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**REPORT OF THE SURVEY  
FOR IMPLEMENTATION PLANNING  
OF THE TECHNICAL COOPERATION PROJECT  
FOR  
THE FORESTRY DEVELOPMENT  
IN THE ARAKAN RANGE IN BURMA**

**MARCH, 1978**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

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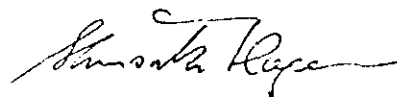
## Preface

The government of Japan has decided to implement the Technical Cooperation Project for the Forestry Development in the Arakan Range of Burma as its first technical cooperation project in forestry for the Socialist Republic of the Union of Burma. This report has been compiled as a result of the surveys conducted by the Japan International Cooperation Agency.

Timber in Burma is an important item in her exports, and the forestry development occupies an important position in the current 2nd 4-year plan. It is significant that this cooperation project on the technology development of hill forests to be developed in the future has started at this juncture.

This survey report was prepared as a result of the JICA survey team, headed by Mr. N. Namura, Director of Forestry Development Cooperation Department which was sent to Burma from June to July, 1977 and of the Consultation team headed by Mr. H. Tezuka, sent from November to December 1977. I hope this report will furnish an important guide for the promotion of this project and will contribute to promoting the forestry cooperation between Japan and Burma. It is desirable that this report will be utilized widely not only by those who are in charge of the project but also by other people concerned.

I wish to express my sincere appreciation to those who participated in this survey, officials of Burmese authorities concerned as well as to officials concerned of the Japanese Government.



Shinsaku HOGEN  
President  
Japan International Cooperation  
Agency

March 1978

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## § 1. Background and Purpose of Survey

Burma is one of the biggest forestry countries in South-East Asia and, for instance, it is said that Burma has a share of 90 per cent in teak resources in the world. Accordingly, timber is the second important export product, and conservation of the forest resources and increase of the production of timber are important policies of Burma.

The forestry area of Arakan Range in the western part of Burma had been left to be undeveloped for many years. In 1974, a cyclone of an intensity scarcely experienced in the history struck the Bassein area resulting in great damage to the forest. Triggered by this disaster, the Government of Burma made a request to Japan in August 1976, for a survey to be conducted in order to look into the possibility of technical assistance by Japan mainly for the purpose of introducing cable logging technology into Burma. In response to this request, Japan International Cooperation Agency dispatched the preliminary survey team in December the same year and long term survey experts for about 2 months since May 1977 in order to conduct the actual survey on technical cooperation area and make arrangements with Burmese authorities concerned.

Consequently, it has been disclosed, while forestry development has been conducted mainly on comparatively gentle slopes in Burma and mechanical development has been introduced in some parts of this area, that the conduct of mechanical development of forestry works still needs some more improvement, and that there is little experience in the technology for logging on the steep slopes to be developed in future, so that it may be considered to be worth-while to introduce operations with yarding machines of Japan.

Upon such survey result, a survey team was sent to Burma in June 1977 for the following purposes:

- (1) To hold a conference with Burmese authorities to discuss the basic plan of the technical cooperation project for forestry development, the procedures necessary for development of the project, a draft of Record of Discussions pertaining to the project etc.,
- (2) To conduct a field survey necessary for implementation planning of the project.

## § 2. Member and Schedule of Survey Team

One team was sent from June 15 through July 5 and another team was sent from November 26 through December 4. The details of the member and schedule are as follows:

Table 1

### Composition of Survey Team for Detailed Design

Name	Responsible for	Present Position
NAMURA Niro	Leader (General)	Director, Forestry Development Cooperation Department, Japan International Cooperation Agency
NISHIWAKI Shigeyoshi	Cooperation Planning	Deputy Director for Technical Cooperation International Cooperation Division Ministry of Agriculture and Forestry
OKADA Yoshinori	Forestry Machinery	Head, Technical Division Iwate Fuji Industrial Co., Ltd.
OKINO Takashi	Forestry Management	Silviculture Division Takigawa Forestry Administration Office Hokkaido Forestry Administration Department
NAGATSUKA Yoichi	General Affairs	Forestry Development Cooperation Department Japan International Cooperation Agency



Table 2

## Schedule for Survey (Detailed Design Team)

No.	Date	Schedule
1	Jun.15 Wed.	Tokyo to Bangkok
2	16 Thu.	Bangkok to Rangoon
3	17 Fri.	Courtesy Call to Ambassador and Courtesy Call to Minister of Agriculture and Forests
4	18 Sat.	Meeting with Long-Term Survey experts
5	19 Sun.	
6	20 Mon.	Meeting with Burmese Government Authorities such as Timber Corporation and Forest Department
7	21 Tue.	
8	22 Wed.	Rangoon to Bassein
9	23 Thu.	Field Survey to Bassein area
10	24 Fri.	
11	25 Sat.	
12	26 Sun.	Bassein to Rangoon and to Pyinmana
13	27 Mon.	Survey tour to Forestry Training School etc. in Pyinmana
14	28 Tue.	Pyinmana to Rangoon
15	29 Wed.	Conference with Burmese Authorities on Contents of R/D
16	30 Thu.	
17	Jul. 1 Fri.	Making a Report to Burmese Authorities on Conducted Survey
18	2 Sat.	Making a Report to Ambassador on Conducted Survey and Evaluation of the Survey
19	3 Sun.	Rangoon to Bangkok
20	4 Mon.	Meeting at JICA Bangkok Office
21	5 Tue.	Bangkok to Tokyo

Table 3

Composition of Survey Team  
(R/D Team)

<u>Name</u>	<u>Responsible for</u>	<u>Present Position</u>
TEZUKA Heizaburo	Leader (General)	President, Forestry Credit Fund
SUZUKI Susumu	Cooperation Planning	Director, Forestry Development Division, Japan International Cooperation Agency
KATO Hitoshi	Education & Training	Director, Forestry Works Division Tokyo Regional Forestry Office Forestry Agency
KUMAGAI Tadao	Forestry Machinery	Head, Planning Division Iwate Fuji Industrial Co., Ltd.

Table 4

Schedule of Survey (R/D Team)

No.	Date	Schedule
1	Nov. 26 Sat.	Tokyo to Bangkok
2	Nov. 27 Sun.	Bangkok to Rangoon, To confer at Embassy
3	Nov. 28 Mon.	} Conference on R/D and Meeting on Technical Cooperation Center for the Development of Hill Forests
4	Nov. 29 Tue.	
5	Nov. 30 Wed.	
6	Dec. 1 Thu.	
7	Dec. 2 Fri.	Signing of R/D
8	Dec. 3 Sat.	Rangoon to Bangkok
9	Dec. 4 Sun.	Bangkok to Tokyo

### § 3. Outline of Survey Conducted

The agenda discussed in the conference held between the Burmese authorities and the Japanese team (detailed design team) in June included the following 3 matters: (1) Cooperation period for the project, (2) Cooperation fund to be shared by Japan for the project, and (3) Production target of timber in the project.

Both parties reached the following common agreement in the conference:

- a. The cooperation period referred to above in paragraph (1) will be a period of 4 years (plus  $\alpha$ ) from a day on which the Record of Discussions will be concluded to the end of March 1982 when the 3rd 4-year plan (FY1978 through FY1981) will terminate.
- b. The cooperation fund referred to above in paragraph (2) cannot be committed officially. The previous performance in case of other project, however, indicated a total of \$US2,500,000 approximately at average including expenses for dispatching experts, providing with equipment, acceptance of trainees, etc.; and
- c. In regard to the production target referred to above in paragraph (3), it is impossible for Japan to share and perform the production itself of Burma in the cooperation project because of the principle and system of technical cooperation of Japan. Accordingly, the cooperation project does not mean to set up the production target but to virtually contribute to improvement of the productivity and increase in production volume.

According to the above agreement, Burmese side and the Japanese team discussed the master plan of the said cooperation project and Record of Discussions.

In the field survey, the team visited Chaungtha Reserved Forest, Myitaya Reserved Forest and Brassein city where there are Divisional Forest Office, which is responsible for the management of forests and production

of timber in south Arakan Range, and the Branch Office of Timber Corporation, and further observed Base Workshop and Central Training School in Pyinmana both of which are the existing installations for forestry machinery.

Then, on December 2, Ministry of Agriculture and Forests of Burma and the Japanese team (R/O team) signed the Record of Discussions to start the technical cooperation project for the purpose of establishment of forestry technology necessary for the suitable development of hill forests so that they may contribute in efficient extraction of forest resources in Arakan Range and other mountaineous forests.

#### 4. Basic Principle for Technical Cooperation

This technical cooperation will be implemented in accordance with the basic principle of the Record of Discussions signed as shown below:

RECORD OF DISCUSSIONS BETWEEN THE JAPANESE FORESTRY  
SURVEY TEAM AND THE MINISTRY OF AGRICULTURE AND  
FORESTS CONCERNING THE TECHNICAL COOPERATION PROJECT  
FOR THE FOREST DEVELOPMENT IN THE ARAKAN RANGE.

In pursuance of the Feasibility Study which was conducted in June and July, 1977, the Japanese Forestry Survey Team, organized by the Japan International Cooperation Agency, and headed by Mr. Heizaburo Tezuka, visited the Socialist Republic of the Union of Burma from 27th November to 3rd December, 1977, for the purpose of discussing with the authorities concerned of the Government of the Socialist Republic of the Union of Burma concerning the desirable measures to be taken by both Governments to implement the Technical Cooperation Project for the Forest Development in the Arakan Range.

As a result of the discussions, both parties agreed to recommend to their respective Governments to carry out the matters referred to in the attached Record of Discussions concerning the technical cooperation in the said project.

2nd December, 1977

Heizaburo Tezuka  
Head of the Japanese  
Forestry Survey Team

Khin Maung Gyi  
Managing Director  
Timber Cooperation  
Ministry of Agriculture  
and Forests  
The Socialist Republic  
of the Union of Burma

## Record of Discussions

1. (1) In line with the forestry policy of the Socialist Republic of the Union of Burma aiming at the enhancement of forestry production on the basis of the third "Four Year Plan", the Government of the Socialist Republic of the Union of Burma and the Government of Japan will cooperate, through their appropriate agencies, in implementing the Technical Cooperation Project for the Forestry Development in the Arakan Range (hereinafter referred to as "the Project"). The purpose of the Project will be to establish forestry techniques for the proper development of hill forest, so as to contribute to the efficient extraction of the forest resources in the Arakan Range and other mountaineous forest areas in Burma. The master plan of the Project is specified in Annex 1.  
  
(2) The Project will be implemented based on the guidelines of the annual work plan to be formulated by the Joint Committee referred to in Article 8.
2. (1) In accordance with laws and regulations in force in Japan, the Japanese authorities concerned will take necessary measures to provide at their own expense the services of the Japanese experts as listed in Annex 2 through the normal procedures under the Colombo Plan Technical Cooperation Scheme.  
  
(2) In accordance with laws and regulations in force in the Socialist Republic of the Union of Burma, the Japanese experts mentioned above and their families will be granted in the Socialist Republic of the Union of Burma privileges, exemptions and benefits within the frame-work of the Colombo Plan Technical Cooperation Scheme.

3. (1) In accordance with laws and regulations in force in Japan, the Japanese authorities concerned will take necessary measures to provide at their own expense such equipment, machinery, vehicles, motor boats, implements, instruments, tools, spare parts and other materials, as listed in Annex 3 required for the Project through the normal procedures under the Colombo Plan Technical Cooperation Scheme.

(2) The articles referred to above will become the property of the Government of the Socialist Republic of the Union of Burma upon being delivered c.i.f. to the Burmese authorities concerned at the ports of disembarkation and/or international airports, and will be utilized exclusively for the implementation of the Project.

4. (1) In accordance with laws and regulations in force in Japan, the Japanese authorities concerned will take necessary measures to receive the Burmese personnel engaged in the Project for technical training or study tour in Japan through the normal procedures under the Colombo Plan Technical Cooperation Scheme.

(2) The Government of the Socialist Republic of the Union of Burma through the authorities concerned will take necessary measures to ensure that the knowledge and experience acquired by the Burmese personnel through technical training in Japan will be utilized primarily for the effective implementation of the Project.

5. (1) In accordance with laws and regulations in force in the Socialist Republic of the Union of Burma, the Government of the Socialist Republic of the Union of Burma through the authorities concerned will take necessary measures to provide at its own expense:

(a) the services of the Burmese experts and other personnel as listed in Annex 4;



- (b) acquisition of land and buildings as listed in Annex 5, as well as other incidental facilities required therefor;
- (c) supply or replacement of articles necessary for the implementation of the Project other than those provided by the Japanese authorities concerned under Article 3(1);
- (d) suitable furnished housing accommodations for the Japanese experts and their families.

(2) In accordance with laws and regulations in force in the Socialist Republic of the Union of Burma, the Government of the Socialist Republic of the Union of Burma through the authorities concerned will take necessary measures to meet:

- (a) expenses necessary for the construction of forest roads and other facilities except for such equipment, machinery, vehicles, tools, spare parts and other materials, as listed in Annex 3;
- (b) expenses necessary for transportation within the Socialist Republic of the Union of Burma of the articles as listed in Annex 3 as well as for the installation, operation and maintenance thereof;
- (c) all operating expenses necessary for the implementation of the Project;
- (d) customs duties, internal taxes and any other charges, if any, imposed in the Socialist Republic of the Union of Burma with respect to the articles to be brought in from Japan as listed in Annex 3;
- (e) expenses for transportation facilities and internal travel in the Socialist Republic of the Union of Burma of the Japanese experts while on duty;
- (f) free medical and dental services and facilities for the Japanese experts and their families in state hospitals in Burma, within the framework of the Colombo Plan Technical Cooperation Scheme;

(g) customs duties and taxes on personal and household effects of the Japanese experts and their families, as well as on one motor car for each expert, within the framework of the Colombo Plan Technical Cooperation Scheme.

6. The Ministry of Agriculture and Forests of the Government of the Socialist Republic of the Union of Burma will be responsible for the administrative matters for the implementation of the Project, and the Japanese experts will provide primarily technical guidance and advice for the Project.
7. The Government of the Socialist Republic of the Union of Burma through the authorities concerned shall undertake to bear claims, if any accidents arise, on the Japanese experts engaged in the Project resulting from, occurring in the course of, or otherwise connected with, the discharge of their official functions in the Socialist Republic of the Union of Burma, except for those claims arising from wilfull misconduct or gross negligence of the Japanese experts.
8. For the successful and smooth implementation of the Project a Joint Committee will be established as specified in Annex 6.
9. The period of cooperation will be from the date of signature of the record of discussions to the end of March in 1982. Concerning the follow-up cooperation thereafter, there will be mutual consultations between the two Governments concerned.

Annex 1. The Master Plan of the Project

1. Set-up of Implementing Organization

(1) The Project will be implemented through the organization as shown in the attached chart.

(2) A Central Office of the Project will be established in the headquarters of the Timber Corporation in Rangoon.

(3) The Central Office will be headed by a Burmese project manager, who is the chief officer in charge of the Project.

A place will be given in the Office for one Japanese chief advisor, who is the chief of the Japanese experts dispatched for the Project.

(4) A Technical Cooperation Centre for the Development of Hill Forests will be established in Rangoon where Japanese experts and their counterparts are to be stationed.

(5) A Pilot Extraction Centre will be established in the South Arakan Area where associate experts and their counterparts are stationed, while Japanese experts and their counterparts will make visits for necessary supervision. The Pilot Centre will be composed of a Model Operation Forest in the Chaungtha reserved forest and a workshop in Bassein. The Scale of the Model Operation Forest will be around 1,000 ha in the Project period.

2. Functions of Each Component

(1) The Central Office will be responsible for the overall administration and supervision of the Project.

It will also run the Joint Committee referred to in Articles 1 and 8, while coordinating the authorities concerned.

(2) The Technical Cooperation Centre will conduct the following activities:

A. Development and Improvement of Requisite Techniques

- (1) Development and improvement of a system of timber extraction techniques in hill forests including cable logging system.
- (2) Development and improvement of a system of maintenance and repair techniques of forestry machinery to contribute to efficient mechanisation.

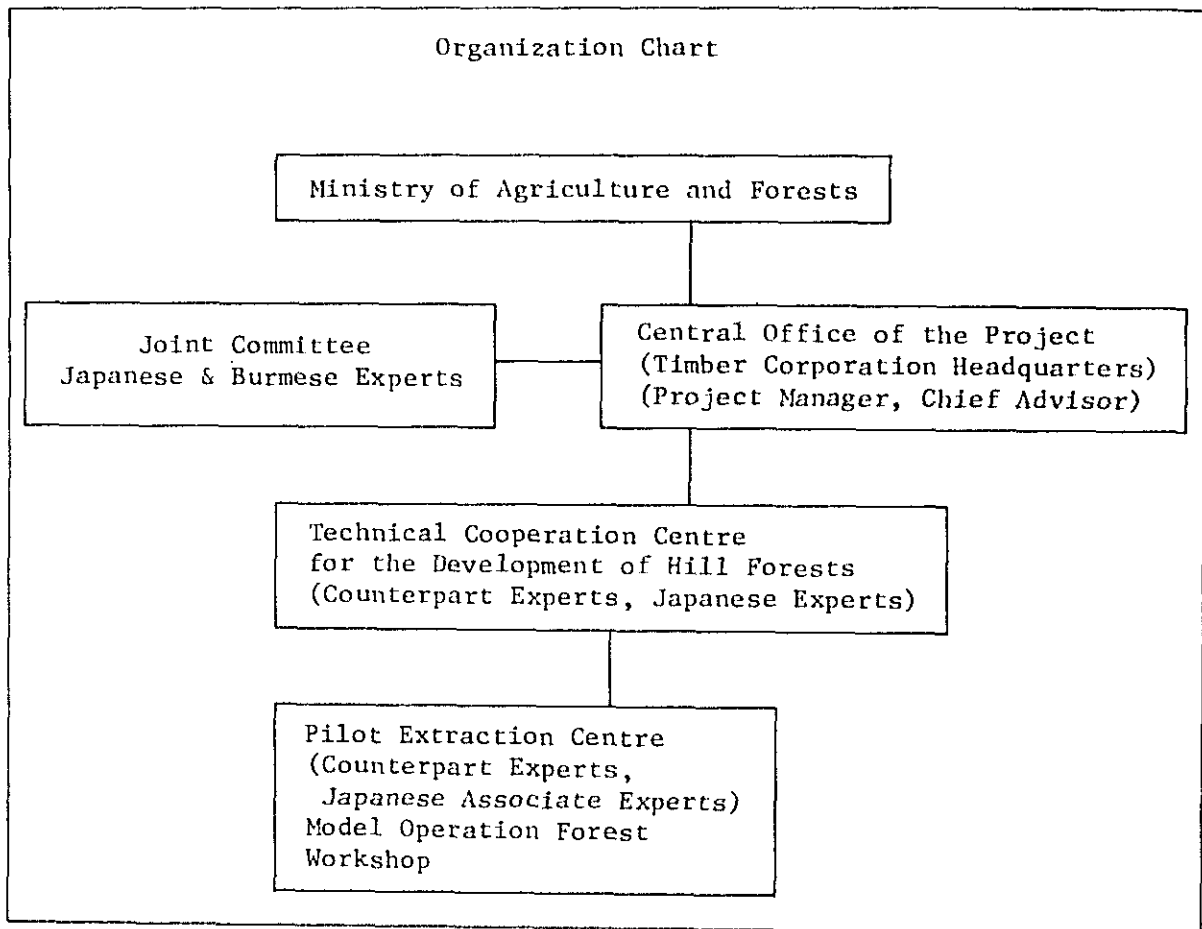
B. Fundamental Training

- (1) Education and Training on the techniques of extraction planning for the rational development of hill forests.
- (2) Education and Training on the operation of a yarder and other machines as well as on the maintenance and repair techniques of forestry machinery.

(3) The Pilot Extraction Centre will conduct the following activities:

- (1) At the Model Operation Forest will be given on-the-job training of various logging operations including cable logging system.
- (2) At the Workshop will be given on-the-job training of maintenance and repair works of forestry machinery.

Organization Chart



Annex 2. Japanese Experts

Category	Field
1. Chief Advisor	
2. Experts	logging extraction machinery civil engineering extraction planning
3. Associate Experts	cable logging tractor logging forest road construction workshop mechanics
4. Liaison Officer	

- Note:
1. The chief advisor will be attached to the Central Office of the project in the headquarters of the Timber Corporation.
  2. Short-term experts in the fields mentioned above as well as other fields to be mutually agreed upon may be dispatched when necessity arises.

Annex 3. Articles to be Provided by  
the Japanese Authorities Concerned

1. Machinery, equipment and materials for extraction
2. Machinery, equipment and materials for forest road construction
3. Machinery, equipment and materials for a workshop
4. Machinery, equipment, implements, instruments and materials for training
5. Vehicles and motor boats
6. Spare parts and materials for repair works
7. Other necessary equipment, tools and materials to be mutually agreed upon.

Annex 4. Burmese Counterparts and other Personnel

Category	Field
1. Project Manager	
2. Deputy Project Manager	
3. Counterparts	logging extraction machinery civil engineering extraction planning
4. Liaison Officer	
5. Clerical and Service Employees	
6. Labourers	



## Annex 5. Land and Buildings

### 1. Buildings

- (1) A room for the Central Office in the headquarters of the Timber Corporation
- (2) Facilities for the Technical Cooperation Centre
  - (1) administrative office
  - (2) laboratories and lecture rooms
  - (3) dormitory for trainees
- (3) Facilities for the Model Operation Forest
  - (1) field accommodation for Japanese experts, counterparts, and trainees
  - (2) sheds for machinery and equipment
- (4) Facilities for the Workshop
  - (1) workshop building
  - (2) sheds for machinery and equipment
  - (3) storehouse for materials and spare parts
  - (4) field accommodation for Japanese experts, counterparts and trainees

### 2. Land.

- (1) All the requisite land for the above buildings
- (2) Land in the vicinity of Rangoon, as a training field for simulated logging operations
- (3) Land in the Chaungtha reserved forest, as the Model Operation Forest

3 ha

approx. 1,000 ha

Annex 6. Composition of the Joint Committee

Chairman:

Project Manager

Japanese Side

Burmese Side

- |                    |                           |
|--------------------|---------------------------|
| 1. Chief Advisor   | 1. Deputy Project Manager |
| 2. Experts         | 2. Counterparts           |
| 3. Liaison Officer | 3. Liaison Officer        |

Note: An official of the Embassy of Japan may attend the meetings of the Joint Committee as an observer.

§ 5. Present Situation of Timber Production and Machinery, and Technical Cooperation to be Implemented in Burma

5-1 Situation of Timber Production

5-1-1 Organization of Operations

Extraction Department of Timber Corporation is responsible for the extraction of timber in Burma.

Extraction Department has 33 production agencies now, and there are 3 production agencies, each in Bassein, Henzada and Thapang of Bassein area which was surveyed this time, and a jurisdictional zone is divided into 3 to 5 ranges each, which are responsible for planned production respectively.

In regard to the annual production volume for 3 agencies in Bassein area, Bassein Agency and Thapang Agency, logging broad leaved trees other than teak, have a production target of 50,000 tons (volume ton) each, and Henzada Agency, which mainly produces teak, is aiming at a production target of 30,000 tons as a current target.

5-1-2 Practical Operations

(a) Felling Operations

In regard to felling operations, the area and felling volume are to be decided through forest management for which the Forest Department is responsible and only selected trees are to be fallen.

For the working circle in Shawbya Range, the hardwood selection working system specified in the Forest Working Plan of the Forest Department is employed.

The hardwood selection working system is almost the same as the felling operations of teak except that the fixed girth of trees to be felled is set at more than 7 feet (67 cm in diameter of breast high), and no girdling conducted. Trees to be felled are about 30 to 40 tons average per hectare.

Felling operations would be conducted by a team of 4 persons, 2 of them being fellers, and the other 2 assuming the tasks of finding and marking trees to be cut and recording them in a field book. Bucking operations are also conducted at the same time in forest in such a manner so that they may make a 6 to 7 meter log within the height to the first main branch.

The average productivity by the team by day stands at about 5 to 6 trees.

(b) Yarding Operations

The yarding operation in the Shawbya District is conducted mainly with 6 to 8 ton wheeled tractors. This is different from the full stem yarding conducted with large type bulldozers for production first as seen in the timber extractions in the other tropical countries and is understood as an excellent point of Burma selection system considering forest conservation and protection of existing live trees.

For yarding at the mountain foot which is of a relatively flat configuration, machines conforming to the condition of the site seem to be introduced.

It seems like, however, some improvements are recommendable to work for combination of machinery and each yarding operations. There is an access road approximately 25 to 30 kilometers east of shawbya camp to lead to the basin of the Bay of Bengal over watersheds. This access road was constructed by the Construction Corporation and is all season road made of a considerable volume of ballast. Yarding operations have been conducted along this access road.

There are very few such "forest roads: as seen in Japan in this area so that they may very often advance felling through spur roads directly from the access road. Accordingly, the yarding distances are generally very long ranging from 1,600 to 3,200 meters average and the yarding volume ranging from 1,000 to 1,500 tons (1,800 to 2,700 cubic meters) per tractor, per year.

The following table includes averaged figures of yarding distances and yarding volumes in other tropical countries for comparative purpose and there are seen large gaps in efficiency between this area and the other countries shown in this table although there is a difference in the actual working hours and working system between them:

Table 5

Country	Size of Tractor	Averaged Yarding Distance (m)	Diameter at Brest (m)	Actual Working Hours (day)	Yarding Volume (cubic meter/day) x Yarding Day (times/day)	Averaged Yarding Volume (cubic meter/day)	Averaged Yarding Volume (cubic meter/150 days/year)
Malaysia	20 ton crawler	200 - 400	70 - 80	4	5 x 18	90	13,500
	7 ton wheel	1,000 - 1,200	70 - 80	4	4 x 10	40	6,000
Philippines	30 ton crawler	200 - 400	80 - 90	6	10 x 15	150	22,500
	"	1,000 - 1,200	80 - 90	6	10 x 8	80	12,000
Indonesia	20 ton crawler	400 - 600	80 - 90	6	5 x 8	40	6,000
Papua New Guinea	14 ton crawler	1,000 - 1,300	60 - 70	6	4 x 8	32	4,800
	8 ton	1,000 - 1,300	60 - 70	6	8 x 10	80	12,000

The averaged yarding volume of a yarding tractor in Japan stands also at 30 - 40 cubic meters a day at 300 - 500 meters of yarding distance for 7 - 12 ton crawler-tractor and 40 - 50 cubic meters a day at 500 - 1,000 meters of yarding distance for 6 ton wheel-tractor. It is supposed that the unfelled forests seen in swamps and on rugged land of this yarded area also were caused not only by the shortage in machinery and equipment but also by yarding system which is good for felling only on good-conditioned land. Yarding operations are conducted on about 15 degree slopes with elephants and buffaloes in these areas. Pre-yarding operations are also conducted with these animals and then logs are transported with tractors over a long distance by such two-step method.

The efficiency of yarding operations with animals, however, is very low, and the annual yarding volume by elephant stands at about 150 - 180 tons (270 - 325 cubic meters) per head and by buffaloes at about 30 - 35 tons (55 - 66 cubic meters) per pair of buffaloes. It would take very much labor to keep, raise and train them, so operations are desired to be converted into mechanized ones in order to increase in production.

(c) Transportation

Transportation is now conducted with combination of land transportation by trucks and water transportation thereafter by rafts. Transportation by trucks is now conducted between Shawbya camp and log yards in felling areas at a distance of about 30 kilometers between them. Ordinary trucks, 6.5 ton, two wheel drive now available are poor in power on rainy days or on slopes and hilly areas. Consequently, it causes one of reasons for decreased productivity.

Logs transported with trucks to timber yards are sorted by species and diameter class into rafts. Many of hardwood trees are sinkers so that they may be made into rafts with bouys like petroleum cans and bamboos etc. Rafted logs are transported to

timber yards in Bassein and so forth, and they are transported to Rangoon with tug-boats all the year round or directly shipped for exports.

(d) Construction of Forest Roads

In regard to construction of forest roads, the construction plan and construction works for forest roads and operational roads are conducted by Extraction Department of Timber Corporation.

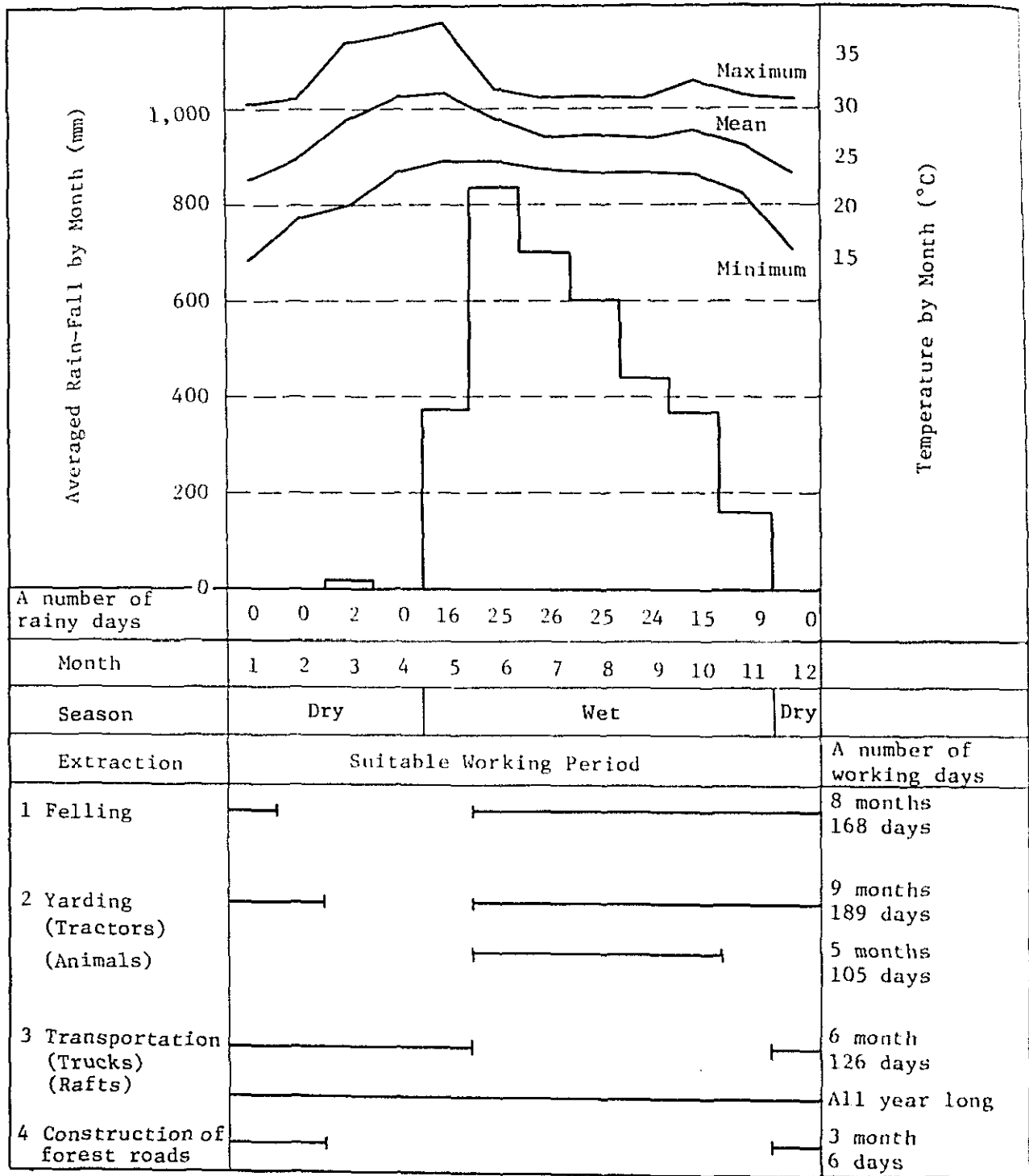
Construction and maintenance are conducted mainly at the initial stage of a dry season every year, and there are few rock belt zones in this area of red soil, which are likely to hamper forest road construction very much, so it is considered comparatively easy to construct and maintain forest roads.

It is a real fact now that constructed roads only roughly made with large bulldozers would keep very stable surface on them in dry seasons and on the other hand, these roads cannot serve as logging roads at all in rainy seasons because these roads are constructed in neglect of the gradient and without side drains and are almost not given gravel. As mentioned above, logging operations and road construction are conducted being governed by natural conditions with clearly divided rainy and dry seasons. In order to increase the productivity in future by shifting conventional operations to mechanized ones, however, it is deemed necessary to develop and improve technology for logging operations and road construction.

In Fig.1 are illustrated the work periods for various operations considering the temperature and precipitation in the Bassein area.



Fig. 1 Temperature and Rain-fall, and Working Period



Remarks: A number of working days in a month is set as 21 days.

## 5-2 Situation of Machinery

### 5-2-1 Maintenance and Repair Works of Machinery and Organization

The Timber Corporation has Engineering Department as well as Extraction Department. The Engineering Department is to give technical advice for introduction of machinery necessary to Timber Corporation and is responsible for all maintenance and repair work of the machinery owned by the Corporation.

Engineering Department is now going to establish a service network to cover all over Burma, and constructed a base workshop in Pyinmana as a real, regular repair work installation through cooperation of CIDA, an international cooperation organ of Canada. Machinery, equipment and personnel, however, are not yet completely provided with, and some improvement may be necessary for the operation of the workshop.

Engineering Department has established, in regard to organization, a nation-wide service network on the base of this Base workshop. In addition to the Base workshop, there are established middle sized static workshops in Mandalay, Swe, Prome and Rangoon respectively as well as mobile workshops in 4 places to furnish direct service to production sites.

Extraction Department is now holding machinery of 102 bulldozers, 102 logloaders, 50 skidders (wheel tractors), 12 motor graders and 1,008 logging trucks. However, it is a present state that capacity utilization is considerably dipping due to lacking in repair workshops and spare parts to be supplied with.

### 5-2-2 Repair Workshops

The stationary workshop in Rangoon is responsible for large repair works, overhaul and maintenance of machines working in Bassein area. However, there have been seen machines unserviceable for a long time because of bad location of the workshop to Bassein at a long distance and consequent inconvenient transportation as well as hard supply with spare parts.

Rangoon Workshop covers 5 service areas of Arakan area including Bassein, Irrawagi, Tanawin, Monsteit and Rangoon but it has not yet a personnel organization enough to function as a workshop covering such large area.

The building of the workshop was once used as assembly factory of agricultural machinery and the size is still enough. However, there are many short coming aspects in the functions as a workshop, and unbalanced repair equipment and machinery are noted.

For example, the equipment and machinery included those that were apparently taken over from the agricultural machine assembly shop such as hydraulic screws used for fastening the bolts of shoe plate, hydraulic lining reveters to fix linings of clutches and brakes, lather machines and drilling machines used for machining, each in 3 units.

These machine tools are considered to be necessary for exchange service when spare parts are not available.

Other equipment for repair include a cylinder honing machine, cylinder boring machine and valve refacing machine for repair of engines, arc welding machine, spot welding machine, grinder and battery charger etc., and there is lacking in measuring tools, special tools, jacks, chain-blocks etc. inevitable for ordinary repair works. There is equipped only with one wheel crane, old model, 2.5 tons as machine instead of a chain block.

Machine repair craftsmen, except assistant craftsmen as trainees, all of them are assigned after they finished technical training program at the training center of the Timber Corporation in Pyinmana.

### 5-2-3 Machines for Extraction

#### (a) Felling

Chain-saws are used generally for felling, and they are of West-Germany or USA make. The chain bars are, for the greater parts, if a length of about 30 inches due to felling works of large size logs.

Felling works by means of hand saws of wood conversion with axes are also carried out, and there are comparatively a few logging works of pruning, etc. in addition to cut off crowns of trees because broad leaved trees in this area are growing high and straight.

(b) Yarding

Yarding machines consist mainly of wheel type tractors (skidders). Crawler type tractors are also provided for both road construction works and yarding works although they are now out of order.

Yarding machines available in Shawbya Range are 9 wheel tractors and 4 crawler tractors, of which only 3 wheel tractors are practically usable for the works, thus causing decrease in production.

The wheel tractors are of 6 - 8 tons, empty weight; 92 - 120 ps, engine output power; and 9 - 14 tons, winch power; and made in Canada and USA. The wheel tractors of 6 tons class are all obsolete apparently used for more than 10 years, and most of them are not usable. The 8 ton wheel tractors, recently introduced, are of the latest model and capital machines for the current yarding works.

The crawler tractors, which are out of order presently, are of 14 - 16 tons, empty weight and mounted with 12 - 17 ton towing winches. In Shawbya Range, however, most of the crawler tractors service is committed to forest road construction works, and it is necessary to consider an efficient yarding method to enhance the characteristics of both wheel tractors and crawler tractors available for yarding works.

For winches of tractors yarding works, 18 - 20 m/m wire rope are used, and the yarding capacity stands at 2 - 3 tons for a 6 ton tractor and 3 - 4 tons for a 8 ton tractor, per yarding work for one time.

(c) Transportation

There are 14 logging trucks and 2 log loaders equipped for transportation in addition to vessels including launches towing rafts.

Presently, 9 logging trucks are serviceable, but the 6.5 ton loading capacity of the trucks is considered a little too small considering the size of logs. Further, they are of the ordinary 2 wheel drive trucks and are thus shortcoming in mobility so that it may be impossible to drive them for transportation on forest roads without greavel in rainy seasons.

The 2 log loaders equipped for loading works were comprised of a large wheel type loader are of old model with a loading capacity of 5.4 tons and an engine output of 150 ps apparently introduced recently and an old machine now being disassembled for repair.

The log loaders are used now for loading of logs onto trucks at log dumps, but the transportation with trucks is limited only in dry seasons so that in rainy season they are utilized for arrangement of logs at timber yards of the camp.

An old truck crane is assigned to the timber yard of logs and is used for timber piling, etc.

(d) Forest Road Construction Machines

In use of bulldozers, tractor shovels, motor graders and dump trucks, all-season roads are constructed, but and these machines, are not always provided at the extraction camp.

Accordingly, extraction roads and operational roads are constructed only with the 14 - 16 ton crawler tractors provided at the camp for use for yarding works, so that these roads are nothing but so-called jungle roads constructed by only bulldozer-pushing.

### 5-3 Details of Technical Cooperation

#### 5-3-1 Development of Technology

##### 5-3-1-1 Logging Operation

###### (a) Principle of Development of Technology

The timber extraction works in this area are conducted in extremely dry seasons and long rainy seasons with a great volume of rain fall as shown on Fig 1 and the technical system is deemed to have been established to some extent in the fields of yarding works on the slope with animal power of elephants and buffaloes etc. to meet these natural condition as working system, and of yarding works with tractors on plain fields.

However, some consideration has to be given to forests left remaining from extractions, incomplete networks of forest roads, or yarding works by animals on about 15 degree slopes with poor productivity etc.

In other words, it is imperative for the yarding operation in this area to establish a technological system for yarding in the mountaineous forests in that here after the will have to proceed onto steep slopes. Accordingly, it is recommendable to adopt the following technology development:

First, the relatively experienced tractor yarding technology should be promoted for development and improvement of the tractor yarding works on the slopes, while technical development and training should be carried out of a cable yarding system with yarding machines on the steep slopes.

It is also necessary to consider the working plan to avoid yarding works as much as possible in heavy rainy seasons for safety when cable yarding and tractor skidding works are conducted on steep slopes.

###### (b) Master Plan

About 1,000 hectares of area be designated as model operation forest in Chaungtha forest of Shawbya Agency, and the development,

improvement, training of yarding technology be conducted on-the-job training on hill forests, as follows:

The yarding operations are divided roughly into 3 matters shown below according to terrain and yarding distance, and machines be combined to meet respective conditions:

- a. Tractor skidding system            for 5 - 10 degree slopes
- b. Tractor skidding plus  
cable yarding system            for 10 to 15 degree slopes
- c. Cable yarding system            for more than 15 degree slopes

This is schematically shown in Fig. 2.

Where "a" indicates a tractor yarding system of combined wheel tractors and crawler tractor to conduct yarding operations within about 500 meters around timber yards, to construct suitable operations roads, and to conduct survey on relation between yarding distance and efficiency of production for improvement of yarding technology,

"b" indicates a yarding system of combination of tractors and yarder with assumption of yarding operations inconvenient over valleys by tractor yarding. To say concretely, tractors are first to conduct yarding works as far as under the yarding cable within area of slopes with about 15 degrees making survey on adequate relation between construction of operations roads and tractor yarding operations on steep slopes during this time for development of efficient yarding system;

Tractors thus pre-yard logs to under the cable, and yarders are to transport them to landing ground near forest roads. In this case yarders function as transporting machines. This system means to conduct development of yarding technology in areas where there are not forest roads and bridges; and

"c" indicates cable yarding with yarders which is to be newly developed in Burma. A project of the most important technology development is a cable-stretching technique, and it is suitable to

introduce large yarders considering the volume and weight of yarding logs. There are also many heavy tools like block cables, wire ropes etc. so that it may be deemed to take considerable time for development and application of cable-stretching technique.

Accordingly, it is considered expedient to develop the cable-stretching system most suitable to the actual working site by reducing yarding volume per cable as much as possible and then repeating restretching works many times, and to master quick cable-stretching technique.

For reference, a mark "※" shown on Fig.2 indicates a training equipment provided, for practical operating technique and cable-stretching technique to be conducted prior to on-the-job training, and also for use during the fundamental training course in connection with lectures to be given at the Training Center in Rangoon.

Extraction is not forecasted for the 1st and 2nd fiscal years due to cable-stretching training to be mainly conducted.

Extraction is forecasted to stand at about 50,700 cubic meters for the 3rd fiscal year and thereafter due to on-the-job training to be given.

#### (c) Construction Plan of Forest Roads

A total plan of road networks is necessary to model working forests centering established access roads in order to smooth conduct of this project.

The following is a draft of the construction plan of forest road networks, and it includes target figures. In regard to actual construction the construction of forest roads is necessary to be conducted flexibly according to development of construction works:

Extraction forest roads:	3 roads	about 8,000 meters
Operations roads:	Total	about 15,600 meters



Fig. 2 Yarding System at Chaungtha Range  
 Model Forest  
 1000ha. (4,000x2500m) app.

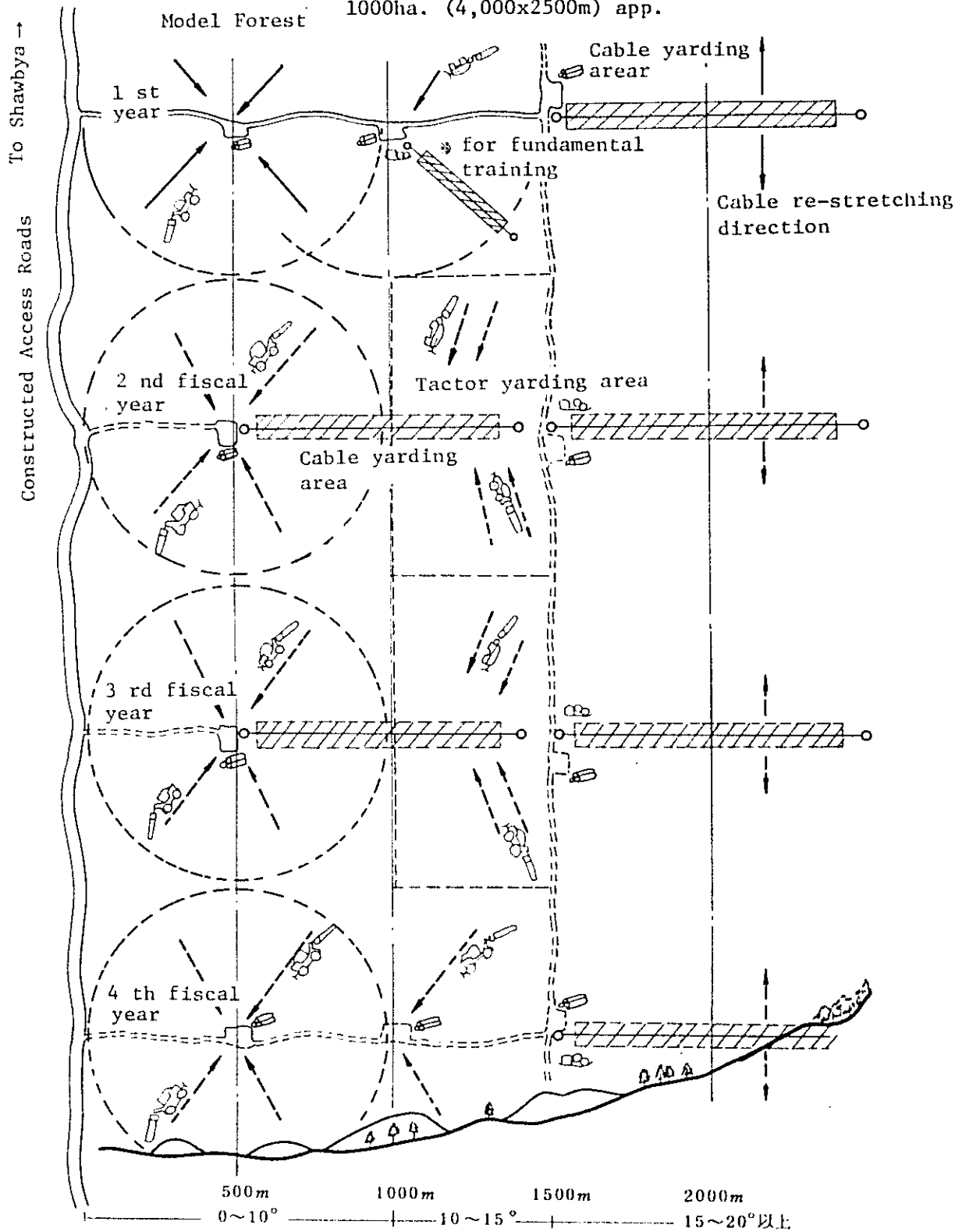


Table 6. Forecast of Extraction after Training

Unit: Cubic meter

By:	Yarding Machine	Wheeltractor	Crawlertractor	Total
1st Fiscal Year Yarding machine x 1 Wheeltractor x 1 Crawlertractor x 1	The volume of extraction is not prescribed due to training.			
2nd Fiscal Year Yarding machine x 2 Wheeltractor x 4 Crawlertractor x 2	The volume of extraction is not prescribed due to training.			
3rd Fiscal Year Yarding machine x 3 Wheeltractor x 7 Crawlertractor x 3 Total	3,000    3,000	  10,800  10,800	   5,400  5,400	3,000  10,800  5,400  19,200
4th Fiscal Year Yarding machine x 4 Wheeltractor x 10 Crawlertractor x 3 Total	4,500   4,500	  18,900  18,900	   8,100  8,900	4,500  18,900  8,900  31,500
Grand Total	7,500	29,700	13,500	50,700

Table 7. Fiscal Annual Plan of Construction of Forest Roads

Fiscal Year for Construction	Extraction Forest Roads	Operations Roads
1st Fiscal Year	1,500 m	3,200 m
2nd Fiscal Year	2,000	3,700
3rd Fiscal Year	1,500	3,700
4th Fiscal Year	3,000	5,000
Total	8,000	15,600

Table 8. Specification for Forest Roads

Item	Extraction Forest Roads	Operations Roads
Width	4.6 m	3 m
Effective width	3.6 m	-
Shoulder	0.5 m x 2	-
Pavement	gravel	-
Gradient	4% to center	-
Thickness	5 to 20 cm; 10 cm at average	-

Extraction forest roads are backbone of operations roads in extraction zones to become branches from access roads and the lines of those roads follow ridge lines as a rule in order to reduce scraped soil.

Construction of those roads are supposed to be made in most of zones almost according to access roads considering convenience to education and training and truck transportation for an entire year.

Operations roads are to be constructed radiating from a log dump as shown on Fig.2, so that road networks may be constructed to meet requirements at the actual sites necessary for various trainings to be given.

Those roads are necessary to improve mechanical equipment for safety of labour and easy working as well as elevation of productivity, and to develop the working system according to each gentle, medium and steep slope.

#### 5-3-1-2 Maintenance

##### (a) Basic Plan

A machinery maintenance installation in this area is very poor as prescribed in 5-2-2.

Craftmen assigned to a repair shop are to be assigned after 9 month technical training to be given at the training center in Pyinmana, and their technical capability is not yet shown due to short repair equipment.

Yarders and tractors necessary for this extraction project are assumed totalling 20 and some for 4 years and the maintenance technology of machines and provision of repair equipment are needed for development of yarding technology for limited period. If attained, it will help very much to extraction works in other Agency area in Bassein area and to convenience to local inhabitants.

Yarders, in particular, to be introduced first to Burma must be maintained and administered to utmost, so the following actions are recommended to be taken:

Repair workshops are to be constructed in Bassein and craftsmen who will have finished basic training at mainly those workshops in Rangoon so as to furnish maintenance service directly to meet requirements at the actual extraction site. Mobile maintenance service is also to be furnished, so that they may be provided with capability for emergency repairs and large repair works to likely happen at the actual extraction sites and they may establish the foundation for stable planned production.

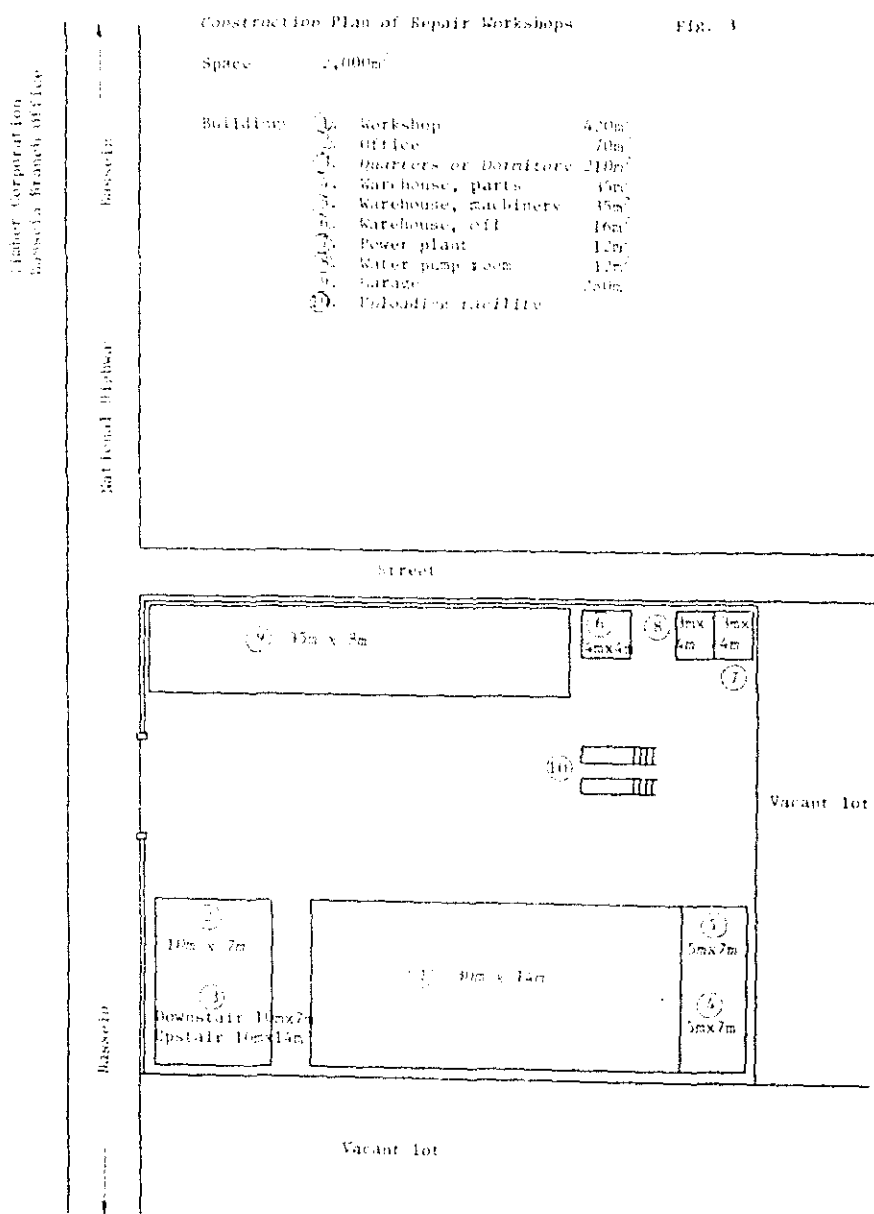


Fig. 4

Item	2 4	Number of Trainees on Man-Year Basis
Actual Training  (A) Logging Ma		20 man (5 man x 4 year)
(B) Logging		60 man (15 man x 4 year) (B') -4 is not conducted.
(C) Maintenance		20 man (5 man-year x 4)
A Number of Trainees		100 man
Training Accepted  (D) Logging		10 man (2 man-year x 5) (D)-1 to be conducted in FY'77
(E) Logging Ma		5 man (1 man-year x 5) (E)-1 to be conducted in FY'77
A Number of Trainees		15 man

Trainees who

Fig. 4

## Education and Training Program on Annual Basis

Item	1978				1979				1980				1981				1982	Number of Trainees on Man-Year Basis											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5		6	7	8	9	10	11	12	1	2	3	4
Actual Training																													
(A) Logging Management																													20 man (5 man x 4 year)
(B) Logging																													60 man (15 man x 4 year) (B') -4 is not conducted.
(C) Maintenance & Repair																													20 man (5 man-year x 4)
A Number of Trainees																													100 man
Training Acceptance by Japan																													
(D) Logging																													10 man (2 man-year x 5) (D)-1 to be conducted in FY'77
(E) Logging Management																													5 man (1 man-year x 5) (E)-1 to be conducted in FY'77
A Number of Trainees	3																												15 man

(B') in this table will be given the actual training on extraction sites as training on job of trainees who will have finished fundamental training according to (B).





5-3-2 Education and Training

5-3-2-1

Education and training is conducted for technology to be given necessary to the following aspects at the training center to be established in Rangoon and related facilities to be established in Bassein area:

(A) Logging Manager

Education and training is conducted according to the following program pertaining to the development of extraction plan and transportation plan for logging works to meet actual requirements there, safety control of logging works, finding-out of technical problems in logging works and analyzing method thereof, and systematic development of each individual technology and method to rationalize yarding works:

(a) Basic Knowledge to Machinery

Oil pressure	0.5 day
Wire rope	1
Basic yarding works	1
Working standard	1
Safety works	0.5
Yarding cable planning	1
<hr/>	
Number of days for lectures	
sub-total	5 days

(b) Development and Improvement of Technology

Modern yarding works	0.5 day
Composition of works	1
Outline of training system	0.5
Logging operations of national forest in Japan	1
<hr/>	
Number of days for lectures	
sub-total	3 days

(c) Development of Plan

Forest management in Japan	0.5 day
Production management	1
Key-points and procedure for development of plan	0.5
Logging plan	2
Plan of development of forest road networks	1
Process management	1
Machinery maintenance	1

---

Number of days for lectures

sub-total 7 days

(d) Practice of Operation of Machinery

Yarding machine operation training	3 days
Safety Check	1
Wire splice	1

---

Number of days for practice

sub-total 5 days

Number of days for education and training

Grand total 20 days (one month)

(B) Logging Craftmen

Basic education and training is conducted to foster cable-stretching craftsmen necessary for transfer of cable logging technique, motor drives and maintenance personnel deepening general knowledge for extraction machinery and developing applied capability.

(a) Special Technology for Machinery

Factors of Machinery	6 days
Electric power	5
Oil pressure	3
Wire rope	3
Basic yarding works	6
Working standard	4
Safety works	2

---

Number of days for lectures

sub-total 29 days

(b) Cable Stretching Technique

Mechanical yarding apparatus and ropeway for transportation (15) days

Yarding machine, carriage, tower and attachments of cable yarding apparatus 2 days

Cable stretching method of cable yarding apparatus 3

Driving machine, carriage, tower and attachments of ropeway for transportation 2

Sorts of ropeways for transportation 2

Wire rope 2

Calculation of maximum tension 2

Inspection of main cable 2

Cable Stretching Works (10) days

Assembly and dismantle of mechanical yarding machines 3 days

Assembly and dismantle of ropeway for transportation 2

Yarding method 3

Transporting method 2

Dynamics Necessary for Cable  
Stretching (10) days

Power (Balancing, composition,  
dissolution and momentum) 2 days

Gravity and center of gravity 2

Pulley 2

Velocity and accelerated velocity 2

Load, stress, and strength and  
factor of safety 2

---

Number of days for lectures

sub-total 35 days

(c) Practice for Cable Stretching

Cable Stretching and Guy Line  
Methods, and Inspection (10) days

Cable stretching 5 days

Guy lining 3

Inspection on main cable,  
haul line, operating line  
and guy line etc. 2

Development and Inspection of  
Support and Deck (8) days

Fixing and inspection support 2 days

Anchor setting 3

To make a deck 3

Setting and Inspection of Major  
Component Machines of Mechanical  
Yarding System (5) days

Setting and inspection of  
yarding machine 3 days

Inspection of carriage and  
attachments 2

Inspection of factor of Safety of Main Cable	(4) days
Inspection of tension of main cable stand	2 days
Inspection of tension of main cable	2
Fastening and Connecting Wire Rope	(4) days
Fastening wire rope	1.5 days
Connecting wire rope	1.5
Sorts and handling of wire rope	1
Eye-Measurement	(1) day
Loading and Unloading	(4) days
Loading	1 day
Unloading	1
Signal	1
Dangerous zone	1
Cable Stretching Practice	10 days
Driving Practice	10
<hr/>	
Number of days for practice	
sub-total	56 days
Number of days for education and training	
Grand total	120 days (6 months)

(C) Repair Craftman

Basic education and training is conducted for methods of mechanical trouble shooting and repair works on the actual extraction site in order to foster techniques for maintenance and repair proper to machines necessary to conduct this technology cooperation project.

(a) Basic Knowledge of Machinery

Basic yarding works	3 days
Working standard	2
Oil pressure	2
Wire rope	2
Maintenance for driving yarding machines and tractors	1
Planning standard for introduction and capacity utilization of yarding machines and tractors	1
Operation of yarding machines and tractors and working method	2
Points of mechanical structure and maintenance of yarding machines and tractors	2
Maintenance inspection procedure of yarding machines and tractors	2

---

Number of days for lectures

sub-total 17 days

(b) Dismantle, Assembly and Operation

Dismantle and assembly of yarding machines	5 days
Dismantle and assembly of diesel engines	5
Wire splice	3
Practice for yarding and transportation with yarding machines and tractors	10

---

Number of days for practice

sub-total 23 days

Number of days for education and training

Grand total 40 days (2 months)

### 5-3-2-2 Training to be Accepted by Japan

This technical cooperation project is smoothly conducted through accepting trainees to cover the following aspects by means of individual and group training, and to give them practical experience of technology of cable yarding operations with yarding machines in Japan.

#### (E) Extraction Manager

Observation practice is conducted mainly at yarding sites with yarding machines to give them the training of basic method of extraction management. Some of trainees are high-ranking senior officials, who are expected to be managers capable enough to participate in development of the basic policy of extraction in Burma.

Modern yarding operations	2 days
Logging operation of national forest in Japan	2
Working system of national forest in Japan	2
Outline of training system	1
Observation practice	13
<hr/>	
Number of days for training	
Total	20 days

#### (F) Extraction Craftmen

Basic education and practice training is conducted according to the following program to give them practical experience of yarding operations with yarding machines.

(a) Basic Education		
Basic yarding operations		6 days
Standard of yarding operations		3
Safety of labour		2
<hr/>		
Number of days for lectures		
	sub-total	14 days
(b) Technique of Cable Operations		
Yarding apparatus with yarding machines		15 days
Cable works with yarding machines		10
Dynamics for cable works with yarding machines		5
<hr/>		
Number of days for lecture		
	sub-total	30 days
(c) Cable Works and Practice of Operation		
Practice of dismantle and assembly of yarding machines		6 days
Cable stretching practice		10
Practice of operation		10
Observation practice		10
<hr/>		
Number of days for practice		
	sub-total	36 days
Number of days for training		
	Grand total	80 days



#### 5-4 Machines and Materials for the Project

As discussed in Section 5-1, Master Plan for Technical Development, introduction of the following machines and materials is considered to be necessary for effective application of the combination of the conventional tractor yarding technology on the plain forests in Burma and the newly introduced machine cable-yarding technology and for development of the application technology.

##### 5-4-1 Machines and Materials for Practical Training for Yarding Operations

Selection of tractors in terms of sort and size depends upon a size of tree to be felled, felling density, felling method, terrain, yarding distance and working period etc. In this case, respective characteristics of wheeled tractors and crawler-tractors are taken into enough consideration. Wheeled tractors have more yarding capacity than crawler-tractors excluding yarding operations roads needed for wheeled tractors, and with less maintenance cost and cheaper price for purchase.

On the other hand, crawler tractors are concurrently available to earth works with advantage of comparatively less construction works of operations roads, while they are poor in efficiency of yarding operations at long distance with more maintenance cost and expensive price for purchase.

It is desirable for wheeled tractors to be designed for yarding operations at mainly long distance to logs at a volume of averaged less than 2-3 cubic meters, with excellent cross-forest mobility and 4 wheel-drive, equipped with a powerful towing winch, and for exclusive use of yarding operations.

It is desirable for crawler-tractors to be designed with a towing winch equipped on tractors for each works because they are used for construction of operations roads for wheeled tractors for each works, for yarding operations at short distance, and for yarding large size (4-5 cubic meters), and also to be designed to be a sort of crawler-tractors with transmission, mechanical drive type considering safety of works on steep slopes and easy maintenance and repair works.

The following is the major functions need for the said tractors:

(a) Wheeled tractor

Specifications

Gross weight		6,000 kg
Dimensions		Length: 5,335 mm
		Width: 2,290 mm
		Height: 2,450 mm
Engine, Piston displacement, Max. horsepower/ Rated speed		4,313 cc; 73 <sup>PS</sup> /2,370 <sup>rpm</sup> diesel engine
Towing winch	Line pull	9,000 kg
	Type	Single drum hydraulically controlled.
Drive system		4 wheel drive
Steering		Hydraulic power steering, articulating frame type
Suspension		Oscillating beam type
		Oscillation: 560 mm
Tire		16.9-30, 10 PR with shredded wire in it.
Minimum road clearance		490 mm

(b) Crawler-tractor

Specifications

Operating weight		15,530 kg
Dimensions		Length: 5,135 mm
		Width, main body: 2,390 mm
		Height: 3,015 mm

Caterpillar	Width, shoe-plate 510 mm
Ground clearance	400 mm
Transmission	Main clutch: wet type, multi-disk, manual
	Speed change gear: Constant mesh
	Steering system: Wet type, steering clutch
Dozer equipment	Angle-dozer
	Size: Width 3,970 mm Height 1,050 mm
Engine	140 <sup>PS</sup> /1,600 <sup>rpm</sup> , diesel
Attachments	Towing winch capacity
	Starting: 23,600 kg Stopping: 12,900 kg
	Weight, empty: 1,280 kg

In regard to necessity for introduction of the cable logging system with yarding machines to Burma, the application of the conventional tractor-yarding system will inevitably come to steep slopes where it will be very difficult to be applied to, considering the development of forest resources in north Arakan Range and Upper Burma etc. in future, and consequently the cable logging system with yarding machines is imperative to be applied to as technology in response to these situations.

The cable yarding system with yarding machines, accordingly, is an operational system to be newly introduced to Burma and it is necessary to select yarding machines and equipment with high safety and excellent operational functions.

(c) Selection of Yarders, Wire Ropes, Blocks According to Basic Plan

(1) Basic Engineering Design for Selection of Yarders and Sky Line Ropes

Selection depends on yarding system, however the selection of necessary machines was made herein for 2 examples of the short distance yarding system with medium class yarder for basic training and the long distance yarding system with large yarder for actual training on the following assumptions:

<u>Item</u>	<u>Basic Training</u>	<u>Actual Training</u>
1. Yarding system	Endless tyler system	Endless tyler system
2. Span	500 m	1,000 m
3. Sky line support	one	two
4. Maximum loading weight	1,500 kg	3,000 kg
5. Gradient	7°	10°
6. Main cable structure	24mm 6 x 7 C/L B type	(special rope) 30mm 6 x f{(a + 7) + 7} B type
7. Lifting line structure	12mm 6 x 19 o/oA type	16mm 6 x 19o/o B type
8. Haul-back line and endless line structure	10mm 6 x 19 o/o	14mm 6 x 19 o/o B type
9. Maximum span	350 m	500 m
10. Weight, equipment	Carriage 113kg Loading block 30kg Guide block x 2 30kg Poise 50kg Sling rope 5kg	Carriage 215kg Loading block 75kg Guide block x 2 30kg Poise 100kg Sling rope 5kg
11. Weight, steel cable/m	Sky line 2.14kg Lifting line 0.533kg Haul-back and endless line 0.364kg	Sky line 3.34kg Lifting line 0.933kg Haul-back and endless line 0.713kg

(Calculation for strength is made at maximum span.)

Consequently, the selection was made for necessary machines as follow:

(2) Selection of Yarding Machines

<u>Item</u>	<u>For Basic Training</u>	<u>For Actual Training</u>
(a) Functions of Yarders Needed		
a. Necessary tension	Weight of log + weight of transport (ground-towing resistance: 2 times approx.)  $P = 1,500 + 228 = 1,728\text{kg}$  $P' = (1,728 \times 1.2) + 190 = 2,264\text{kg}$	  $P = 3,000 + 425 = 3,425\text{kg}$  $P' = (3,425 \times 1.2) + 509 = 4,619\text{kg}$
b. Extraction speed	Yarding: $V = 60 \text{ m/min}$	$V = 60 \text{ m/min}$
c. Necessary horse power	$\text{HP} = \frac{P \times V}{4500 \times q}$  $= \frac{2,264 \times 60}{4,500 \times 0.75}$  $= \text{more than } 40 \text{ ps}$	$\text{HP} = \frac{4,619 \times 60}{4,500 \times 0.75}$  $= \text{more than } 82 \text{ ps}$

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<u>Item</u>	<u>For Basic Training</u>	<u>For Actual Training</u>
(b) Selection of Yarders		
a. A number of drums	3 (one endless drum)	3 (one endless drum)
b. Winding capacity	1st drum: 10mm, more than 1,300m	2nd drum: 14mm, more than 1,500m
	2nd drum: 12mm, more than 950mm	2nd drum: 16mm, more than 860m
c. Engine clutch	Dry, single disk, oil pressure	Dry, single disk, oil pressure
d. Drum clutch	Inside expansion, mechanical	Inside expansion, air pressure
e. Brake	1st and 2nd drums  Belt, cam, manual	1st and 2nd drums  2 belts, air pressure (with a mechanical lever for emergency)
	Endless drum  Outside squeezing, manual	Endless drum  Outside squeezing, air pressure
f. Weight machine	2,450 kg	5,000 kg
g. Engine	71.5ps/2,400rpm  Water-cooling, 4 cylinders, diesel	92ps/1,950rpm  Air-cooling, 6 cylinders, diesel

Yarding machines for basic training were selected considering the possibility of transfer to actual use for extraction in future.

(3) Selection of Wire Ropes

Sorts	Fundamental Training, Span: 500 m		Actual Training, Span: 1,000m	
	Standard	Q'ty	Standard	Q'ty
1. Sky line	6 x 7 C/L Type B Rope dia: 24mm	600m	6xF{(a+7)+7} Special rope Type B Rope dia: 30mm	1,200m
2. Lifting line	6 x 19 0/0 Type A Rope dia: 12mm	700m	6 x 19 0/0 Type B Rope dia: 16mm	1,300m
3. Endless line	6 x 19 0/0 Type A Rope dia: 10mm	1,200m	6 x 19 0/0 Type B Rope dia: 14mm	2,500m
4. Haul back line	6 x 19 0/0 Type A Rope dia: 10mm	1,200m	6 x 19 0/0 Type B Rope dia: 14mm	2,500m
5. Heel line	6 x 19 0/0 Type A Rope dia: 12mm	300m	6 x 19 0/0 Type A Rope dia: 14mm	300m
6. Support line	6 x 19 0/0 Type A Rope dia: 16mm	200m	6 x 19 0/0 Type A Rope dia: 18mm	400m
7. Guy line	6 x 19 0/0 Type A Rope dia: 16mm	600m	6 x 19 0/0 Type A Rope dia: 18mm	1,000m
8. Anchor line	6 x 19 0/0 Type A Rope dia: 18mm	100m	6 x 19 0/0 Type A Rope dia: 20mm	100m
9. Lead rope	6 x 19 0/0 Type A Rope dia: 6mm	600m	6 x 19 0/0 Type A Rope dia: 6mm	1,200m

Remarks: Abriviations  
C/L stands for bare, Lang Lay, and use of black rope grease.  
O/O stands for bare, Ordinary Lay, and use of red rope grease.

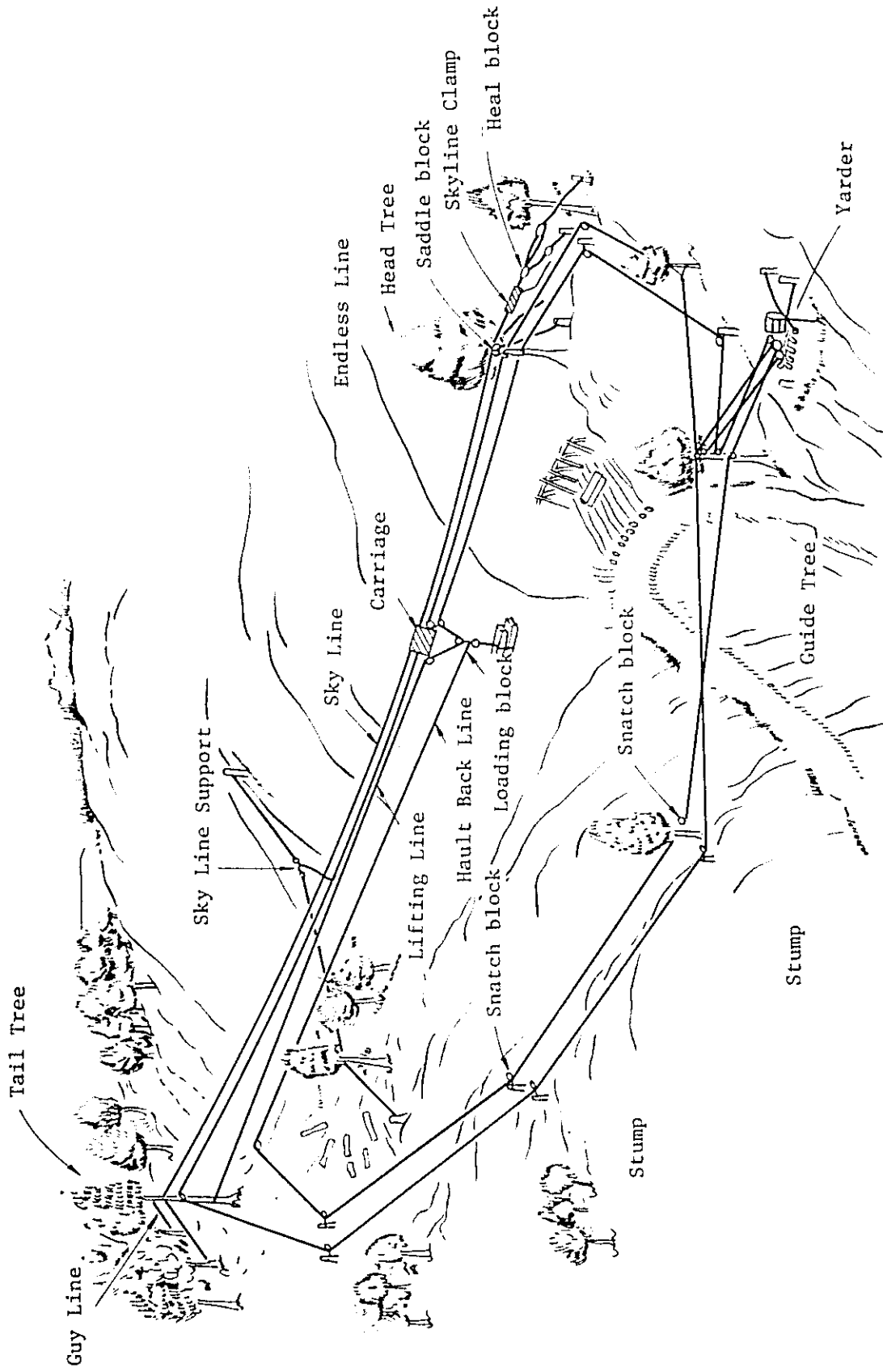
## (4) Selection of Attachments

	Fundamental Training Span: 500m		Actual Training, Span: 1,000m	
	Specifications	Q'ty	Specifications	Q'ty
Carriage	22 - 28mm 3 ton	1	24 - 32mm 5 ton	1
Loading block	12 - 14mm 3 ton	1	12 - 16mm 5 ton	1
Saddle block	24 - 28mm 20 ton	2	28 - 32mm 25 ton	2
Heel block	12 - 16mm 15 ton	2	12 - 16mm 20 ton	2
Skyline clamp	24 - 28mm 20 ton	1	28 - 32mm 28 ton	1
Skyline support	24 - 28mm 5 ton	2	28 - 32mm 7.5 ton	4
Operating line support	8 - 14mm	1	8 - 16mm	1
Snatch block	12 inch 12 - 14mm 3 ton	2	12 inch 12 - 16mm 5 ton	5
"	9 inch 12 - 14mm 3 ton	5	9 inch 12 - 14mm 3 ton	10
"	7 inch 8 - 14mm 3 ton	7	7 inch 8 - 14mm 3 ton	10
Wire clips	12mm	60	14mm	70
"	16mm	20	18mm	40
"	24 - 25mm	5	28mm	5
Shackles	10mm	15	16mm	20
"	22mm	2	28mm	2
Special shackles	16mm	2	22mm	2
Sling ropes	12mm x 3m	5	14mm x 3m	5
"	12mm x 4m	5	14mm x 4m	5
"	12mm x 5m	5	14mm x 5m	5
Wire splice tool	16 & 18mm Needles	1 set	16 & 18mm Needles	1 set
Tightening tool	Tilfor max pall 1.5 ton	1	Tilfor max pall 3.0 ton	1
Climing spiles	For climbing tree	2	For climbing tree	2
Safety belt	"	2	"	2
Transceiver	For communication	1 set	For communication	1 set
Rope cutter	6 - 32mm	1	6 - 32mm	1
Jacks	3 ton	1	5 ton	1

Utilization of main equipment is shown on Fig. 5.



Endless tyler Logging System



## 5-4-2 Machines and Materials Construction of Forest Roads

Construction of forest roads is conducted in proportion to the development of extraction in the Model Extraction Forests and the following machines are selected as machines for construction of these forest roads and as machines for maintenance of road-surface for actual training in Model Extraction Forests:

### (a) Bulldozers

#### Specifications

Weight	15,530 kg
Size	Length: 5,135 mm Width, body: 2,390 mm Height: 3,015 mm
Caterpillar	Width, shoe plate: 510 mm Track-length: 2,240 mm
Ground pressure	0.63 kg/cm <sup>2</sup>
Dozer attachments	Angle dozer Size: width 3,970mm x length 1,050mm
Engine	140ps/1,600rpm, diesel
Transmission	Direct drive
Attachments	3 rippers, oil pressure empty weight 1,610 kg

### (b) Motor grader

#### Specifications

Weight	9,500 kg
Size	Length: 6,760 mm Width: 2,650 mm Height: 3,080 mm
Tire size	Front wheel: 9.00-20-10PR Rear wheel: 11.00-20-10PR
Engine	110ps/1,900rpm, diesel
Scarifier	9 rippers, Load: 3,455 kg

### 5-4-3 For Maintenance and Repair Works

Selection is conducted for machines, equipment and tools etc. necessary to technical cooperation HL projects as a whole.

#### (a) Machines and Equipment

- |  |  |
|--|--|
| 1. Precision engine lathe              | Swing on bed, 430mm, Spacing between centers, 670mm                              |
| 2. Upright drilling machine            | Swing, 540mm; hole drilling capacity, 40mm                                       |
| 3. Welding set, arc, alternate current | Rd dia., 2.6 - 5m  |
| 4. Gas cutting tool & Regulator set    | Gas welding machine, cutting machine, Oxygen and acetylene adjuster, and others. |
| 5. Electric grinder                    | Size of grindstone:<br>205 x 19 x 15.9mm   |
| 6. Electric disk sander                | Grindstone, outer-diameter: 150mm  |
| 7. Electric chain block                | 2 tons; maximum elevation 3m<br>5 tons; maximum elevation 5m                     |
| 8. Hydraulic garage jack               | 3 tons; maximum elevation 480m<br>5 tons; maximum elevation 560m                 |
| 9. Portable hydraulic jack             | 10 tons; maximum elevation 150mm<br>10 tons; maximum elevation 165mm             |
| 10. Steam cleaner                      | Output capacity: 400 ℓ/h<br>Vapour pressure: 4 to 7 kg/cm <sup>2</sup>           |
| 11. Engine driven AC generator         | Output: 37 kw,<br>Engine: 69ps/2,200rpm  |
| 12. Air compressor                     | Tank capacity: 65ℓ,<br>Motor output: 200V/0.75kW                                 |
| 13. Electric drill                     | Drilling capacity: 10φ   |
| 14. Air impact wrench                  | Capacity: 20mm, (bolt diameter)  |
| 15. Silicon battery charger            | Power: AC 200V<br>Voltage adjustment: 0 to 75V                                   |

16. Battery tester	Battery available: 6 to 24V Sel-motor: 1 to 10 ps
17. Electro-tester	Engine available: 4 cycles, 4, 6, and 8 cylinders
18. Diesel nozzle tester	Pressure gauge: 0 to 500 kg/cm <sup>2</sup>
19. Diesel fuel pump test stand	Testing capacity: 8 cylinders
20. Vice	Nominal dimention 125 mm Service clearance 130 mm
21. Parts wash bench	Output: 14 /min Tank capacity: 100 l Size: 1,270 × 970 × 690 mm

(b) Tools

a. For measuring

- |                               |                                  |
|-------------------------------|----------------------------------|
| 1. Outside micrometer caliper | 2. Vernoer caliper               |
| 3. Firm-joint caliper         | 4. Steel compass                 |
| 5. Steel tape measure         | 6. Straight measure, stainless   |
| 7. Folio rule                 | 8. Thickness gauge               |
| 9. Screw pitch gauge          | 10. Dial indicator               |
| 11. Magnetic base             | 12. Thermometer, for maintenance |
| 13. Battery hydrometer        | 14. Tire pressure gauge          |
| 15. Piston filler gauge       |                                  |

b. For dismantle and assembly

- |                                 |                           |
|---------------------------------|---------------------------|
| 1. Double-end wrench set        | 2. Tappet wrench set      |
| 3. Double offset box wrench set | 4. Socket wrench set      |
| 5. Adjustable wrench            | 6. Adjustable pipe wrench |
| 7. Hexagon wrenicy set          | 8. Combination plyer      |
| 9. Water pump plyer             | 10. Radio pench           |
| 11. Cutting plyer               | 12. Nipper                |
| 13. Snap ring plyer             | 14. Driver set            |
| 15. Driver, minus               | 16. Driver, plus          |
| 17. Stubby driver               | 18. Automatic driver      |

- |   |  |
|---|--|
| 19. Hand hammer                               | 20. Plastic hammer                         |
| 21. Wooden hammer                             | 22. Rubber hammer                          |
| 23. Testing hammer                            | 24. Tire service tool set                  |
| 25. Puller set                                | 26. Stud remover                           |
| 27. Piston vice                               | 28. Piston ring tool                       |
| 29. Valve lifter                              | 30. Diesel engine cylinder<br>liner puller |
| 31. Diesel injection pump<br>special tool set |  |

c. For processing

- |                                |                         |
|--------------------------------|-------------------------|
| 1. File set, steel             | 2. File set, small size |
| 3. Rimmer set                  | 4. Tap and dies set     |
| 5. Scraper blade               | 6. Cloth scissors       |
| 7. Electric soldering iron set | 8. Metal scissors       |
| 9. Metal jack                  | 10. Fender tool set     |

- |                       |                        |
|-----------------------|------------------------|
| 1. Grease pump        | 2. Oil stone           |
| 3. Torch lamp         | 4. Working light       |
| 5. Rigid rack         | 6. Engine cleaning gun |
| 7. Air flow gun       | 8. Spray gun           |
| 9. Air chuck          | 10. Torque wrench      |
| 11. Tube-vulcanizer   | 12. Tube-testing tank  |
| 13. Service cripper   | 14. Tool tray          |
| 15. Tool box          | 16. Tool cabinet       |
| 17. Tool stand        | 18. Working bench      |
| 19. Shelf, bin, parts |                        |

(c) Mobile service

- |                                  |   |
|----------------------------------|---|
| 1. Service car (Truck)           | Loading capacity: 2,000 kg<br>Engine, output: 85ps/4,000rpm<br>with one ton hanging crane |
| 2. Engine driven AC<br>generator | Output: 2.5 kW<br>Engine: 5ps/3,600rpm, gasoline  |

3. Air compressor	Output capacity: 2 m <sup>3</sup> /min Engine: 21.5ps/2,600rpm
4. Engine welder	Welding electrode: 1.2 - 3.2mm Engine: 8ps/3,600rpm, gasoline
5. Service tool set	Various tool sets

5-4-4 Machines and Materials for Fundamental Training.

Requisite training aids and tools are selected according to the training program as prescribed in Education and Training Plan as follows:

(a) Medium size yarding machines (for dismantle and assembly training)

Specifications

A number of drums	3 (to including endless drums)		
Engine	Water cooling, 4 cylinders, diesel, 4,048cc, 71.5ps/2,400rpm		
Size	Length 4,260mm x width 1,640mm x height 1,430mm		
Weight	2,450 kg		
Drum size	1st and 2nd drums		
	diameter	width	flange diameter
	320mm	x 640mm	x 630mm
	Endless drum		
	diameter	width	
	443mm	x 158mm	
Engine clutch	Dry, single plate, oil pressure		
Drum clutch	Inside expansion mechanical		
Drum brake	1st and 2nd drums		
	belt, cam and manual		
	Endless drum		
	Outside squeezing, mechanical, and manual		
Wind-in capacity (1st and 2nd drums)	Rope diameter	10mm	1,370m
		12mm	950m

Wind-up capacity  
(Average wind-in diameter)

1st and 2nd drums

normal wind, 1st: 2,290kg

reverse wind, 1st: 1,955kg

Endless drum

normal wind, 1st: 2,410kg

reverse wind, 1st: 2,065kg

Wind-up speed  
(Average wind-up diameter)

1st and 2nd drums

normal wind, 1st: 111 m/min

reverse wind, 1st: 123 m/min

(b) Small size yarding machine set

Content of set

1. Yarding machine

Wind-up capacity: 1.2 tons

(averaged wind-in diameter)

A number of drums: 3

(endless drum)

15ps/2,400rpm, diesel engine,

empty weight 825kg

2. Wire rope

18mm (6 x 7C/L) 500m

10mm (6 x 19 0/0) 1,100m

8mm (6 x 19 0/0) 2,000m

3. Block rope

Carriage, loading clamp, saddle

block, heel block, sky line

block, snatch block, wire clip,

shackle, and sling set

4. Tools

Wire cutter, wire splice tool,

tightener, climbing tool,

safety belt, transceiver.

(c) Audi-visual training aids and tools

a. Yarding machine training system

- |                    |   |
|--------------------|---|
| 1. 8mm projector   | Input: 200V/50Hz<br>Size: 24cm x 17cm x 14cm<br>Weight: 4kg                   |
| 2. Casette film    |   |
| 3. Slide projector | Movie film, 35mm, half size<br>iustamatic                                     |
| 4. Program slide   | 398 frames (in plastic magazine)  |
| 5. Program sheet   | Big size: 134 sheets (in vinyl case)<br>Small size: 91 sheets (in vinyl case) |

b. Yarding machine model set

- |                          |   |
|--------------------------|---|
| 1. Yarding machine model | 3 drums, electric, size:<br>1,200mm x 400mm x 400mm app.  |
| 2. Block rope model set  | Carriage, loading block, control<br>block, heel block, sky line<br>support, heel block with clump,<br>snatch block, sling block,<br>and wire clip |
| 3. Wire rope             | 4mm (6 x 19 0/0) 30m<br>3mm (6 x 19 0/0) 100m<br>2mm (6 x 19 0/0) 100m  |

c. Wire rope splice set

- |                              |   |
|------------------------------|---|
| 1. Wire rope splice<br>tools | Wire needle, chisel,<br>chisel table, hammer, radiopench<br>and pench                           |
| 2. Wire rope splice<br>model | Tape measure, dividing measure,<br>short splice, long splice,<br>finished and functioning model |
| 3. Long splice tools         |   |



d. Video-television set

1. Video-cassette recorder Power: AC200 - 220V/50Hz  
Consumption power: 100W  
Weight: 27kg
2. Video-monitor Power: AC200 - 220V/50Hz  
Consumption power: 49W  
Weight: 12.6kg
3. Video-camera Power: AC200 - 220V/50Hz  
Consumption power: 11W  
Weight: 3.6kg  
(View-finder tripod)
4. Power cord Code reel, 50m
5. Video-cassette tape

(d) Equipment for Practice of Dismantle and Assembly

a. Machinery equipment

1. Upright drilling machine
2. Electric glinder
3. Chain block
4. Portable hydraulic jack
5. Electric drill
6. Electro-tester
7. Diesel nozzle tester
8. Vice
9. Diesel fuel pump test stand
10. Air compressor
11. Part washing table

b. Measuring tools

1. Outside micro-meter caliper
2. Vernier caliper
3. Firm-joint caliper
4. Measure, straight, stainless steel
5. Measure, fold
6. Thickness gauge
7. Screw pitch gauge
8. Dial indicator
9. Magnetic base
10. Piston filler gauge
11. Battery hydrometer
12. Steam cleaner

c. Precessing tools

- |                          |                         |
|--------------------------|-------------------------|
| 1. File set, steel       | 2. File set, small size |
| 3. Reamer set            | 4. Tap and dies set     |
| 5. Electric solding iron |                         |

d. Tools for Dismantle and Assembly

- |   |  |
|---|--|
| 1. Open-end wrench set                        | 2. Tappet wrench set                       |
| 3. Double offset box wrench set               | 4. Socket wrench set                       |
| 5. Adjustable wrench                          | 6. Adjustable pipe wrench                  |
| 7. Hexagon wrench set                         | 8. Combination plyer                       |
| 9. Water pump plyer                           | 10. Radio cutting plyer                    |
| 11. Cutting plyer                             | 12. Nipper                                 |
| 13. Snap ring plyer                           | 14. Driver set                             |
| 15. Plus & minus driver                       | 16. Stubby driver                          |
| 17. Automatic driver                          | 18. Hand hammer                            |
| 19. Plastic hammer                            | 20. Stud remover                           |
| 21. Piston vice                               | 22. Piston ring tool                       |
| 23. Valve lifter                              | 24. Diesel engine cylinder<br>liner puller |
| 25. Diesel injection pump<br>special tool set | 26. Sling wire                             |

c. Others

- |                     |                   |
|---------------------|-------------------|
| 1. Grease pump      | 2. Oil stone      |
| 3. Torch lamp       | 4. Air gun        |
| 5. Torque wrench    | 6. Tool tray      |
| 7. Tool box         | 8. Tool cabinet   |
| 9. Tool stand       | 10. Working bench |
| 11. Air conditioner |                   |

#### 5-4-5 Other Necessary Equipment

##### a. Liaison and survey machinery

1. Light Van 5 persons, 1,800cc, 95ps,  
gasoline engine, air-conditioned
2. Jeep 4 persons, 4,230cc, 140ps,  
gasoline engine, steel cabin
3. Micro-bus 26 persons, 2,977cc, 85ps,  
diesel engine, air-conditioned
4. Speed-boat Displacement: 4.13 tons  
130ps×2 gasoline engines  
with cabin
5. Radio set
  1. Bassein-Shawbya
  2. Shawbya-Chaungtha
6. Air conditioner

##### b. Clerical machinery

1. Copying machine Size: 515w x 392d x 268h  
Weight: 33kg
2. Calculating machine Size: 178w x 223d x 61h  
Weight: 1,050 g; 12 digits
3. Typewriter, English Size: 416w x 360d x 130h  
Weight: 7.3kg, portable
4. Others Filing cabinet, desk, stool,  
stationery

Remarks: Burma is now provided with electric power, 220V/50Hz and it is necessary to select appropriate machinery to meet those conditions.

