of US\$ 11.8 million will be allocated to road and bridge sub-sector. A 10% of the objected roads are assumed to fall into the roads under the Road Construction Center. Of which 50% are assumed to be allocated to the equipment operation cost. Thus, US\$ 590,000 ($10\% \times 50\%$) is expected for equipment operation cost. Further, a total of US\$ 35 million of commodity loan is programmed under the same project, of which 5% are assumed to be allocated to MPWT. A 40% of the MOPW's allocation is expected to RBD, of which 60% is to be administration cost. Thus, US\$420,000 ($US\$35 \times 5\% \times 40\% \times 60\%$) will be available as administration cost.

- 3) Rehabilitating some parts of national highway in Cambodia
 - United States Agency for International Development (USAID)

A total of US\$36.35 million will be allocated to the rehabilitation of National Roads RN3 and RN4. About 10% are assumed to be contracted with RBD, of which 20% to fall into the roads under the Road Construction Center. Thus, about US\$726,000 ($US\$36.35 \times 10\% \times 20\%$) to be expected for the equipment operation cost and administration cost.

- 4) Production and sales of crushed stone

A stone crushing machine of a capacity of 30ton/hour will be supplied under the Project. Sales of aggregates to the above mentioned projects, and other projects or even to private sector will be revenue of the reinforced Road Construction Center. Approximately US\$270,000 is expected as the sales revenue.

- (4) Balance of the recurrent expenditure and expected revenue
Balance of the expenditure and revenue in the next 5 years is assumed as shown in Table 3-3.

Table 3-3 Estimates for Income and Expenditure of the Road Construction Center

Unit: (1000 US\$)

Item	1993	1994	1995	1996	1997	1998
1. Road Recovery Programme under the Project						
1) Recurrent Revenue	(250)	335	335	470	470	470
2) Revenue by Projects						
(1) Special Rehabilitation Assistance (ADB Loan)	-----	2,640	2,640	2,640	-----	-----
(2) Emergency Rehabilitation Project (IDA Loan)	-----	335	335	335	-----	-----
(3) Rehabilitating Some Parts of National Highway (USAID)	-----	242	242	242	-----	-----
(4) Sales of Crushed Stone	-----	273	273	273	-----	-----
Total of Revenue	-----	3,490	3,490	3,490	-----	-----
2. Expenditure		670	670	670	670	670
Balance		2,820	2,820	2,820	-670	-670

Expected revenues associated to the prospective projects will fully cover the operation cost incurred after the Project be completed. Particularly, the Special Rehabilitation Assistance Project of ADB is deemed to correspond to some 75% of the total estimated revenue, which is thus considered seriously essential for the Project. Sales revenue of crushed stones by the mobile crushing machine which will be supplied under the Project also covers some 8% of the total revenue, hence being a fairly important element.

It is expected that assistance from foreign donor agencies or countries will be continued for the years on and after 1997.

3.2.3 Programmes Assisted by the Foreign Donor Agencies or Countries

Concept of the Project is to strengthen the capacity of the Road Construction Center which will play a vital role in the road infrastructure recovery programme. By restructuring and strengthening or co-working with the existing road rehabilitation units, Emergency Repair Unit for Trunk National Road, ERU, will execute the rehabilitation projects both on force account and contract basis under the control of RBD. Also the capacity of equipment repair/maintenance will be reinforced to self-sustainable level by renovating and improving workshop facilities under the Project. The Project components are introduction of construction equipment toward the establishment of the ERUs and improvement of workshop facilities. Thus, there is no project of similar nature in the recipient circle of MPWT or there is no overlapping of the elements with other specified projects to date.

Relation between the Project and the programmes assisted by the foreign donor agencies is summarized in Table 3-4.

Table 3-4 Relation between the Project and the Programmes assisted by the Foreign Donor Agencies or Countries

Programme	Objected Roads	Objectives	Work Type	Relation
OPS/UNDP	RN5 and Provincial roads in Pursat	Increase of agricultural products Repatriate and immigration support for UNTAC equipment supply	Emergent repair	Emergency recovery intends short term repair works which effects to be lasting in 1 year at most to support the activities of the UNTAC The equipment to be supplied under the Project
AIDAB	RN5	Co-work with OPS/UNDP	Emergent repair of bridges	are essential for the continuous road maintenance after emergency recovery programme.

Programme	Objected Roads	Objectives	Work Type	Relation
ADB	RN2,3,5,6,7, and 15	Recovery of socio-economic infrastructure	Emergent repair Rehabilita- tion	Short term repair same as OPS/UNDP programme. Rehabilitation intends the works which effects to be lasting 5-6 years. As RDB's almost all equipment are deployed to the OPS/UNDP programme, equipment to be supplied under the Project will be used on force account basis by RBD. Operation cost of the equipment will be allocated from this ADB programme.
IDA	RN5: from Battambang to Thai border RN6: from Kompong Thom to RN5 junction Provincial roads in Battambang	Recovery of socio-economic infrastructure Equipment supply	Routine maintenance	There is no overlapping with the roads under the Road Construction Center. Equipment maintenance services and aggregates production which are secured by the Project will be provided to this programme.
USAID	RN4 RN3: from Kampot to RN4 junction RN5: from Phnom Penh- Kom. Chhnang RN26	Recovery of trunk road	Rehabilita- tion	The equipment to be supplied under the Project will be used on contract basis by RDB. Operation cost for the equipment to be supplied will be allocated from this USAID programme.

Note: AIDAB - Australian International Development Assistance Bureau

3.2.4 Project Component

The Project component is summarized in Fig. 3-1.

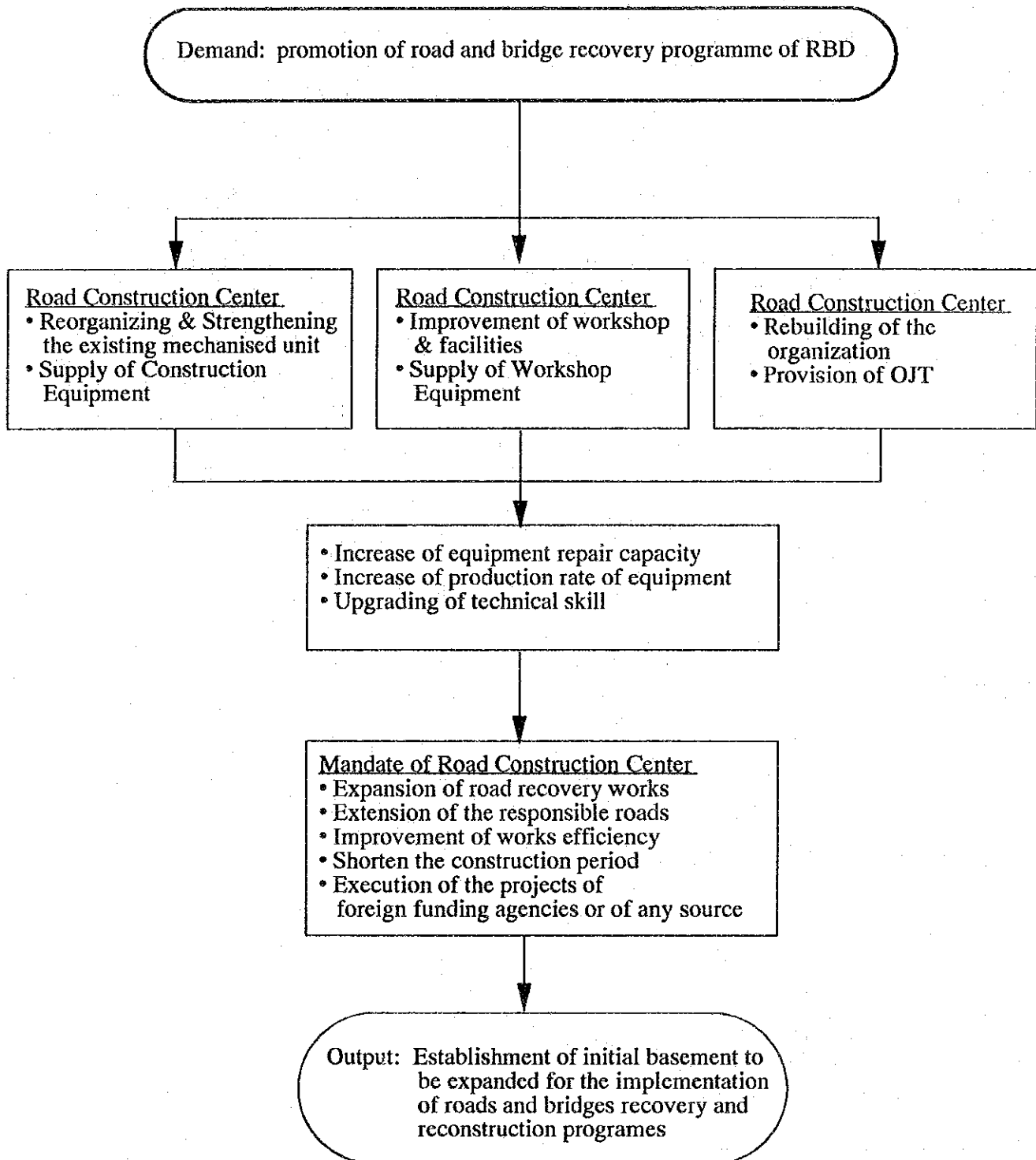


Fig. 3-1 Project Component

Brief description of each component is as follows:

Rehabilitation / Construction of the Building and Facilities

- 1) Workshop (A) : To be constructed within the premises
- 2) Workshop (B) : To be rehabilitated from the existing workshop
- 3) Operation Quarter & Warehouse : To be rehabilitated from the existing machine shop
- 4) Garage & Parts Storage : To be rehabilitated from the existing warehouse
- 5) Administration Office : To be constructed within the premises
- 6) Power supply facility, water supply facility, sewage facility and ancillary facilities such as generator house, fuel and lubrication stand, etc. : To be rehabilitated/constructed
- 7) Equipment Yard : To be rehabilitated
- 8) In-Site Road : To be rehabilitated

Provision of Equipment

- 1) Workshop Equipment : To include maintenance equipment, tools, etc. of the minimum and essential requirement
- 2) Construction Equipment : To include construction equipment for establishment of emergency repair units, drainage unit, aggregates production unit, transport unit and mobile workshop unit together with spareparts

3.2.5 Requested Facilities and Equipment

(1) Construction/Rehabilitation of Building and Facilities

- 1) The workshop and maintenance/repair equipment and ancillary tools are core items of the Project and the workshop will be used to conduct essential repairs of construction equipment and also to provide OJT space.
- 2) Only rehabilitation and extension of an existing workshop building was requested for the first place, but the request was changed to a construction of new building by the following reasons:
 - Only an extension of existing building will cause difficulties both on the planned path flow and work flow.

- Existing concrete pillar and girder is not structurally strong enough to support the load of proposed overhead crane. Also, proposed gantry crane will arise operational difficulties on the work flow.
 - The existing premises has enough space for a new building
- 3) The existing workshop building can be improved by rehabilitating a truss structure and floor.
 - 4) The administration office was originally planned as part of the multipurpose building which would be rehabilitated from the existing machine shop. However, considering that the RBD's physical functions to be shifted soon from Phnom Penh offices to this Road Construction Center, the staff to be accommodated there shall increase more than was estimated initially. Furthermore, as several expatriate staff are proposed for the training purpose, it was change to construct as a new building.
 - 5) Machine shop is planned as part of a new workshop building. While the existing machine shop building is rehabilitated to the operation quarter with practice room and resting room for workshop workers and staff, and warehouse for construction materials, plant and equipment.
 - 6) Garage and parts storage is reformed by rehabilitating the existing warehouse as originally requested.
 - 7) As there is no public water supply, sewage system, and electricity line on site, these facilities are to be newly constructed.
 - 8) Fuel stand, washing stand and other ancillary facilities which are of general requirements for workshop are to be newly constructed.
 - 9) Equipment yard and in site road are to be rehabilitated.
- (2) Workshop Facilities

An optimal size and dimension of the workshop which will present a model workshop in Cambodia in the near future, are decided in conjunction with the following factors.

- Quantity of operable construction equipment owned by RBD
- Number of operating machines/vehicles by type
- Annual number of workable days and hours at the workshop
- Working conditions of equipment on site
- Actual situation of on-site repair and maintenance operations
- Strength and quality of workers of the existing workshop
- Scope of the work to be conducted in the workshop
- Contents of required maintenance equipment and tools

1) Estimate of quantity of equipment subject to repair and maintenance of the workshop

It is necessary to first estimate number of subjected machines and vehicles for repair and maintenance services to determine the dimension of the workshop. In order to determine an adequate number of the bays of workshop, number of the operable and reparable machines subject to repair and maintenance in the following at least five years should be considered. The number of machines and vehicles of RBD in operation is estimated at some 259. Given that most of the machines and vehicles currently in operation stand with very severe working conditions, those will be almost scrapped after five year.

Rough estimates is made to determine the number of equipment in the following 5 years after completion of the Project, which is shown in Table 3-5.

Table 3-5 Estimated Number of Construction Machineries for Repair and Maintenance Services of the Workshop

Equipment	Current Number	Estimated Number in next 5 Years				Number of Machines/Vehicles to be Serviced by New Workshop
		Scrap	-88 (50%)	Procured under the Project	Procured through other sources	
Construction Machineries	82	-82 (100%)	25	75	100	100
Vehicles	177	-88 (50%)	30	200	319	350

2) Number of bay required

Number of bay required for repair and maintenance of the above mentioned construction machine and vehicles are determined as follows (Details are shown in Annex 10):

Construction Machine	medium repair	2.0
	heavy repair	4.0
	<hr/>	
	Total	6.0
Vehicles	medium repair	9.0
	heavy repair	6.0
	<hr/>	
	Total	15.0

Not only Workshop (A) (new construction) but also Workshop (B) (rehabilitation) will be required to secure of the necessary number of bays for vehicle repair.

3) Scope of work and facilities proposed

The following scope of work, facilities and equipment are proposed for the workshop.

- A. Full-scale repair services including overhauling of heavy equipment will be provided.
- B. With regard to the manufacturer of spare parts, a machining and heat treatment of large parts are not considered at the present stage.
- C. The following sections are provided for maintenance and repair services.
 - Chassis repair shop
 - Engine repair shop
 - Fuel component repair & test room
 - Electric component repair & test room
 - Battery service room
 - Power train shop
 - Machine shop
 - Welding & fabrication shop
 - Undercarriage rebuilding shop
 - Compressor room
 - General tools and special tools room
 - Parts warehouse

(3) Plan for Maintenance Equipment

The basic design for the repair and maintenance equipment to be provided under the Project should take the same manner, conditions and aspects described as the facility plan into consideration to provide coherent maintenance and repair services. However, preventive maintenance will be made by mobile workshop to be introduced under the Project. Special points to note in the selection of equipment for each maintenance work are as follows

1) Chassis Repair, Overhaul and Assembly

Aiming efficiency improvement on the overhauling of heavy equipment, install 5 ton and 3 ton overhead cranes of manual. Various hydraulic jacks and supporting equipment will be provided also to deal the chassis of heavy equipment.

2) Engine Repair

A 3 ton jib crane to hoist engines will be installed to achieve the efficient operation in dismantling parts and component. An engine mounting table will also be installed for safe and proper work. Boring and honing of cylinders, grinding and correction of valves and the grinding of cylinder heads will be included for the additional work of the shop.

3) Fuel component repair

Bosch type tester will be installed to service the fuel injection system of construction equipment.

4) Electric component repair

A comprehensive electrical equipment tester will be installed to test such as various electrical equipment, as starter motors and AC generators, etc. which are equipped to construction equipment and vehicles.

5) Battery service

Necessary tools and equipment to repair and charge batteries of construction equipment and vehicles will be provided together with a distilled water maker.

6) Power line repair

Tools and equipment required for servicing of transmission devices such as torque converters, transmission differential gears and clutches, etc.

- 7) Machine tool
As per an equipment list shown hereinafter, lathes and ordinary machine tools, engine crank shaft grinding machine and a line boring machine will be installed.
- 8) Welding and fabrication
Arc welder, gas welder, hydraulic press, etc., will be installed for fabrication and repair of the bodies of equipment.
- 9) Undercarriage repair
Equipment including as tire removal press, track press and truck shoe bolt removal machine will be provided in order to reduce the spare parts cost by extending the life of suspension system components.
- 10) Compressed air supply
A diesel-operated air-compressor will be installed in the engine testing room to supply compressed air throughout the workshop.
- 11) Tire repair
An equipment to remove and repair tyres including extra-large tyres for construction equipment be provided.
- 12) Painting
Facilities for painting work for vehicles body will be constructed outside of the workshop within the premises.
- 13) Washing
When construction machines are delivered to the workshop by trailer, they are usually soiled with dirt. So, they need to be thoroughly washed out before being allowed into the workshop section for disassembling of the chassis, etc. for which a high-pressure hot water spray and a steam cleaner are provided.

In addition to the equipment above, mobile workshop, pick-up truck and station wagon will be assigned to the workshop as of a field service system.

(4) Construction Equipment

1) Motorability of the road sections under the Road Construction Center

Based on the road reconnaissance and relevant information, the road sections under the Road Construction Center are classified into the following categories, A, B, C and D according to motorability, which is shown in Table 3-6.

Table 3-6 Motorability of the Road Sections under the Road Construction Center

National Road	Total Length (km)	Project Section (km) Ratio to the Total Length (%)	Road Length in Motorability Class (km)			
			A	B	C	D
I. Bituminous Road						
RN 1	167	61 (36.5)	61	0	0	0
RN 2	135	76 (56.3)	42	34	0	0
RN 3	202	75 (37.1)	75	0	0	0
RN 5	407	91 (22.3)	85	0	0	0
RN 6	385	42 (10.9)	42	0	0	0
RN 7	180	68 (37.8)	58	0	0	10
RN 15	97	97 (100.0)	64	10	10	13
Sub-Total	1,573	510 (32.4)	427	44	16	23
Ratio (100%)		100.0	83.7	8.6	3.1	4.5
II. Lateritic Road						
RN 26	61	40 (65.6)	0	0	40	0
Others	50	50 (100.0)	0	0	50	0
Sub Total	111	90 (81.1)	0	1	90	0
Ratio (100%)		100.0	0	0	100	0

Where, "motorability" is defined as follows:

Maximum Possible Speed by 4WD	Motorability
50 km/h <	A
40 ~ 50 km/h	B
30 ~ 40 km/h	C
<30 km/h	D

2) Content of road recovery network

Road maintenance works are generally classified into:

- Routine Maintenance including urgent repair and temporary recovery which may be effective for the longest one year,
- Periodic Maintenance including recovery work of a limited section which effect will last for at longest about three years,
- Rehabilitation comprising recovery of entire section,
- Upgrading which entails an improvement of alignment, pavement geometric dimensions, etc.,
- Reconstruction or new Construction.

The objected emergency recovery work of the trunk national roads shall need routine and periodic maintenance which are defined in the above using the construction equipment to be introduced under the Project. The existing roads, except RN4 has been constructed in 1920s or 1930s with macadam pavement which appears not to bear the current increasing traffic volumes and heavier axle loads. The strengthened macadam or bituminous surface treatment, however, shall be considered for the emergency asphaltic repair of the roads.

The recovery works are intended for the extension as follows:

- | | | |
|------------------------|------------------------|----------------------------|
| • Routine Maintenance | Bituminous road | 500 km/year |
| | Laterite surfaced road | 100 km/year |
| • Periodic Maintenance | Bituminous road | 170 km/year (500km/3years) |
| | Laterite surfaced road | 35 km/year (100km/3years) |

Based on the achievement in the last 10 years for road repair and maintenance and also survey of existing road, the contents of the routine and periodic maintenance to be executed shall be as follows:

Routine Maintenance:

No.	Item	Description
1	Asphalt patching (asphalt road)	: Assumed to be 1% of the total surface
2	Base failure repair (asphalt road)	: Base repair to be carried out prior to the above work
3	Brading of laterite road	: Assumed to be done once per year
4	Spot repair of laterite road	: Repair of pot holes on laterite road. Average 10cm of selected material to be placed. Assumed to be done on, say, 5% of the total surface
5	Ditch cleaning	: Grading of side ditch. Assumed to be conducted for, say, 10% of the total road length
6	Shoulder blading	: Assumed to be done once per year

Periodic Maintenance: In addition to routine maintenance, periodic maintenance will be executed at the interval of 3 years. Length of deteriorating sections assumed to be 40% to programmed road length.

No.	Item	Description
7	Base preparation (asphalt paved road):	Scarifying, grading and compaction of the existing road pavement, base course and subgrade, on which 15cm of new base course to be constructed with selected material from borrows
8	Gravel resurfacing (laterite surface road):	Scarifying, grading and compaction of existing road surface, on which 15cm of selected material from borrows be placed
9	Shoulder rehabilitation	: Shoulder be reconstructed with 10cm thick of selected material from borrows
10	Drainage structure	: Say, 100m ³ of concrete per km be applied for the structure
11	Asphalt surface Work	: Constructed with macadam or double bitumen surface treatment (DBST)

Production of crushed stone and Selected Material:

No.	Item	Description
12	Crushed stone	: To be used for the aggregates of surface course and concrete structures
13	Selected material	: To be used for the above work items, 12, 14, 41, 45 and 46

3) Study on Equipment Schedule

The required equipment was determined considering the schedule of works, work volume, extent covered by the project roads, and the controlled area by the existing RBD's road rehabilitation units. After detailed analysis, establishment of four Emergency Repair Units (ERUs), a drainage unit, a transport unit, a aggregate production unit and a mobile workshop unit were proposed to meet the minimum and essential requirement at present.

	Unit/Objected National Road	Objected Length
ERU I	Part of RN2 and RN3	151 km
ERU II	Part of RN5 and RN26	131 km
ERU III	Part of RN6 and RN7	110 km
ERU IV	Part of RN1 and RN15	158 km
	Drainage Unit	550 km
	Transport Unit	550 km
	Aggregate Production Unit	550 km
	Mobile Workshop Unit	550 km

- Recovery work for the sections from Takeo to Vietnam border in RN2, and from Ang Tasom to Kampot in RN3 will be done by reorganizing and reinforcing the existing RBD's road rehabilitation units and provincial public works of Takeo and Kampot.

- Rehabilitation project for RN4, which was constructed in the mid-1960s, will start within a year assisted by USAID. The construction period is anticipated to be 2 to 3 years. The project also covers the section from Kampot to the junction with RN4. The construction equipment to be used for the project will be possibly transferred to RBD for the maintenance of the completed road. The Road Construction Center will be responsible for these equipment which may be transferred to RBD.
- Urgent repair project has been under way for the section around from Kompong Chhnang to Sisophon in RN5 financed by UNDP, the Governments of Australia and Sweden, etc. The RBD is involved therein on force account basis, in which almost all construction equipment possessed by the existing road rehabilitation units "5A" and "5B" are being concentrated. The works are grouped into routine and periodic maintenance which correspond to the item defined in the above.
- In parallel with the above emergency recovery project, the UNDP has programmed to start an extensive rehabilitation project for the entire sections of RN5 applying the ADB's fund available. The work is defined as rehabilitation of "short term objective" which work effects last for five years or more after the completion. However, it is obvious that successive routine and periodic maintenance work will be necessary.
- Also the emergency repair of any other sections out of the scope of the Project should be executed by the RBD's existing fleet according to priority order of the roads.

Proposed formation of ERUs in relation to the works is summarized as follows:

Unit Formation	Operations	Physical Allocation
(1) ECU I	<p>Routine Maintenance</p> <ul style="list-style-type: none"> •Asphalt patching(bitumenous road) •Base failure repair(bitumenous road) •Blading of laterite road •Spot repair of laterite road •Ditch cleaning •Shoulder blading <p>Periodic maintenance</p> <ul style="list-style-type: none"> •Base course (bitumenous road) •Regravelling (laterite road) •Shoulder •Asphaltic surface course <p>Production of selected material (borrow pit)</p>	<p>Trunk National Road Emergency Repair Units (ERUs) belong to Road Construction Center in order to reinforce, supplement and jointly work with the existing National Road Rehabilitation Units</p>
(2) ERU II	Same as above	
(3) ERU III	Same as above	
(4) ERU IV	Same as above	
(5) Drainage Unit	Recovery of drainage structure	
(6) Transport Unit	Transport of construction materials & equipment	
(7) Aggregate Production Unit	Production of aggregates for surface course and concrete structures	
(8) Mobile Workshop Unit	Maintenance and repair services on site	

Determination of construction equipment to be supplied is made as follows:

$$\text{Required number of operation group} = \frac{\text{(Required work volume per year)}}{\text{(Productivity per operation group per year)}}$$

$$\text{Required number of equipment} = \text{(Equipment composition of a operation group)} \times \text{(Required number of operation group)}$$

Calculation of required number of operational group, equipment composition of a operation group and required number of equipment are detailed in ANNEX 11, for which following conditions are taken into account.

- Each ERU shall be a self-sustainable fleet. However, the equipment to be used in part-time and for limited purpose shall be arranged in a common unit.
- Because the emergency repair works required under the Project corresponds largely to routine maintenance than periodic maintenance above defined, the equipment proposed for the routine maintenance are given an priority, i.e. motor grader, asphalt kettle sprayer, hand guide roller, rammer, etc.
- The transport unit and mobile workshop unit will provide services to the four ERUs in transport or maintenance of construction materials and equipment. Heavy equipment allocated to the Drainage Unit and Aggregate Production Unit are also used for immediate road repair work, if emergent and necessary.

The proposed equipment schedule is shown in Table 3-7.

Expected annual production is shown in Table 3-8.

Table 3-7 Equipment Schedule proposed under the Project

Equipment	Number	Remarks
<u>ERUs/Road Construction Center</u>		
1. Bulldozer	4	1/1repair unit
2. Motor grader	4	1/1repair unit
3. Wheel loader	4	1/1repair unit
4. Excavator	2	1/2repair units
5. Tandem roller	2	1/2repair units
6. Vibration roller	4	1/1repair unit
7. Dump truck	8	2/1repair units
8. Asphalt distributor	2	1/2repair units
9. Asphalt kettle sprayer	4	1/1repair unit
10. Rammer	4	1/1repair unit
11. Hand guided vibration roller	4	1/1repair unit
12. Water tanker	4	1/1repair unit
13. Fuel tanker	4	1/1repair unit
14. Pickup	4	1/1repair unit
15. Station wagon	4	1/1repair unit
16. Chip spreader	2	1/2repair units
<u>Central Workshop/Road Construction Center</u>		
1. Hydraulic track crane	1	Transport Unit
2. Trailer / Tractor	1	Transport Unit
3. Mobile workshop	1	Mobile Workshop Unit
4. Wheel loader	2	Aggregate Production Unit
5. Tractor shovel	1	Aggregate Production Unit
6. Mobile stone crusher	1	Aggregate Production Unit
7. Pickup	2	Mobile Workshop Unit
8. Station wagon	1	Mobile Workshop Unit
9. Flat bed truck	2	Transport Unit
10. Crawler drill	1	Aggregate Production Unit
11. Air compressor attached to crawler drill	1	Aggregate Production Unit
12. Air compressor	2	Aggregate Production Unit
13. Generator	2	Drainage Unit
14. Concrete cutter	1	Common use
15. Line marker	1	Common use
16. Concrete mixer	4	Drainage Unit
17. Concrete vibrator	8	Drainage Unit
18. Asphalt kettle	2	Transport Unit
19. Water pump	4	Drainage Unit
20. Radio set	11	Common use

Table 3-8 Proposed Road Repair Work by ERUs

Item	Annual Production
1. Routine Maintenance (Emergent Repair)	
Asphalt patching	500 km/year
Base failure repair	500 km/year
Blading of laterite road	100 km/year
Spot repair of laterite road	100 km/year
Ditch cleaning	120 km/year
Shoulder blading	600 km/year
2. Periodic Maintenance (Emergent Rehabilitation)	
Base preparation	68 km/year
Gravel resurfacing	14 km/year
Shoulder rehabilitation	160 km/year
Bituminous surface work	68 km/year
Production of selected material	70,000 m ³ /year
3. Drainage Structure Unit	
Drainage structure	2,000 m ³ /year
4. Aggregate Production Unit	
Production of crushed stone	10,000 m ³ /year

3.2.6 Necessity of the Technical Assistance

The Road Construction Center intends to play a leading role in extending the overall roads recovery operations in Cambodia. The mandate will not be limited to implement the present emergency recovery programme, but also materialize the rehabilitation and reconstruction projects within medium and long term road improvement programme. Under the present severe conditions, particularly with scarce allocated resources, precise and realistic planning and management staff will be required in the fields of road administration, construction scheme and equipment control. When considering the present technical strength and capacity available in Cambodia, intensive and continuous support for training of such staff by expatriate experts seems necessary.

The workshop attached to the Road Construction Center will be the sole and unique workshop in Cambodia which can provide an essential series of maintenance and repair services. Generally, an initial operation is considered very important for efficient and smooth operation in routine. Also, when an improvement or establishment of other workshops at important cities be realized, this very workshop will become a leading case, thus a continuous in the workshop training by expatriate experts in the fields of workshop management and equipment repairs are regarded very significant. The Government of Cambodia has requested an assistance from the Government of Japan in such fields. The study team recommends the Government of Japan to study possibility of the assistance.

3.2.7 Basic Policy For Project Cooperation

After the proposed Project has been examined from variety of viewpoints, with inclusion of review of the background, objectives, contents, appropriateness of implementation programme, and management plan, etc., the necessity for the Project, the feasibility of Project and implementation capability of Cambodian side, are confirmed. The Project also complies with Japanese grant aid cooperation criteria, so that the Project not only improves the efficiency of construction equipment for the prompt rehabilitation of infrastructures essential to a consolidation of the economic activities in Cambodia, but also by upgrading equipment repair skills and building the men and institutions through the provision of OJT at the Road Construction Center contributes to create capable work forces and circles in Cambodia. These analyses ensures that the Project conform to the objectives of Japanese grant aid cooperation and its implementation be appropriate. In terms of the positive prospects, the implementation of the Project with Japanese grant aid appears highly recommendable.

3.3 Outline of the Project

3.3.1 Executing Agency

Executing agency is the Roads and Bridges Department (RBD) under the control of the Ministry of Public Works and Transport (MPTW).

(1) Structure

Fig. 3-2 shows the organization and function of the Road Construction Center under the reorganized RBD. Structure required for an operation after completion of the Project is outlined below:

1) Road repairs

Staff and laborers required for an execution of repair works of the trunk national roads after the equipment be introduced (4-ERUs and ancillary units) is summarized as follows:

Status	For the Road Emergency Repairs	Existing Number
Engineer	5	
Assistant engineer	7	
Foreman	15	
Operator	30	
Driver	40	
Laborer	90	
Carpenter	8	
Mechanic	3	
Assistant mechanic	5	
Oddmen	2	
	205	386

Existing number indicates the strength of existing Road Rehabilitation Units, i.e. RN1, RN2+3, RN5A, RN5B and RN6, which are being reorganized into the Road Construction Center.

2) Equipment repair and maintenance at the Central Workshop

Staff and laborers required for an execution of equipment repair and maintenance at the Workshop under the Project is as follows:

Status	For the Road Emergency Repairs	Existing Number
Engineer	3	
Assistant engineer	6	
Foreman	13	
Mechanic	22	
Assistant mechanic	25	
	69	88

The table indicates that existing personnel capacity for both operation and maintenance seems rather satisfactory for an additional equipment to be introduced under the Project.

3.3.2. Plan of Operation

The equipment to be introduced under the Project will form four Emergency Repair Units (ERUs), a drainage unit, a aggregates production unit, a transport unit and a mobile workshop unit. The ERUs are not only confined to the construction work, but also cover:

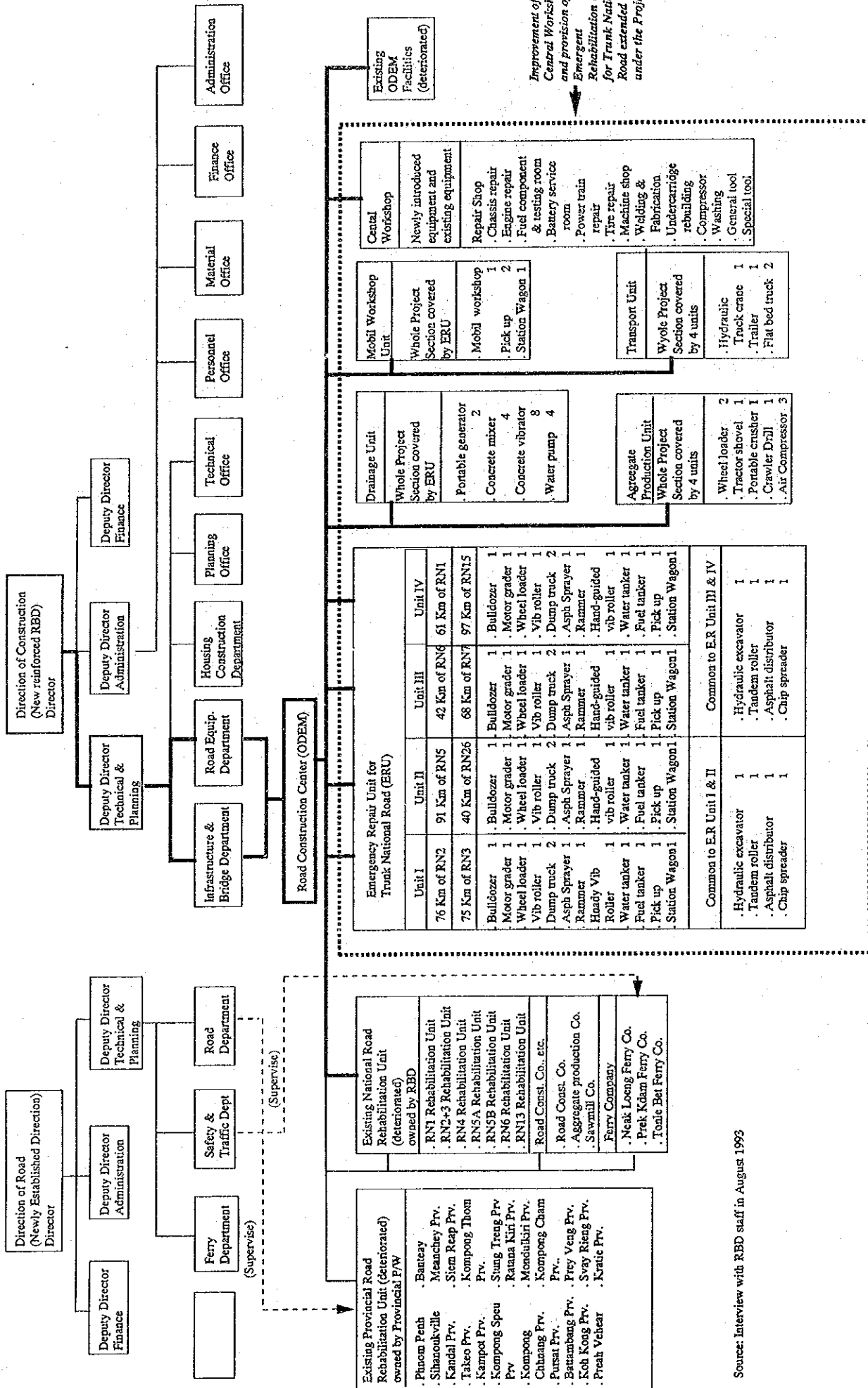
- Preparation of road inventory of the objected road,
- Survey and identification of the road sections to be repaired,
- Design and cost estimates of repair work of road,
- Coordination with planning section of the Road Construction Center,
- Scheduling of repair works according to priority.

Once a repair work of the specific section is decided to start, the relevant repair unit shall prepare a plan of operation comprising material-, equipment-, labor- and time schedule, etc. In the case of asphalt patching work in routine maintenance operation, selected materials from borrows pit, aggregates from quarries, bitumen from the Road Construction Center shall be delivered to the sites prior to the commencement of the works. In parallel with the delivery of materials, the ERU will organize an asphalt patching group from available equipment such as wheel loader, tandem roller, dump truck, asphalt kettle sprayer, rammer, hand guided roller, etc., then, execute a

patching work from one site to another. Where deterioration of a section exceeds the degree of patching work in routine maintenance, the base course preparation and asphalt surface works in periodic maintenance are required. In this case, base course group and asphalt patching group will be organized using bulldozer, motor grader, wheel loader, tandem roller, vibration roller, water tanker, asphalt distributor, chip spreader, etc.

Since the number of common use equipment is limited, it is not possible to assign them to each operation group exclusively and continuously. The equipment are not necessarily used at the same time, but most of them are of part-time use only, thus a careful rotation system shall be established. In view point of effectiveness in use, the equipment shall be used without an interruption due to moving from one work group to another. As for heavy equipment, an operator will be fixed to specific equipment, i.e. an operator shall move from one site to another with the equipment, which will enable for the operator to oversee easily the condition of equipment, then to facilitate the preventive maintenance of the equipment.

A maintenance system can be established in conjunction with an improvement of the central workshop. An introduction of a mobile workshop will enable the preventive maintenance be made on site. An adequate member of mechanics shall be assigned to the mobile workshop. The purpose of an improvement of workshop is an improvement of work efficiently of the construction equipment. Consequently, on-the-job training at the improved workshop will be one of the most essential factors for successful operation of the workshop. An effective training system needs to be established, together with an establishment of training facilities in as nearby as possible future. Typical work flow at the workshop is shown in Fig. 3-3.



Source: Interview with RBD staff in August 1993

Fig. 3 - 2 Organization and Function of The Road Construction Center (ODEM) under the Reorganized MOPW and RBD (Proposed by MOPW in August 1993)

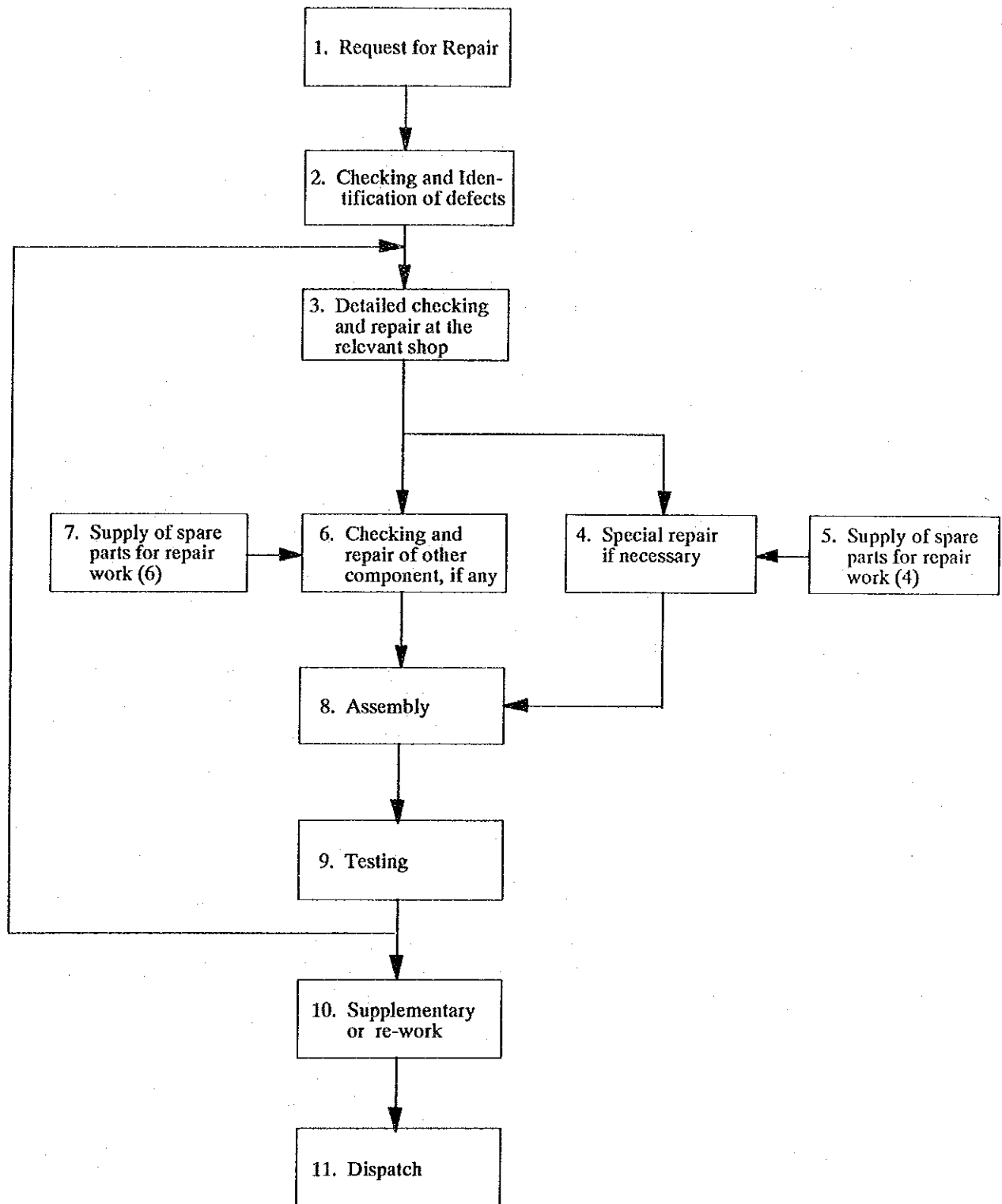


Fig. 3 - 3 Typical Workflow at Workshop

3.3.3 Location and State of the Project Site

(1) Facilities

The Road Construction Center is located at around 14 km in the western suburb of Phnom Penh along RN4. The premises is of 14ha (400m long in NS direction, 350m long in EW direction), and is almost flat.

(2) Access to the Site and Condition of infrastructures

RN4 (Phnom Penh - Sihanouk Ville or Phnom Penh to the ODEM site) is one of the most important national roads in Cambodia, and is rather well maintained. There is no public water supply, sewage line and power supply around the ODEM site.

3.3.4 Natural Condition

(1) Climate

Phnom Penh is located in the Mekong basin. The climate is categorized as of tropical monsoon. A year is divided into two seasons, i.e. dry season (November - April) and wet season (May-October). Monthly temperature and rainfall in Phnom Penh is shown in Table 3-9.

Table 3-9 Average Monthly Temperature and Rainfall in Phnom Penh

Month	1	2	3	4	5	6	7	8	9	10	11	12
Temperature (°C)	26.1	27.5	28.9	29.4	28.8	28.1	27.6	27.7	27.3	27.2	26.7	25.4
Rainfall (m/m)	9	8	28	73	146	129	129	147	231	250	134	36

(2) Wind

The maximum wind velocity of 12m/sec recorded is rather modest.

(3) Earthquakes

Cambodia has not been hit by severe earthquake

3.3.5 Outline of the Facilities and Equipment

(1) Buildings and Facilities

Buildings and facilities to be rehabilitated and/or constructed are summarized in Table 3-10.

Table 3-10 Outline of the Facilities

Item	Shop / Room	Remarks
1	<p>Workshop (A)</p> <ul style="list-style-type: none"> - Chassis repair shop - Engine repair shop - Fuel component repair & test room - Electric component repair & test room - Battery service room - Power line repair room - Machine shop - Welding and fabrication shop - Undercarriage rebuilding shop - General tools & special tools room - Parts warehouse - Office / Reception - WC / Pantry, Corridor 	New construction/reinforced concrete structure, one story building, steel truss structure
2	<p>Workshop (B)</p> <ul style="list-style-type: none"> - Garage - Parts storage 	Rehabilitation of existing workshop building/flooring, reinforcement of existing pillar & beam, roofing
3	<p>Operation Quarter & Warehouse</p> <ul style="list-style-type: none"> - Engineer's room - Office - Meeting room - Practice room - Warehouse of equipment/materials - Locker-resting room - Shower room - WC 	Rehabilitation of existing vehicle & machine shop building/flooring, reinforcement of existing pillar & beam, roofing
4	<p>Garage & Parts Storage</p> <ul style="list-style-type: none"> - Parts storage - Garage 	Rehabilitation of existing warehouse building/flooring, reinforcement of existing pillar & beam, roofing

5	Administration Office - Director's room - Deputy Director's room - Engineer's room - Meeting room - Practice room - Office / Reception - Storage - Pantry - WC, Corridor	New construction/reinforced concrete structure, one story building
6	Other Ancillary Facilities - Generator house - Fuel stand - Washing stand - Paint shop - Unloading deck - Equipment yard - Elevated water tank & well - Parking - Guard house - Power lead-in - Transformer facility - In-site announcing facility	Rehabilitation of existing facilities/new construction
7	Water Supply Facility	New installation
8	Power Supply Facility	Now installation
9	Sewage Facility	New installation
10	In-Site Road	Concrete paving
11	Equipment Yard	Gravelling

(2) Workshop Equipment

Maintenance equipment to be supplied for the workshop are summarized in Table 3-11

Table 3-11 Outline of the Workshop Equipment

Item	Name	Functions / Remarks
1	Chassis Repair Equipment & Tools - Overhead traveling crane 5 ton and 3 ton - Hydraulic jack - Tractor support (front & rear) - Tractor lift & cart - Lubricator	- Dismounting and mounting of heavy component - Lubrication after repair & assembly
2	Engine Repair Equipment & Tools - Jib crane 3t, Engine positioner, etc. - Cylinder boring machine, Boring machine, Electric grinder etc.	- Dismounting and mounting of engine - Repair of parts
3	Fuel Component Repair and Testing Equipment & Tools - Fuel injection pump tester, pump, etc.	- Repair and testing of fuel injection system
4	Electric Component Repair & Testing Equipment & Tools - Starter generator test bench, Regulator tester	- Testing of starter motor, A.C. generator, etc.
5	Battery Service Equipment & Tools - Silicon quick charger	- Repair and charging of battery
6	Power Train Repair Equipment & Tools - Engine positioner, Mobile floor crane	- Dismounting and mounting of component
7	Machine Tool - Lathe, Bench drill press, Hack sawing machine	- Fabrication of parts

8	Welding and Fabrication Equipment & Tools - A.C. arc welder, Gas-shield arc welder etc. - Hydraulic press	- Welding - Fabrication
9	Undercarriage Repair Equipment & Tools - Roller and idler press, Track press, shoebolt impact wrench	- Dismounting and mounting
10	Air Compressor	- Supplying compressed air
11	Tire Repair Equipment & Tools - Hydraulic tire removing tool, Termopress, etc.	- Removing and repairing of tire
12	Cleaning Equipment & Tools - Hot water high pressure washer, steam cleaner	- washing and cleaning
13	General & Special Tools	- Tools used for workshop equipment and construction equipment
14	Parts Rack - Racks of various dimension	- Storage of small size spareparts

3) Construction Equipment

Construction equipment to be supplied are summarized in Table 3-11.

Table 3-12/1 Outline of the Construction Equipment

Item	Name	Qty	Functions / Remarks
For Emergency Repair Unit (ERU)			
1.	Bulldozer with ripper 21 t class	4	- Scarifying of existing pavements & base courses - Fill work - Borrow pit operation
2.	Motor Grader 3.7 m class	4	- Scarifying of pavement & base courses, re-forming of sub-grade - Spreading and forming of base course - Grading of shoulders, gravel/laterite roads - Grading of earthen side ditch

Item	Name	Qty	Functions / Remarks
3.	Wheel Loader 12 t class	4	- Loading of borrow materials on to dump trucks - Loading of base course materials and surface course materials at site
4.	Hydraulic Excavator 19t class	2	- Excavation of side ditch - Excavation & loading of borrow materials - Excavation of drainage structures
5.	Tandem Roller 10 t class	2	- Compaction of surface course (macadam or double bitumen surface treatment: DBST)
6.	Vibration Roller 10 t class	4	- Compaction of filling and base courses
7.	Dump Truck 10 t class	8	- Disposal of extra excavated materials - Transport of excavated & borrow materials - Transport of aggregates
8.	Asphalt Distributor 6,000 lr.	2	- Transport of bitumen - Spreading of bitumen (for large area operation)
9.	Asphalt Sprayer	4	- Spraying of bitumen (for small area operation)
10.	Rammer	4	- Compaction of base course in patch works or pot hole repairs
11.	Hand Guided Vibration Roller 1 t	4	- Compaction of surface course in patch works or pot hole repairs
12.	Water Tanker 8,000 lr	4	- Watering of compacted materials - Water supply to site
13.	Fuel Tanker 8,000 lr	4	- Fuel supply to site

Item	Name	Qty	Functions / Remarks
14	Pick up	4	- Transport of tools, small sized equipment, materials & labors - Supervision of works
15.	Station Wagon	4	- Survey works - Supervision of works
16.	Chip Spreader	2	- Spreading of aggregates for surface course (macadam or DBST)

Table 3-12/2 Outline of the Construction Equipment

For Drainage Unit, Aggregate Production Unit, Transport Unit, Mobile Workshop Unit			
1.	Hydraulic Truck Crane 30 t class	1	- Loading and unloading of construction equipment and materials - Installation of drainage structures
2.	Trailer & Tractor 25 t class	1	- Transport of construction equipment
3.	Mobile Workshop	1	- Maintenance and repair of construction equipment at site
4.	Wheel Loader 16 t class	2	- Loading of aggregates onto dump trucks at quarry
5.	Tractor Shovel 18 t class	1	- Loading of aggregates onto dump trucks at quarry
6.	Portable Stone Crusher 30 - 40 t/h	1	- Production of aggregates
7.	Pick up	2	- Transport of tools, small sized equipment, materials & laborers - Supervision of works
8.	Station Wagon	1	- Supervision of works
9.	Flatbed Truck	2	- Transport of tools, construction equipment & materials
10.	Crawler Drill	1	- Drilling of blasting hole at quarry

Item	Name	Qty	Functions / Remarks
11.	Portable Air Compressor 17m ³ /min.	1	- Supply compressed air for crawler drill
12.	Portable Air Compressor 5 m ³ /min.	2	- Rock excavation at quarry - Supply compressed air for breaker for rock breaking or demolition of existing structures
13.	Generator 50 KVA	2	- Lighting for night works at site - For pump - For welder
14.	Concrete Cutter	1	- Cutting of existing asphaltic concrete pavement for patch works
15.	Hand Guided Line Marker	1	- Line marking on carriageways
16.	Concrete Mixer 1.0 m ³	4	- Production of concrete mix for drainage structures
17.	Concrete Vibrator	8	- Concreting for drainage structures
18.	Asphalt Kettle 6m ³	2	- Storage of bitumen
19.	Water Pump	4	- Pumping up of water for drainage structural work
20.	Radio Set	11	- Communication between the Road Construction Center, construction sites and Provincial Public Works depots

3.3.6 Equipment Maintenance Plan

(1) Maintenance Operation

Maintenance and repair of the equipment to be introduced under the Project will be executed in stages. The range of the responsibilities in each stage will be concretely defined. Early stages cover routine and periodic maintenances, which include cleaning, checking of fuel, lubricant, grease up, parts change, idling, and minor repair. The maintenance works in these stages will be executed by the mobile workshop to be introduced under the Project. Further stages which deal with major parts change, major repair including engine overhaul will be conducted at the Workshop which will be improved under the Project.

(2) Maintenance Organization

In line with improvement of the Road Construction Center's workshop, the organization will be strengthened to realize effective equipment maintenance operation.

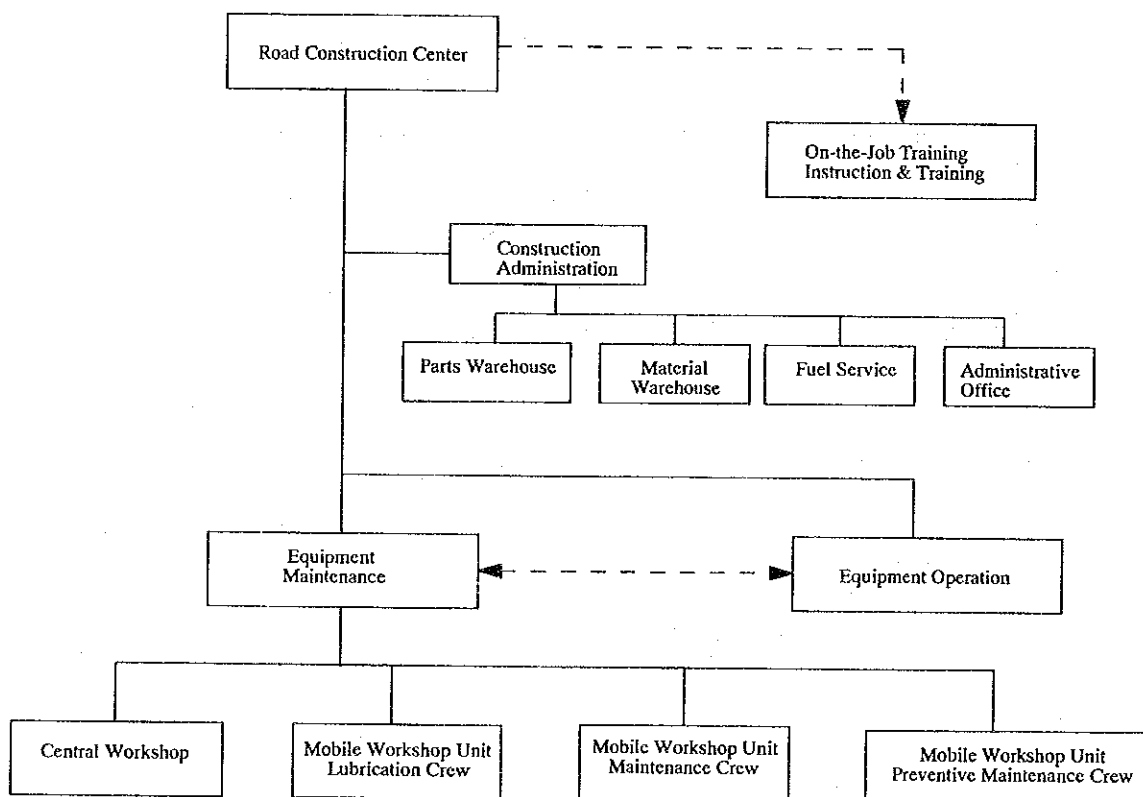


Fig. 3-4 Maintenance Organization

CHAPTER IV. BASIC DESIGN

CHAPTER IV BASIC DESIGN

4.1 Design Policy

The primary objective of the proposed facilities are to improve production rate of the construction equipment through regular provision of an appropriate repair services and training of relevant technical staff and mechanics through OJT system developed at the workshop. Consequently, the design policy for workshop facilities and equipment is to place an emphasis on a function of the workshop as a key repair station, and also on the safety and easiness to use and maintain. The design policy should also be compatible with local practices and conditions including technical level and natural factors.

4.1.1 Natural Conditions

(1) Climate

The climate is characterized with high temperature and humidity of tropical monsoon throughout a year. Appropriate type of air conditioning equipment will be installed in the rooms for the Director, Assistant Director and Expatriate Staff, and electric fans in the other rooms.

(2) Topography

Phnom Penh is situated in the Mekong basin and the ground is low and flat. The study team conducted a topographic survey, which results are appended in Annex 6.

(3) Soil

Bearing strength of the ground seems to be nearly 30 ton/m² judged from the site inspection. In this basic design, 20 ton/m² of bearing capacity of ground will be adopted.

(4) Ground water

Ground water is supposed to lie between 10m to 30m below the ground level. The existing wells will be rehabilitated to supply water for the facilities within the complex.

(5) Earthquake

Presently, there are no building standards or criteria prescribed in Cambodia. There is no concept of an seismic design either. Hence the essential part of the Japanese Building Standards be adopted.

(6) Wind

Maximum wind velocity recorded in the area is 12m/sec. Considering safety 20m/sec is adopted as design wind velocity.

4.1.2 Social Conditions

Consideration will be given to the local customs, including a use of Thai style water closets in the design of facilities.

4.1.3 Local Construction Industries

(1) Permits and Authorization for Building Construction

No Government permit or authorization is required in Cambodia for planning and construction of buildings. Also, there are no laws regulating building construction. The buildings constructed with financial assistance from foreign donor agencies uses their own building standards.

(2) Related Laws and Regulations to Building Construction

There is no laws regulating construction works under the Project. Since the facilities to be constructed or rehabilitated under the Project is located within an existing premise of the Road Construction Center, no law interferes with an implementation of the Project.

(3) Technical Level of Local Construction Companies

Private construction contractors, architect design offices and building consultants have not been developed in Cambodia to date. Due to hostilities in past 2 decades, and socio-economic confrontations therefrom, activity of construction companies was virtually impossible, except for some state owned enterprises established after 1979. Since Paris Accords in 1990, construction of hotel, restaurants, and other facilities have been booming being inspired by the mobilization of UNTAC and other foreign agencies, etc. Most

constructions are contracted by several construction companies of Singapore, Thailand or Hong Kong. Cambodian private companies are established as sub-contractors to the foreign contractors. The trend will continue even after withdrawal of UNTAC. Detailed design and supervision of the constructions under the Project will be contracted by Japanese consulting firms. Several part of the works such as building construction or equipment installation may be sublet to local contractors, however, under the circumstances mentioned above, sub-contractors could be selected from Singapore, Thailand and Hong Kong origins, etc. Considering production rate, technical skills and efficiency of mobilization, sub-contractors from Thailand is considered most competitive and appropriate, if necessary. Precise schedule control of construction is very essential in order to complete the works within relatively short period with the Japanese grant aid cooperation system.

(4) Technical Skills and Availability of Local Workers

All the workers at existing construction sites in Phnom Penh seem Cambodians, but exceptionally, there are some Vietnamese and Thais. In respect to capability and availability of workers, no specific problems are anticipated.

(5) Quality and Availability of Local Construction Materials

Construction materials such as cement, sand, gravel, bricks, concrete blocks, reinforced bars and frame materials, etc. will be supplied from local sources. Finishing materials such as wooden furnishings, seal furnishings, aluminum furnishings, ceiling board, calcium silicate board, and electrical equipment such as switch boards, distribution board, control board, electric cables, cable pipes, lighting fixtures, air conditioner, electric fan, ceiling fan shall be procured from Thailand. However, industrial products of high quality such as generator, instrument for fuel station, radio instruments, pump, etc. shall be procured from Japan.

(6) Transport Infrastructure

Cambodia has two international ports, i.e. Phnom Penh river port and Sihanoukville sea port. The former handles fairly light and small to medium sized cargoes because only shallow draft ships be allowed to anchor (at most 3,000 ton class), while the latter deep sea port can deal with heavy and large sized goods transported by large ocean liners (at most 20,000 ton class

vessels). Landing facilities of Sihanoukville port is well established, thus unloading operation can be conducted without long anchorage.

RN4 is one of the most important road of the country with 7 meter wide asphalt pavement, and the surface condition is fair. Accordingly, regarding route of transport for the goods imported from Japan or the third country, those with heavy and large size shall be unloaded at Sihanoukville port, then use RN4 for inland transport. However, for small to medium sized goods Phnom Penh port seems appropriate for security purposes.

Other infrastructure such as water supply, power line, sewage system are not available around the Project site. Power supply by generator for continuous operation of the facilities is required.

4.1.4 Use of Local Construction Companies, Equipment and Materials

(1) Use of Local Companies

Maximum use of local companies as sub contractors to the Japanese prime contractor under the Project will contribute to the transfer of construction technology, and also generate direct economic benefits in local construction market.

(2) Local Availability of Construction Equipment

Most of the equipment to be used for the construction can be leased locally, which includes 20ton truck crane required to erect the roof structures and overhead crane.

(3) Use of Local Material

Construction materials such as cement, sand, gravel, bricks, concrete blocks, reinforced bars and frame materials, etc. can be procured from local sources.

4.1.5 Operation and Maintenance Capability of the Implementing Agency

As for building construction, the method to be familiar in Cambodia and materials locally available shall be used as much as possible for the easier maintenance in future. As for facilities, the locally available equipment and materials which are also

easy to operate and maintain will be employed. Tools and equipment supplied for the workshop shall be of popular use and of easy maintenance.

4.1.6 Scope and Level of Facilities and Equipment

(1) Facility

The Basic Design must take into account the natural and social conditions, status of local construction industry and technical level as well as operation and maintenance capacity of the Implementing Agency after completion of the Project. It also intends to minimize the construction period and cost employing appropriate construction materials and method.

The facilities under the Project are intended to function as headquarter for an implementation of the emergency road repair of trunk national roads for the first place, and also medium and long term roads improvement in near future including a workshop function mandated to provide essential repair services for the construction equipment currently used and newly introduced for the road works. Thus the facilities shall be designed not only to meet the present requirements but also to allow for future extension of the functions.

The facilities comprises:

- Workshop (A) (construction of a new building),
- Workshop (B) (rehabilitation of the existing workshop),
- Operation Quarter and Warehouse (rehabilitation of the existing machine shop),
- Garage and Warehouse (rehabilitation of the existing warehouse),
- Administration Office (construction of a new building),
- Other Facilities.

Land reclamation, planting, installation of fence or wall, etc., are excluded from the scope of works.

(2) Equipment

The maintenance equipment shall be not only to meet a minimum requirement but also to be able to provide an essential and common services. The construction equipment shall be to correspond to the minimum requirement for

the emergency road repair works required for the important road sections of the trunk National Roads.

4.1.7 Implementation Schedule

The Project will be implemented over two Japanese fiscal years. The programme for each fiscal year of both facility construction and equipment procurement shall be finished within the same fiscal year in accordance with the regulation of the Japanese grant aid system. The Project components in each fiscal year are as follows:

As virtual functions of the RBD may now start to shift from Phnom Penh to the Road Construction Center and earlier opening of an administration office is necessary, its completion is programmed in the first fiscal year. Construction equipment to be provided in the first fiscal year comprises those in order to form a single Road Emergency Rehabilitation Unit (ERU), an aggregate production unit and a transport unit. As for the workshop equipment, the installation schedule requires to be coordinated with construction of the workshop (A), the procurement is programmed in the second stage.

4.2 Examination of Design Conditions

4.2.1 Facility Plan

(1) Calculation of Required Number of Service Bays

Number of service bays is calculated to determine the size and dimensions of the facilities under the Project. The RBD has a total of 259 operable machines and vehicles as of August 1993. There is no any available workshop in Cambodia except the Road Construction Center to be improved under the Project. Then, all the equipment of the RBD will be repaired at this workshop after improved. Dimension of a bay is to be 6mx12m which is generally adopted in Japan. Number of bays was determined as follows:

Chassis repair shop	4 bays (Workshop A)
Undercarriage shop	2 bays (Workshop A)
Vehicle repair shop	2 bays (Workshop A)
Vehicle repair shop	13 bays (Workshop B)
<hr/>	<hr/>
Total	21 bays

This facility will be able to repair 100 heavy equipment and 350 vehicles for a year on an assumption that annual working days to be at 250 days.

(2) Floor Area of Each Shop/Room

1) Workshop A (new building)

Floor area of each shop/room, was determined as follows:

- a) Chassis repair shop : 4 bays
- b) Heavy vehicle repair shop : 1 bay
- c) Light vehicle repair shop : 1 bay
- d) Undercarriage repair shop : 2 bay
- e) Engine repair shop : Determined by dimension & layout of equipment
- f) Fuel component repair & test room : Same as above
- g) Electric component repair & test room: Same as above
- h) Battery service room : Same as above
- i) Power line repair room : Same as above
- j) Machine shop : Same as above
- k) Welding & fabrication shop : Same as above
- l) Tool room : Same as above
- m) Parts storage : Same as above
- n) Office : 4.5 - 5.5 m²/person
- o) WC : 1 place

2) Workshop B (rehabilitation of the existing workshop)

: No change of floor area

3) Operation Quarter & Warehouse (rehabilitation of the existing machine shop)

- a) Engineer's room : 5.0 m²/person
- b) Office : 4.5 - 5.5 m²/person
- c) Meeting room : 3.5 - 4.5 m²/person
- d) Practice room : 3.0 - 4.0 m²/person
- e) Warehouse : 1 place
- f) Locker & resting room : 3.5 - 4.5 m²/person
- g) Shower room : 1 place
- h) WC : 2 places (men x 1, women x 1)

4) Parts Storages & Garage (rehabilitation of the existing warehouse)
: no change of floor area

5) Administration Office (new building)

- a) Director's room : 30 - 35 m²/person
- b) Deputy Director's room : 15 m²/person
- c) Engineer's room : 15 m²/person
- d) Meeting room : 3.5 - 4.5 m²/person
- e) Practice room : 3.0 - 4.0 m²/person
- f) Office : 4.5 - 5.5 m²/person
- g) WC : 2 places (men x 1, women x 1)

(3) Path of Flow

1) Workshop (A)

The chassis repair shop, undercarriage repair shop and heavy & light vehicle repair shop shall be located at facade of the workshop building to facilitate equipment going in and out of the building. Other shops and rooms shall be located at the inner part of building. The engine repair room, welding & fabrication shop which issuing noise shall be located apart from the office.

2) Supplementary Facilities

Two overhead cranes with lifting capacity of 5ton and 3ton respectively will be installed in the workshop service bays. A jib crane will be installed at the engine repair shop. Each bay shall be equipped with at least a compressed air outlet and a power outlet.