

Table 3.2-4 LIST OF REQUESTED EQUIPMENT (2/2)

| EQUIPMENT | SURAT THANI | SONG KHLA | TOTAL |
|-------------------------------------------------|-------------|-----------|------------|
| 6. TRANSPORTATION | | | |
| 6.1 Water Truck | 6 | 4 | 10 |
| 6.2 Fork Lift Truck | 1 | 1 | 2 |
| 6.3 Fuel Truck | 2 | 2 | 4 |
| 6.4 Service Truck | 1 | 1 | 2 |
| 6.5 Flat Bed Truck | 5 | 1 | 6 |
| 6.6 Crane Truck | 2 | 1 | 3 |
| 6.7 Truck Trailer + Semi-Trailer | 2 | 1 | 3 |
| 6.8 Self-Loading Truck Extra Long Wheel Base | 1 | 1 | 2 |
| Sub Total (6) | 20 | 12 | 32 |
| 7. MULTIPLE PURPOSE EQUIPMENT | | | |
| 7.1 Farm Tractor | 0 | 1 | 1 |
| 7.2 Truck Tractor | 0 | 1 | 1 |
| 7.3 Diesel Generator | 2 | 2 | 4 |
| 7.4 Portable Generator | 4 | 5 | 9 |
| 7.5 Mobile-Workshop | 1 | 1 | 2 |
| 7.6 Over-Head Crane | 1 | 1 | 2 |
| Sub Total (7) | 8 | 11 | 19 |
| 8. INSPECTION CAR/MICRO BUS | | | |
| | 10 | 7 | 17 |
| Sub Total (8) | 10 | 7 | 17 |
| TOTAL | 87 | 67 | 154 |

3.2.5 Study on Need of Technical Assistance

The dispatch of Equipment based Construction experts and mechanical engineers is requested by the Government of the Kingdom of Thailand as described in the Minutes of Discussion signed on February 5th 1991 at the time of field survey on the Project.

This assistance is, as described in Clause 4.4.3, planned into "technical training on equipment operation and maintenance" and "inspection and delivery" aiming at the guidance for inspection, operation and maintenance of the Supplied equipment, also for the planning and management of effective utilization of equipment on each Project.

3.2.6 Basic Policy for Cooperation

Based on the study and examination mentioned in the previous sections, the necessity and effect of the Project were favorably evaluated and the capability of Project execution and equipment maintenance of the Government of the Thailand was confirmed. Moreover, the effect of the Project was assessed to be confirmed with Japan's Grant Aid System. Therefore the implementation of the project by Japan's Grant Aid Programm was evaluated so adequate.

3.3 PROJECT DESCRIPTION

3.3.1 Executing Agency and Operational Structure

The executing agency of the Government of Thailand for the Project is the Department of Highways, Ministry of Transport and Communications. Surat Thani and Song Khla Road Construction Centers are the executing agencies for the implementation of the Project.

Organization and number of personnel of Surat Thani Road Construction Center are shown in Tables 3.3-1 and 3.3-2, and Song Khla Center are shown in Tables 3.3-3 and 3.3-4.

The Project aims at providing the necessary road construction equipment of Rank A for Surat Thani Center 34 units and Song Khla Center 24 units. The equipment presently owned by both Centers are short in quantities for their organization and project size. Their equipment have become old and some necessary equipment are borrowed from private companies. Based on this situation, it is considered that the Proposed equipment will be effectively utilized, well maintained and efficiently operated. However, the level up of skills for operation and maintenance of up-dated new equipment, and effective placement and utilization of equipment fleets for each Project will be required.

Table 3.3-1 (1) SURAT THANI ROAD CONSTRUCTION CENTRE

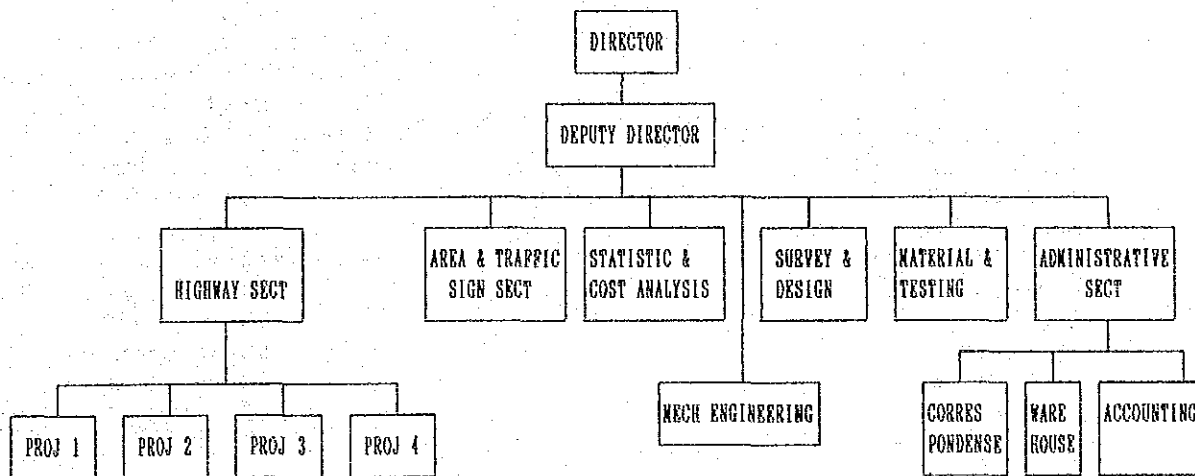


Table 3.3-1 (2) MECHANICAL ENGINEERING SECTION

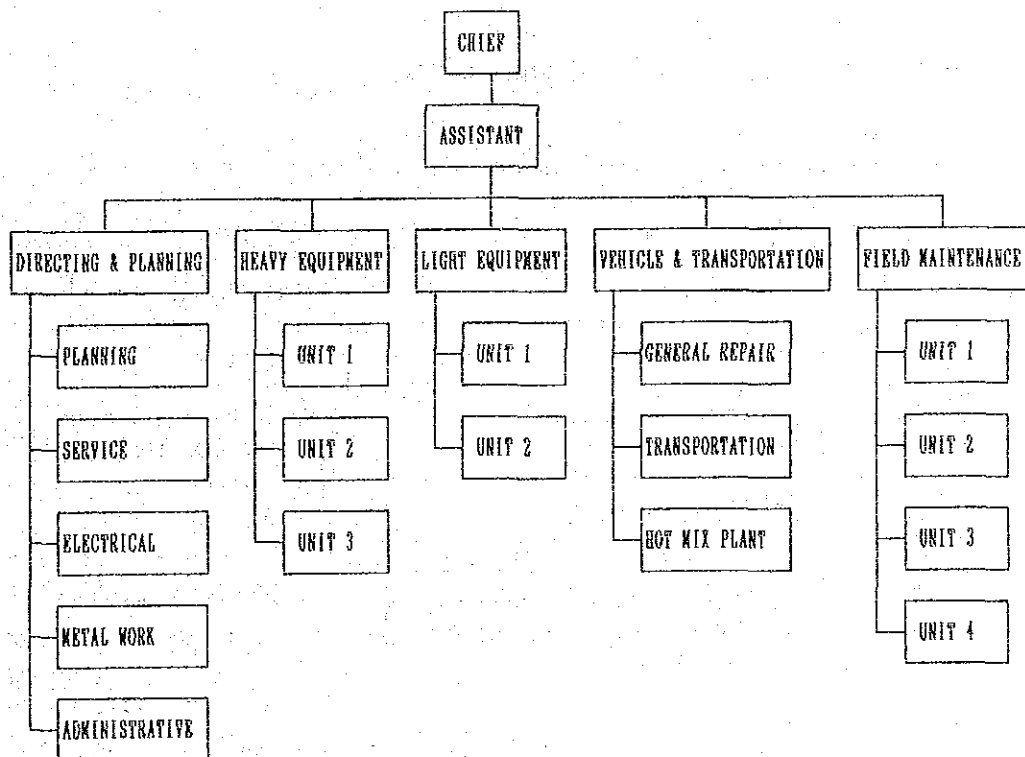


Table 3.3-2 STAFF AND PERSONNEL OF SURAT THANI CONSTRUCTION CENTER

| Position | Person |
|---------------------------|------------|
| Director | 1 |
| Chief Project Engineer | 1 |
| Project Engineer | 4 |
| Civil Engineer | 2 |
| Chief Mechanical Engineer | 1 |
| Mechanical Engineer | 1 |
| Technician | 65 |
| Mechanic | 21 |
| Head Administrator | 1 |
| Administrator | 3 |
| Clerk | 19 |
| Operator | 99 |
| Driver | 26 |
| Fitter | 10 |
| Electrician | 5 |
| Carpenter | 8 |
| Watchman | 23 |
| Skill Labour | 29 |
| Labour (Temporary) | 435 |
| Total | 754 |

Table 3.3-3 ORGANIZATION CHART OF SONG KHLA CENTER

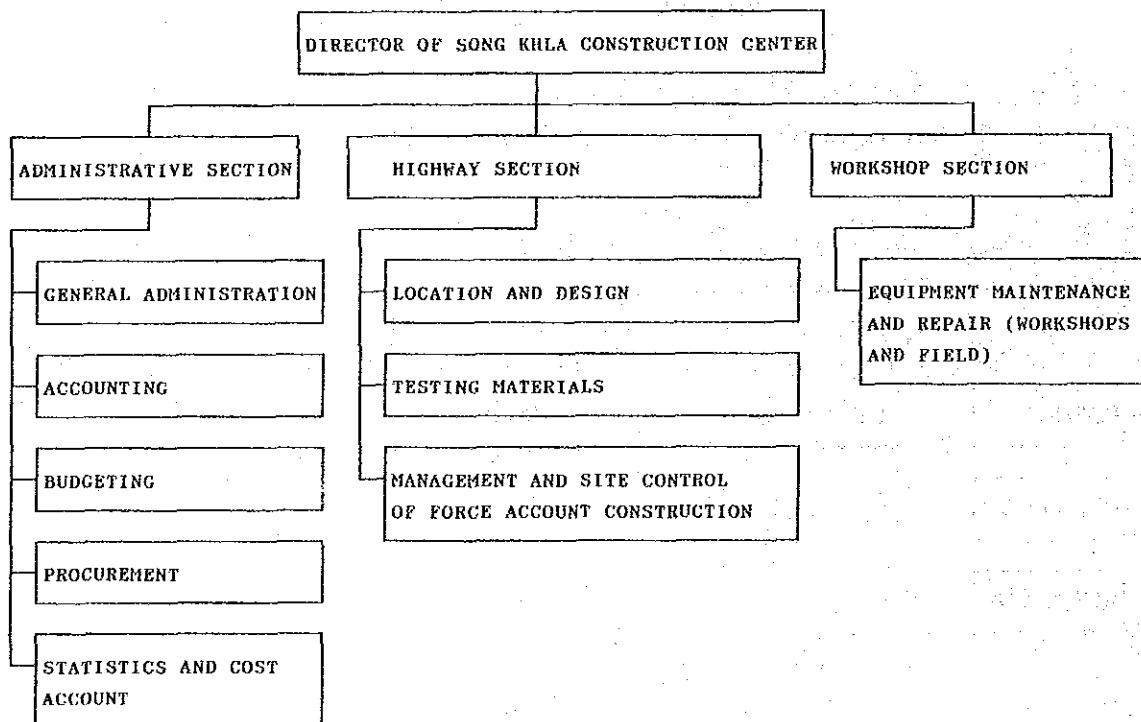


Table 3.3-4 STAFF AND PERSONNEL OF SONG KHLA CONSTRUCTION CENTER

| Position | Person |
|---------------------------|------------|
| Director | 1 |
| Chief Project Engineer | 1 |
| Project Engineer | 3 |
| Civil Engineer | 3 |
| Chief Mechanical Engineer | 1 |
| Mechanical Engineer | 2 |
| Technician | 39 |
| Mechanic | 48 |
| Head Administrator | 1 |
| Administrator | 7 |
| Clerk | 24 |
| Operator | 78 |
| Driver | 13 |
| Fitter | 10 |
| Electrician | 7 |
| Carpenter | 5 |
| Watchman | 6 |
| Labour (Temporary) | 300 |
| Total | 549 |

3.3.2 Operation Plan

(1) Road construction plan of both Road Construction Centers.

The main road construction projects presently planned by both Centers are listed in Tables 3.3-5 and 3.3-6. From the Tables, Surat Thani Center has to complete 543.1 km (90.5 km/yr) road construction by 1996, and Song Khla 478.3 km (79.7 km/yr) by 1996. Including these main projects, the road construction length of both Centers in 1990 is 155.4 km for Surat Thani and 53.3 km for Song Khla.

Under the DOH 7th Road Development Plan, Surat Thani Center plans an average of 120 km/yr road construction and Song Khla plans an average of 80 km/yr. Although the project size and construction condition differ in both Centers, the outline of an average project can be described as follows:

- Annual road construction length: 10 km
- Construction cost: 27 million Baht
- 2-lane road

- In Surat Thani Center there are many equipment manufactured in 1975-1980 which exceeded ordinary equipment life limit. Its capacity and
- Double bituminous surface treatment pavement
- Improvement of existing earth road
- Construction in flat area

Note: Annual construction length of 10 km was estimated based on the past 3 years' construction results of both Centers.

| | |
|------------------------------------|---------------------------------------------------------|
| Total construction length | 557.5 km |
| Number of projects | 53 |
| Average annual construction length | $557.5 \div 53 = 10.5 \text{ km} \approx 10 \text{ km}$ |

Table 3.3-5 MAJOR HIGHWAY PROJECTS OF SURAT THANI ROAD CONSTRUCTION CENTER

| No. | Route | Class | Project | Length (km) |
|-------|-------|-------|-------------------------------------|-------------|
| 1 | 4230 | F4 | Khuanmaidng-Nabon | 15.2 |
| 2 | 4232 | F4 | Amphoe sichol-Amphoe kanom | 32.0 |
| 3 | 4006 | F4 | Ratchagrud-Amphoe lungsuan | 68.6 |
| 4 | 4158 | F4 | Klongteng-Khaovisaed | 16.1 |
| 5 | 4151 | F4 | Kuannonghong-Kapangd | 36.0 |
| 6 | 4191 | F4 | Amphoe Chaiya-Thungnangpao | 13.5 |
| 7 | 4227 | F4 | Nai-Oa-Nuaklong | 15.0 |
| 8 | 4151 | F4 | Kapang-Lamtab | 40.2 |
| 9 | - | F4 | Watbangsaphan-Bangchak | 13.5 |
| 10 | - | F4 | Siyakphotong-Watdansmoson | 14.6 |
| 11 | 4223 | F4 | Jr. 4112 (Ban Huaipun)-Pumriang | 18.3 |
| 12 | 4036 | F4 | Jr. 4-Laemkruad | 12.8 |
| 13 | 4035 | F4 | Jr. 4 (Amphoe Aoluk)-Amphoe Phrasan | 65.5 |
| 14 | 4134 | F4 | Amphoe langsuan-Amphoe lamae | 20.0 |
| 15 | 4011 | F4 | Jr. 41-Pumriang | 11.1 |
| 16 | 4043 | F4 | Jr. 4 Thamaprao | 13.2 |
| 17 | 4192 | F4 | Komuk-Motai | 20.7 |
| 18 | 4010 | F4 | Bangrud Bannai | 17.5 |
| 19 | 4009 | F1 | Suratthani-Nasarn | 40.0 |
| 20 | 4231 | F4 | Amphoe Parkpanang-Laentalumpuk | 18.3 |
| 21 | 4116 | F4 | Amphoe Tungsong-Namron | 18.2 |
| 22 | 4214 | F4 | Jr. 4110-Route No. 4151 | 22.8 |
| Total | | | | 543.1 |

Table 3.3-6 MAJOR HIGHWAY PROJECTS OF SONG KHLA ROAD CONSTRUCTION CENTER

| No. | Route | Class | Project | Length (Km) |
|-------|-------|-------|------------------------------------|-------------|
| 1 | 4193 | F4 | Sungaipadi-Waeng | 15.8 |
| 2 | 4122 | F4 | King Amphoe Pabonnua-Lochangkra | 32.2 |
| 3 | 4181 | F4 | Jr. 4-Amphoe Akphayun | 26.6 |
| 4 | 4095 | F4 | Amphoe Sabayoi-Khaodaeng | 20.7 |
| 5 | 4111 | F4 | Kuaniang-Pakcha | 11.2 |
| 6 | 4163 | F4 | Jr. 4 (Khuandinso)-Khaopu | 42.1 |
| 7 | 4062 | F4 | Amphoe Baytong-Phukhaothong | 105.7 |
| 8 | 4182 | F4 | Jr. 41-Laemtant | 12.1 |
| 9 | 4013 | F4 | Pakphanang (East Coast-West Coast) | 9.4 |
| 10 | 4115 | F4 | Dusongyo-Jumo | 16.0 |
| 11 | 4057 | F2 | Susgaikolok-Waeng-Khetdan | 28.0 |
| 12 | 4113 | F2 | Amphoe Natavi-Prakob | 30.4 |
| 13 | 4063 | F1 | Jr. 410-Dalohalow | 27.0 |
| 14 | 4027 | F4 | Nikomattanaphakti-Tomo | 25.3 |
| 15 | | F1 | Dalohalow-Amphoe Yingo | 30.0 |
| 16 | | S1 | Route No.42-Amphoe Yarang | 20.0 |
| 17 | | F4 | Amphoe Yaring-Amphoe Panare | 13.4 |
| 18 | 4062 | F4 | Jr. 410-Bangnanglinae | 12.3 |
| Total | | | | 478.2 |

(2) Plan for provision of equipment

As described in Section 3.2, the requested equipment, excluding inspection cars and micro buses, are considered necessary and urgent to carry out the planned road construction of both Centers. On the other side, the Project implementing capability of both Centers related to the quantities of equipment and the amount of budget is evaluated as presented in Table 3.3-7.

Table 3.3-7 CONSTRUCTION EQUIPMENT AND BUDGET

| | Total Number of Equipment | No. of Unable Equipment | Usable Equipment (Unit) | | | | Required Equipment (Unit) | | | 1991 (Million Baht) |
|-------------|------------------------------|----------------------------|-------------------------|-------|----------|-------|---------------------------|--------|-------|---------------------------|
| | | | DOH | Japan | Borrowed | Total | Rank A | Rank B | Total | |
| Surat Thani | 287 | 192 | 38 | 32 | 25 | 95 | 34 | 43 | 77 | 311.5 |
| Song Khla | 189 | 124 | 54 | 3 | 8 | 65 | 24 | 36 | 60 | 222.3 |

The total number of equipment presently owned by Surat Thani is 287 with 192 of unusable equipment and 95 of usable one, and Song Khla is 189 with 124 of unusable and 65 usable. From the present equipment management situation in both Centers, it is considered that their organization, number of personnel, equipment operation and maintenance level are able to manage the total number of their equipment.

Budget for Surat Thani Center in 1991 is 311.5 million Baht and Song Khla Center is 222.3 million Baht. Budget increase rate over previous year of Surat Thani is 1.39 and Song Khla is 1.35. The budget increase rate of both Centers is higher than 1.08 of other six Centers. The budget per one usable equipment is 3.3 million Baht for Surat Thani Center. These figures are 0.8 million Baht higher than that of the other six Centers.

This fact shows the strong ambition of the Government of Thailand to aim at developing Southern Thailand. Considering the budget per one equipment in the case of adding required equipment, the budget is 1.8 million Baht in Surat Thani Center, 1.8 million Baht in Song Khla Center. This 1.8 million Baht is very high comparing with the average budget of the other six Centers. Both Centers have enough budget even if all of required equipment would be cooperated to both Centers.

As a result, implementing ability of both Centers is able to deal with the total number of arranging plan equipment. But it is judged that it is proper to arrange, into two ranks, the equipment in accordance with the budget schedule, and the projects implementation schedule proposed by both Centers. Reasons for this ranking are as follows:

- This project is of great urgency, and aims at having its effect in a short time.
- Radical increase of new type equipment brings the deterioration and insufficiency of drivers, operators and mechanics.
- Excessive increase of new type equipment obstructs the efficient use of equipment.

Rank A : Minimum necessary construction equipment to be provided

- Necessary equipment to facilitate the extensively delayed projects under construction due to the equipment shortage.
- Necessary equipment to improve the extensively hampered equipment construction capacity of the Center due to the equipment shortage.

Rank B : Other necessary equipment to be provided

- Necessary equipment to facilitate the urgent projects whose

commencement is extensively delayed due to the equipment shortage.

- Necessary equipment to improve the decreased equipment construction capacity of the Center due to the equipment shortage.

Based on the above Ranking criteria, the number of equipment and their rank were decided through the field study and the discussion by JICA study team and the representatives from the DOH and both Centers as shown in Table 3.3-8.

3.3.3 Outline of Equipment

Table 3.3-8 shows the type and number of proposed equipment. Selection of type, number of equipment and equipment specifications are discussed in Section 4.3.

Table 3.3-8 PROPOSED EQUIPMENT AND ITS RANK

| Type of Equipment | Surat Thani | | | Song Khla | | | Total | | |
|-----------------------------------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| | Rank | Rank | Total | Rank | Rank | Total | Rank | Rank | Total |
| | A | B | | A | B | | A | B | |
| 1. Earth Moving Equipment | 6 | 10 | 16 | 7 | 5 | 12 | 13 | 15 | 28 |
| 2. Earth Excavation Equipment | 5 | 0 | 5 | 3 | 0 | 3 | 8 | 0 | 8 |
| 3. Earth Solidifying Equipment | 6 | 2 | 8 | 2 | 3 | 5 | 8 | 5 | 13 |
| 4. Earth Transportation Equipment | 7 | 8 | 15 | 6 | 4 | 10 | 13 | 12 | 25 |
| 5. Pavement Equipment | 1 | 4 | 5 | 0 | 7 | 7 | 1 | 11 | 12 |
| 6. Transportation Equipment | 9 | 11 | 20 | 6 | 6 | 12 | 15 | 17 | 32 |
| 7. Multiple Purpose Equipment | 0 | 8 | 8 | 0 | 11 | 11 | 0 | 19 | 19 |
| 8. Inspection Car and Micro Bus | - | - | - | - | - | - | - | - | - |
| Total | 34 | 43 | 77 | 24 | 36 | 60 | 58 | 79 | 137 |

3.3.4 Management Plan

(1) Method of equipment management

Construction equipment management is divided into equipment operation management and equipment maintenance management. The method (key point) of each management is briefly summarized below.

i) Principle of equipment management

The points of equipment management to carry out the rational construction are;

- To arrange only the necessary equipment to the construction site.
- To increase the equipment work hour and the equipment efficiency.
- To conduct the equipment management by functional system.
- To operate the equipment in its proper operating condition.
- To secure the skilled operators and foremans through intentional training.
- To prepare and utilize the equipment operation records and the equipment maintenance records.
- To develop mechanized construction practice.

ii) Operation management

It is necessary to review the following items to improve the equipment work hour and its efficiency.

- To establish the efficient equipment operation plan.
- To prevent the equipment problems by planned maintenance and proper repair.
- To secure the skilled operators.
- To select the proper equipment suitable for scope of work and site conditions.
- To conduct the proper operation and construction practice.

iii) Maintenance management

It is necessary to observe the following items, including the inspection and oil supply, during operation to keep the equipment in proper operational condition.

- Daily inspection:
The inspection before and after daily work by operator.
- Weekly and monthly inspection:
The periodical inspection at equipment regular running hours by

special mechanic.

- Overhaul: The regular periodic examination by special mechanic.

(2) Guidance for equipment operation and maintenance

Recent construction equipment have been incorporating hydraulic and electro-mechanic operating devices. The technical guidance for use of these equipment shall be required.

(3) Equipment maintenance cost

As described in Section 2.2, 8.3% of annual budget of Surat Thani Road Construction Center (18.65 million Baht) has extended as equipment maintenance cost, and 12.0% (19.67 million Baht) at Song Khla Road Construction Center. The maintenance cost for the Proposed equipment will be properly managed within these annual budgets.

3.4 TECHNICAL COOPERATION

As described in Clause 3.2.5, the dispatch of Equipment based Construction experts and mechanical engineers, who will give the advice and guidance to the responsible persons in charge of this Project from the Government of the Kingdom of Thailand, is considered to be indispensable to execute the Project effectively and obtain the fruitful results.

The recent construction equipment have been adopting hydraulic and electro-mechanic operation system. The guidance for their operation and maintenance is necessary. On the other side, each Center is executing annually 10 to 15 projects with an average length of 10 km per one project at the same time. This method will require considerable quantities of equipment. To solve this problem, the planning and controlling of equipment efficient placement and their utilization are necessary.

Therefore, it is desirable that the technical cooperation is extended in line with the construction supervision with the following objectives.

- Guidance for inspection and test operation of the Supplied equipment.
- Guidance for operation and maintenance of the Supplied equipment.
- Advice and guidance for maintenance management of the Supplied equipment.
- Advise, guidance and check for planning and controlling of equipment efficient placement and utilization to correspond the scope of work and the site conditions.

CHAPTER FOUR

BASIC DESIGN

CHAPTER 4

BASIC DESIGN

4.1 DESIGN POLICY

The selection of most suitable equipment type, and calculation for reasonable number of equipment required were carried out based on the following basic considerations.

- To select the main construction equipment required for the objectives of implementation of road construction projects and the work condition under Surat Thani Road Construction Center and Song Khla Road Construction Center.
- To select the appropriate equipment suitable for the present conditions of equipment operation and maintenance in both Road Construction Centers.
- To calculate the necessary number of equipment to perform the projects by theoretical calculation based on equipment standard working capacity.

4.2 STUDY ON DESIGN CRITERIA

The determination of the most suitable equipment type among the candidate equipment were made through discussions by the representatives from the Department of Highways and members of the Study Team. The main points for the selection of equipment were as follows:

- Equipment whose spare parts are interchangeable and convenient to obtain.
- Multipurpose equipment and/or combined facility equipment.
- Energy saving equipment.
- Human engineering equipment.

The selected equipment to be provided under Japan's Grant Aid are listed in

Clause 4.3-2. The specifications for those equipment are applied from JAPAN'S CONSTRUCTION EQUIPMENT SPECIFICATIONS BOOK 1989, Japan Mechanized Construction Association.

4.3 BASIC PLAN

4.3.1 Selection of Types and Number of Equipment

- (1) Calculation of the number of equipment necessary for the road construction plan

The number of necessary equipment for the construction of planned roads under the Surat Thani and Song Khla Centers were theoretically calculated based on the equipment standard working capacity. A summary of the calculation is mentioned below. The condition and results of the calculation are reported in Appendix-9. The standard working capacity of equipment for each work item was calculated using the method described in ROAD CONSTRUCTION EARTH WORK MANUAL 1987, Japan Road Association.

Main Condition of Road Construction Work Used for Calculation

- Work Item : Roadbed, Subbase and Base courses, Shoulder and Surface course
- Surfacing : Double Bituminous Surface Treatment
- Topography : Flat
- Standard Road : Carriage way width 5.5 m
Cross Section Shoulder width 2 x 1.75 m
- Size of Project : 10 km in length for one project

Standard Equipment Fleet and Possible Annual Construction Volume

The standard equipment fleet (type and number of equipment) and the necessary working days to construct each construction item for a 10 km project were calculated based on the work volume of each construction item and standard working capacity of each corresponding equipment.

The list of standard equipment fleet and possible annual work volume for the construction of 10 km project are shown in Table 4.3-1.

Table 4.3-1 STANDARD EQUIPMENT FLEET AND ANNUAL WORK VOLUME

| Work Item | Standard Equipment Fleet | | | Required Days for a 10 km Construction | | Possible Annual Work Volume |
|--------------------------|--------------------------|---------------------|---------------------|----------------------------------------|---------------|-----------------------------|
| | Name of Equipment | Class | Number of Equipment | Working Days | Calendar Days | |
| Roadbed | Bulldozer | 21 t | 2 | | | |
| | Tractor Shovel | 1.8 m ³ | 2 | 40 days | 60 days | 39 km |
| | Motor Grader | 3.7 m | 1 | | | |
| | Rubber Tired Roller | 15 t | 1 | | | |
| | Water Truck | 6,000 l | 1 | | | |
| | Dump Truck | 8 t | 7 | | | |
| | Subbase Course | Motor Grader | 3.7 m | 1 | | |
| Vibratory Roller | | 12 t | 1 | | | |
| Macadam Roller | | 10 t | 1 | 46 days | 69 days | 34 km |
| Water Truck | | 6,000 l | 1 | | | |
| Tractor Shovel | | 1.8 m ³ | 2 | | | |
| Dump Truck | | 8 t | 10 | | | |
| Base Course and Shoulder | | Motor Grader | 3.7 m | 1 | | |
| | Vibratory Roller | 12 t | 1 | | | |
| | Macadam Roller | 10 t | 1 | 48 days | 72 days | 33 km |
| | Water Truck | 6,000 l | 1 | | | |
| | Tractor Shovel | 1.8 m ³ | 2 | | | |
| | Dump Truck | 8 t | 7 | | | |
| | Surface Course | Asphalt Distributor | 6,000 l | 1 | | |
| Chip Spreader | | Tail Gate | 1 | | | |
| Rubber Tired Roller | | 12 t | 1 | 29 days | 44 days | 53 km |
| Tractor Shovel | | 1.4 m ³ | 2 | | | |
| Dump Truck | | 8 t | 3 | | | |

Note : Possible working days of 234 days during one year was applied for this calculation.

Number of Necessary Equipment for Surat Thani and Song Khla Centers

The necessary equipment fleet unit for construction of 120 km/yr and 150 km/yr under Surat Thani Center, 80 km/yr and 100 km/yr under Song Khla Center were calculated based on the results shown in Table 4.3-1, and the total numbers of necessary equipment divided into equipment work groups are listed in Table 4.3-2.

Table 4.3-2 NUMBER OF NECESSARY EQUIPMENT TO PERFORM PLANNED ANNUAL ROAD CONSTRUCTION PROJECT UNDER SURAT THANI AND SONG KHLA CENTERS

| Equipment | | Number of Necessary Equipment | | | |
|---------------------------------------|--------------------|-------------------------------|---------|------------------|---------|
| | | Surat Thani Center | | Song Khla Center | |
| Group | Class | 120 km* | 150 km* | 80 km* | 100 km* |
| 1. Earth Moving Equipment | | | | | |
| Bulldozer | 21 t | 6.2 | 7.6 | 4.2 | 5.2 |
| Motor Grader | 3.7 m | 10.2 | 12.7 | 6.9 | 8.5 |
| Sub Total | | 16.4 | 20.3 | 11.1 | 13.7 |
| 2. Excavation/Loading Equipment | | | | | |
| Tractor Shovel | 1.8 m ³ | 16.8 | 20.9 | 11.4 | 14.0 |
| 3. Earth Solidifying Equipment | | | | | |
| Rubber Tired Roller | 12t, 15t | 5.4 | 6.6 | 3.6 | 4.5 |
| Vibratory Roller | 12t | 7.1 | 8.9 | 4.8 | 5.9 |
| Macadam Roller | 10t | 7.1 | 8.9 | 4.8 | 5.9 |
| Tandem Roller | 8t | 2.3 | 2.8 | 1.5 | 1.9 |
| Sub Total | | 21.9 | 27.2 | 14.7 | 18.2 |
| 4. Earth/Aggregates Hauling Equipment | | | | | |
| Dump Truck | 8t | 88.8 | 110.5 | 60.0 | 73.9 |
| 5. Asphalt Paving Equipment | | | | | |
| Asphalt Distributor | 6,000 l | 2.3 | 2.8 | 1.5 | 1.9 |
| Chip Spreader | Tail Gate | 2.3 | 2.8 | 1.5 | 1.9 |
| Sub Total | | 4.6 | 5.6 | 3.0 | 3.8 |
| Total | | 148.5 | 184.5 | 100.2 | 123.6 |

* Planned Annual Road Construction Length

Number of Available Equipment after Providing Rank A

For the above calculated figures, it is considered that by providing new equipment (Rank A) for both Centers, the required equipment for the annual average road construction length of both Centers under the DOH's 7th Road Development Plan (Surat Thani 120 km, and Song Khla 80 km) will be nearly fulfilled, and both Centers will be able to cope with the urgent projects adequately. Table 4.3-3 shows the relationship between the number of calculated necessary equipment and the available equipment after the strengthening.

The total numbers of equipment required for both Road Construction Centers are as follows:

| Construction Center | Construction Length | Number of Necessary Equipment |
|---------------------|---------------------|-------------------------------|
| Surat Thani | 120 km/yr | 148 units |
| | 150 km/yr | 184 units |
| Song Khla | 80 km/yr | 100 units |
| | 100 km/yr | 123 units |

Table 4.3-3 NUMBER OF NECESSARY EQUIPMENT AND AVAILABLE EQUIPMENT AFTER PROVIDING RANK A
(a) Annual Road Development Length; 120 km, 80 km

| Center | Necessary Equipment (unit) | Available Equipment (unit) | | | Available/Necessary |
|-------------|----------------------------|----------------------------|--------------|-------|---------------------|
| | | Present Owned | New Proposed | Total | |
| Surat Thani | 148 | 83 | 34 | 117 | 79 % |
| Song Khla | 100 | 60 | 24 | 84 | 84 % |

(b) Annual Road Development Length; 150 km, 100 km

| Center | Necessary Equipment (unit) | Available Equipment (unit) | | | Available/Necessary |
|-------------|----------------------------|----------------------------|--------------|-------|---------------------|
| | | Present Owned | New Proposed | Total | |
| Surat Thani | 184 | 83 | 34 | 117 | 64 % |
| Song Khla | 123 | 60 | 24 | 84 | 68 % |

Note : No. of present owned excluding inspection car and micro bus.

4.3.2 Specifications of Proposed Equipment

The types and standard specifications for the equipment were proposed based on the study results reported in Section 4.1 and 4.2 and through discussions by the JICA Study Team and the representatives from the DOH.

The standard specifications for the finally proposed equipment are listed in Table 4.3-4. The specifications were applied from JAPAN'S CONSTRUCTION EQUIPMENT SPECIFICATION BOOK 1989, Japan Mechanized Construction Association.

Table 4.3 - 4(1) STANDARD SPECIFICATIONS FOR PROPOSED GRANT AID CONSTRUCTION EQUIPMENT

| | | | | | 1. EARTH MOVING EQUIPMENT | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-------------------------------------------------------------------------------------------|
| BULLDOZER | | 1.1 CRAWLER TRACTOR | 1.3 CRAWLER TRACTOR | 1.5 CRAWLER TRACTOR | MOTOR GRADER | | 1.7 MOTOR GRADER |
| FLYWHEEL HORSEPOWER SAE J 1349 | HP /rpm | more than 300 /2,000 | more than 200 /2,000 | more than 120 /2,000 | FLYWHEEL HORSEPOWER SAE J 1349 | HP /rpm | more than 150 /2,500 |
| OPERATING WEIGHT | kg | more than 35,000 | more than 21,000 | more than 13,000 | OPERATING WEIGHT | kg | more than 12,000 |
| PERFORMANCE - Travel speed Forward Reverse | km/h km/h | 3.5 - 12.0 4.5 - 14.0 | 3.5 - 12.0 4.5 - 14.0 | 2.9 - 10.0 3.5 - 12.0 | PERFORMANCE - Travel speed Forward Reverse - Min. turning radius - Axle oscillation (front total) - Articulation angle (each) | km/h km/h mm deg deg | 3.0 - 55.0 3.7 - 55.0 less than 7,000 more than 30 more than 20 |
| BULLDOZER EQUIPMENT - Blade capacity (SAE) - Max. lift above ground - Max. drop below ground | m ³ mm mm | more than 7.80 more than 1,400 more than 550 | more than 3.20 more than 1,200 more than 500 | more than 2.20 more than 930 more than 400 | BLADE RANGE - Max. lift above ground - Max. drop below ground | mm mm | more than 450 more than 500 |
| DIMENSIONS - Overall length - Overall width (excl. blade & trunnion) - Overall height - Ground clearance - Track gauge - Length of track on ground | mm mm mm mm mm mm | more than 6,200 more than 2,500 less than 3,800 more than 450 more than 2,100 more than 3,100 | more than 5,000 more than 2,400 less than 3,500 more than 400 more than 1,900 more than 2,700 | more than 4,500 more than 2,900 less than 3,000 more than 310 more than 1,850 more than 3,000 | DIMENSIONS - Overall length - Overall width (excl. blade) - Overall height - Wheel base - Ground clearance | mm mm mm mm mm | more than 8,300 less than 2,400 less than 3,200 less than 6,000 more than 600 |
| ENGINE - Type - Piston Displacement | ltr | Direct injection turbocharged more than 18.00 | Direct injection turbocharged more than 10.00 | Direct injection turbocharged more than 10.00 | ENGINE - Type - Piston displacement | ltr | Direct injection turbocharged more than 6.00 |
| POWER TRAIN - Torque converter, Damper or Main clutch - Transmission - Brake - Final drive | | Single stage T/C Planetary Wet Spur gear | Single stage T/C Planetary Wet Spur gear | Single stage T/C Planetary Wet Spur gear | POWER TRAIN - Torque converter or Main clutch - Transmission | | Hydro-shift or Power-shift Planetary gear and multiple disc clutch |
| UNDERCARRIGE - No. of rollers (carrier / track) - Ground pressure - Max. width of shoes - Track shoe | kg/cm ² mm | more than 2/7 less than 1.10 more than 710 Lubricated track | more than 2/6 less than 0.75 more than 510 Lubricated track | more than 2/6 less than 0.30 more than 800 Lubricated track | BRAKES - Service brake - Parking brake | | Dry, drum Dry, drum |
| ATTACHMENT - Canopy - Blade - Ripper No. of shanks Tooth point - Drawbar | | Steel Canopy Straight-tilt Multi-shank ripper(rigid type) less than 3 Replaceable Non | Steel Canopy Straight-tilt Multi-shank ripper(rigid type) less than 3 Replaceable Non | Steel Canopy Angle dozer Non Fixed type | TIRE - Type - Size : Front Rear | | Tubeless 13.00 - 24x10 PR 13.00 - 24x10 PR |

Table 4.3 - 4 (2) STANDARD SPECIFICATIONS FOR PROPOSED GRANT AID CONSTRUCTION EQUIPMENT

| 2. EARTH EXCAVATOR | | | | 3. EARTH SOLIDIFYING EQUIPMENT | | | | |
|-----------------------------|--------------------------------------|------------------------|-------------------------------|--------------------------------|----------------|---------------------------------------|---------------------------------------|---------------------------------------|
| HYDRAULIC EXCAVATOR | | 2.1 HYDRALIC EXCAVATOR | 2.2 HYDRALIC EXCAVATOR | EARTH SOLIDIFYING EQUIPMENT | | 3.1 SELF-PROPELLED VIBRATION ROLLER | 3.2 SELF-PROPELLED VIBRATION ROLLER | 3.2 RUBBER TIRED ROLLER |
| FLYWHEEL HORSEPOWER | HP | more than 200 | more than 120 | FLYWHEEL HORSEPOWER | HP | more than 120 | more than 120 | more than 90 |
| OPERATING WEIGHT | kg | more than 29,000 | more than 18,000 | OPERATING WEIGHT | kg | more than 5,500 | more than 5,500 | more than 6,000 |
| BUCKET CAPACITY(SAE heaped) | m ³ | 0.5 - 1.8 | 0.36 - 1.4 | - On the front axle | kg | more than 4,500 | more than 4,500 | more than 8,000 |
| PERFORMANCE | | | | - On the rear axle | kg | more than 10,000 | more than 10,000 | more than 14,000 |
| | - Swing speed | rpm | more than 7.5 | - Total weight | kg | | | |
| | - Max. travel speed | km/h | more than 3.2 | EMPTY WEIGHT | kg | | | more than 3,000 |
| | - Arm crowd force | kg | more than 13,000 | - On the front axle | kg | - | - | more than 5,000 |
| - Bucket digging force | kg | more than 17,000 | - On the rear axle | kg | - | - | more than 8,000 | |
| WORKING RANGE | | | | - Total | kg | | | |
| | - Max. digging height | mm | more than 9,500 | DIMENSIONS | | | | |
| | - Max. dumping height | mm | more than 6,800 | - Overall length | mm | more than 5,500 | more than 5,500 | more than 4,500 |
| | - Max. vertical wall digging depth | mm | more than 6,000 | - Overall width | mm | more than 2,000 | more than 2,000 | more than 2,000 |
| | - Max. digging reach at ground level | mm | more than 10,000 | - Overall height | mm | less than 2,400 | less than 2,400 | less than 2,500 |
| DIMENSIONS | | | | - Wheel base | mm | more than 3,300 | more than 3,300 | more than 3,500 |
| | - Overall length | mm | more than 10,000 | - Rolling width | mm | more than 1,600 | more than 1,600 | more than 2,000 |
| | - Overall width | mm | less than 3,200 | SPEED | | | | |
| | - Overall height | mm | less than 3,250 | - Forward & Reverse | km/h | 0 - 14.0 | 0 - 14.0 | 0 - 20.0 |
| | - Ground clearance | mm | more than 475 | MIN. TURNING RADIOUS (outer) | mm | less than 6,200 | less than 6,200 | less than 6,700 |
| | - Tail swing radius | mm | less than 3,300 | ENGINE | | | | |
| | - Track length | mm | more than 4,500 | - Type | | Water-cooled diesel engine | Water-cooled diesel engine | Water-cooled diesel engine |
| | - Track gauge | mm | more than 2,500 | - Piston displacement | ltr | more than 5.00 | more than 5.00 | more than 5.00 |
| | ENGINE | | | POWER LINE | | | | |
| | - Type | | Direct injection turbocharged | - Transmission | | Hydrostatic & mechanical transmission | Hydrostatic & mechanical transmission | Hydrostatic & mechanical transmission |
| - Piston displacement | ltr | more than 7.00 | - Differential | | Auto lock type | Auto lock type | Auto lock type | |
| HYDRAULIC SYSTEM | | | | - Vibrator | | Eccentric shaft type | Eccentric shaft type | - |
| | - Hydraulic pump | | 2 x Variable piston | WATER SPRINKLER SYSTEM | | Water pressue type | Water pressure type | Water pressure type |
| - Max. flow (main pump) | ltr/min | more than 450 | more than 300 | TIRE | | | | |
| TRACK SHOE | | | | - Size | | 23.1 - 26x8 PR | - | 9.00 - 20x10 PR |
| | - Shoe width | mm | Triple-grouser more than 600 | - No. of tire | | 2 | | more than 8 |
| ATTACHMENT | | | | DRUM | | | | |
| | - Hydraulic breaker | | | - Size | mm | more than 1,500 | more than 1,300 | - |
| | Weight | kg | less than 950 | - No. of drum | | 1 | 2 | - |
| | Point chisel | | Yes | | | | | |
| | Flat-end-chisel | | Yes | | | | | |
| | - Pile driver | | Non | | | | | |
| Frequency | cpm | - | 1,500 - 2,300 | | | | | |
| - Narrow bucket | | Yes | Yes | | | | | |
| - U-shaped bucket | | Yes | Yes | | | | | |

Table 4.3 - 4 (3) STANDARD SPECIFICATIONS FOR PROPOSED GRANT AID CONSTRUCTION EQUIPMENT

| 4. EARTH TRANSPORTATION EQUIPMENT | | | | 5. ASPHALT PAVEMENT EQUIPMENT | | |
|-----------------------------------|--------------------|----------------------------|--------------------|-------------------------------|-----------------------------|----------------------------|
| EARTH TRANSPORTATION EQUIPMENT | | 4.1 DUMP TRUCK | 4.2 DUMP TRUCK | ASPHALT PAVEMENT EQUIPMENT | | 5.1 ASPHALT DISTRIBUTOR |
| FLYWHEEL HORSEPOWER | HP | more than 160 | more than 160 | FLYWHEEL HORSEPOWER | HP | more than 160 |
| MAX. LOADING CAPACITY | kg | more than 8,000 | more than 6,000 | DIMENSIONS | | |
| VEHICLE WEIGHT | kg | more than 4,500 | more than 4,300 | | | |
| GROSS VEHICLE WEIGHT | kg | more than 12,500 | more than 10,300 | - Overall length | mm | more than 7,000 |
| DIMENSIONS | | | | - Overall width | mm | less than 2,500 |
| | - Overall length | mm | more than 6,000 | - Overall height | mm | less than 2,800 |
| | - Overall width | mm | less than 2,500 | - Wheel base | mm | more than 4,200 |
| | - Overall height | mm | less than 3,000 | - Ground clearance | mm | more than 250 |
| | - Wheel base | mm | more than 3,700 | - Asphalt tank capacity | ltr | 6,000 |
| | - Ground clearance | mm | more than 200 | ENGINE | | |
| | - Bed Capacity | m ³ | more than 5.0 | - Type | | Water-cooled diesel engine |
| | Inside length | mm | more than 3,700 | - Piston displacement | ltr | more than 10.00 |
| | Inside width | mm | more than 2,000 | ASPHALT TANK PUMP | | |
| | Inside height | mm | more than 600 | - Engine | HP | more than 12 |
| Floor height(Empty) | mm | less than 1,550 | - Compressor | kW | more than 10 | |
| PERFORMANCE | | | ASPHALT SPRAY | | | |
| - Travel speed | km/h | more than 50 | - Type | | Nozzle spray with bitumeter | |
| - Grade-ability | deg | more than 30 | - Max. spray width | mm | 3,600 | |
| - Min. turning radius | mm | less than 7,500 | - Spray capacity | ltr/min | 70 - 350 | |
| ENGINE | | | - Nozzle spacing | mm | 100 - 150 | |
| - Type | | Water-cooled diesel engine | | | | |
| - Piston displacement | ltr | more than 10.00 | | | | |
| POWER LINE | | | | | | |
| - Transmission | | Synchromesh | Synchromesh | | | |
| - Differential | | more than | more than | | | |
| Gearshift | | 5 F - 1 R | 5 F - 1 R | | | |
| BRAKE | | | | | | |
| - Type | | Hydraulic and Air | Hydraulic and Air | | | |
| TIRE | | | | | | |
| - Size | | 6.0 - 10x14 PR | 6.0 - 10x14 PR | | | |
| VESSEL | | | | | | |
| - Type | | Lock / Tail gate | Lock / Tail gate | | | |

Table 4.3 - 4 (4) STANDARD SPECIFICATIONS FOR PROPOSED GRANT AID CONSTRUCTION EQUIPMENT

| TRUCK | UNIT | 6.1 WATER TRUCK | 6.3 FUEL TRUCK | TRUCK | UNIT | 6.5 FLAT BET TRUCK | 6.7 TRUCK CRANE | 6.8 TRUCK CRANE | TRUCK | | 6.9 TRUCK TRAILER | TRUCK | | 6.10 SELF-LOADER TRUCK |
|-------------------------------------------------------------------------------------------------------------|------|------------------------------------------|------------------------------------------|-------------------------|------|--------------------|-----------------|-----------------|---------------------------|----|----------------------------|--------------------------|----|----------------------------|
| FLYWHEEL HORSEPOWER | HP | more than 160 | more than 160 | FLYWHEEL HORSEPOWER | HP | more than 160 | more than 220 | more than 215 | TYPE | | Semi-trailer | TYPE | | Out rigger and Winch |
| TANK CAPACITY | ltr | more than 6,000 | more than 6,000 | MAX. LOADING CAPACITY | kg | 6,000 | -- | -- | TRAILER HEAD | | | ENGINE OUTPUT | HP | More than 200 |
| NO. OF WATER SPRAY NOZZLE | | Front 2, Rear 2 | -- | CRANE PERFORMANCE | | -- | Hydraulic | Hydraulic | - Engine output | HP | more than 330 | AUTRIGGER WINCH CAPACITY | KG | 1 R - 1 L more than 20,000 |
| DIMENSIONS - Overall length - Overall width - Overall height - Wheel base - Ground clearance | mm | more than 7,400 | more than 7,000 | - Type | Mt | -- | more than 25.0 | more than 7.5 | - Engine type | | Water-cooled diesel engine | | | |
| | mm | less than 2,400 | less than 2,500 | - Max. lifting capacity | mm | -- | more than 3,000 | more than 2,500 | - Max. combination weight | kg | more than 40,000 | | | |
| | mm | less than 2,600 | less than 2,700 | Operating radius | m | -- | more than 31.0 | more than 13.0 | - Vehicle weight | kg | more than 15,000 | | | |
| | mm | more than 4,000 | more than 4,000 | Boom length | | | | | - Dimensions | | | | | |
| ENGINE - Type - Piston displacement | ltr | Water-cooled diesel engine more than 6.0 | Water-cooled diesel engine more than 6.0 | AUTRIGGER | | | | | Overall length | mm | more than 6,000 | | | |
| | | | | - Width extended | m | -- | more than 6.0 | more than 4.00 | Overall width | mm | more than 2,300 | | | |
| | | | | | | | | | Overall height | mm | more than 2,500 | | | |
| | | | | | | | | | - Transmission | | | | | |
| | | | | | | | | | No. of Speeds | | more than 10 F - 2 R | | | |

4.4 IMPLEMENTATION PLAN

4.4.1 Implementation Policy

The Project shall be implemented within the scope of Japan's Grant Aid Program. The Government of the Kingdom of Thailand is the authority of the Project. After signing of the Exchange of the Notes between the Government of Japan and the Government of the Kingdom of Thailand, the Project shall be implemented in accordance with the provisions of Japan's Grant Aid Program.

In the Kingdom of Thailand, Department of Highways under the Ministry of Transport and Communications is the responsible organization for the administration of the Project, and Surat Thani Road Construction Center and Song Khla Road Construction Center are the executing organization for the implementation of the Project. The outline of the organizations are described in Section 3.3.

In implementing the Project, the Project cost shouldered by the Government of Japan covers the manufacturing of the proposed construction equipment, transportation of the equipment from Japan to the port of entry in the Kingdom of Thailand and the relevant consulting services for the implementation of the Project.

The scope of undertaking by the Government of the Kingdom of Thailand covers the transportation of the proposed construction equipment from the port of entry to Surat Thani and Song Khla Road Construction Centers and the implementation of operation and maintenance of the equipment.

4.4.2 Procurement Plan

In both Surat Thani and Song Khla Centers, the skills on practicing of equipment operation, maintenance and repairs are well developed by their accumulated experiences.

However, for the innovated new equipment which will be provided in the Project, the guidance and training of equipment operation, maintenance and repairs including its attachment devices as well as effective usage of equipment correspond to the object and conditions of construction work will be required.

The road construction plans under both Road Construction Centers are to carry out annually 10 to 15 projects, with an average length of 10 km,

which are in widely separated locations. In order to carry out those projects, considerable number of equipment fleets will be required. Therefore, the programming, effective and efficient placement of equipment and utilization corresponding to the characteristics of individual equipment as well as the scope and condition of construction work will be necessary. Also, the guidance and advice relevant to the equipment utilization and construction management are required.

The execution of the engineering training assistance is considered to be appropriate by conducting the following two phases separately.

First Phase : Initial Training (Two Months)

- Guidance and training on the equipment inspection, test run and operation
- Guidance and training on the equipment operation, maintenance and repair
- Guidance and advice on the equipment utilization for scope and conditions of individual project
- Guidance and advice on the programming and controlling of effective placement and utilization of equipment

Second Phase : Follow-up Training (Two Months)

- Survey on the performance of equipment operation, guidance and training on the solution of troubles
- Survey on the performance of maintenance and repair, guidance and training on the solution of related troubles
- Survey on the equipment usage on individual project base
- Check and advice on the effective placement and utilization of equipment for individual projects

4.4.3 Construction and Supervisory Plan

Considering the reliability of the production control and the work efficiency of construction equipment and the availability of manufacturer's maintenance and repair services and also the time for delivery of the equipment for the implementation of the Project, the equipment shall be procured in Japan.

4.4.4 Implementation Schedule

Main three steps to be considered in proposing the implementation schedule are as follows.

- Detailed Design
- Procurement
 - Tendering
 - Manufacture of Equipment
 - Transportation of Equipment
- Technical Training on Equipment Operation and Maintenance

The time periods required for detailed design, procurement and technical training on equipment operation are estimated as three (3) months, six (6) months and three (3) months, respectively. The proposed implementation schedule is shown in Table 4.4-1.

(1) Detailed Design

After signing of the Exchange of Notes between the Government of Japan and the Government of the Kingdom of Thailand, the detailed design related to providing construction equipment shall be executed by a Japanese consulting firm. The detailed design works shall comprise the following preparations.

- Specifications for the Grant Aid Equipment
- Cost Estimation of the Project
- Tender and Contract Documents for the Equipment Procurement
- Operation Manual for the Equipment
- Maintenance Manual for the Equipment

(2) Procurement

(a) Tendering

Consultant shall execute the following services relevant to the tendering for the Kingdom of Thailand.

- Tender Notice
- Tender Prequalification
- Tendering
- Tender Evaluation

Table 4.4-1 PROJECT IMPLEMENTATION SCHEDULE

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---------------------------------------|----------------------------------------|---|---|---|---|--------|---------------------------------------------|---|---|----|---------------------|----|----|
| Detailed Design | (3 months) | | | | | | | | | | | | |
| Equipment Procurement and Supervisory | Manufacture of Equipment (9 months) | | | | | Export | Training on Equipment Operation/Maintenance | | | | Inspection/Delivery | | |

(b) Manufacture of equipment

After formalizing the contract, the contractor will receive the note of contract from the Government of Japan. Then, the contractor will manufacture the equipment.

(c) Transportation of equipment

The Japanese contractor will execute the marine transportation from Japan to Song Khla port of the Kingdom of Thailand. The Government of Thailand has the responsibility of the land transportation from Song Khla to both construction Centers.

(3) Technical training on equipment operation and maintenance

Japanese Equipment based Construction experts and mechanical engineers should guide and advise on the equipment operation and maintenance.

4.4.5 Scope of Work

Based on the Minutes of Discussions, the scope of work for the project covers the responsibilities of the Governments of Japan and Thailand as

follows:

(1) The Government of Japan is responsible for the following.

(a) Construction equipment manufacture and supply for the project.

These construction equipment consist of:

1. Earth moving equipment
2. Earth excavator
3. Earth solidifying equipment
4. Earth transportation equipment
5. Pavement equipment
6. Material/equipment transportation equipment
7. Multiple purpose equipment

(b) Delivery of Construction equipment from Japan to designated port (Song Khla port) of entry in Thailand.

(c) The dispatch of Japanese Equipment based Construction experts and mechanical engineers in order to guide/advise for inspection, operation and maintenance of the supplied equipment, as well as for the planning and management of effective utilization of equipment on each project.

(2) The Government of the Kingdom of Thailand is responsible for the land transportation from Song Khla port to the Surat Thani and Song Khla Road Construction Centers, and operation, maintenance and management of the supplied equipment after receiving the equipment from Japan.

The cost to be shouldered by the Thailand is roughly estimated as follows:

| | | |
|------------------------|-------|---------------|
| In-land transportation | 760 | thousand Baht |
| Assembling | 3,800 | thousand Baht |
| | <hr/> | |
| Total | 4,560 | thousand Baht |

CHAPTER FIVE

**PROJECT
EVALUATION
AND CONCLUSION**

CHAPTER 5

PROJECT EVALUATION AND CONCLUSION

The construction of roads for which Surat Thani and Song Khla Road Construction Centers are responsible is encountering substantial delays due to the deterioration of the road construction equipment both Centers possess from long use as well as the shortage in the substantial quantities of the equipment. The Project aims at providing road construction equipment to both Centers in order to strengthen and improve the road construction ability of both Centers and to promote the road development in the region.

The effect and impact by implementing the Project is evaluated as follows:

- The working capacity of the road construction equipment is evaluated to be upgraded by more than 40%, thus the road construction ability will be facilitated proportionally to the improved equipment capacity. In particular, the urgent restoration of the roads damaged by floods in Southern Thailand in 1988 is anticipated.
- In both Centers, more than 200 engineers and mechanics are engaging presently in road construction activities. Their education and training will be enhanced both in quality and quantity by conducting the training program of the Project.
- The organization for budget, personnel and management system in both Centers is appropriately operated. Therefore, the equipment provided by the Project will be effectively utilized.
- The implementation of the Project will facilitate the road construction and road development in Southern Thailand. This will promote the decentralization of incomes.
- The above effect will contribute to improving the standard of living and incomes of residents in the influential area of twelve provinces with a population of about 6.4 million and an area of 61,400 km².

Considering the effect to promote the road development and to improve the living of residents in the area, the implementation of the Project is evaluated as appropriate. The extent of improving the present situation and

effects of implementing the Project are summarized in Table 5.5-1.

Table 5.5-1 EFFECT AND EXTENT OF IMPROVING PRESENT SITUATION BY IMPLEMENTING THE PROJECT

| Present Condition and Problems | Proposed Measures | Effect and Improvement Level by the Project |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. Due to the absolute shortage of construction equipment owned by Surat Thani and Song Khla Centers, the road construction in the region has been considerably delayed.</p> | <p>- To provide the necessary new construction equipment.</p> | <p>- The working capacity of the total equipment will be raised by more than 40%, thus the road construction projects in the region will be promoted. - Regional development of South Thailand is one of the main themes by the Government of Thailand. By implementing the Project, the road construction and road development will be extensively facilitated, thus the development and dispersion of industries and the equalization of incomes will be promoted.</p> |
| <p>2. Due to the presence of remarkably aged and deteriorated equipment in Surat Thani and Song Khla Centers, the expenditures of maintenance and repair of equipment are increasing.</p> | <p>- To provide the necessary new equipment, and also to assist in the guidance and training on equipment operation, maintenance and repair.</p> | <p>- The maintenance expenditure for equipment will be considerably reduced, thus the ratio of construction expenditure to the budget will be increased. Effective utilization of the budget will become feasible.</p> |
| <p>3. The road construction projects under Surat Thani and Song Khla Centers are widely separated annually into 10 to 15 projects with an average length of 10 km. Efficient utilization of equipment fleets for those projects is necessary.</p> | <p>- To advise on the planning and control for sequenced execution of grouped projects, equipment fleet combination and its effective placement and utilization.</p> | <p>- Effective utilization of equipment fleets will be facilitated, thus the road construction projects in the region will be promoted.</p> |

RECOMMENDATION

In order to assure the smooth implementation of the Project and the efficient utilization of the provided road construction equipment, the followings are recommended.

The recent construction equipment have not only been improved in capacity but also incorporating hydraulic, pneumatic and electronic-mechanical devices requiring special technical know-how and skills. In order to maxi-

mize the efficient utilization of those equipment, the guidance and training on the technical knowledge and operation principles of those innovated equipment shall be conducted.

Both Road Construction Centers are planning to perform annually 10 to 15 construction projects with an average length of 10 km respectively. In order to perform these plans, construction management such as sequencing of construction schedule corresponding to the scope of work of each project, optimum operation with equipment combination, programming and controlling of efficient utilization of equipment fleet, shall be conducted.

It is advisable that the technical assistance on the above matters should be conducted by the consultant as a part of its supervision service of the Project implementation.

APPENDIX

1. MEMBER LIST OF THE BASIC STUDY TEAM
2. SURVEY SCHEDULE
3. LIST OF PERSONS MET
4. MINUTES OF DISCUSSIONS
5. LIST OF REQUIRED EQUIPMENT
6. LIST OF COLLECTED DATA
7. COUNTRY DATA
8. EQUIPMENT LIST OF 8-ROAD CONSTRUCTION CENTERS
9. ANALYSIS ON REQUIRED NUMBER OF CONSTRUCTION EQUIPMENT
10. THE COST TO BE SHOULDERED BY THAILAND

APPENDIX 1

MEMBER LIST OF THE BASIC STUDY TEAM

1. MEMBER OF THE BASIC DESIGN STUDY TEAM
FOR FIELD SURVEY
2. MEMBER OF THE BASIC DESIGN STUDY TEAM
FOR EXPLANATION OF THE DRAFT FINAL REPORT

1. NAME OF BASIC DESIGN STUDY TEAM FOR FIELD SURVEY

MEMBERS OF THE FIELD SURVEY TEAM

Tetsumi Murata

Leader
Grant Aid Division,
Economic Cooperation Bureau,
Ministry of Foreign Affairs

Masayuki Aihara

Equipment Management Planner,
Assistant Director,
Minister's Secretariat,
Engineering Affairs Management Division,
Ministry of Construction

Tsuneo Bekki

Road Construction and Management Planner,
Katahira & Engineers International

Shigenobu Suzuki

Equipment Control and Maintenance Planner,
Katahira & Engineers International

2. MEMBER OF THE BASIC STUDY TEAM FOR EXPLANATION OF THE DRAFT FINAL REPORT

NAME OF STUDY TEAM

Isamu Goto

Team Leader
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Yuki Aratsu

Project Coordinator,
Second Basic Design Study Division,
Grant Aid Planning and Survey Department,
Japan International Cooperation Agency
Ministry of Construction

Tsuneo Bekki

Road Construction and Maintenance Planner,
Katahira & Engineers International

APPENDIX 2

SURVEY SCHEDULE

1. ITINERRARY OF THE BASIC DESIGN STUDY TEAM
2. ITINERARY OF MISSION FOR EXPLANATION OF DRAFT FINAL REPORT

1. Itinerary of the basic design study team

Survey schedule of the study team from January 27th, 1991 to February 15th, 1991 is bellow.

| No. | Date | Activities | |
|-----|-------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| 1. | Jan. 27, 1991 (Sun.) | Tetsumi Murata, Masayuki Aihara, Tsuneo Bekki, Shigenobu Suzuki Arrival to Bangkok | |
| 2. | Jan. 28, 1991 (Mon.) | . Courtesy Call to JICA . Courtesy Call to Embassy of Japan . Courtesy Call to DOH | |
| 3. | Jan. 29, 1991 (Tue.) | . Meeting at DOH . Explanation of Inception report, Survey schedule, Questionnaire, and Japan's Grant Aid | |
| 4. | Jan. 30, 1991 (Wed.) | . Site Investigation in Surat Thani (Murata, Aihara and Bekki) | Inspection of Road Construction Center of Surat Thani |
| | | . Site Investigation in Song Khla (Suzuki) | Inspection of Road Construction Center of Song Khla |
| 5. | Jan. 31, 1991 (Thu.) | . Site Investigation (Surat Thani Group) | . Route 4191 . Route 4 |
| 6. | Feb. 1, 1991 (Fri.) | . Site Investigation (Surat Thani Group) | . Route 4104 . Asphalt Plant |
| | | . Site Investigation (Song Khla Group) | . Route 4122 . Route 4121 . Route 4181 |

| No. | Date | Activities |
|-----|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7. | Feb. 2, 1991 (Sat.) | <ul style="list-style-type: none"> . Surat Thani to Song Khla |
| | | <ul style="list-style-type: none"> Inspection of Song Khla Road Construction Center . Route 4181 |
| | | <ul style="list-style-type: none"> . Port of Song Khla |
| 8. | Feb. 3, 1991 (Sun.) | <ul style="list-style-type: none"> . Surat Thani to Bangkok . Discussion among Study Team . Review/analysis of collection data |
| 9. | Feb. 4, 1991 (Mon.) | <ul style="list-style-type: none"> . Meeting with staff of DOH . Discussion on the questionnaire . Discussion on the number of required construction equipment . Meeting on Minutes of Discussions |
| 10. | Feb. 5, 1991 (Tue.) | <ul style="list-style-type: none"> . Minutes signed . Review/analysis of collection data . Greeting to JICA . Greeting to Embassy of Japan . Discussion about the specification . Murata (Leader) returned to Japan |
| 11. | Feb. 6, 1991 (Wed.) | <ul style="list-style-type: none"> . Aihara returned to Japan . Discussion on the equipment specifications . Discussion on the details of questionnaire . Review/analysis of collected data |
| | | <ul style="list-style-type: none"> . Site investigation in Surat Thani (Suzuki) |

| No. | Date | Activities |
|-----|-------------------------|-----------------------------------------------------------------------------------------------|
| 12. | Feb. 7, 1991 (Thu.) | . Review/analysis of collected data |
| | | . Field inspection (Surat Thani) Route 4232 |
| 13. | Feb. 8, 1991 (Fri.) | . Review/analysis of collected data |
| | | . Field inspection (Surat Thani) Route 4016 |
| 14. | Feb. 9, 1991 (Sat.) | . Review/analysis of collected data Inception report, |
| | | . Field inspection (Surat Thani) Route 4227 Route 4224 |
| 15. | Feb. 10, 1991 (Sun.) | . Review/analysis of collected data |
| | | . Field inspection (Surat Thani) Route 4151 Route 4224 |
| 16. | Feb. 11, 1991 (Mon.) | . Meeting at DOH on additional data |
| | | . Review/analysis of collected data |
| 17. | Feb. 12, 1991 (Tue.) | . Field inspection (Surat Thani) Route 4036 Route 4037 |
| | | . Review/analysis of collected data |
| 17. | Feb. 12, 1991 (Tue.) | . Field inspection (Surat Thani) Route 4036 Route 4037 |
| | | . Review/analysis of collected data |

| No. | Date | Activities |
|-----|-------------------------|------------------------------------------------------------------------------------|
| 18. | Feb. 13, 1991 (Wed.) | . Meeting at DOH . Review/analysis of collected data |
| | | . Surat Thani to Bangkok |
| 19. | Feb. 14, 1991 (Thu.) | . Review/analysis of collected data . Reporting to JICA . Greeting to DOH |
| 20. | Feb. 15, 1991 (Fri.) | Bangkok to Tokyo |

2. Itinerary of Mission for explanation of Draft Final Report

The mission schedule from April 23th, 1991, to May 1st, 1991 is bellow.

| No. | Date | Activities |
|-----|--------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 1. | April 23, 1991 (Tue.) | Isamu Goto, Yuki Aratsu, and Tsuneo Bekki Arrival to Bangkok |
| 2. | April 24, 1991 (Wed.) | . Courtesy Call to JICA . Courtesy Call to Embassy of Japan . Explanation and Discussion on Draft Final Report |
| 3. | April 25, 1991 (Thu.) | . Meeting at DOH . Explanation and Discussion on Draft Final Report |
| 4. | April 26, 1991 (Fri.) | . Goto and Aratsu arrived in Surat Thani ----- . Bekki in Bangkok . Explanation and Discussion on Draft Final Report |
| 5. | April 27, 1991 (Sat.) | . Inspection of Surat Thani Road Construction Center by Goto and Aratsu ----- . Collected data by Bekki |
| 6. | April 28, 1991 (Sun.) | Goto and Aratsu back to Bangkok Discussion among Study Team |
| 7. | April 29, 1991 (Mon.) | . Meeting with staff of DOH . Discussion about Minutes of Document |
| 8. | April 30, 1991 (Tue.) | . Minutes signed |
| 9. | May 1, 1991 (Wed.) | Bangkok to Tokyo |

APPENDIX 3

LIST OF PERSONS MET

- I. BASIC DESIGN STUDY
- II. EXPLANATION AND DISCUSSION FOR THE
DRAFT FINAL REPORT

I. BASIC DESIGN STUDY

1. List of Persons Met

| Name and Organization | Position |
|---------------------------------------------------------------------|--------------------------------------------------|
| Embassy of Japan in Thailand | |
| Mr. Yoshihiko Kamo | First Secretary |
| Mr. Kouichi Noguchi | Second Secretary |
| JICA Office in Thailand | |
| Mr. Shinji Abe | Resident Representative |
| Mr. Yoshio Tanigawa | Deputy Resident Representative |
| Mr. Junji Yokokura | Assistant Resident Representative |
| Mr. Tatsuo Suzuki | Assistant Resident Representative |
| Department of Highways, Ministry of Transport and Communications | |
| Mr. Sripon Kommai | Director General |
| Mr. Suphol Dhevapalin | Deputy Director General for Operation |
| Mr. Songsawasdi Duangratana | Deputy Director General for Engineering |
| Mr. Suphol Chienpradit | Chief Engineer for Construction |
| Mr. Sophon Yaipakdee | Director of Aid Control Office |
| Mr. Thaweewat Ratanawadee | Director of Mechanical Division |
| Mr. Prasert Warunyooratana | Assistance Director of Aids Control Office |
| Mr. Kunchit Thongmark | Director of Planning Division |
| Mr. Prawat Rattanasuwan | Director of Location & Design Division |
| Mr. Damrong Nimsawat | Director of Revolving Fund Office |
| Mr. Pichien Charoenkolkit | Director of Training Division |
| Mr. Vichai Ruangsawasdi | Senior Civil Engineer, Planning Division |
| Mr. Peerapon Panyin | Assistance Engineer of Mechanical Engineering |
| Mr. Veeravat Tesprayoon | Chief of Heavy Equipment Section |
| Mr. Tsuneo Kato | Traffic Engineering Expert |
| Mr. Yutaka Kawanishi | Expert in Toll Highway Planning |

| Name and Organization | Position |
|--------------------------------------|-----------------------------------------------------------------|
| Surat Thani Road Construction Center | |
| Mr. Chalernsak It-tarat | Director of Surat Thani Road Construction Center |
| Mr. Boonsong Chaichati | Deputy Director of Surat Thani Road Construction Center |
| Mr. Chunpon Boonsriroj | Chief of Workshop Section, Surat Thani Road Construction Center |
| Song Khla Road Construction Center | |
| Mr. Pravit Vatcharamani | Director of Song Khla Road Construction Center |
| Mr. Nipon Meytaseth | Deputy Director of Song Khla Road Construction Center |
| Mr. Taweewong Goolsriroj | Chief of Workshop Section, Song Khla Road Construction Center |
| Mr. Somchai Deipiraffanamamongkol | Material Engineer of Song Khla Road Construction Center |
| Mr. Thanya Yianwinya | Project Engineer of Route 4181 |

II. EXPLANATION AND DISCUSSION FOR THE DRAFT FINAL REPORT

1. List of Persons Met

| Name and Organization | Position |
|---------------------------------------------------------------------|--------------------------------------------------------|
| Embassy of Japan in Thailand | |
| Mr. Kouichi Noguchi | Second Secretary |
| JICA Office in Thailand | |
| Mr. Shinji Abe | Resident Representative |
| Mr. Junji Yokokura | Assistant Resident Representative |
| Department of Highways, Ministry of Transport and Communications | |
| Mr. Sripon Kommai | Director General |
| Mr. Sukree Dheerangool | Deputy Director General for Administration |
| Mr. Songsawasdi Duangratana | Deputy Director General for Engineering |
| Mr. Suphol Dhevapalin | Deputy Director General for Operation |
| Mr. Suphol Chienpradit | Chief Engineer for Construction |
| Mr. Prinya Sutabutra | Chief Engineer for Maintenance |
| Mr. Vichien Suthsupha | Chief Engineer for Maintenance |
| Mr. Therdsak Sethmanop | Secretary |
| Mr. Kanchit Thongmak | Director of Planning Division |
| Mr. Prawat Ratanasuwan | Director of Location & design Division |
| Mr. Arthorn Peetathawatchai | Director of Training Division |
| Mr. Praphol Samutrapapoot | Director of National Highways Construction Division |
| Mr. Mahinthorn Sarttri | Director of Feeder Roads |
| Mr. Chinchai Mahasaen | Director of Maintenance Division |
| Mr. Thiwat Ratanawadee | Director of Mechanical Division |
| Mr. Anun Nuntapisut | Director of Loans Control Office |
| Mr. Sophon Yaipakdee | Director of 3rd Highway Construction Office |

| Name and Organization | Position |
|----------------------------|----------------------------------------------------------------------|
| Mr. Prasert Warunyuratana | Assistant Director of 3rd Highway Construction office |
| Mr. Bancha Wadhanasin | Chief of Programming and Highway Control System Section |
| Mr. Somchai Hittrawat | Chief of Post Project Evaluation Section |
| Mr. Vichai Ruangsawasdi | Project Co-ordinator |
| Mr. Sanga Sirapitool | Director of Mechanical Engineering Office |
| Mr. Chumphol Boonsriroj | Chief of Mechanical Section Kanchanaburi Highway Construction Center |
| Mr. Likhit Khaodhien | Director of 4th Highway Construction Office |
| Mr. Pravitt Wacharamanee | Director of Song Khla Highway Construction Center |
| Mr. Chalerm Sakdi Itarajda | Director of Surat Thani Highway Construction Center |
| Mr. Yutaka Kawanishi | Expert in Toll Highway Planning |

APPENDIX 4

MINUTES OF DISCUSSIONS

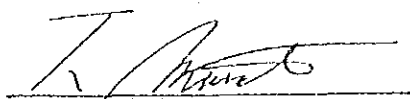
MINUTES OF DISCUSSIONS
ON
THE PROJECT
FOR
PROVIDING EQUIPMENT
FOR
ROAD CONSTRUCTION AND REHABILITATION
IN
THE SOUTH THAILAND RURAL AREA
IN
THE KINGDOM OF THAILAND

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a basic design study on the Project for Providing Equipment for Road Construction and Rehabilitation in the South Thailand Rural Area (hereinafter referred to as "the Project"), and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Thailand, the study team headed by MR. Tetsumi MURATA, Grant Aid Division, Economic Cooperation Bureau, Ministry of the Foreign Affairs, from January 27th to February 15th, 1991.

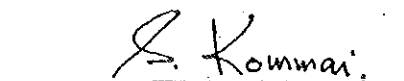
The team had a series of discussions on the Project with the officials concerned the Government of Thailand and conducted a field survey.

As a result of the study and discussions, both parties agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Bangkok, February 5th, 1991



Mr. Tetsumi MURATA
Team Leader
Basic Design Study Team
JICA



Mr. Sriporn KOMMAI
Director General
Department of Highways
The Kingdom of Thailand

1. TITLE OF THE PROJECT

The title of the project is the "Project for Providing Equipment for Road Construction and Rehabilitation in the South Thailand Rural Area".

2. OBJECTIVE OF THE PROJECT

The objective of the Project is to provide necessary equipment to Surat Thani and Song Khla Road Construction Centers in the South Thailand, which contributes to development of the South Thailand rural area and to engineering training for the staff of the Centers.

3. PROJECT SITES

The project sites are located at Surat Thani and Song Khla Road Construction Centers, as shown in Annex 1.

4. EXECUTING ORGANIZATION

Department of Highways, Ministry of Transport and Communications, is the responsible organization for the administration of the Project and Surat Thani Road Construction Center and Song Khla Road Construction Center are the executing organization for the implementation of the Project and are responsible for its operation and maintenance after completion of the Project.

5. EQUIPMENT REQUEST BY THE GOVERNMENT OF THAILAND

The outline of the equipment requested by the Government of Thailand is shown in Annex 2.

The Japanese study team will convey to the Government of Japan the request of the Government of Thailand that the former take necessary measures to cooperate in implementing the Project and provide the equipment within the scope of Japan's Grant Aid Program.

6. TECHNICAL ASSISTANCE REQUESTED BY THE GOVERNMENT OF THAILAND.


The Government of Thailand requested the Government of Japan to send experts, mechanical engineers, for the Project.

7. SYSTEM OF JAPAN'S GRANT AID PROGRAM

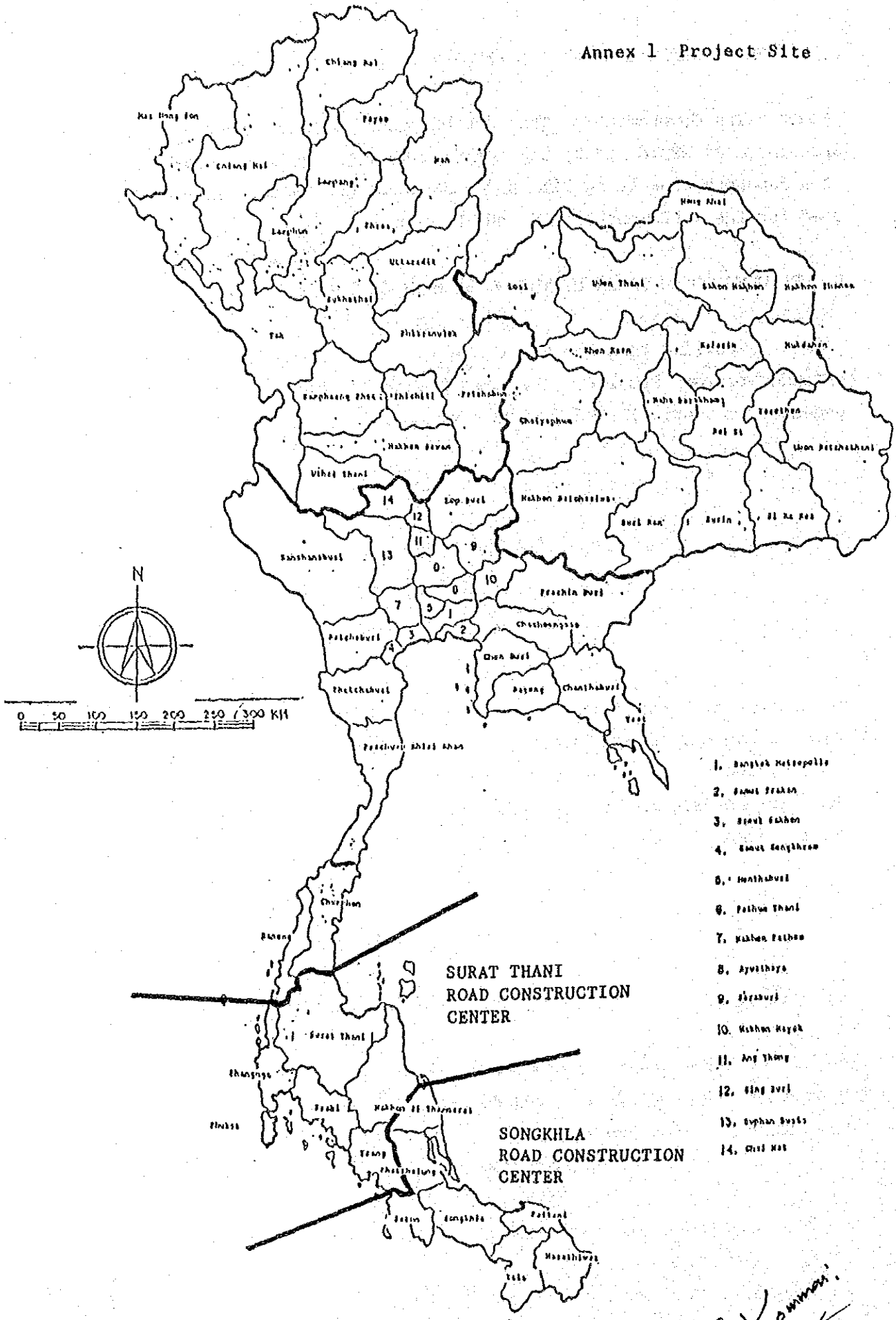
The Government of Thailand has understood the system of Japan's Grand Aids as explained by the team, which includes a principal for use of a Japanese consulting firm and a Japanese contractor and/or firm be used for the implementation of the Project.

8. MEASURES TO BE TAKEN BY THE GOVERNMENT OF THAILAND

Provided that the Grant Aid by the government of Japan is extended to the Project, the Government of Thailand will take the necessary measures listed in Annex 3.

P. Komma


Annex 1 Project Site



- 1. Bangkok Metropolitan
- 2. Samut Prakan
- 3. Samut Sakhon
- 4. Samut Songkhro
- 5. Nonthaburi
- 6. Pathum Thani
- 7. Nakhon Pathom
- 8. Ayutthaya
- 9. Si Racha
- 10. Nakhon Nayok
- 11. Ang Thong
- 12. Sing Buri
- 13. Suphan Buri
- 14. Chai Nat

P. K. ...

ANNEX 2. OUTLINE OF EQUIPMENT REQUESTED BY
THE GOVERNMENT OF THAILAND

| TYPE OF EQUIPMENT | SPECIFICATION | SURAT THANI CENTER | | | SONG KHLA CENTER | | | TOTAL | | | | | | | |
|------------------------------------------|---------------------------------------------------|--------------------|------|-------|------------------|------|-------|-------|------|-------|--|--|--|--|--|
| | | RANK | RANK | TOTAL | RANK | RANK | TOTAL | RANK | RANK | TOTAL | | | | | |
| | | A | B | | A | B | | A | B | | | | | | |
| 1. EARTH MOVING EQUIPMENT | | | | | | | | | | | | | | | |
| 1.1 CRAWLER TRACTOR (BULLDOZER) | 300 HP. RIPPER | 0 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 4 | | | | | |
| 1.2 CRAWLER TRACTOR (BULLDOZER) | 300 HP. | 0 | 2 | 2 | 2 | 0 | 1 | 0 | 3 | 3 | | | | | |
| 1.3 CRAWLER TRACTOR (BULLDOZER) | 200 HP. RIPPER | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 2 | 3 | | | | | |
| 1.4 CRAWLER TRACTOR (BULLDOZER) | 200 HP. | 0 | 2 | 2 | 2 | 0 | 2 | 0 | 4 | 4 | | | | | |
| 1.5 CRAWLER TRACTOR (BULLDOZER) | 120 HP. SWAMP TYPE | 2 | 0 | 2 | 2 | 1 | 0 | 1 | 3 | 3 | | | | | |
| 1.6 WHEEL LOADER | 190 HP. CAP 1.8 CU.M. | 0 | 2 | 2 | 2 | 0 | 2 | 0 | 4 | 4 | | | | | |
| 1.7 MOTOR GRADER | 150 HP. | 4 | 0 | 4 | 4 | 3 | 0 | 7 | 0 | 7 | | | | | |
| SUB TOTAL 1 | | 6 | 10 | 16 | 7 | 5 | 12 | 13 | 15 | 28 | | | | | |
| 2. EARTH EXCAVATOR | | | | | | | | | | | | | | | |
| 2.1 HYDRAULIC EXCAVATOR | CAP. 0.5 - 1.8 CU.M. | 2 | 0 | 2 | 2 | 1 | 0 | 3 | 0 | 3 | | | | | |
| 2.2 HYDRAULIC EXCAVATOR | CAP. 0.36 - 1.4 CU.M. | 3 | 0 | 3 | 3 | 2 | 0 | 5 | 0 | 5 | | | | | |
| SUB TOTAL 2 | | 5 | 0 | 5 | 3 | 0 | 3 | 8 | 0 | 8 | | | | | |
| 3. EARTH SOLIDIFYING EQUIPMENT | | | | | | | | | | | | | | | |
| 3.1 SELF - PROPELLED VIBRATORY ROLLER | (S.P.V.) 120 HP. WEIGHT 10 TONS. (J.V.) VIB | 3 | 0 | 3 | 3 | 1 | 1 | 4 | 1 | 5 | | | | | |
| 3.2 SELF - PROPELLED VIBRATORY ROLLER | | 1 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 2 | | | | | |
| 3.3 RUBBER TIRE ROLLER | | 2 | 2 | 4 | 4 | 0 | 2 | 2 | 4 | 6 | | | | | |
| SUB TOTAL 3 | | 6 | 2 | 8 | 2 | 3 | 5 | 8 | 5 | 13 | | | | | |

S. Kommai

| TYPE OF EQUIPMENT | SPECIFICATION | SIJRAT THANI CENTER | | | SONG KHILA CENTER | | | TOTAL | | | | | | | | | | | |
|--------------------------------------|----------------------|---------------------|------|-------|-------------------|------|-------|-------|------|-------|---|---|----|----|---|----|--|--|--|
| | | RANK | RANK | TOTAL | RANK | RANK | TOTAL | RANK | RANK | TOTAL | | | | | | | | | |
| | | A | B | | A | B | | A | B | | | | | | | | | | |
| 4. EARTH TRANSPORTATION | | | | | | | | | | | | | | | | | | | |
| 4.1 DUMP TRUCK | 8 TONS | 7 | 8 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 8 | 15 | | | | | |
| 4.2 DUMP TRUCK | 6 TONS | 0 | 0 | 0 | 6 | 4 | 10 | 8 | 4 | 10 | 8 | 4 | 10 | 8 | 4 | 10 | | | |
| SUB TOTAL 4 | | 7 | 8 | 15 | 6 | 4 | 10 | 13 | 12 | 25 | | | | | | | | | |
| 5. PAVEMENT EQUIPMENT | | | | | | | | | | | | | | | | | | | |
| 5.1 ASPHALT DISTRIBUTOR | | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | | | |
| 5.2 PAVEMENT CUTTER | | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 4 | 0 | 2 | 4 | 4 | 0 | 4 | | | |
| 5.3 CHIP SPREADER | | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 2 | | | |
| 5.4 LINE MARKER | | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 4 | 0 | 2 | 4 | 4 | 0 | 4 | | | |
| SUB TOTAL 5 | | 1 | 4 | 5 | 0 | 7 | 7 | 1 | 11 | 12 | | | | | | | | | |
| 6. MATERIAL/EQUIPMENT TRANSPORTATION | | | | | | | | | | | | | | | | | | | |
| 6.1 WATER TRUCK | | 3 | 3 | 6 | 2 | 2 | 4 | 5 | 5 | 10 | | | | | | | | | |
| 6.2 FORK LIFT TRUCK | | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | | | | | | | | | |
| 6.3 FUEL TRUCK | | 1 | 1 | 2 | 0 | 2 | 2 | 1 | 3 | 4 | | | | | | | | | |
| 6.4 SERVICE TRUCK | | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | | | | | | | | | |
| 6.5 FLAT BED TRUCK | 6 TONS | 1 | 2 | 3 | 1 | 0 | 1 | 2 | 2 | 4 | | | | | | | | | |
| 6.6 FLAT BED TRUCK | 4 TONS | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | | | | | | | | | |
| 6.7 CRANE TRUCK | CAP. 25 TONS | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 2 | | | | | | | | | |
| 6.8 CRANE TRUCK | CAP. 7.5 TONS | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | | | |
| 6.9 TRUCK TRAILER | CAP. 40 TONS | 2 | 0 | 2 | 1 | 0 | 1 | 3 | 0 | 3 | | | | | | | | | |
| SEMI - TRAILER | | | | | | | | | | | | | | | | | | | |
| 6.10 SELF - LOADING TRUCK | 10 WHEELS | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 2 | | | | | | | | | |
| EXTRA LONG WHEEL BASE | WINCH (CAP. 20 TONS) | | | | | | | | | | | | | | | | | | |
| SUB TOTAL 6 | | 9 | 11 | 20 | 6 | 6 | 12 | 15 | 17 | 32 | | | | | | | | | |

J. Kommai

| TYPE OF EQUIPMENT | SPECIFICATION | SURAT THANI CENTER | | | SONG KHLA CENTER | | | TOTAL | | |
|------------------------|---------------|-------------------------------|--------|-------|------------------|--------|-------|--------|--------|-------|
| | | RANK A | RANK B | TOTAL | RANK A | RANK B | TOTAL | RANK A | RANK B | TOTAL |
| | | 7. MULTIPLE PURPOSE EQUIPMENT | | | | | | | | |
| 7.1 FARM TRACTOR | | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| 7.2 TRUCK TRACTOR | | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| 7.3 DIESEL GENERATOR | | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 4 | 4 |
| 7.4 PORTABLE GENERATOR | | 0 | 4 | 4 | 0 | 5 | 5 | 0 | 9 | 9 |
| 7.5 MOBILE WORKSHOP | | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 2 | 2 |
| 7.6 OVER - HEAD CRANE | | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 2 | 2 |
| SUB TOTAL 7 | | 0 | 8 | 8 | 0 | 11 | 11 | 0 | 19 | 19 |
| TOTAL | | 24 | 43 | 77 | 24 | 36 | 60 | 58 | 79 | 137 |

A. Kammari

Annex 3 NECESSARY MEASURES TAKEN BY THE GOVERNMENT OF THAILAND

1. To provide data and information necessary for the design during implementation of Project.
2. To ensure prompt unloading, tax exemption, custom clearance at the port of disembarkation in Thailand and prompt internal transportation of the equipment provided under the Grant Aid.
3. To exempt any equipment, materials and supplies brought into and/or purchased in Thailand in connection with the performance of the works from any tax, duties and levies which are imposed in Thailand
4. To exempt Japanese nationals engaged in the Project from custom duties, internal taxes and other fiscal levies which may be imposed in Thailand with respect to the supply of the materials and services under the verified contracts.
5. To accord Japanese nationals whose services may be required in connection with the supply of materials and services under the verified contract such facilities as may be necessary for their entry and stay therein for the performance of their work.
6. To bear commissions to the Japanese foreign exchange bank for the banking services based on the Banking Arrangement, in accordance with Japan's Grant Aid procedure.
7. To bear all expenses, other than those to be borne by the Grant Aid, necessary in connection with the implementation of the Project.
8. To ensure the necessary budget and personnel for proper and effective operation and maintenance of the equipment provided under the Grant Aid.

S. Kommai.

MINUTES OF DISCUSSIONS
THE BASIC DESIGN STUDY ON THE PROJECT
FOR PROVIDING EQUIPMENT
FOR
ROAD CONSTRUCTION AND REHABILITATION
IN THE SOUTH THAILAND RURAL AREAS
IN
THE KINGDOM OF THAILAND
(DRAFT REPORT)

In January 1991, the Japan International Cooperation Agency (hereinafter referred to as JICA) dispatched the Basic Design Study Team on the Project for Providing Equipment for Road Construction and Rehabilitation in the South Thailand Rural Areas (hereinafter referred to as the Project), and through a series of discussions, field survey in here, and technical examination of the results in Japan, has designed the appropriate plan for the Project and prepared the Draft Report of the Basic Design Study.

In order to explain and to consult on the components of the Draft Report, JICA sent a team, headed by Mr. Isamu GOTO, Director, Construction Equipment Division, Economic Affairs Bureau, Ministry of Construction, from April 23rd to May 1st, 1991.

As a result of the discussions, both parties confirmed the main items described on the attached sheets.

Bangkok, April 30th, 1991

後藤 勇

Mr. Isamu GOTO
Leader
Draft Report Explanation Team
JICA

S. Kommai

Mr. Sriporn KOMMAI
Director General
Department of Highways
The Kingdom of Thailand

ATTACHMENT

1. The Government of Thailand has agreed to the Basic Design proposed in the Draft Report.
2. The Government of Thailand has understood Japan's Grant Aid System and reconfirmed the necessary measures to be taken by the Government of the Kingdom of Thailand as agreed on the Minutes of Discussions on the Project signed in February 5th 1991, on condition that the Grant Aid by the Government of Japan will be extended to the Project.
3. The Government of Thailand has confirmed that budget and personel required for the Project will be appropriately allocated and assigned for proper operation and effective maintenance of the equipment provided under the Grant Aid.
4. The Final Report (10 copies in English) on the Project will be submitted to the Government of Thailand within June 1991.

APPENDIX 5

LIST OF REQUIRED EQUIPMENT

TABLE- 2 NUMBER OF MACHINES IN SHORT (1)
(SURAT THANI CONSTRUCTION CENTER)

| TYPES OF EQUIPMENT | EXISTING MACHINES | | | FOR FUTURE WORKS | |
|---------------------------------------|-------------------|---------------------|------------------------|--------------------------|--------------------------|
| | DELIVERY YEAR | QUANTITY (MACHINES) | NO. of USABLE MACHINES | NO. of MACHINES REQUIRED | NO. of MACHINES IN SHORT |
| 1. EARTH MOVING EQUIPMENT | | | | | |
| 1.1 CRAWLER TRACTOR (BULLDOZER) | 1970 | 11 | 3 | 13 | 10 |
| 1.2 WHEEL LOADER | 1971 | 4 | 2 | 4 | 2 |
| 1.3 TRACTOR SHOVEL | 1970 | 2 | 2 | 2 | 0 |
| 1.4 MOTOR GRADER | 1972 - 1973 | 6 | 2 | 6 | 4 |
| 1.5 MOTOR SCRAPER | 1970 - 1972 | 2 | 2 | 3 | 0 |
| SUB TOTAL (1) | | 25 | 11 | 27 | 16 |
| 2. EARTH EXCAVATOR | | | | | |
| 2.1 HYDRAULIC EXCAVATOR (BACKHOE) | 1970 | 1 | 0 | 5 | 5 |
| SUB TOTAL (2) | | 1 | 0 | 5 | 5 |
| 3. EARTH SOLIDIFYING EQUIPMENT | | | | | |
| 3.1 SELF-PROPELLED VIBRATORY ROLLER | 1971 | 5 | 2 | 6 | 4 |
| 3.2 MACADAM ROLLER | 1971 | 2 | 2 | 2 | 0 |
| 3.3 TANDEM ROLLER | 1972 - 1973 | 2 | 2 | 2 | 0 |
| 3.4 RUBBER TIRE ROLLER | 1970 - 1972 | 8 | 3 | 7 | 4 |
| 3.5 VIBRATION RANHER | 1970 | 3 | 0 | 0 | 0 |
| SUB TOTAL (3) | | 20 | 0 | 17 | 8 |
| 4. PAVEMENT EQUIPMENT | | | | | |
| 4.1 ASPHALT FINISHER | 1972 - 1973 | 2 | 2 | 2 | 0 |
| 4.2 ASPHALT PLANT | 1972 - 1973 | 2 | 2 | 2 | 0 |
| 4.3 ASPHALT DISTRIBUTOR | 1971 | 1 | 0 | 1 | 1 |
| 4.4 PAVEMENT CUTTER | ---- | 0 | 0 | 2 | 2 |
| 4.5 CHIP SPREADER | 1970 | 4 | 4 | 4 | 0 |
| 4.6 LINE MARKER | 1971 | 1 | 0 | 2 | 2 |
| 4.7 ROAD STABILIZER | 1971 | 2 | 0 | 0 | 0 |
| 4.8 ASPHALT KETTLE | 1971 | 2 | 2 | 2 | 0 |
| SUB TOTAL (4) | | 14 | 10 | 15 | 5 |

TABLE- 3 NUMBER OF MACHINES IN SHORT (2)
(SURAT THANI CONSTRUCTION CENTER)

| TYPES OF EQUIPMENT | EXISTING MACHINES | | | FOR FUTURE WORKS | |
|-----------------------------------------------------|-------------------|---------------------|------------------------|--------------------------|--------------------------|
| | DELIVERY YEAR | QUANTITY (MACHINES) | NO. OF USABLE MACHINES | NO. OF MACHINES REQUIRED | NO. OF MACHINES IN SHORT |
| 5. TRANSPORTATION | | | | | |
| 5.1 DUMP TRUCK | 1970 - 1972 | 20 | 10 | 25 | 15 |
| 5.2 WATER TRUCK | 1970 - 1972 | 7 | 3 | 9 | 6 |
| 5.3 FORK LIFT TRUCK | 1970 | 1 | 1 | 2 | 1 |
| 5.4 FUEL TRUCK | 1970 - 1972 | 2 | 1 | 3 | 2 |
| 5.5 SERVICE TRUCK | 1970 - 1972 | 2 | 1 | 2 | 1 |
| 5.6 FLAT BED TRUCK | 1970 | 2 | 1 | 4 | 3 |
| 5.7 FLAT BED TRUCK | 1970 - 1972 | 3 | 0 | 2 | 2 |
| 5.8 CRANE TRUCK | 1970 | 1 | 0 | 2 | 2 |
| 5.10 TRUCK TRAILER + SEMI-TRAILER | 1970 | 1 | 1 | 3 | 2 |
| 5.11 SELF-LOADING TRUCK EXTRA LONG WHEEL BASE | 1970 | 1 | 1 | 2 | 1 |
| 5.12 INSPECTION CAR | 1970 | 11 | 6 | 14 | 8 |
| 5.13 MICRO-BUS | 1970 | 1 | 0 | 2 | 2 |
| SUB-TOTAL (5) | | 52 | 25 | 70 | 45 |
| 6. OTHER EQUIPMENT (MULTIPLE-PURPOSE) | | | | | |
| 6.1 FARM TRACTOR | 1971 | 3 | 1 | 1 | 0 |
| 6.2 TRUCK TRACTOR | 1970 | 1 | 1 | 1 | 0 |
| 6.3 DIESEL GENERATOR | 1970 | 1 | 0 | 2 | 2 |
| 6.4 PORTABLE GENERATOR | 1970 | 6 | 2 | 6 | 4 |
| 6.5 MOBILE-WORKSHOP | ---- | 0 | 0 | 1 | 1 |
| 6.6 OVER-HEAD CRANE | | 1 | 1 | 2 | 1 |
| SUB TOTAL (6) | | 12 | 5 | 13 | 8 |
| GRAND TOTAL | | 124 | 60 | 147 | 87 |

TABLE- 4 NUMBER OF MACHINES IN SHORT (1)
(SONG KIHA CONSTRUCTION CENTER)

| TYPES OF EQUIPMENT | EXISTING MACHINES | | | FOR FUTURE WORKS | |
|---------------------------------------|-------------------|---------------------|------------------------|--------------------------|--------------------------|
| | DELIVERY YEAR | QUANTITY (MACHINES) | NO. of USABLE MACHINES | NO. of MACHINES REQUIRED | NO. of MACHINES IN SHORT |
| 1. EARTH MOVING EQUIPMENT | | | | | |
| 1.1 CRAWLER TRACTOR (BULLDOZER) | 1965 - 1966 | 9 | 3 | 10 | 7 |
| 1.2 TRACTOR SHOVEL | 1965 | 3 | 1 | 1 | 0 |
| 1.3 MOTOR GRADER | 1965 - 1966 | 4 | 2 | 5 | 3 |
| 1.4 WHEEL LOADER | ---- | 0 | 0 | 2 | 2 |
| SUB TOTAL (1) | | 16 | 6 | 18 | 12 |
| 2. EARTH EXCAVATOR | | | | | |
| 2.1 HYDRAULIC EXCAVATOR (BACKHOE) | 1965 - 1968 | 4 | 1 | 4 | 3 |
| SUB TOTAL (2) | | 3 | 1 | 4 | 3 |
| 3. EARTH SOLIDIFYING EQUIPMENT | | | | | |
| 3.1 SELF-PROPELLED VIBRATORY ROLLER | ---- | 0 | 0 | 3 | 3 |
| 3.2 HACADAM ROLLER | 1965 - 1968 | 5 | 2 | 2 | 0 |
| 3.3 RUBBER TIRE ROLLER | 1968 | 2 | 1 | 3 | 2 |
| SUB TOTAL (3) | | 7 | 3 | 6 | 5 |
| 4. PAVEMENT EQUIPMENT | | | | | |
| 4.1 ASPHALT DISTRIBUTOR | 1974 | 1 | 1 | 2 | 1 |
| 4.2 PAVEMENT CUTTER | ---- | 0 | 0 | 2 | 2 |
| 4.3 CHIP SPREADER | ---- | 0 | 0 | 2 | 2 |
| 4.4 LINE MARKER | ---- | 0 | 0 | 2 | 2 |
| SUB TOTAL (4) | | 1 | 1 | 8 | 7 |

TABLE- 5 NUMBER OF MACHINES IN SHORT (2)
(SONG KHILA CONSTRUCTION CENTER)

| TYPES OF EQUIPMENT | EXISTING MACHINES | | | FOR FUTURE WORKS | |
|----------------------------------------------------|-------------------|---------------------|------------------------|--------------------------|--------------------------|
| | DELIVERY YEAR | QUANTITY (MACHINES) | NO. of USABLE MACHINES | NO. of MACHINES REQUIRED | NO. of MACHINES IN SHORT |
| 5. TRANSPORTATION | | | | | |
| 5.1 DUMP TRUCK | 1965 | 10 | 5 | 15 | 10 |
| 5.2 WATER TRUCK | 1965 | 1 | 0 | 4 | 4 |
| 5.3 FORK LIFT TRUCK | --- | 0 | 0 | 1 | 1 |
| 5.4 FUEL TRUCK | 1965 | 2 | 1 | 3 | 2 |
| 5.5 SERVICE TRUCK | ---- | 0 | 0 | 1 | 1 |
| 5.6 FLAT BED TRUCK | 1966 | 4 | 2 | 3 | 1 |
| 5.7 CRANE TRUCK | 1961 | 1 | 0 | 1 | 1 |
| 5.8 TRUCK TRAILER + SEMI-TRAILER | ---- | 0 | 0 | 1 | 1 |
| 5.9 SELF-LOADING TRUCK EXTRA LONG WHEEL BASE | ---- | 0 | 0 | 1 | 1 |
| 5.10 INSPECTION CAR | 1965 - 1977 | 6 | 3 | 9 | 6 |
| 5.11 PASSENGER CAR | 1965 | 2 | 0 | 0 | 0 |
| 5.12 MICRO-BUS | ---- | 0 | 0 | 1 | 1 |
| SUB TOTAL (5) | | 26 | 11 | 40 | 29 |
| 6. OTHER EQUIPMENT (MULTIPLE-PURPOSE) | | | | | |
| 6.1 FARM TRACTOR | ---- | 0 | 0 | 1 | 1 |
| 6.2 TRUCK TRACTOR | 1968 | 1 | 0 | 1 | 1 |
| 6.3 DIESEL GENERATOR | ---- | 0 | 0 | 2 | 2 |
| 6.4 PORTABLE GENERATOR | ---- | 0 | 0 | 5 | 5 |
| 6.5 MOBILE-WORKSHOP | ---- | 0 | 0 | 1 | 1 |
| 6.6 OVER-HEAD CRANE | ---- | 1 | 1 | 2 | 1 |
| SUB TOTAL (6) | | 3 | 1 | 12 | 11 |
| GRAND TOTAL | | 56 | 23 | 90 | 67 |

APPENDIX 6

LIST OF COLLECTED DATA

LIST OF COLLECTED DATA

General

1. Highways in Thailand
2. Highway Map in Thailand
3. Ministry of Transport and Communication
4. National Development Plan (1987-1991)
5. 7th Development Plan for Transport Sector (1992-1996)
6. Regional Development Plan for Southern Thailand (1992-1996)
7. Existing Condition of Transport Sector
8. Highway Construction and Rehabilitation Plan (1989-1996)
9. Length by Class of Roads and Bridges
10. Average Construction Cost
11. Equipment List of Six Construction Centers
12. Development Plan of Southern Seaboard
13. Road Development Study in the Southern Region (JICA)
14. Progress Reports I and II and Interim Report for the Toll Highway Development Study in the Kingdom of Thailand (JICA)
15. Territory and Annual Budget of 6 Construction Centers
16. Chaophaya Terminal International
17. Thailand in Figures 1990
18. Transportation 3rd Edition
19. Regional Industrial Development in Thailand, Theory and Practice
20. Thailand National Resources Profile

Surat Thani Road Construction Center

1. 1991 Machine Inventory
2. 1991 Construction Schedule
3. Location Map of Project in 1991
4. History of Center
5. Annual Budget Allocation (1965-1991)
6. Detailed Budget Allocation
7. Organization, Number of Staff
8. Past Performance Record (Budget and Length)
9. Frequency and Time Duration of Repair of Equipment
10. Rough Cost Estimation for In-Land Transportation of Equipment
11. Definition of Present Status of Equipment

Song Khla Road Construction Center

1. 1991 Machine Inventory
2. 1991 Construction Schedule
3. Location Map of Project in 1991
4. History of Center
5. Annual Budget Allocation (1965-1991)
6. Detailed Budget Allocation (1986-1990)
7. Organization, Number of Staff
8. Past Performance Record (Budget and Length)
9. Analysis in Equipment Operation/Repair

APPENDIX 7

COUNTRY DATA

- Table-1 Gross National Product (By Industrial Origin 1970-1988)
- Table-2 Land and Population (1988)
- Table-3 Employed Persons : By Industry (1989)
- Table-4 General Outline of the Kingdom of Thailand (1990)
- Table-5 Aid's Fund Flow (1990)
- Table-6 Japanese Economic Cooperation and Trade (1990)
- Table-7 Thailand's International Trade (1986-1988)
- Table-8 Export and Import Value (1988)
- Table-9 Principal Agricultural Products (1988/1989)
- Table-10 Principal Manufacturing Production (1988-1989)
- Table-11 Export and Import Value : By Product (1988)
- Table-12 Social Environment Southern Region (1987)
- Table-13 Main Agricultural Production in Southern Thailand (1988)

Table-1 Gross National Product (By Industrial Origin 1970-1988)

(Unit : Million Baht)

| | 1970 | 1975 | 1980 | 1984 | 1985 | 1986 | 1987 | 1988e |
|-------------------------------------------------------------|---------|---------|---------|---------|-----------|-----------|-----------|-----------|
| Agriculture | 38,163 | 81,521 | 152,852 | 175,190 | 169,895 | 180,841 | 198,284 | 247,748 |
| Crops | 24,429 | 55,469 | 101,437 | 113,069 | 105,221 | 108,217 | 121,098 | 153,576 |
| Livestock | 3,925 | 7,591 | 15,488 | 16,883 | 14,995 | 19,870 | 22,595 | 24,847 |
| Fisheries | 2,612 | 5,131 | 8,115 | 11,339 | 12,763 | 15,136 | 14,304 | 15,069 |
| Forestry | 2,433 | 4,261 | 8,613 | 9,212 | 8,962 | 9,048 | 9,037 | 9,311 |
| Agricultural services | 1,002 | 3,090 | 5,447 | 6,791 | 7,438 | 7,111 | 7,199 | 7,838 |
| Simple agricultural processing products | 3,762 | 5,979 | 13,752 | 17,896 | 20,516 | 21,459 | 24,051 | 27,107 |
| Mining & quarrying | 4,382 | 6,582 | 22,147 | 32,954 | 40,167 | 34,398 | 38,207 | 44,333 |
| Manufacturing | 23,503 | 56,636 | 139,936 | 218,050 | 224,456 | 255,029 | 295,512 | 357,851 |
| Construction | 7,818 | 11,594 | 34,764 | 56,092 | 56,824 | 56,564 | 62,995 | 74,524 |
| Electricity & water supply | 1,624 | 3,417 | 6,289 | 18,618 | 23,590 | 28,689 | 31,858 | 37,487 |
| Transportation & communication | 9,161 | 16,790 | 37,863 | 69,530 | 78,076 | 85,371 | 92,947 | 106,834 |
| Wholesale & retail trade | 27,108 | 58,177 | 110,176 | 154,891 | 153,130 | 169,828 | 192,381 | 232,231 |
| Banking, insurance & real estate | 3,646 | 8,019 | 19,926 | 34,426 | 35,988 | 37,376 | 48,671 | 60,032 |
| Ownership of dwellings | 8,520 | 13,546 | 22,798 | 37,253 | 41,091 | 44,842 | 48,802 | 52,702 |
| Public administration & defence | 6,721 | 13,368 | 30,711 | 45,019 | 48,545 | 50,612 | 52,712 | 56,242 |
| Services | 16,739 | 33,689 | 81,047 | 131,389 | 142,637 | 151,129 | 171,665 | 195,752 |
| Gross Domestic Product (GDP) | 147,385 | 303,319 | 658,509 | 973,412 | 1,014,399 | 1,094,679 | 1,234,030 | 1,465,736 |
| Plus : Net factor income payment from the rest of the world | 221 | -13 | -5,394 | -11,451 | -17,597 | -22,437 | -22,599 | -25,339 |
| Gross National Product (GNP) | 147,606 | 303,306 | 653,115 | 961,961 | 996,802 | 1,072,242 | 1,211,431 | 1,440,406 |
| △ | 26,271 | 52,095 | 119,581 | 188,684 | 195,353 | 221,017 | 253,010 | 316,897 |
| National income (NNP) | 121,336 | 251,211 | 533,534 | 773,277 | 801,449 | 851,225 | 958,421 | 1,123,509 |
| Per capita GNP (Baht) | 4,058 | 7,328 | 13,980 | 18,968 | 19,287 | 20,364 | 22,599 | 26,412 |

e = estimates

Source : 1. National Income of Thailand, New Series 1970-1987.
National Economic and Social Development Board

2. National Income of Thailand, 1988 Edition.
National Economic and Social Development Board

Table-2 Land and Population

(1988)

| Region / Province | Land (Km ²) | Population (1000PSNS) | Density (PSNS/Km ²) |
|-------------------|-------------------------|-----------------------|---------------------------------|
| Northern | 169,644.5 | 10,731.6 | 63.3 |
| Northeastern | 168,854.5 | 19,254.1 | 114.0 |
| Eastern | 36,502.5 | 3,595.2 | 98.5 |
| Western | 43,046.7 | 3,217.4 | 74.7 |
| Central | 16,593.4 | 2,791.9 | 168.3 |
| Metro Bangkok | 7,758.2 | 8,509.5 | 1,096.8 |
| Southern | 70,715.2 | 6,861.1 | 97.0 |
| Whole Kingdom | 513,115.0 | 54,960.8 | 107.0 |

Source : Registration Division, Local Administration Department, Ministry of Interior

Table-3 Employed Persons : By Industry, 1989

| Industry | Employed persons | (%) |
|-----------------------------------------------|------------------|-------|
| Agriculture, Forestry, Hunting and Fishing | 17,350 | 61.9% |
| Mining and Quarrying | 77 | 0.3% |
| Manufacturing | 2,705.0 | 9.7% |
| Construction, Repair and Demolition | 824.0 | 2.9% |
| Electricity, Gas, Water and Sanitary Services | 127.0 | 0.5% |
| Commerce | 3,134.0 | 11.2% |
| Transport, Storage and Communication | 680.0 | 2.4% |
| Service | 3,110.0 | 11.1% |
| Activities not Adequately Described | - | - |
| Total | 28,007.0 | 100% |

Source : Estimation of Structure Population and Labour Force, 1988-1989, Department of Labour, Ministry of Interior

Table-4 General Outline

(1/2)

| Item U N I T year | G D P Billion Baht | Agriculture | Mining and manu- facturing | | Other | GDP Defla- tor 1980年 =100 | Public fina- nce income and expendi- ture million Baht | Lending rate Annual interest (%) | exchange quotation 1 Baht = \$ 1 |
|----------------------------------|--------------------------|-------------|----------------------------------------------|---------------|-------|---------------------------------------|-----------------------------------------------------------------------|----------------------------------------------|-------------------------------------------|
| | | | Composition rate by economic activity (%) | Manufacturing | | | | | |
| 1965 | 81.3 | - | - | - | - | 36.2 | -521 | - | 20.800 |
| 1970 | 136.1 | 28.5 | 18.0 | 15.9 | 53.5 | 38.8 | -5,400 | - | 20.800 |
| 1975 | 298.8 | 31.3 | 19.5 | 18.1 | 49.2 | 62.8 | -6,265 | - | 20.379 |
| 1980 | 684.9 | 25.4 | 21.8 | 19.6 | 52.8 | 100.0 | -32,266 | 18.00 | 20.476 |
| 1981 | 786.2 | 23.9 | 21.8 | 20.1 | 56.5 | 108.0 | -25,667 | 19.00 | 21.820 |
| 1982 | 846.1 | 22.3 | 21.2 | 19.5 | 58.0 | 111.6 | -53,748 | 19.00 | 23.000 |
| 1983 | 924.9 | 22.1 | 20.8 | 19.1 | 57.1 | 115.8 | -36,633 | 17.63 | 23.000 |
| 1984 | 988.9 | 19.3 | 22.0 | 19.9 | 58.3 | 116.4 | -33,975 | 18.75 | 23.639 |
| 1985 | 1,041.4 | 17.1 | 22.9 | 20.1 | 60.0 | 118.3 | -55,705 | 19.00 | 27.159 |
| 1986 | 1,098.4 | 16.7 | 22.8 | 20.6 | 60.5 | 121.4 | -48,264 | 17.00 | 26.299 |
| 1987 | 1,223.2 | - | - | - | - | 126.1 | -28,368 | 15.00 | 25.723 |
| 1988 | - | - | - | - | - | - | 14,913 | - | 25.294 |

(2/2)

| Item U N I T year | Export's Sum | Import's Sum | Current balance | | long- term Capital balance | long-term | | Total balance | Foreign money reserve | Consumer price index 1980 =100 |
|----------------------------------|-----------------|-----------------|------------------|--------|-------------------------------------|----------------|-----------------|------------------|-----------------------------|--------------------------------------------|
| | | | Trade balance | | | Public fund | Private fund | | | |
| 1965 | 622 | 771 | -15 | -50 | 71 | - | - | 16.0 | 739 | 34.9 |
| 1970 | 710 | 1,299 | -250 | -462 | 110 | 324 | 402 | -82 | 906 | 39.5 |
| 1975 | 2,377 | 3,280 | -607 | -673 | 256 | - | - | -53 | 1,775 | 62.9 |
| 1980 | 6,505 | 9,213 | -2,070 | -1,902 | 2,107 | 1,904 | 1,703 | -206 | 3,026 | 100.0 |
| 1981 | 7,038 | 9,951 | -2,569 | -2,029 | 1,885 | 4,975 | 2,099 | 43 | 2,727 | 112.7 |
| 1982 | 6,945 | 8,548 | -1,003 | -731 | 1,384 | 5,993 | 2,317 | -231 | 2,652 | 118.6 |
| 1983 | 6,368 | 10,287 | -2,874 | -2,861 | 1,464 | 6,867 | 2,655 | -324 | 2,556 | 123.0 |
| 1984 | 7,413 | 10,398 | -2,109 | -1,898 | 1,786 | 7,154 | 3,372 | 516 | 2,689 | 124.1 |
| 1985 | 7,122 | 9,244 | -1,537 | -1,322 | 1,615 | 9,836 | 3,370 | 82 | 3,003 | 127.1 |
| 1986 | 8,753 | 9,138 | 247 | 388 | 58 | 11,537 | 3,108 | 684 | 3,776 | 129.4 |
| 1987 | 11,546 | 12,849 | -526 | -386 | 571 | 13,963 | 3,108 | 912 | 5,211 | 132.6 |
| 1988 | 15,579 | 19,078 | -1,671 | -2,074 | 311 | 13,375 | 3,529 | 2,596 | 7,112 | 137.8 |

Source : Handbook of Overseas Economic Cooperation 1990

Tabl-5 Aid's Fund Flow (Net base)

(Million Baht)

| Item \ Year | 1984 | 1985 | 1986 | 1987 | 1988 |
|---------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------------------------------------------------|
| Official Development Assistance | 474.1 | 480.9 | 496.0 | 506.4 | 563.1 |
| Between 2 Countries | 375.0 | 396.7 | 398.9 | 431.3 | 507.2 |
| 5 Higher countries | JPN (232.0) USA (35.0) FRG (26.1) AUT (22.6) CAN ((17.1) | JPN (264.1) USA (32.2) FRG (24.0) AUT (21.8) CAN ((14.1) | JPN (260.4) USA (32.0) FRG (27.7) AUT (18.7) CAN (17.2) | JPN (302.4) CAN (26.3) USA (23.0) FRG (21.9) AUT (16.6) | JPN (360.6) FRG (35.1) CAN ((29.2) USA (22.0) AUT (21.1) |
| Among many countries | 99.0 | 84.2 | 97.1 | 75.1 | 55.9 |
| Between 2 countries | 64.5 | 29.4 | -64.5 | -91.9 | -113.2 |
| Among many countries | 331.5 | 296.0 | 151.6 | -36.8 | -452.1 |
| PF | 602.0 | 72.7 | -9.0 | 546.5 | 354.1 |
| Total | 1,472.1 | 879.0 | 574.2 | 924.2 | 352.0 |

Table-6 Japan's Economic Cooperation and Trade

(Million Baht)

| Item \ Year | 1984 | 1985 | 1986 | 1987 | 1988 | |
|-------------------------|-------------------------|------------------------------------------|--------------------|----------|--------------------------------|--------------------|
| ODA | grant | 90.41 | 117.23 | 125.76 | 135.56 | 138.44 |
| | (Technical cooperation) | (40.21) | (40.69) | (54.19) | (72.64) | (94.28) |
| | loan | 141.61 | 146.87 | 134.66 | 166.88 | 222.18 |
| | Total | 232.02 | 264.10 | 260.41 | 302.45 | 360.62 |
| Others (net) | 351.09 | 144.96 | 100.34 | 305.23 | 234.59 | |
| Sum total (Net) | 538.11 | 409.06 | 360.75 | 607.68 | 595.21 | |
| export from Japan | 2,424.56 | 2,030.39 | 2,029.68 | 2,953.26 | 5,161.81 | |
| import from Japan | 1,039.65 | 1,026.91 | 1,390.90 | 1,796.00 | 2,751.43 | |
| 1988 Principal Products | Export | Machinery Transportation equipment | 1,427.66 923.21 | Import | Groceries processed product | 1,115.37 874.94 |

Source : Handbook of Overseas Economic Cooperation 1990

Table-7 Thailand's International Trade (1986-1988)

Unit : Million Baht

| Year | Exports | Imports | Balance of Trade | Export/Import Ratio | Balance of Payment |
|------|-----------|-----------|------------------|---------------------|--------------------|
| 1986 | 231,224.9 | 241,357.7 | (10,132.8) | 0.96 | 33,578 |
| 1987 | 299,838.9 | 335,010.2 | (35,171.3) | 0.90 | 18,183 |
| 1988 | 403,569.8 | 513,114.3 | (109,544.5) | 0.79 | 40,489 |

Source : 1. International Trade Statistics (In Thai language), Dept. of Business Economics, Ministry of Commerce
 2. Thailand Export Monitor, Tera International Co., Ltd.
 3. Bank of Thailand's Quarterly Economic Bulletin, March 1971-1989

Table-8 Export and Import Value : By Country, 1988

(Million Baht)

| Country | Thailand's Exports to | Thailand's Imports from |
|------------------------------|-----------------------|-------------------------|
| Australia | 7,497 | 8,779 |
| Belgium | 5,364 | 8,255 |
| Canada | 7,203 | 6,757 |
| China | 12,008 | 17,191 |
| France | 9,597 | 12,413 |
| Germany, Federal Republic of | 18,635 | 27,572 |
| Hong Kong | 17,969 | 6,369 |
| India | 5,602 | 4,317 |
| Italy | 7,409 | 6,094 |
| Japan | 64,412 | 148,905 |
| Korea, Republic of | 6,438 | 14,233 |
| Malaysia | 11,946 | 10,748 |
| Netherlands | 22,015 | 5,461 |
| Saudi Arabia | 9,013 | 5,132 |
| Singapore | 30,981 | 38,196 |
| Switzerland | 4,279 | 7,617 |
| Taiwan | 7,339 | 21,334 |
| United Arab Emirates | 6,235 | 6,200 |
| United Kingdom | 14,885 | 15,185 |
| United States of America | 80,865 | 69,557 |

Source : Foreign Trade Statistics of Thailand December, 1988
 Department of Customs, Ministry of Finance

Table-9 Principal Agricultural Products

(Thousand Ton)

| Agricultural Products | 1986 | 1987 | 1988 |
|-----------------------|---------|---------|---------|
| Rice | 18,868 | 18,428 | 21,263 |
| Smoked Sheet Rubber | 811.1 | 891.4 | 861.8 |
| Cassava Roots | 15,255 | 19,554 | 22,307 |
| Fruits | 5,317 | 5,362 | 5,539 |
| Maize, Shelled | 4,309 | 2,781 | 4,675 |
| Sugar Cane | 24,450 | 27,191 | 36,668 |
| Vegetable | 165.9 | 178.0 | 208.5 |
| Soy bean | 356 | 338 | 517 |
| Coconuts | 1,279.6 | 1,310.5 | 1,377.6 |
| Mung bean | 301 | 267 | 333 |

Source : Agricultural Statistics of Thailand Crop year 1988/1989

Table-10 Principal Manufacturing Production

| Production | Unit | 1988 | 1989 | 1989 | 1989 |
|----------------------|----------------|------------|-----------|-----------|-----------|
| Diesel Fuel | Thousand Liter | 3,473,600 | 884,882 | 979,551 | 1,186,267 |
| Smoked Rubber Sheet | Ton | 856,123 | 278,041 | 175,869 | 235,583 |
| Gasoline | Thousand Liter | 2,525,163 | 602,770 | 652,861 | 736,079 |
| Cigarette | Million unit | 33,992 | 9,216 | 9,921 | 8,977 |
| Passenger Car | Unit | 59,283 | 20,493 | 18,832 | 16,008 |
| Cement | Ton | 11,519,442 | 3,611,780 | 3,937,758 | 3,685,194 |
| Prepared Animal Feed | Thousand Liter | 2,488.7 | 586.9 | 583.9 | 650.6 |
| Motorcycle | Unit | 497,533 | 138,295 | 143,940 | 151,959 |
| Truck | Unit | 97,062 | 32,450 | 34,539 | 40,373 |

Source : Industrial Statistics 3rd Quarter 1989, Information Center, Industrial Economics and Planning Division, Ministry of Industry

Table-11 Export and Import Value : By Product, 1988

Unit : Million Bath

| Product | Thailand's Exports |
|---------------------------------------|--------------------|
| Fish and Crustaceans | 19,998 |
| Tapioca, Legume, Edible Vegetables | 22,247 |
| Cereals | 38,716 |
| Canned and Preparations of Fish, Meat | 21,072 |
| Sugar and Sugar Confectionary | 10,363 |
| Natural Rubber and Rubber Products | 31,828 |
| Knitted or Crocheted Articles | 14,891 |
| Garment and Clothing Accessories | 31,259 |
| Precious Stones and Jewelry | 25,065 |
| Mechanical Equipments and Parts | 22,340 |
| Electrical Equipments and Parts | 37,379 |
| Product | Thailand's Imports |
| Fish and Crustaceans | 14,107 |
| Mineral Fuels, Oils | 39,182 |
| Organic Chemicals | 20,684 |
| Plastics and Articles | 17,565 |
| Cotton, Yarn and Woven Fabrics | 11,350 |
| Precious Stones and Jewelry | 13,893 |
| Iron and Steel | 48,492 |
| Mechanical Equipments and Parts | 89,890 |
| Electrical Equipments and Parts | 58,975 |
| Vehicles, Accessories and Parts | 34,194 |
| Aircrafts and Parts | 15,658 |
| Special Transactions | 20,453 |

Source : Foreign Trade Statistics of Thailand, December 1988
 Department of Customs, Ministry of Finance

Table-12 Social Environment of Southern Region : Employee and Passenger Cars

| | No. of Business Establishments (1988) | No. of Employees (1988) | Minimum Wage (1990) | No. of Passenger Cars (1988) | No. of Cars/1000 population (1988) | No. of Personal Vans and Trucks (1988) | No. of Motorcycles (1988) |
|---------------------|---------------------------------------|-------------------------|---------------------|------------------------------|------------------------------------|----------------------------------------|---------------------------|
| Krabi | 421 | 7,382 | 74 Bath/day | 1,023 | 4 | 5,228 | 31,989 |
| Phangnga | 1,765 | 10,076 | 84 | 1,564 | 8 | 4,014 | 14,754 |
| Phuket | 1,025 | 14,585 | 90 | 4,881 | 31 | 6,939 | 63,895 |
| Surat Thani | 1,581 | 17,359 | 74 | 3,705 | 5 | 11,122 | 71,256 |
| Trang | 1,307 | 17,123 | 74 | 2,979 | 6 | 6,806 | 47,500 |
| Nakhon Si Thammarat | 1,443 | 23,544 | 74 | 5,300 | 4 | 17,000 | 80,000 |
| Narathiwat | 1,135 | 9,195 | 74 | 1,404 | 3 | 4,410 | 63,579 |
| Pattani | 954 | 8,399 | 74 | 2,141 | 4 | 6,344 | 36,505 |
| Phatthalung | 1,053 | 4,447 | 74 | 631 | 1 | 2,440 | 27,084 |
| Satun | 413 | 4,716 | 74 | 795 | 4 | 1,919 | 16,011 |
| Songkhla | 2,598 | 37,506 | 74 | 9,888 | 9 | 15,085 | 112,161 |
| Yala | 1,123 | 9,770 | 74 | 2,470 | 7 | 4,794 | 48,009 |
| Total (A) | 14,816 | 164,102 | 76 | 36,781 | 7 | 86,101 | 612,744 |
| Whole Kingdom (B) | 149,611 | 2,494,702 | 85 | 1,146,512 | 209 | 1,061,348 | 3,894,824 |
| A / B | 0.10 | 0.07 | 0.89 | 0.03 | 0.03 | 0.08 | 0.16 |

Source : Thailand in Figures 1990

Table-13 Main Agricultural Production in the Southern Thailand (1988)

| Agricultural Product Changwat | Rice (Ton) | Oil palm (Ton) | Laang Saad (Ton) | Rambutan (Ton) | Cashew nut (Ton) | Smoked sheet rubber (Ton) | Coconut (Unit) | Durian (Unit) | Staw (Ton) |
|----------------------------------|---------------|-------------------|---------------------|-------------------|---------------------|---------------------------------|-------------------|------------------|---------------|
| Krabi | 39,553 | 410,696 | 240 | 10,627 | 3,932 | 45,531 | 34,476,530 | 2,379,150 | 8,537 |
| Phangnga | - | 4,893 | 445 | 4,806 | 6,035 | 70,270 | 12,906,500 | 2,576,821 | 16,880 |
| Phuket | 1,814 | 370 | - | 624 | 590 | 16,799 | 19,739,645 | 867,620 | 3,608 |
| Surat Thani | 105,921 | 219,132 | 3,242 | 77,833 | 2,691 | 142,133 | 238,597,600 | 3,719,820 | 36,113 |
| Trang | 43,920 | 30,349 | 1,827 | 3,279 | 1,292 | 131,000 | 14,514,045 | 1,832,220 | 4,523 |
| Nakhon Si Thammarat | 194,027 | - | 4,366 | 19,219 | 3,004 | 169,104 | 126,047,180 | 5,374,370 | 44,348 |
| Narathiwat | 68,816 | - | 11,057 | 30,907 | 690 | 139,989 | 31,097,360 | 11,735,200 | 6,090 |
| Pattani | 70,763 | - | 404 | 6,985 | 2,544 | 33,921 | 46,018,440 | 2,954,580 | 3,565 |
| Phatthalung | 204,045 | - | 1,017 | 2,090 | 221 | 61,046 | 12,305,960 | 1,667,520 | 6,013 |
| Satun | 39,651 | 82,337 | - | 1,787 | 476 | 33,065 | 4,872,504 | 654,265 | 1,187 |
| Song khla | 132,111 | 10,103 | 1,264 | 11,592 | 3,689 | 158,011 | 18,195,300 | 6,334,400 | 8,640 |
| Yala | 23,556 | - | 1,483 | 16,692 | - | 94,446 | 8,893,500 | 7,471,230 | 7,805 |
| Total A | 924,177 | 757,880 | 25,345 | 186,441 | 25,164 | 1,095,315 | 567,664,564 | 47,567,196 | 147,309 |
| Whole Kingdom B | 21,263,000 | 885,100 | 55,633 | 448,542 | 41,894 | 1,276,673 | 1,496,110,410 | (TON 222,252) | 172,856 |
| A / B | 4.3 | 85.6 | 45.6 | 41.6 | 60.1 | 85.8 | 37.9 | - | 85.2 |

Source : Thailand in Figures 1990

