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LETTER OF TRANSMITTAL

LOCATION MAP

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4. Technical Manual for Plate Making and Printing

## 1. Introduction

In response to the request of the Royal Thai Government, the Japan International Cooperation Agency implemented aerial photography (1:20,000) for 4,000 km<sup>2</sup> and 1:10,000 topographic mapping for about 2,000 km<sup>2</sup> of the Bangkok metropolitan area (Longitude 100°15' - 101°00'E, Latitude 13°30' - 14°00'N) as well as 1:4,000 topographic mapping for about 300 km<sup>2</sup> of the central area of Bangkok.

The Project started in September 1986 and the aerial photography commenced in March 1987 due to the delay of flight permission. As the base for aerial photography, Don Muang airport located north of the area to be photographed was used. Because it is an international airport, strict safety control regulations were imposed on take-off and landing of the aircraft. Favoured by fine weather, however, the aerial photography was successfully completed as originally planned.

The field work such as ground control point survey, leveling, and field identification were also completed on schedule by 42 Japanese engineers in close cooperation with the Bangkok Metropolitan Administration (BMA), Royal Thai Survey Department (RTSD), etc.

The aerial triangulation, compilation, drafting and proof printing were conducted from Japan in June 1987 through September 1988. During this period, 1 BMA and 10 RTSD counterparts visited Japan.

The printing was conducted in Thailand in December 1988 through February 1989. The materials necessary for printing were transported to Thailand from Japan. At the commencement of printing, 4 Japanese experts were dispatched to Thailand and gave technical guidance using a manual on plate making and printing of 1:10,000 topographic maps.

As for printing colors, generally reddish warm colors with high brightness and chroma were chosen after consideration of the country's buddist image, the population's preferences, etc. As a result, the urban area is represented in red and brown as the keynote, and the agricultural area, in green and blue. It is fully expected that these topographic maps will be used as basic materials for urban development planning of the Bangkok metropolitan area and to the overall and multi-purpose development of Thailand.



## 2. Outline of Survey

### 2-1 Background of Survey

#### 2-1-1 Background of request

The Bangkok metropolitan area of Thailand has been suffering from the widely prevailing urban problems of traffic congestion, inadequate housing developments, insufficient sewerage system due to drastic expansion of urbanization.

Furthermore, other than the above general urban problems, there are problems related to chronic inundation caused by frequent flooding of the Chaophraya River, which runs through the center of the area, as well as by ground subsidence.

The Royal Thai Government has been making efforts to prepare and implement drastic and comprehensive urban planning in order to improve such unfavourable conditions in the area and to establish a sound environment. To prepare correct, rational and comprehensive urban development plans, it was necessary to grasp the actual state of the present Bangkok metropolitan area accurately in detail. Therefore, it was a most urgent and important role for the Royal Thai Government to prepare urban base maps.

Under such circumstances, the Royal Thai Government requested technical cooperation in topographic mapping of the Japanese Government who has abundant experience in the field.

#### 2-1-2 Outline of request

The Royal Thai Government sent a letter to the Japanese Government, dated May 8 requesting technical cooperation in topographic mapping of the Bangkok metropolitan area.

The outline of the request made by the Royal Thai Government was as follows:

- (1) 1:20,000 aerial photography covering 4,000 km<sup>2</sup> including Bangkok and its surrounding areas for various surveys and planning.

(2) 1:10,000 topographic mapping covering 2,000 km<sup>2</sup> of Bangkok metropolitan area for multi-purpose usages.

(3) 1:4,000 topographic mapping covering 200 - 300 km<sup>2</sup> of Bangkok central area for multi-purpose usages.

## 2-2 Description of Survey

### 2-2-1 Preliminary survey

In order to discuss on technical cooperation in topographic mapping requested by the Royal Thai Government, a first phase preliminary survey team (5-member team headed by Mr. Kazuhiko Ohtake, Topographic Department Director of Geological Survey Institute of Japan) from January 27 through February 8 '86 and a second phase survey team (6-member team headed by the same) from February 24 through March 20 '86 were dispatched.

Discussion with the Thai side during the preliminary surveys were conducted mainly with BMA, the requesting agency of Thailand, and RTSD.

After a series of discussions, the Scope of Work of topographic mapping of the Bangkok metropolitan area (hereinafter referred to as S/W) was agreed on. Outline of the S/W is as follows:

#### (1) Outline of survey

Aerial photography (1:20,000)	4,000 km <sup>2</sup>	
Topographic mapping (1:10,000)	2,000 km <sup>2</sup>	
		61 sheets (an English and a Thai version)
Topographic mapping (1:4,000)	300 km <sup>2</sup>	
		40 sheets (an English and a Thai version)



(2) Specifications

i) Ground control point survey

JICA Specs. 3rd order Accuracy:  $\frac{\sqrt{X^2 + Y^2}}{S} = \frac{1}{25,000}$   
(S: km)

ii) Leveling

JICA Specs. 3rd order Accuracy: 12 mm  $\sqrt{S}$  (S: km)  
Minor order Accuracy: 60 mm  $\sqrt{S}$  (S: km)

iii) Monument

Monumentation of the ground control points shall be subject to the BMA Specifications.

iv) Planimetry

JICA Specs. A class Accuracy: 0.5 mm on the map

v) Elevation

a) 1:10,000 topographic map

JICA Specs. A class Accuracy: Spot heights by  
photogrammetry 0.7 m  
Contour 1 m

b) 1:4,000 topographic map

JICA Specs. A class Accuracy: Spot heights by  
photogrammetry 0.7 m  
Direct leveling points  
0.1 m  
Contour 1 m

vi) Reference ellipsoid: Everest

vii) Datum: Indian datum 1975

viii) Vertical: Mean sea level at Koh Lak

xi) Projection: Universal Transverse Mercator Projection

x) Contour line intervals

a) 1:10,000 topographic map 2 m

b) 1:4,000 topographic map 2 m

xi) Format

a) 1:10,000 topographic map 50 cm x 75 cm (for 5 km x 7.5 km)

b) 1:4,000 topographic map 62.5 cm x 93.75 cm  
(for 2.5 km x 3.75 km)

#### 2-2-2 Outline of survey activities

Outline of the survey and related activities for topographic mapping of the Bangkok metropolitan area, Thailand is as follows:

Period	Item	Description
May 5 1985	Request	Request for technical cooperation to Japanese Government in topographic mapping
Jan. 27 - Feb. 8 '86	1st phase preliminary survey	Discussions on the topographic mapping with BMA
Feb. 24 - March 20 '86	2nd phase preliminary survey	Discussions including field survey and agreement on the S/W with BMA
July 7 - Sep. 4 '86	JICA training	Mr. Chailurt Panjatevakupt
Oct. 13 - Nov. 19 '86	1st year work (Field work)	Discussions on plan of operation and assembly of aircraft
March 5 - June 25 '87	1st year work (Field work)	Aerial photography, ground control point survey, leveling, pricking, field identification

Period	Item	Description
June 22 ~ Sep. 30 '87	JICA training	Mr. Somsak Nuanurai Mr. Krith Bunthid
Aug. 11 '87 - March 15 '88	2nd year work (Indoor work in Japan)	Aerial triangulation, stereo plotting compilation, 1:4,000 map drafting
Sep. 22 - Dec. 31 '87	JICA training	Mr. Chamnong Chanthamala Mr. Boonlert Thasanakroongsin
Dec. 1 - Jan. 29 '88	2nd year work (Field work)	Field completion
Dec. 22 '87 - Apr. 7 '88	JICA training	Mr. Ratachai Phadungwai Mr. Patthanapong Ongartitthichai
Apr. 1 - July 7 '88	JICA training	Mr. Neramit Sichamnong Mr. Suppalert Chaichana
July 5 - Sep. 30 '88	3rd year work (Indoor work in Japan)	1:10,000 map drafting and plate making
July 3 - Sep. 30 '88	JICA training	Mr. Nopphaolon Chotsiri Mr. Boonlert Thadrong
Nov. 29 - Dec. 22 '88	3rd year work (in Thailand)	Technical guidance for printing
March 7 - 16 '89	3rd year work (in Thailand)	Confirmation of printing

### 2-2-3 Outline of work implemented

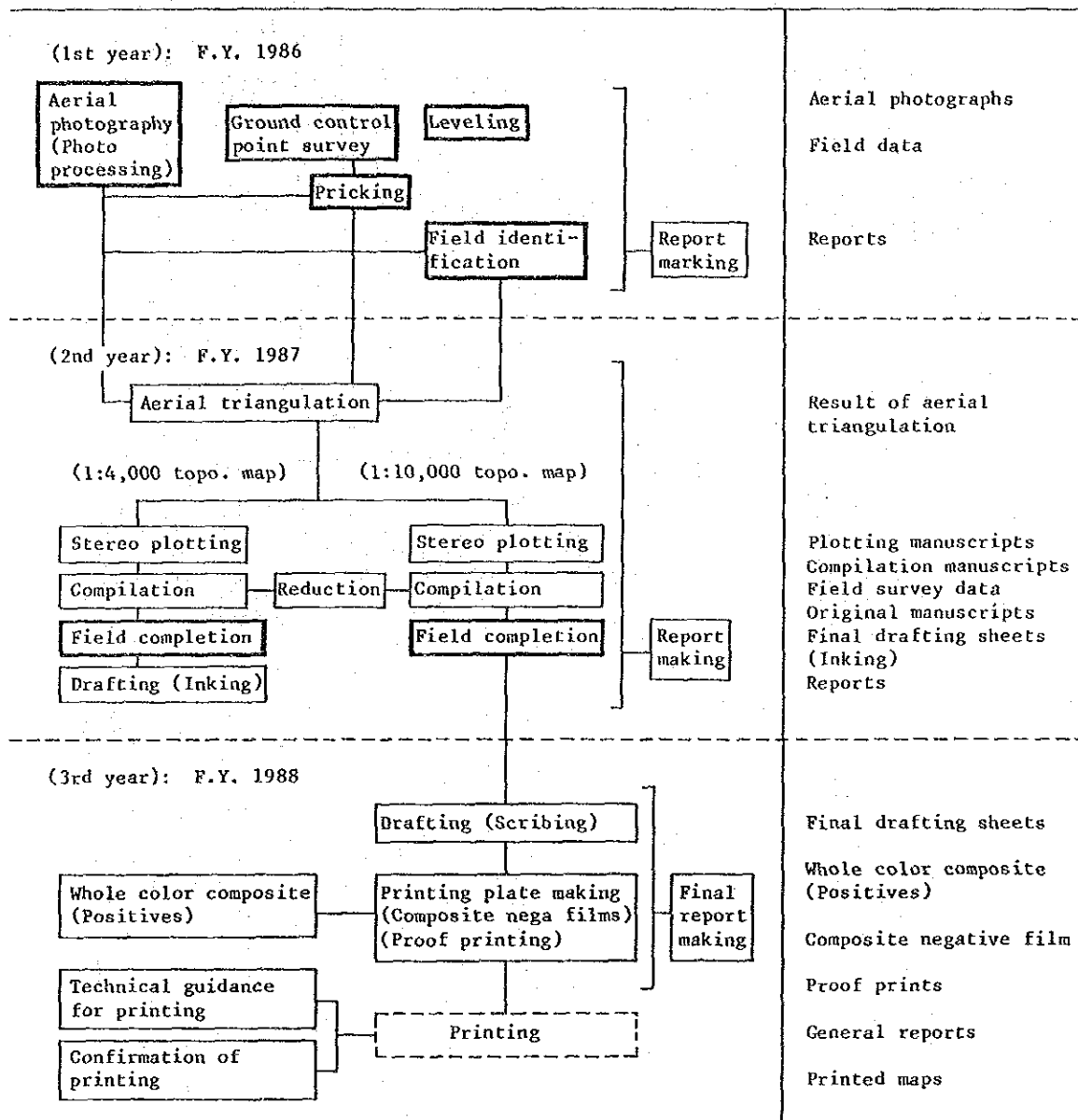
The work implemented during the topographic mapping is outlined as follows:

Item	Amount of Work		Remarks
	Original plan	Result	
Aerial photography (1:20,000)	4,000 km <sup>2</sup>	4,000 km <sup>2</sup>	17 courses
Ground control point survey	67 points	67 points	
Leveling 3rd order Minor order	50 km 250 km	50 km 250 km	Otherwise, 3rd order leveling (about 850 km) was conducted by BMA.

Item	Amount of Work		Remarks
	Original plan	Result	
Pricking			
Ground control points	70 points	70 points	
Bend marks	400 points	400 points	
Field identification	1:4,000 300 km <sup>2</sup>	300 km <sup>2</sup>	
	1:10,000 1,700 km <sup>2</sup>	1,700 km <sup>2</sup>	
Aerial triangulation	422 models	425 models	
Stereo plotting	1:4,000 300 km <sup>2</sup>	300 km <sup>2</sup>	40 sheets
	1:10,000 1,700 km <sup>2</sup>	1,700 km <sup>2</sup>	57 sheets
Compilation	1:4,000 300 km <sup>2</sup>	300 km <sup>2</sup>	40 sheets
	1:10,000 2,000 km <sup>2</sup>	2,000 km <sup>2</sup>	61 sheets
Field completion	1:4,000 300 km <sup>2</sup>	300 km <sup>2</sup>	40 sheets
	1:10,000 1,700 km <sup>2</sup>	1,700 km <sup>2</sup>	57 sheets
Drafting	1:4,000 300 km <sup>2</sup>	300 km <sup>2</sup>	40 sheets (an English and a Thai version)
	1:10,000 2,000 km <sup>2</sup>	2,000 km <sup>2</sup>	61 sheets (an English and a Thai version)
Plate making	1:10,000 61 sheets (2 kinds)	61 sheets each for an English and a Thai version	
Printing	1:10,000	Conducted by Thai side	
Technical guidance in printing		Including technical manual for plate making and printing	
Confirmation of printing		Including technical explanation of printing	

Note: According to the minutes of discussion dated on May 27, 1987, the printing was, not as originally planned, conducted in Bangkok by the Thai side. The technical guidance and confirmation of the printing were concurrently conducted in Bangkok by the Japanese side.

Flow of work for the topographic mapping is as follows:



: Field work  
 : Indoor work  
 : Work conducted by Thai side



## 2-3 Supervision of Field Work

During the field work, JICA sent the following advisors to Bangkok for technical meetings with the Thai side and for supervision of the field work:

(First year)

Kiyoshi Mimura: Head of National Large Scale Mapping Div.,  
Topographic Dept., Geographical Survey Institute  
(GSI), Ministry of Construction

Takeshi Nakano: Deputy Head of First Development Survey Div.,  
Social Development Cooperation Dept., JICA

Yoshikazu Yamada: Staff of First Development Survey Div., Social  
Development Cooperation Dept., JICA

(Second Year)

Kiyoshi Mimura: Same as above

Takeshi Nakano: Same as above

(Third Year)

Kiyoshi Mimura: Head of Planning Div., Topographic Dept.,  
Geographical Survey Institute (GSI), Ministry of  
Construction

## 2-4 Outline of Each Year Work

### 2-4-1 First year work (F.Y. 1986)

#### (1) Description of work

##### 1) Outline

In the first year, the aerial photography, ground control point survey, leveling, pricking and field identification necessary for the 1:10,000 and 1:4,000 topographic mapping were carried out.

##### 2) Aerial photography

The aerial photography (scale: 1:20,000) was conducted for the mapping area (2,000 km<sup>2</sup>) and its surrounding using a wide angle camera (f: 15 cm).

Together with the aerial photography, the photo processing work was carried out in Bangkok for reproduction of the aerial photographs necessary for mapping.

##### 3) Ground control point survey

Based on the RTSD triangulation points, the 3rd order ground control points were established by traversing using a distance meter, transit, etc.

The monumentation was made based on the Thai specifications.

##### 4) Leveling

Based on the 3rd order bench marks installed by BMA, the leveling was carried out using auto level and staff. For the 1:10,000 topographic mapping area, leveling was conducted based on the BMA specifications. For the 1:4,000 mapping area, minor order leveling was carried out.

##### 5) Pricking

The pricking of the RTSD triangulation points and newly established points was conducted to obtain the control points for aerial triangulation and mapping.

The pricking of bench marks was also carried out to obtain the vertical controls.



6) Field identification

Planimetric features, geographical names, etc. necessary for topographic mapping were surveyed and confirmed in the field given consideration to the map symbols.

The results were drawn on the enlarged aerial photos and reference materials for the preparation of materials for stereo plotting and compilation. The symbols used were those agreed on between Thailand and Japan.

(2) Amount of work

Items of Work		Amount of Work
Aerial photography	Coverage	4,000 km <sup>2</sup>
	Scale	1:20,000
	Number of courses	17 courses
Ground Control Point Survey		67 points
Leveling	3rd order	about 850 km (by BMA)
	3rd order	50 km
	Minor order	250 km
Pricking	Control points	70 points
	Bench marks	400 points
Field identification	1:4,000 topo maps	300 km <sup>2</sup>
	1:10,000 topo maps	1,700 km <sup>2</sup> *
Report		English 50 copies
		Japanese 50 copies

\* For urban areas, the field identification was conducted by the 1:4,000 mapping.

(3) Period of work

(Field Work)

Headquarters: Oct. 13 '86 - Nov. 19 '86  
March 5 '87 - June 25 '87

Aerial photography: Oct. 13 '86 - Nov. 5 '86  
March 5 '87 - Apr. 17 '87

Photo processing: Oct. 15 '86 - Nov. 5 '86  
March 10 '87 - May 18 '87

Ground control point survey (including leveling and pricking):  
March 10 '87 - June 22 '87

Field identification: March 18 '87 - June 10 '87

(Indoor Work)

Data arrangement: June 29 '87 - July 13 '87

Report preparation: June 1 '87 - July 30 '87

(4) Formation of field survey team

Leader	Tositomo Kanakubo
Deputy leader	Isao Ikeshima
Mapping planner	Chozo Obara
Chief surveyor	Yoshikazu Ibusuki

(Aerial Photography 3 members)

Pilot	Kiyoshi Ono
Camerman	Masao Iwata
Mechanic	Yohji Ebara

(Photo Processing 2 members)

Engineer	Noriaki Machida
Engineer	Tsutomu Inui

(Ground Control Point Survey 18 members)

Ryosuke Itoh	Kazumi Satoh
Motonori Nakashima	Ryoichi Sekiguchi
Katsuyuki Kondo	Hiroaki Hayashi

Manabu Tsutsui	Akimasa Takahashi
Mitsuo Sasaki	Yukio Miyazaki
Nobutaka Komuro	Takehiko Ohno
Shozo Shimoda	Masashi Kita
Kazuhiro Ishizuka	Norio Oikawa
Yoshichika Mochizuki	Fumihiko Kashiro

(Field Identification 14 members)

Mitsuo Sunaoshi	Tatsuo Sakaguchi
Kazuya Tabuchi	Mitsuyoshi Takasaki
Yasuo Hongo	Hiroshi Doi
Kazuomi Masuda	Hiroshi Saito
Akihito Yamashita	Tsuneo Okumura
Hikaru Horigome	Keiji Noguchi
Tetsuo Kashio	Yasuki Kondo

2-4-2 Second year work (F.Y. 1987)

(1) Description of work

1) Outline

In the second year work, the indoor work such as aerial triangulation, stereo plotting, and compilation was conducted. As for the 1:4,000 topographic mapping, a series of work including drafting was completed to obtain the final result. As for the field work, the field completion was conducted in Bangkok.

2) Aerial triangulation

In the aerial triangulation, the geodetic coordinates of pass points, control points, etc. necessary for mapping were obtained using a stereo comparator, and the adjustment computation was conducted to determine the planimetry and heights of those points by the block adjustment of the analytical method.

### 3) Stereo plotting

Based on the results of aerial triangulation, field identification, etc., various features to be represented on the topographic maps were plotted to prepare the plotting manuscripts.

For the 1:4,000 and 1:10,000 topographic maps, the intermediate contour lines were delineated at 2 m intervals and the spot heights, including direct leveling points, were plotted at 5 cm intervals in average on the map.

### 4) Compilation

Based on the compilation manuscripts and using the field survey results and collected data, the compilation was conducted, according to the symbol specifications.

As for the compilation of 1:10,000 topographic mapping area, the area covered by 1:4,000 topographic mapping was compiled by the reduced compilation of 1:4,000 compilation manuscripts.

### 5) Field completion

The important items related to topographic and planimetric features, geographical names, etc. and the uncertain items found in the course of stereo plotting and compilation were checked and confirmed in the field, and the original manuscripts of topographic maps were prepared.

The supplementary or checking survey was conducted on the major changes after aerial photography and other matters in the field.

### 6) Drafting

The drafting in the second year work was done only for the 1:4,000 topographic maps. The drafting was conducted by the inking method based on the original manuscripts of 1:4,000 topographic maps and according to the symbol specifications agreed upon between Japan and Thailand.

The final drafting sheets were prepared in English and in Thai.

(2) Amount of work

Item of Work	Amount of Work	
Aerial triangulation	425 models	17 copies
Stereo plotting		
1:4,000	300 km <sup>2</sup>	40 sheets
1:10,000	1,700 km <sup>2</sup>	57 sheets
Compilation		
1:4,000	300 km <sup>2</sup>	40 sheets
1:10,000	2,000 km <sup>2</sup>	61 sheets (Reduced compilation for 300 km <sup>2</sup> )
Field completion		
1:4,000	300 km <sup>2</sup>	40 sheets
1:10,000	1,700 km <sup>2</sup>	57 sheets
Drafting (inking)	300 km <sup>2</sup>	40 sheets
Report	English	50 copies
	Japanese	50 copies

(3) Period of work

Field work

(H.O.) Dec. 1 1987 - Jan. 29 1988

(Field completion) Dec. 4 1987 - Jan. 27 1988

Indoor work (Japan)

(Aerial triangulation) Aug. 11 1987 - Aug. 31 1987

(Stereo plotting) Sep. 1 1987 - Nov. 16 1987

(Compilation) Sep. 16 1987 - Nov. 30 1987

(Drafting) Dec. 1 1987 - March 27 1988

(Reporting) Jan. 5 1988 - March 28 1988

(4) Formation of field party

Leader Tositomo Kanakubo  
Deputy Leader Isao Ikeshima  
Mapping planner Chozo Obara  
Chief surveyor Yoshikazu Ibusuki

Field completion (10 members)

Kazuo Furukata	Kazuhiro Ishizuka
Mitso Sunaoshi	Hiroshi Saito
Kazuya Tabuchi	Yasuki Kondo
Yasuo Hongo	Akimasa Takahashi
Mitsuyoshi Takasaki	Masashi Kita

2-4-3 Third year work (F.Y. 1988)

(1) Description of work

1) Outline

In the third year, the indoor work such as drafting and plate making was conducted for the 1:10,000 topographic map. Furthermore, the technical guidance in printing and the confirmation of printing were made in Thailand.

2) Drafting

Based on the original manuscripts of 1:10,000 topographic maps, 6-color separation drafting was conducted by scribing for the preparation of final drafting sheets and whole color composite (positive), for each the English and the Thai version.

The symbol specifications were based on those agreed upon.

3) Plate making

Image printing was made on PS plates for each color using the final drafting sheets, and proof prints were then made by the off-set method. After checking the proof prints, the composite negative films necessary for printing were made for each color. As for black, the composite negative film was prepared for each the English and the Thai version.

4) Technical guidance in printing

The printing was conducted in Thailand. For this, the technical manual for plate making and printing of the 1:10,000 topographic map was prepared, and the technical guidance was given in Thailand based on the manual.

5) Confirmation of printing

The finish of printed maps was confirmed in Thailand. At the same time, for technical transfer, Japanese experts participated in the seminar on technical guidance held by BMA.

(2) Amount of work

Item	Amount of Work	
Drafting (Scribing) 1:10,000	2,000 km <sup>2</sup>	61 sheets (for each the English and the Thai version)
Plate making 1:10,000	2,000 km <sup>2</sup>	61 sheets (for each the English and the Thai version)
Technical guidance	Guidance in plate making and printing including preparation of manual	
Confirmation of printing	Confirmation of printing including participation in seminar	
Reporting	English edition	50 copies
	Japanese edition	50 copies

(3) Period of work

Field work

(Technical guidance) Nov. 29 - Dec. 22, 1988

(Confirmation of printing) March 7 - March 16, 1989

Indoor work

(Drafting) July 5 - Aug. 31, 1988

(Plate making) July 18 - Sep. 30, 1988

(Reporting) Aug. 1, 1988 - March 29, 1989

(4) Formation of field party

Technical guidance (4 members)

Leader	Tositomo Kanakubo
Deputy leader	Isao Ikeshima
Plate making engineer	Hideki Yanagisawa
Printing engineer	Zenichiro Sekiguchi

Confirmation of printing (4 members)

Leader	Tositomo Kanakubo
Deputy leader	Isao Ikeshima
Mapping planner	Chozo Obara
Chief surveyor	Yoshikazu Ibusuki



### 3. Technical Report

In this chapter, the outline of the first and second year works will be given along with the technical report of the third year work. Detailed description of the first and second year works is to be referred to in each year work report.

#### 3-1 Aerial Photography

##### 3-1-1 Outline

The aerial photography was conducted using the aircraft and camera transported from Japan. The coverage of aerial photography was 4,000 km<sup>2</sup> of the Bangkok metropolitan area (Latitude 13°30' - 14°00'N, Longitude 100°15' - 101°00'E). (See Fig. 1)

##### 3-1-2 Specifications of aerial photography

- |                          |   |
|--------------------------|---|
| (1) Coverage:            | 4,000 km <sup>2</sup>                           |
| (2) Photographing scale: | 1:20,000  |
| (3) Number of courses:   | 17 courses                                      |
| (4) Total course length: | 782 km  |
| (5) Flight altitude:     | 3,000 m   |
| (6) Camera:              | WILD RC-10 15/23                                |
| (7) Overlap:             | Overlap 60% (average)<br>Side lap 30% (average) |



### 3-1-3 Instruments and materials for aerial photography

#### (1) Aerial photography

- (a) Aircraft: CESSNA TU-206
- (b) Camera: WILD RC-10 15/23
- (c) Film: KODAK PLUSX

#### (2) Photo processing

- (a) Development of film
  - Developer: KODAK VERSAMAT
- (b) Printing
  - Contact printer: ZEISS KG-30

### 3-1-4 Aerial photography

Don Muang Airport located north of the photographing area was used for the base of aerial photography. Because Don Muang airport is an international airport, there were some restrictions on the flight. Principal restrictions were as follows:

- (1) The flight plan shall be submitted half an hour before take-off for flight permission.
- (2) Permission shall be granted on the condition that eye-visibility is at more than 8 km.
- (3) RTSD security officer shall be on board at the time of aerial photography.

Due to the delay of flight permission, the aerial photography was restricted during the period December 19, 1986 - February 1987 which was considered the best season for aerial photography.

However, the aerial photography was successfully completed during the period March 6 - 31, 1987 owing to the exceptionally fine weather.

At the time of operation, Mr. Monton, RTSD security officer, was on board.

(1) Description of photographing work

- (a) Photographing days: 10 days
- (b) Test flight: 2 times
- (c) Total flight hours: 27 h 20 m
- (d) Result: 17 courses, 791 photos

To avoid strong halation because of high solar altitude, the operation was made during the time 15:00 - 16:30, considered as optimum time.

3-1-5 Photo processing

Development and printing of the exposed film was made at RTSD using its facilities.

(1) Inspection

After printing, the inspection was conducted on the following items:

- (a) Overlap 60% as standard
- (b) Side lap 30% as standard
- (c) Cloud, cloud shadow which might effect the subsequent work
- (d) Uneven development
- (e) Halation or smoke from field fires which might effect the subsequent work

The results of the inspection were excellent.

(2) Film annotation

The film annotation was made according to the specifications agreed upon. (See Fig. 2)

Form for the film annotation

Course No.	Date / Month / Year	Scale	Photo No.
C 1	BMA	26 / 3 / 87	1 20,000 001

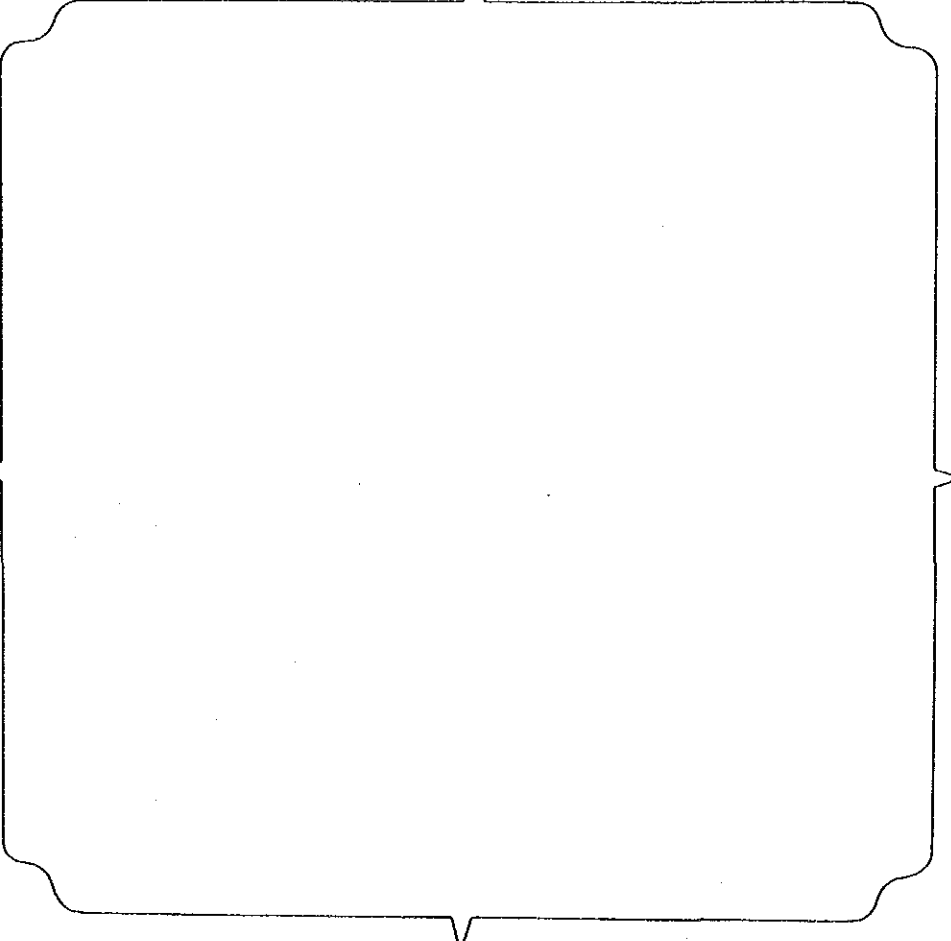


Fig. 2 Film Annotation

3-1-6 Result of aerial photography

Numbers of the aerial photographs per strip are shown in the following Table 1.

Table 1 Number of Aerial Photographs per Strip

Course No.	Counter No.	Roll No.	Photo No.	Number
1	2691 - 2735	4	1 - 45	45
2	2490 - 2534	3	1 - 45	45
3	2443 - 2487	3	1 - 45	45
4	2751 - 2795	4	1 - 45	45
5	1835 - 1881	2	1 - 47	47
6	1785 - 1831	2	1 - 47	47
7	3252 - 3295	6	1 - 44	44
8	1666 - 1711	1	1 - 46	46
9A	1618 - 1653	1	1 - 36	36
9B	2933 - 2946	5	1 - 14	14
10	1570 - 1615	1	1 - 46	46
11	1522 - 1567	1	1 - 46	46
12A	2885 - 2908	5	1 - 24	24
12B	2381 - 2393	3	1 - 13	13
12C	2915 - 2929	5	1 - 15	15
13A	2279 - 2306	2	1 - 28	28
13B	3034 - 3055	5	1 - 22	22
14A	2988 - 3021	5	1 - 34	34
14B	2427 - 2440	3	1 - 14	14
15	3149 - 3193	6	1 - 45	45
16	2806 - 2850	4	1 - 45	45
17	3196 - 3240	6	1 - 45	45
Total				791

## 3-2 Third Order Ground Control Point Survey

### 3-2-1 Outline

In the survey area, the number of the RTSD existing ground control point was 7 triangulation points. Using these points, 67 points were newly established according to the specifications for the 3rd order ground control point survey.

### 3-2-2 Specifications

- (1) Order: Third order ground control survey
- (2) Limits:
  - 1) The distance between points is to be 6 km as a standard.
  - 2) The number of sides of a polygon is to be 6 or less.

### 3-2-3 Operation

#### (1) Point distribution plan

The point distribution plan was prepared based on 1:50,000 topographic map, taking into consideration that the 3rd order ground control points are to be used as control points of the subsequent aerial triangulation.

#### (2) Point selection

The survey area was flat at less than 2 m above sea level on the average. In the urban area where tall buildings stand, roof top spaces were used for the operation. In the suburbs where many trees are planted along waterways and intervisibility is very poor, high observation towers were constructed.

Construction of the high observation towers totaled 17 with a maximum height of 22 m and an average of 15 - 16 m.

In selecting the points, the following matters were taken into consideration:

- (a) Points should be easily usable for ground control point survey.
- (b) Permanent monuments should be easily identifiable and safely maintainable.
- (c) Positions should be easily identifiable for easy pricking on the aerial photographs.

After the point selection, the ground control point survey network was prepared. (See Fig. 3)

### (3) Monumentation

The monumentation of 3rd order ground control points was carried out according to the specifications agreed upon with the Thai side, as shown in Fig. 4, for ground station markers, as well as in Fig. 5, for roof station markers.

The description of control points was prepared according to the form shown in Fig. 6.

### (4) Observation

As for the observation of the horizontal angle, 2 sets of observation were conducted using WILD T2. The allowances of the differences of angle and the double angle were confirmed to be within 10" and 20", respectively.

For the distance measurement, one set of observations consisting of 3 readings was conducted using the electro-optical distance meter YHP3808. The discrepancies between sets were confirmed to be within 1:40,000.



NET OF GROUND CONTROL POINT SURVEY

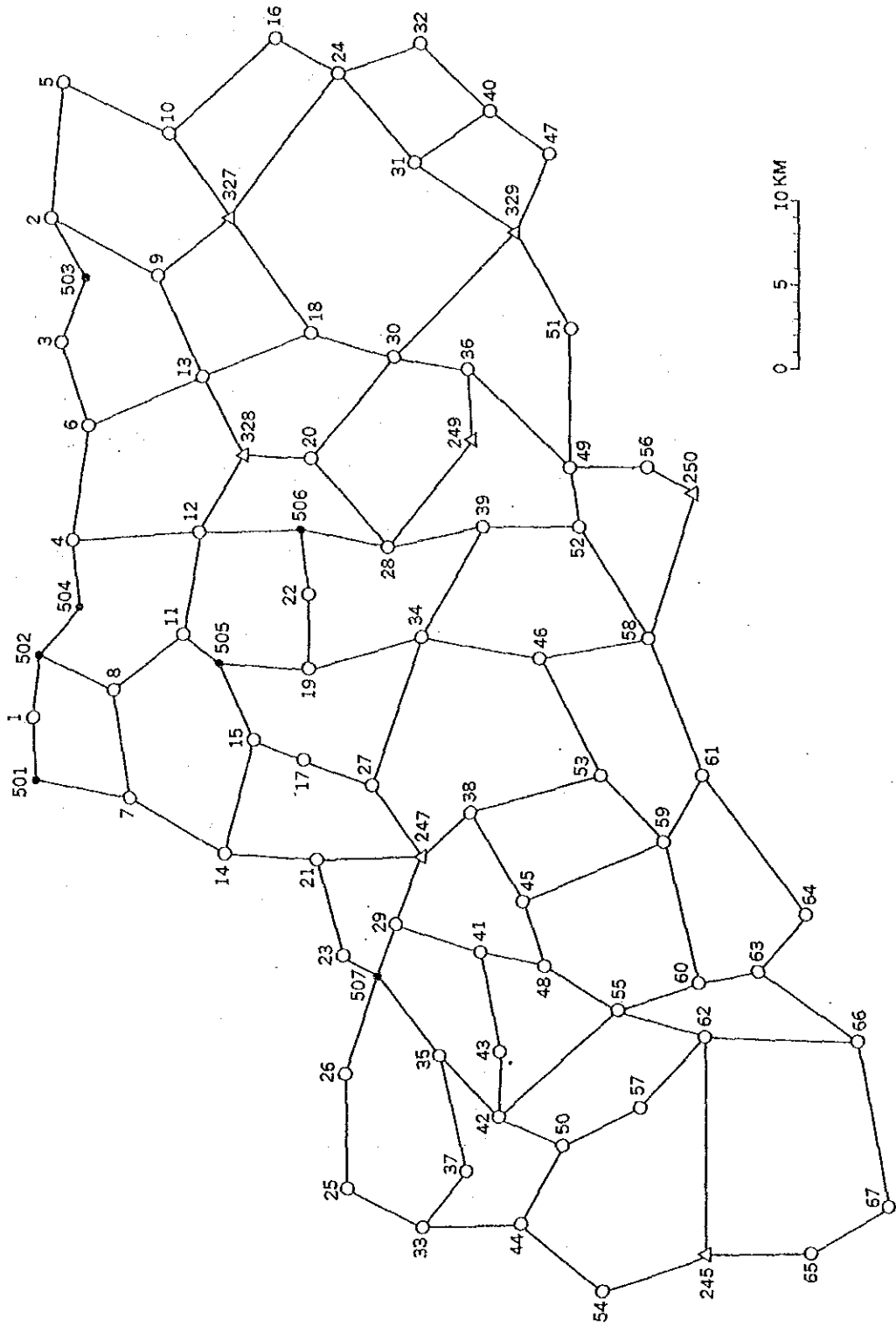
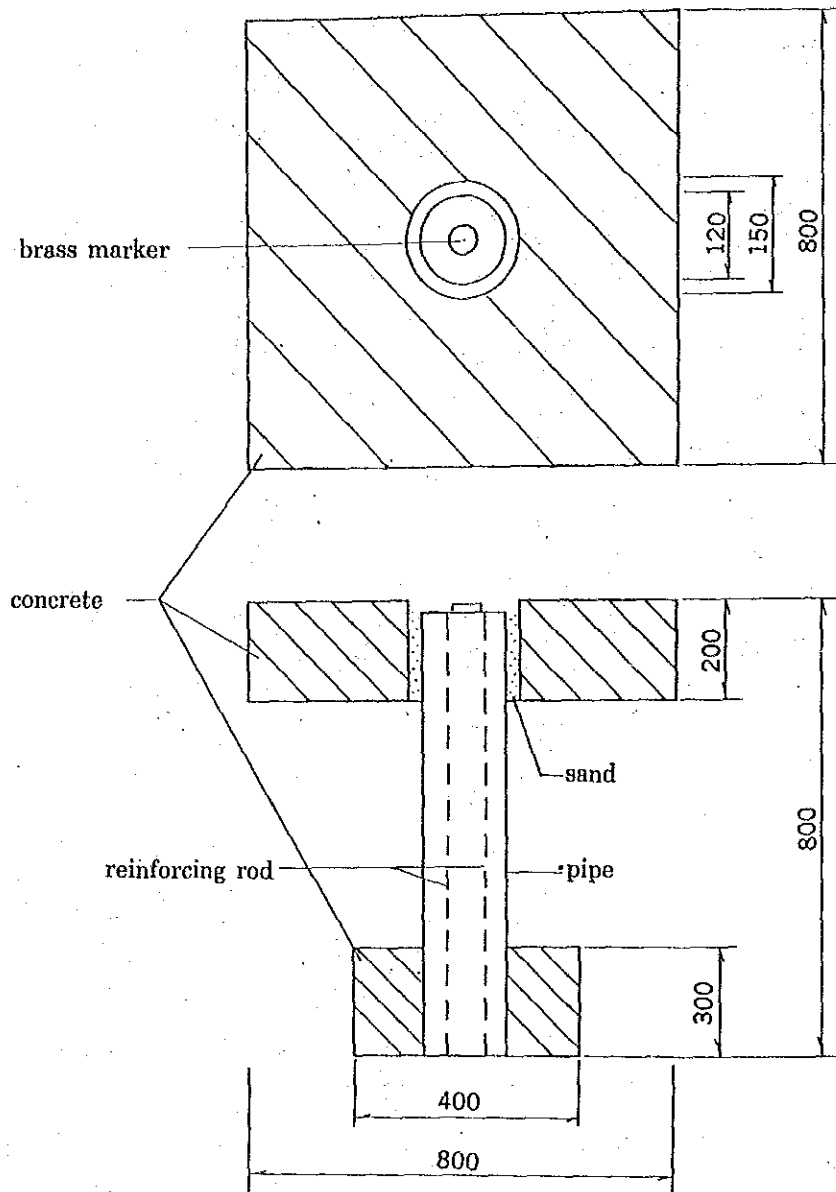


Fig. 3 Net of Ground Control Point Survey

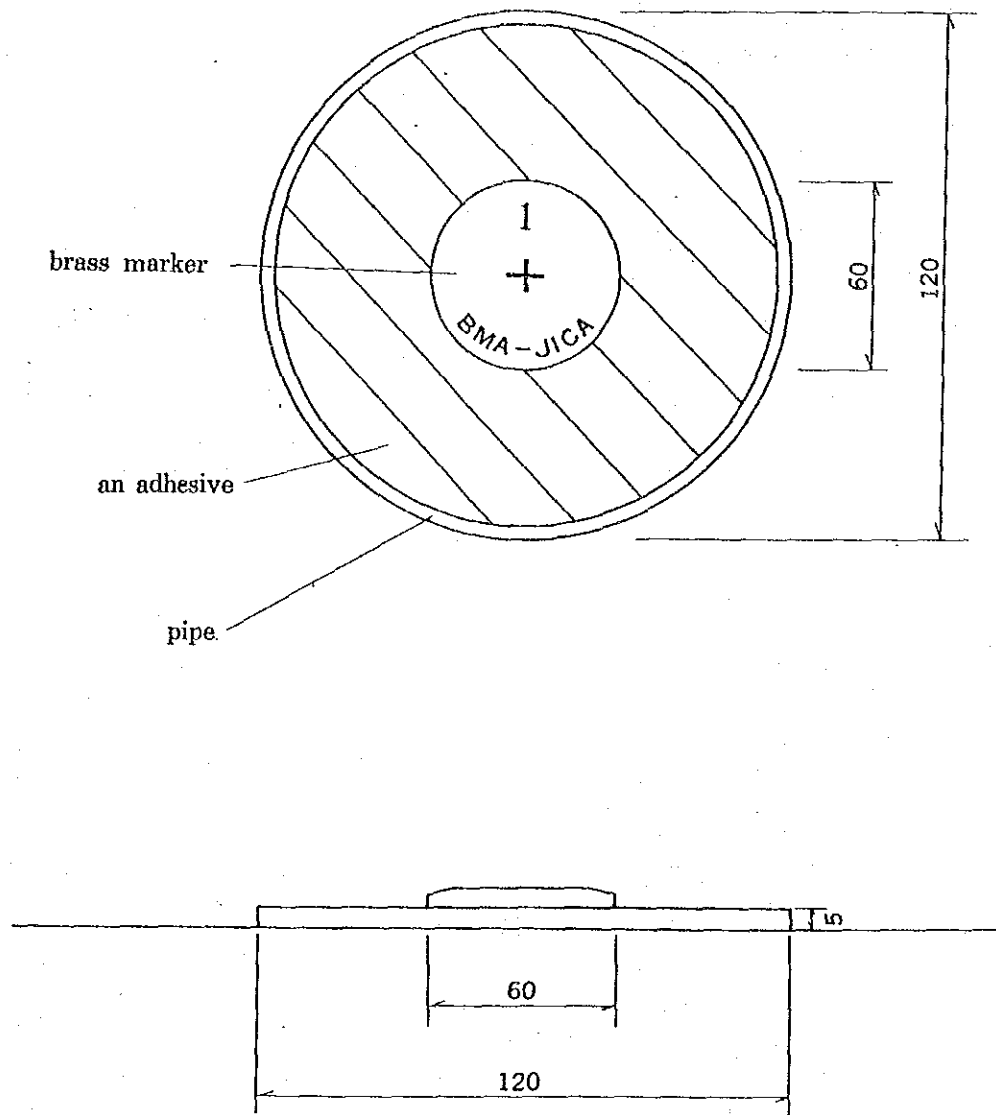
# SETTING OF STATION MARKER ON THE GROUND



UNIT: mm

Fig. 4 Setting of Station Marker on the Ground

# SETTING OF STATION MARKER ON THE ROOF



UNIT: mm

Fig. 5 Setting of Station Marker on the Roof

# DESCRIPTION OF CONTROL POINT

Station Name		17
1/50000 map name Amphoe Bang Khen	1/250000 map name Bangkok Metropolis	
Date of Establish April 7, 1987	Location on the roof	
Type of Marker Brass Marker	Marker No 17	
Address Hyatt Central Plaza Hotel, Tambon Lat Phrao, Amphoe Bang Khen Bangkok		
Description <p style="margin-left: 40px;"><u>From Don Muang Airport go to Bangkok before Lat Phrao</u></p> <p style="margin-left: 40px;"><u>Overfly Bridge 0.2 Km. Hyatt Central Plaza Hotel is</u></p> <p style="margin-left: 40px;"><u>on beside Thanon Vibhavadi Rangsit.</u></p> <p style="margin-left: 40px;"><u>Control point is on the roof of Hotel.</u></p>		
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Sketch</p> </div> <div style="width: 50%;"> </div> </div>		

Fig. 6 Description of Control Point

(5) Computation

(a) Point accuracy computation

The computation for checking point accuracy was conducted by fixing the point (No. 245 (0, 0)) and direction (No. 329) with the following residuals:

	X(m)	Y(m)
No. 245	0.0	0.0
No. 329	0.0	-0.1
No. 249	0.1	0.3
No. 250	0.4	-0.3
No. 328	0.0	1.8
No. 247	0.1	0.0
No. 327	24.9	5.1

As a result of checking No. 327, it was discovered that Wat (temple) was constructed at the location of the triangulation point recently. Therefore, this point was treated as not a given point but as a new point in the precise computation.

The results of point accuracy computation are shown in Fig. 6 - Fig. 8.

(b) Comparison of observed values of the long base line with the computed values

The observation of the long base lines of 8 routes was carried out and the comparison of the observed values with the computed values is shown as follows:

Observed line	Observed value (m)	Computed value (m)	Difference (m)
No. 215 - No. 67	11,377.907	11,377.703	+0.204
No. 13 - No. 5	19,339.395	19,339.259	+0.136
No. 13 - No. 1	22,848.068	22,848.030	+0.038
No. 17 - No. 1	16,527.406	16,526.991	+0.415
No. 17 - No. 25	25,812.471	25,812.243	+0.229
No. 24 - No. 5	16,456.368	16,456.297	+0.071
No. 24 - No. 329	14,304.056	14,303.919	+0.137
No. 61 - No. 66	18,455.999	18,455.899	+0.100

TOPOGRAPHIC MAPPING OF BANGKOK METROPOLITAN AREA

NET ADJUSTMENT COMPUTATION

OF GROUND CONTROL POINT SURVEY

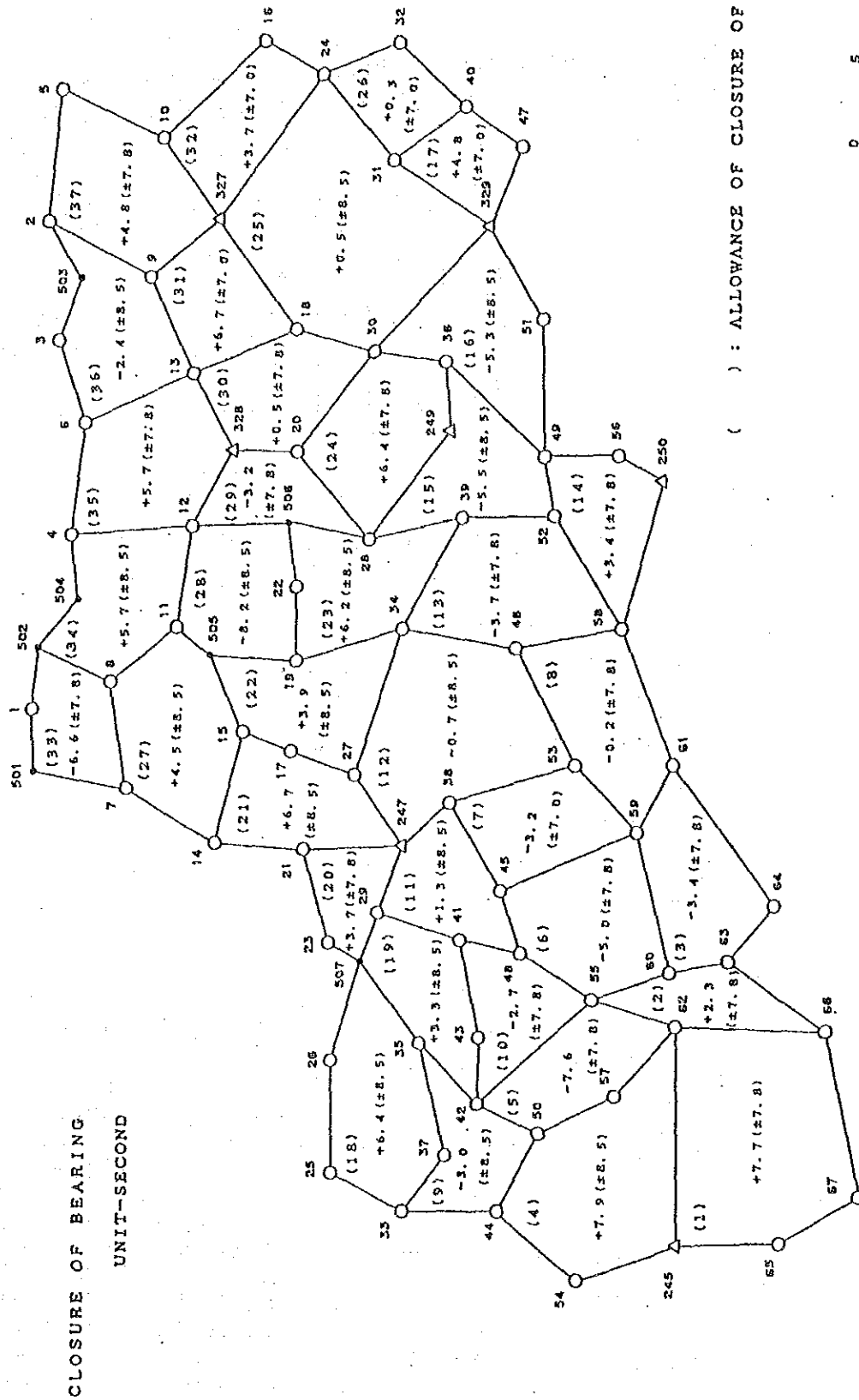


Fig. 7 Net Adjustment Computation of Ground Control Point Survey



NET ADJUSTMENT COMPUTATION  
OF GROUND CONTROL POINT SURVEY

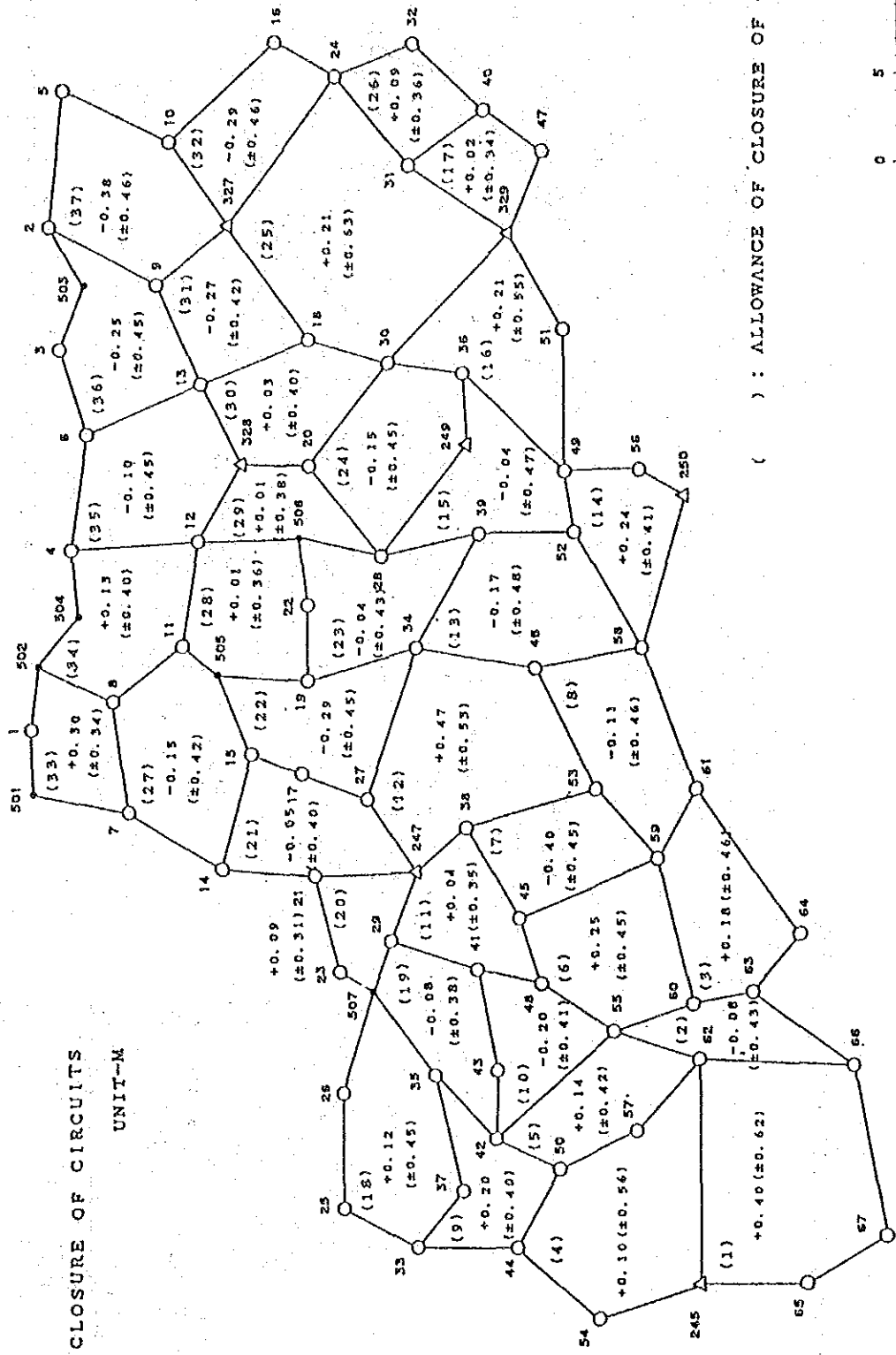


Fig. 9 Net Adjustment Computation of Ground Control Point Survey



(6) Precise computation

The factors used in the precise computation are as follows:

Spheroid: Everest  
 Coordinate of origin: N 0 m  
 E 500,000 m  
 Scale factor: 0.9996  
 Coordinate system: UTM Zone 47

The net adjustment computation was conducted by fixing the coordinates of 6 points (No. 245, 247, 249, 250, 328, 329) eliminating No. 327, considering results of the first computation and the assumptive adjustment computation by fixing one point and one direction.

The accuracy obtained from the final net adjustment computation is shown in Table 2.

The computation was conducted according to the following equations:

1. Horizontal angle observation equation

$$-Z_n + A_n.m \Delta X_n - B_n.m \Delta Y_n - A_n.m \Delta X_m + B_n.m \Delta Y_m + \theta_{n.m}' - t_{n.m}' = \delta_{n.m}$$

2. Measurement of distance observation equation

$$-B_n.m \Delta X_n - A_n.m \Delta Y_n + B_n.m \Delta X_m + A_n.m \Delta Y_m + \frac{\rho''}{S_{n.m}} (S_{n.m}' - S_{n.m}) = \delta_{n.m}$$

3. Trigonometric leveling observation equation

$$\frac{\cos^2 \frac{1}{2}(\alpha_n' - \alpha_m')}{S} \rho'' \left\{ \Delta H_m \left(1 - \frac{H_m'}{R}\right) - \Delta H_n \left(1 - \frac{H_n'}{R}\right) \right\} + \frac{1}{2}(\alpha_n' - \alpha_m') - \frac{1}{2}(\alpha_1 - \alpha_2) = \delta_n$$

4. Weight of observation equation

$$P_s = \frac{m t^2 \cdot S^2}{(m_0^2 + K^2 S^2) \rho^2}$$

$P_s$ : Weight of measurement of distance observation equation for  
 fixed horizontal angle observation equation's weight is 1.  
 $m_0$ : Error not proportional to length  
 $K$ : Constant of proportion  
 $S$ : Distance between 2 points (n and m)  
 $\rho$ :  $\rho'' = 206265''$

(7) Main instruments for 3rd order ground control point survey

The main instruments used for the 3rd order control point survey were as follows:

Transit	WILD T3	1 set
Transit	WILD T2	12 sets
Distance meter	K&E	1 set
Distance meter	YHP3808A	6 sets
Signal lamp		12 sets
Helio trope		3 sets
Reflecting prism		108 elements

Table 2 Accuracy Obtained from Final Net Adjustment Computation of  
3rd Order Ground Control Point Survey

Point No.	MX	MY	MS	MH
	m	m	m	m
No. 245	0.000	0.000	0.000	0.000
No. 247	0.000	0.000	0.000	0.055
No. 249	0.000	0.000	0.000	0.000
No. 250	0.000	0.000	0.000	0.000
No. 328	0.000	0.000	0.000	0.000
No. 329	0.000	0.000	0.000	0.000
No. 327	0.051	0.044	0.067	0.000
No. 1	0.045	0.053	0.069	0.052
No. 2	0.060	0.059	0.084	0.074
No. 3	0.057	0.056	0.080	0.000
No. 4	0.041	0.047	0.063	0.000
No. 5	0.069	0.063	0.094	0.095
No. 6	0.043	0.048	0.065	0.000
No. 7	0.046	0.047	0.066	0.001
No. 8	0.041	0.043	0.060	0.000
No. 9	0.049	0.044	0.066	0.068
No. 10	0.060	0.054	0.081	0.000
No. 11	0.037	0.035	0.051	0.053
No. 12	0.029	0.028	0.040	0.000
No. 13	0.032	0.030	0.043	0.057
No. 14	0.039	0.040	0.057	0.000
No. 15	0.037	0.038	0.053	0.000
No. 16	0.060	0.057	0.083	0.063
No. 17	0.035	0.037	0.051	0.050
No. 18	0.034	0.037	0.050	0.000
No. 19	0.038	0.038	0.054	0.070
No. 20	0.022	0.028	0.035	0.054
No. 21	0.030	0.036	0.047	0.059
No. 22	0.038	0.038	0.053	0.073
No. 23	0.037	0.033	0.050	0.000
No. 24	0.052	0.050	0.072	0.000
No. 25	0.058	0.049	0.076	0.000
No. 26	0.057	0.043	0.072	0.000

Point No.	MX	MY	MS	MH
	m	m	m	m
No. 27	0.032	0.029	0.043	0.065
No. 28	0.029	0.031	0.042	0.000
No. 29	0.029	0.024	0.038	0.047
No. 30	0.028	0.030	0.041	0.000
No. 31	0.038	0.042	0.057	0.000
No. 32	0.060	0.048	0.077	0.071
No. 33	0.054	0.045	0.071	0.065
No. 34	0.036	0.037	0.052	0.069
No. 35	0.046	0.038	0.060	0.067
No. 36	0.029	0.022	0.036	0.049
No. 37	0.054	0.046	0.071	0.083
No. 38	0.026	0.026	0.037	0.066
No. 39	0.033	0.038	0.050	0.000
No. 40	0.047	0.036	0.059	0.062
No. 41	0.036	0.035	0.050	0.000
No. 42	0.046	0.037	0.059	0.044
No. 43	0.047	0.039	0.061	0.000
No. 44	0.045	0.045	0.063	0.067
No. 45	0.036	0.035	0.050	0.066
No. 46	0.039	0.042	0.057	0.000
No. 47	0.039	0.032	0.050	0.063
No. 48	0.037	0.037	0.052	0.049
No. 49	0.027	0.032	0.042	0.059
No. 50	0.046	0.041	0.062	0.000
No. 51	0.043	0.034	0.055	0.092
No. 52	0.032	0.033	0.046	0.061
No. 53	0.038	0.041	0.056	0.000
No. 54	0.036	0.044	0.057	0.087
No. 55	0.041	0.039	0.057	0.000
No. 56	0.023	0.026	0.035	0.046
No. 57	0.048	0.047	0.067	0.065
No. 58	0.040	0.033	0.051	0.000
No. 59	0.040	0.041	0.057	0.064
No. 60	0.045	0.045	0.064	0.048

Point No.	MX	MY	MS	MH
	m	m	m	m
No. 61	0.047	0.042	0.063	0.079
No. 62	0.043	0.042	0.060	0.000
No. 63	0.048	0.050	0.069	0.000
No. 64	0.054	0.058	0.079	0.069
No. 65	0.031	0.052	0.064	0.091
No. 66	0.048	0.057	0.075	0.088
No. 67	0.036	0.066	0.076	0.111
No. 501	0.051	0.055	0.075	0.000
No. 502	0.044	0.050	0.066	0.051
No. 503	0.060	0.055	0.082	0.060
No. 504	0.047	0.048	0.067	0.053
No. 505	0.036	0.035	0.051	0.054
No. 506	0.032	0.035	0.047	0.059
No. 507	0.037	0.029	0.047	0.033

MX: Mean Square Error of X-coordinate

MY: Mean Square Error of Y-coordinate

MS: Mean Square Error of Position

MH: Mean Square Error of Height

As a result of the net adjustment computation, the following mean square error of unit weight was obtained.

Coordinate 2".27 (allowance 3".5)

Height 3".47 (allowance 4".0)

### 3-3 Leveling

#### 3-3-1 Outline

The 3rd order leveling was carried out outside of 1:4,000 mapping area where no BMA leveling point exists, and the minor order leveling was conducted in the 1:4,000 mapping area.

#### 3-3-2 Specifications

##### (1) Route plan

The 3rd order leveling route plan was to cover 50 km in the environs connecting the BMA leveling route. The minor order leveling route was planned to cover the 1:4,000 mapping area evenly with a route distance of 250 km.

##### (2) Point selection

At the point selection, attention was paid to the following:

- (a) Points are to be on stable ground and exist in good locations for maintenance.
- (b) Points are to be easily identifiable in the field and exist in good locations for pricking on aerial photos.

##### (3) Observation

As for the 3rd order leveling, duplicate observation was carried out using auto levels with the following results.

<u>Number of route</u>	<u>Distance</u>	<u>Maximum error</u>	<u>Minimum error</u>	<u>Mean square error</u>
10	50 km	11 mm	1 mm	2.43 mm

The minor order leveling was conducted also using auto levels and closed to given points from given points with the following results.

<u>Number of route</u>	<u>Distance</u>	<u>Maximum error</u>	<u>Minimum error</u>	<u>Mean square error</u>
126	250 km	52 mm	0 mm	7.12 mm

The minor order leveling route map is shown in Fig. 10.

### 3-4 Pricking

#### 3-4-1 Outline

The positions of ground control points and bench marks necessary for stereo plotting and aerial triangulation were checked and confirmed in the field, and the points clearly identifiable on aerial photos were selected and pricked.

#### 3-4-2 Pricking Work

##### (1) Pricking points

The existing RTSD control points, BMA bench marks and the newly established 3rd order control points were pricked as follows:

Description of Pricked Points

Category	Existing points	Newly established points	Total
Control points	3	67	70
Bench marks	400	0	400
Total	403	67	470

LEVELING ROUTE NET-WORK

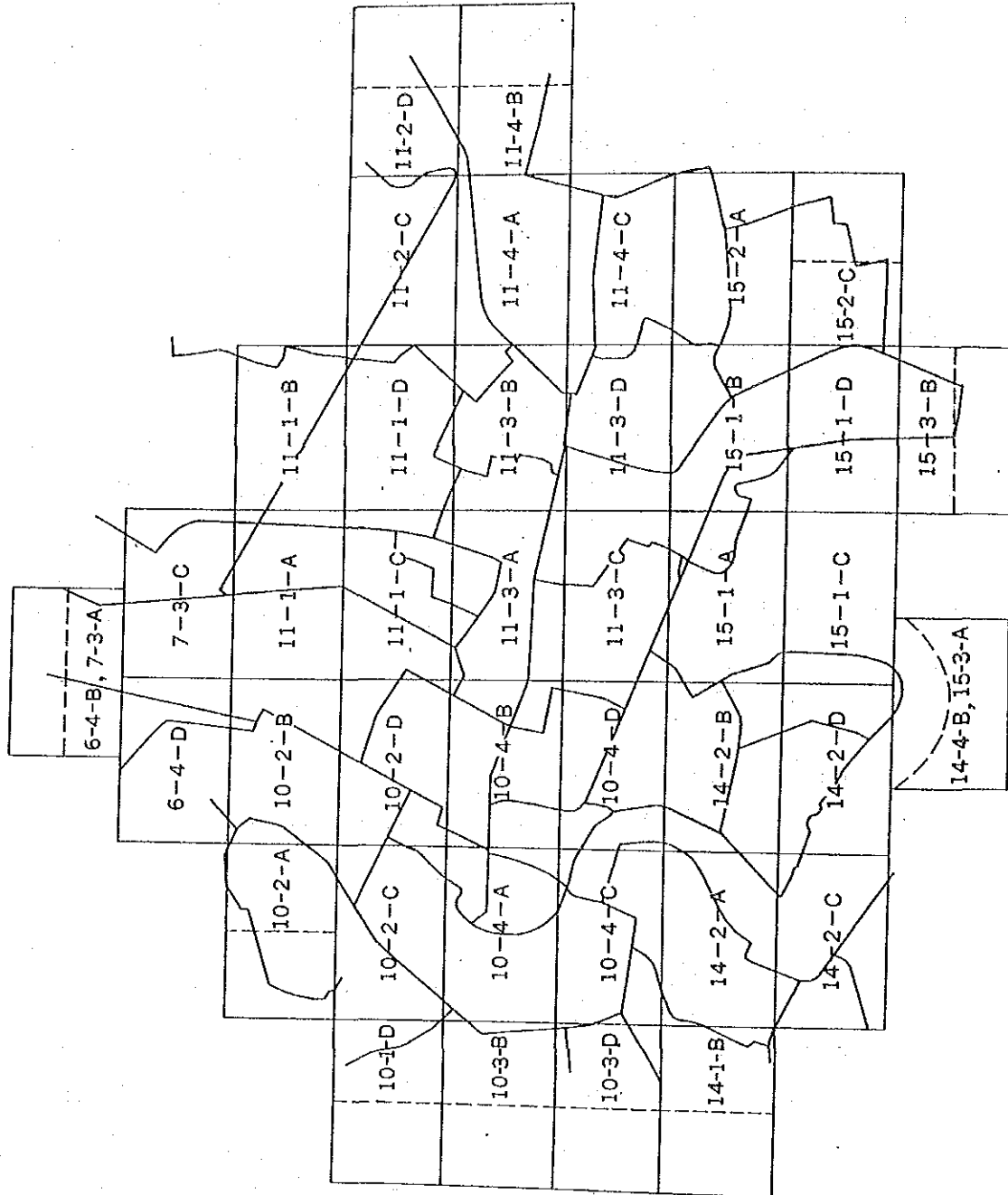


Fig. 10 Leveling Route Network



## (2) Pricking

### (a) Control points

The eccentricity of control points was made to the points clearly identifiable on aerial photos and the pricking was conducted on the aerial photos 4-time enlarged. The elements of eccentricity were measured by transit, distance meter, compass and alidade by the method suitable to the conditions of sites.

### (b) Bench marks

As for the existing BMA bench marks, the pricking was made on the aerial photos 4-time enlarged. Relative heights were measured using plane table and alidade.

### 3-4-3 Computation and data preparation

The eccentric reduction was made based upon the measured values of the angle and distance, and the results were compiled in the descriptions of control points and the description of bench marks.

The forms of description for control points and bench marks are shown in Fig. 11 and Fig. 12 respectively.

# POINT DESCRIPTION

Station No.		Operated by	
No. 35		Checked by	
		Date	
Zone No.	Coordinates of Station		
	N	E	H
Main Point	-- .	-- .	-- .
Eccentric Point	-- .	-- .	-- .
Supplementary Point	-- .	-- .	-- .
Sketch-map of Station and Neighborhood		Photograph of Station	
<div style="display: flex; align-items: center; justify-content: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg); margin-right: 10px;">Placita Hershman 2 Road.</div> </div>		<div style="display: flex; justify-content: space-between; margin-bottom: 5px;"> <span>C-8 No. 009</span> <span>NORTH  EAST</span> <span>C-8 No. 010</span> </div>	

Fig. 11 Point Description

## DESCRIPTION OF POINT(BENCH MARK)

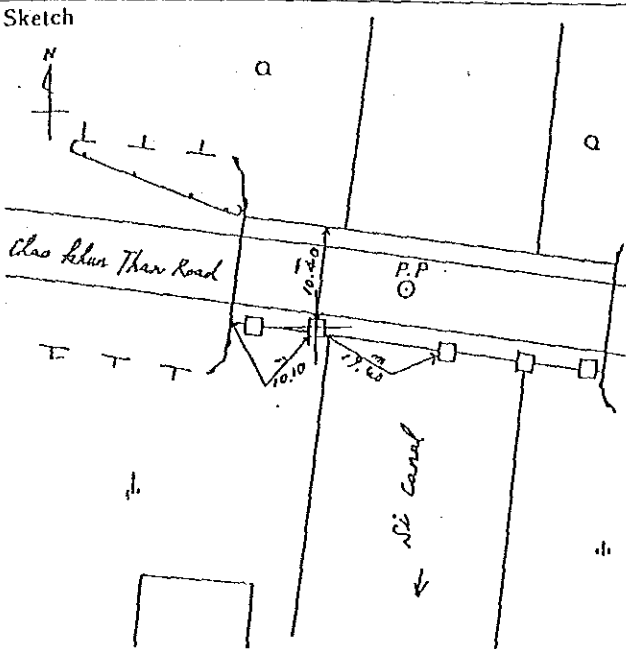
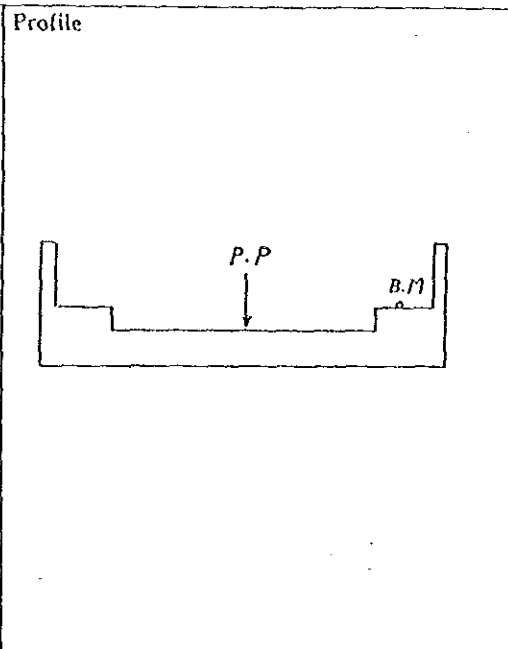
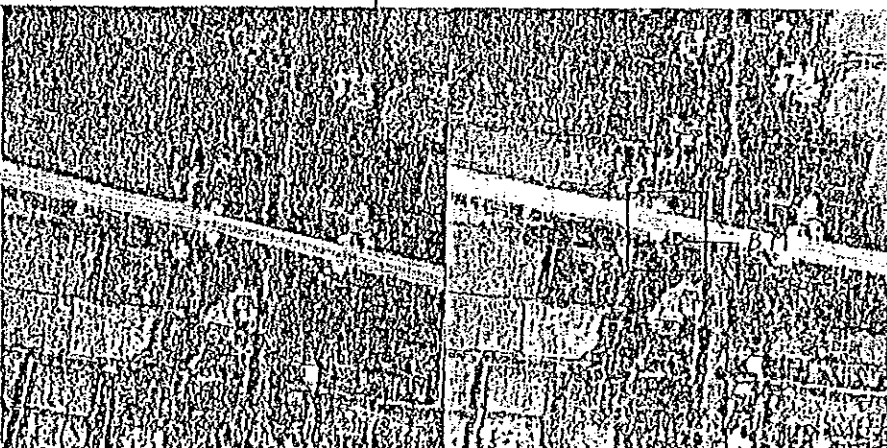
Station Name	Station No. 442	Location on the bridge
Route Name		Sheet Name 1/50,000 Amphoe Bang Bo
Standard Elevation Bench mark 4.633 ✓	Pricking point 4.842 ✓	Established Date
Type of Bench Mark Small brass bench mark		
Description(Address) Footpath of the Bridge that cross over Si Canal, Chao Khun Than Rd., Lat Krabang District		
Sketch 	Profile 	
Note	CB-032	photo CB-033
		

Fig. 12 Description of Point (Bench Mark)

### 3-5 Field Identification

#### 3-5-1 Outline

The field identification was carried out in accordance with the symbol specifications for 1:4,000 and 1:10,000 topographic maps.

Planimetric features, geographical names, etc. to be shown on the map were surveyed and confirmed in the field based on preliminary studies, and the results were incorporated in the aerial photos and other materials.

For the efficiency in subsequent stereo plotting work and unified accuracy, data collection was carried out in the field.

#### 3-5-2 Map symbols

The preliminary study on topographic map symbols was conducted in Japan, and the uncertain or doubtful items were discussed between both sides prior to the commencement of field work.

Based on the results of the discussion, the following items were also surveyed in the field.

##### (1) For 1:4,000 map

- |                        |                |
|------------------------|----------------|
| 1) Gasoline station    | 6) Chimney     |
| 2) Propane gas station | 7) Radio tower |
| 3) Warehouse           | 8) Crane       |
| 4) Material yard       | 9) Turf        |
| 5) Gate                | 10) Fountain   |

##### (2) For 1:10,000 map

- |                  |                |
|------------------|----------------|
| 1) Warehouse     | 5) Radio tower |
| 2) Material yard | 6) Crane       |
| 3) Gate          | 7) Turf        |
| 4) Chimney       | 8) Fountain    |

### 3-5-3 Preliminary study

For preliminary study, the guide maps, administrative and road source maps, etc. on sale in Thailand were used except the existing maps of RTSD.

On the basis of these materials, the features able to be drawn or photo-identifiable were plotted on the aerial photos and other source maps. The doubtful items or those requiring confirmation in field were marked on the aerial photos for the preparation of field identification work.

### 3-5-4 Field identification

Based on the preliminary study, the survey team composed of 7 parties (2 Japanese surveyors, 1 BMA and 1 RTSD counterparts for each party) began with field identification from the 1:4,000 mapping area (urbanized area) with regard to the items difficult or impossible to identify on the aerial photos and those related to the application of map symbols and to the annotation. The names of facilities, rivers, railways, etc. were investigated and incorporated into the annotation notes which were carried by each party and filled in by the staff of BMA and RTSD in English or Thai, and those names were transferred on the annotation data sheets.

The facilities whose sites were difficult to enter were incorporated based on photo-interpretation.

### 3-5-5 Data collection

Other than the field confirmation, data collection included geographical and river names at BMA and ward offices. As for the area where accurate maps were not available, the outline maps were used.

### 3-5-6 Incorporation of results

The results of field confirmation and photo-interpretation were incorporated in aerial photos 4-time enlarged for the 1:4,000 topographic maps and on the double enlargements for the 1:10,000 maps.

### 3-6 Aerial Triangulation

#### 3-6-1 Outline

The aerial triangulation was conducted to determine the geodetic coordinates of pass and tie points necessary for stereo plotting on the basis of the results of ground control and leveling points.

Quantities related to the aerial triangulation are as follows:

Photo scale:	1:20,000
Number of course:	17 courses
Number of models:	425 models
Control points used:	Planimetry 82 points
	Height 225 points

The aerial triangulation network is shown in Fig. 13.

#### 3-6-2 Main instruments and camera

Pricking device:	PUG-II (WILD)
Observation instrument:	STECOMETER (ZEISS JENA)
Computer:	FACOM M-360R (FUJITSU)
Camera:	RC-10 (WILD)
	Focus length: 153.79 mm
	Lens: AVIOGON
	Distortion: Maximum 4 $\mu$
	(See Table 3)

BANGKOK METROPOLITAN AREA AERIAL TRIANGULATION NETWORK

图-13 空中三角测量实施一览图

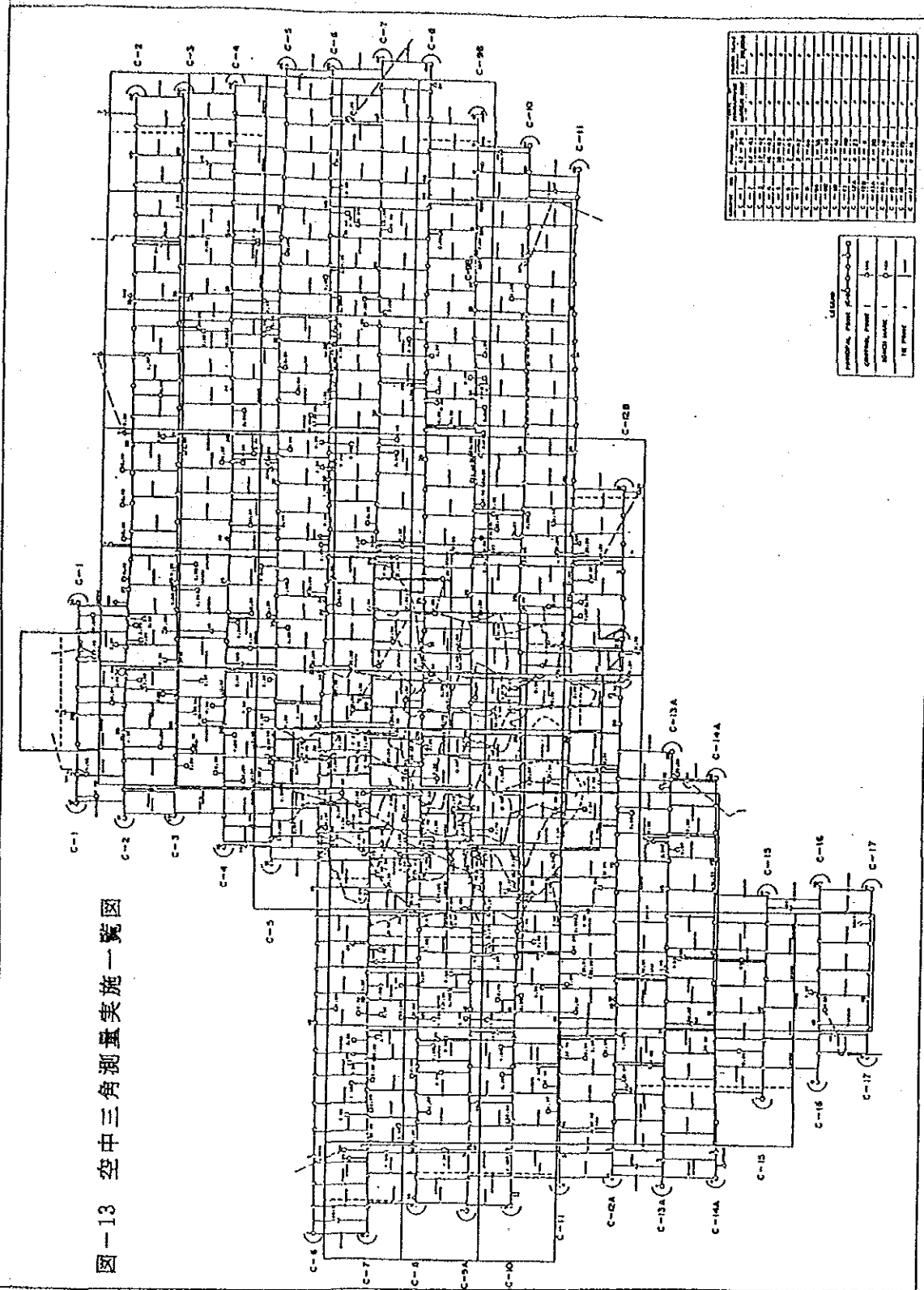


Fig. 13 Bangkok Metropolitan Area Aerial Triangulation Network

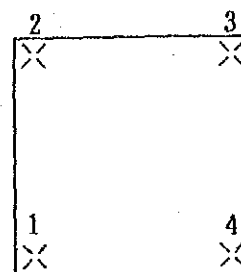
Table 3 Distortion

Lens 15 UAG II No. 3135 Calibration Date 86/6/30

Aperture F/5.6

Calibrated Focal Length 153.79 mm

Radius (mm)	Semi-Diagonal ( $\mu$ )				Mean ( $\mu$ )
	1	3	2	4	
0	0	0	0	0	0
10	-2	-2	-2	-3	-2
20	-3	-3	-2	-3	-3
30	-4	-3	-3	-5	-4
40	-4	-5	-2	-5	-4
50	-4	-4	-3	-5	-4
60	-4	-4	-5	-5	-4
70	1	-1	-1	-1	-1
80	1	0	3	0	1
90	3	3	3	1	3
100	5	4	5	3	4
110	3	2	4	2	3
120	2	1	1	2	2
130	-1	1	-2	-1	-1
140	0	1	-3	1	0
150	0	1	-2	0	0





### 3-6-3 Technical details of aerial triangulation

The technical details of aerial triangulation is described below.

#### (1) Selection and pricking

As for the pass point selection, 3 points were selected in the common area where 3 aerial photos were overlapped and stereoscopic measurement was possible. As for the tie point, 1 tie point per each model was selected in the area side-lapped by the adjacent course.

The pass points, tie points and other necessary points selected on the contact prints were transferred onto diapositives using a pricking device.

#### (2) Measurement

The coordinate measurement of fiducial marks at the four corners of the photo, control points, pass points, tie points, etc. was conducted at the measuring unit of  $1\mu$  using a stecometer.

As for the measurements, readings were made twice independently. When the differences of both readings was within  $20\mu$ , the averages were adopted as the measured values. If they exceeded, re-measurement was conducted.

#### (3) Inner Orientation

The measurement of fiducial marks of 4 corners was conducted by using Hermert's transformation equation within the limit of fiducial mark residual of  $30\mu$ . In case the limits were exceeded, re-measurement was conducted.

The results of inner orientation of 442 photos are as follows:

Mean square error:  $13.3\mu$

Maximum:  $20.0\mu$

(4) Relative orientation

The limit of residual parallax in the relative orientation was 30 on the diapositives. If the limit was exceeded, re-measurement was conducted.

The results of residual parallax in the relative orientation of 425 models are as follows:

Mean square error: 6.7  $\mu$

Maximum: 19.9  $\mu$

(5) Successive orientation

The limit of discrepancies of pass points in the common area with the adjacent model was specified within 0.5% of the flight altitude as to planimetry and height.

The discrepancies in the successive orientation of 425 models conducted at this time were as follows:

Mean square error			Maximum		
X	Y	Z	X	Y	Z
0.01%	0.11%	0.15%	0.04%	0.35%	0.35%

(6) Adjustment computation

The simultaneous adjustment of the computations, forming the entire project area into one block, was carried out on planimetry and height by the independent model method.

For the adjustment computation, the following 3-Dimensional Orthogonal Transformation Equation was used:

$$X = \lambda (a_{11}x + a_{12}y + a_{13}z) + X_0$$

$$Y = \lambda (a_{21}x + a_{22}y + a_{23}z) + Y_0$$

$$Z = \lambda (a_{31}x + a_{32}y + a_{33}z) + Z_0$$

where  $\lambda$  : scale  
 $X_0, Y_0, Z_0$ : origin  
 $a_{11}$ :  $\cos\psi \cdot \cos\kappa$   
 $a_{12}$ :  $\cos\omega \cdot \sin\kappa + \sin\omega \cdot \sin\psi \cdot \cos\kappa$   
 $a_{13}$ :  $\sin\omega \cdot \sin\kappa - \cos\omega \cdot \sin\psi \cdot \cos\kappa$   
 $a_{21}$ :  $-\cos\psi \cdot \sin\kappa$   
 $a_{22}$ :  $\cos\omega \cdot \cos\kappa - \sin\omega \cdot \sin\psi \cdot \sin\kappa$   
 $a_{23}$ :  $\sin\omega \cdot \cos\kappa + \cos\omega \cdot \sin\psi \cdot \sin\kappa$   
 $a_{31}$ :  $\sin\psi$   
 $a_{32}$ :  $-\sin\omega \cdot \cos\psi$   
 $a_{33}$ :  $\cos\omega \cdot \cos\psi$

The mean square error and maximum of the residual of control points and those of the discrepancy of tie points in the adjustment computation are as follows:

(Residual of control points)

Number of courses and models	Number of control points		Residual of control points (Planimetry)		Residual of control points (Height)		Remarks
	Planimetry	Height	Mean square error	Maximum	Mean square error	Maximum	
17 courses 425 models	82 points	225 points	0.52 m	1.13 m (0.38%)	0.39 m	1.10 m (0.37%)	JICA SPECS. LIMIT Planimetry 0.8 % height 0.8 %

(Discrepancy of tie points)

Planimetry		Height		Remarks
Mean square error	Maximum	Mean square error	Maximum	
0.24 m	0.54 m (0.18%)	0.19 m	0.64 m (0.21%)	JICA SPECS. LIMIT Planimetry 0.8 %

In this adjustment computation, the obtained results were more accurate than the limits of the specifications. These excellent results were considered to be attributable to the following:

- 1) The control points were well distributed.
- 2) None of the control points were neglected in the adjustment computation, and the results of observation and computation conducted in the field were excellent.
- 3) The aerial triangulation was made using the program of the independent model method.

### 3-7 Stereo Plotting

#### 3-7-1 Outline

The stereo plotting was conducted by stereo plotter based on the results of aerial triangulation, field identification, etc.

#### 3-7-2 Specifications

Plotting scale: Same as the scale of each map (1:4,000 and 1:10,000)

Coverage:           1:4,000 map       300 km<sup>2</sup>  
                  1:10,000 map   1,700 km<sup>2</sup>

Instruments:       STEREO PLOTTER A8  
                  PLANIMAT D2  
                  PLANICART E2

Projection:        UTM

Neat lines:        1:4,000    2.5 km x 3.75 km  
  (62.5 cm x 93.75 cm on the map)  
                  1:10,000  5.0 km x 7.5 km  
  (50.0 cm x 75.0 cm on the map)

Sheet index:       Code number and sheet name are shown in Fig. 14 and 15.

As for the code numbering, the conformity with the 1:20,000 topographic map of Thailand was considered.

Sheet materials: Plotting sheet polyester base #500  
Accuracy: Planimetry Class A (0.5 mm on the map)  
Height Class A (1/3 of contour interval)  
Measuring interval for spot height:  
in every 5 cm on the map including control points.

TOPOGRAPHIC MAPPING SHEET INDEX

FOR

1 : 4,000

		6-4-B 7-3-A PRACHA CHUI			
6-4-D BANG SOK	7-3-C HO WANG				
10-2-B BANG SU	11-1-A SUAY CHATUCHAK	11-1-B LAT PHRAO			
10-2-D DUSIT	11-1-C DIR DAENG	11-1-D HUA KHUANG	11-2-C KHONG CHAY	11-2-D BANG KAPI	
10-4-B URUPHONG	11-3-A MAKASAI	11-3-B KHONG SAMSEN	11-4-A RAMKHAENG	11-4-B LAM SAU	
10-4-D BANG RAK	11-3-C SUAY LUMPINI	11-3-D EKKAMAI	11-4-C HUA MAX		
14-2-B YANNAVA	15-1-A KHONG TOEI	15-1-B PHEA KHANONG	15-2-A ONNUT		
14-2-D RAMA 9 BRIDGE	15-1-C BANG MACHAO	15-1-D BANG CHAK	15-2-C UDOM SUK		
14-2-C RAT BURANA	14-4-B 15-3-A PAK LAT	15-3-B BANG NA			
10-2-A BANG PHLAT					
10-2-C BANG YIKHAY					
10-4-A PHEA NAKHON					
10-4-C WONG WIAN YAI					
14-2-A KRUNG THEP BRIDGE					
14-2-C RAT BURANA					
10-1-D TALING CHAN					
10-3-B PHAN NOK					
10-3-D KHONG BANG WAEX					
14-1-B BANG KHUN THIAN					

LEGEND

— CODE NUMBER

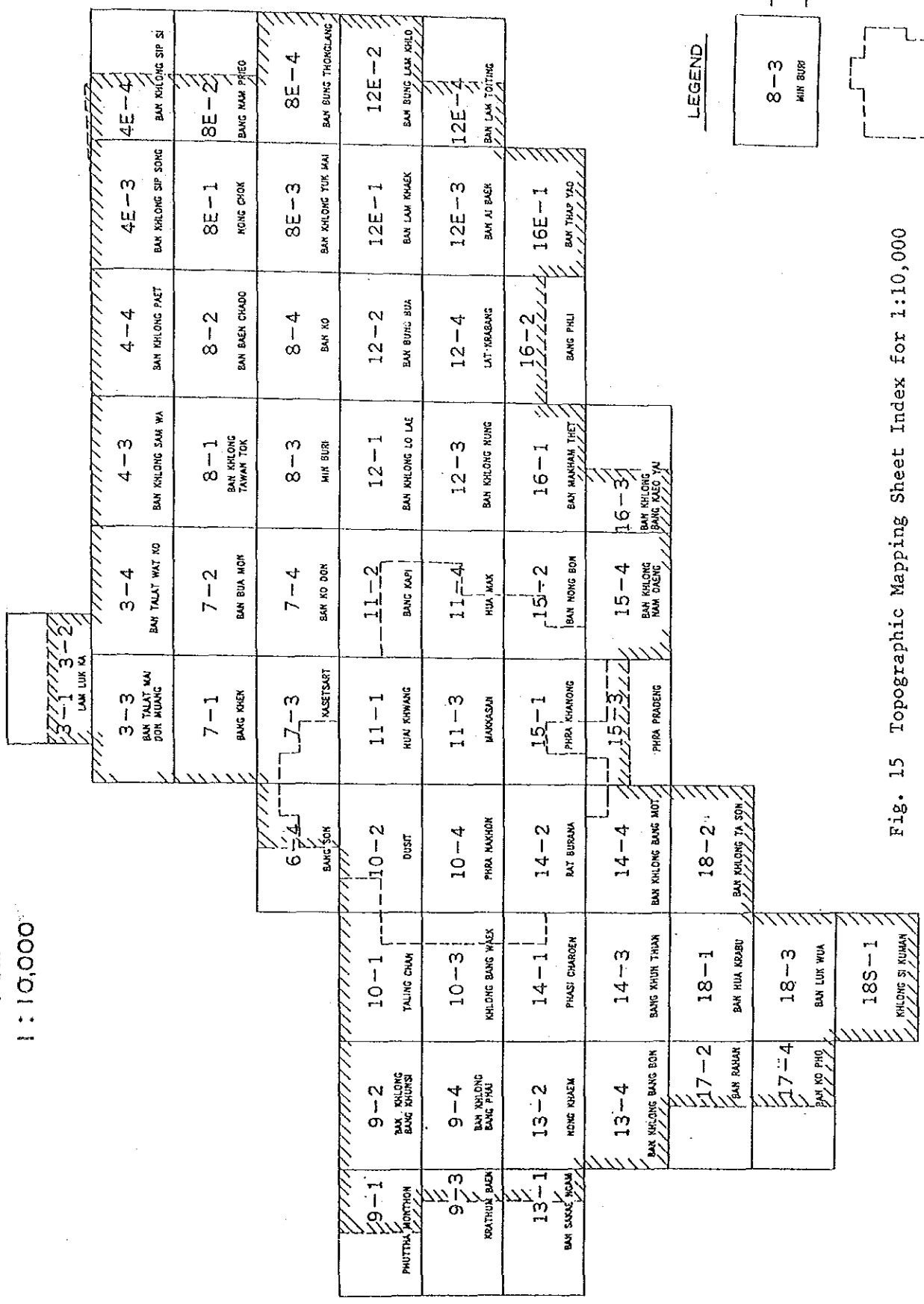
— SHEET NAME

11-1-A	SUAY CHATUCHAK
--------	----------------

Fig. 14 Topographic Mapping Sheet Index for 1:4,000

TOPOGRAPHIC MAPPING SHEET INDEX  
FOR

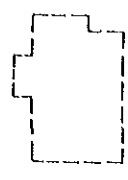
1 : 10,000



— CODE NUMBER  
— SHEET NAME

8-3  
MIN BURI

LEGEND



1 : 4,000  
MAPPING AREA

Fig. 15 Topographic Mapping Sheet Index for 1:10,000

### 3-7-3 Stereo plotting

#### (1) Plotting of pass points, tie points, control points, etc.

The plotting of the pass points, tie points, control points, sheet lines, etc. was conducted using an automatic drafting machine (Xynetics XP-1100) with a specified plotting error of less than 0.2 mm on the map.

#### (2) Orientation

The relative orientation was carried out by using 6 pass points with the specified residual parallax of less than 0.02 mm on diapositives. In the absolute orientation, the errors of planimetry on the map and height were specified to be less than 0.3 mm and 0.5 m, respectively.

According to the final results of absolute orientation on the basis of the record sheet, the maximum errors are as follows:

Scale	Planimetry	Height
1:4,000	0.2 mm	0.3 m
1:10,000	0.2 mm	0.5 m

#### (3) Plotting

(a) The plotting was carried out in the order of linear features (roads, railways, etc.), buildings, vegetation and contour lines based on the symbol specifications agreed upon. And the spot height measurement was conducted lastly.

(b) The color assignment for plotting was as follows:

Black: Roads drawn to scale, railways, buildings  
Red: Symbolized roads, indicated points, fences, small objects  
Green: Vegetation boundaries, vegetation symbols, roads in park  
Orange: Contour lines (intermediate contour)  
Violet: Coastal lines, rivers, lakes, salt beds



- (c) The spot heights were measured twice independently and the mean values were recorded on the overlays. The measuring interval for spot height was approx. 5 cm on the map including control points.

The spot heights were principally selected at the following positions:

- o Forks-in-the-road
  - o River junctions
  - o High points or depressed points in the area
  - o Other points necessary for clear representation of topography
- (d) In the delineation of contour lines, attention was paid so as not to deform the representation of topography since the mapping area is generally flat.
- (e) The matching of adjacent sheets was made with utmost care.

#### (4) Inspection

After the completion of stereo plotting, the plotting manuscripts were checked for errors or omissions of contour lines, planimetric features, etc., by comparing them with the aerial photos used for field identification, the data collected, etc. Errors and omissions were corrected and supplemented respectively, while, uncertain items were specified as the items to be confirmed in field completion.

### 3-8 Compilation

#### 3-8-1 Outline

The compilation was conducted using the plotting manuscripts, the field identification results, etc. and according to the symbol specifications agreed upon.

### 3-8-2 Specifications

#### (1) Scale and coverage of the compilation

1:4,000      300 km<sup>2</sup>  
1:10,000    2,000 km<sup>2</sup>\*

\* The compilation for 300 km<sup>2</sup> was made by the reduced compilation of the 1:4,000 compilation manuscripts.

#### (2) Number of sheets

1:4,000      40 sheets  
1:10,000    61 sheets

#### (3) Neat lines

1:4,000      2.5 km x 3.75 km (62.5 cm x 93.75 cm on the map)  
1:10,000    5.0 km x 7.5 km (50.0 cm x 75.0 cm on the map)\*

\* Extension was made for 3 sheets (4E-3, 4E-4 and 18S-1).

#### (4) Papers

The following shrink-proof papers were used for the compilation:

Compilation manuscripts: polyester base #500

#### (5) Mechanical plotting

The neat lines, ground control points, etc. were plotted by an automatic plotting machine (Xynetics XP-1100). The discrepancy of neat lines and diagonal lines in length was limited to less than 0.3 mm and 0.4 mm respectively.

### 3-8-3 Compilation

(1) The compilation manuscripts were made on the basis of the plotting manuscripts and the data collected, as well as according to the symbol specifications agreed upon.

(2) The color assignment for compilation was as follows:

Black: Roads drawn to scale, railways, buildings, index contour

Red: Symbol roads, administrative boundaries, small features, fence/wall, function symbols

Green: Vegetation boundaries, vegetation, parks

Orange: Contour lines

Purple: Sea and rivers, water bodies such as lakes and ponds, fish ponds, salt beds

(3) For the efficiency in subsequent field completion and drafting as well as for easy inspection, the following reference materials were prepared:

Ground control point data sheet:

Ground control points, bench marks, minor order leveling points, spot heights were plotted.

Administrative boundary data sheet:

Data collected from BMA and ward offices were incorporated.

Road source map:

The express way, primary and secondary national highway were classified by color.

Annotation data sheet:

The photo lettering of English annotation was completed at the time of compilation. As for Thai annotation, however, only the assessment of annotation data prepared in the field identification was made by comparing it with the English annotation. Therefore, the Thai photo lettering was decided to be done at the field completion.

- (4) The reduced compilation for 1:10,000 mapping was, after the 1:4,000 map compilation, conducted by the photo processing method. The spot heights and annotation were selected.
- (5) The compilation was carefully carried out so as not to make any mistakes or omissions. In case uncertain items were found, necessary instructions were made on the overlay for the reference of field completion.

#### 3-8-4 Details of compilation

- (1) The roads of more than 2 m in width for the 1:4,000 map and those of more than 5 m in width for the 1:10,000 map were drawn to scale, and others were symbolized.
- (2) The railways were represented in single lines running along the center line of track.
- (3) The buildings were represented as isolated buildings on the 1:4,000 maps. On the 1:10,000 maps, the representation of buildings was classified into the isolated buildings and the generalized areas. Regarding such representation, particularly, many efforts were made so as to create the harmonious representation of urban landscapes.
- (4) The solid buildings were marked with "K" and the prominent buildings were colored in brown for better classification.
- (5) As for the area for which the reduced compilation was made from 1:4,000 to 1:10,000, particular attention was paid to the buildings, vegetation, spot heights, etc. so as to be consistent with the area for which the direct 1:10,000 plotting and compilation were made.
- (6) Representations of the depressions, roads and contour lines along rivers were handled with particular attention.
- (7) The matching was made directly on the compilation manuscripts.

### 3-8-5 Inspection

After the compilation work, the compilation manuscripts were checked with their blue prints and corrected, paying due attention to the collation with field identification photos and data, the relationship between contour lines and spot heights, the conformity with the symbol specifications, etc. At the same time, uncertain items were marked as the items to be confirmed in the field completion.

### 3-9 Field Completion

#### 3-9-1 Outline

In the field completion, the administrative boundaries, geographical and other names were represented on the compilation manuscripts based on the data provided by BMA. Then, if necessary, the important items shown on the manuscripts were confirmed in the field along with the supplementary or checking survey on the changes brought about after aerial photography.

#### 3-9-2 Specifications

##### (1) Scale and coverage

1:4,000	300 km <sup>2</sup>
1:10,000	1,700 km <sup>2</sup> (field work)
	2,000 km <sup>2</sup> (indoor work)

##### (2) Number of sheets

1:4,000	40 sheets
1:10,000	57 sheets (field work)
	61 sheets (indoor work)

##### (3) Data and reference materials

Main data and reference materials were prepared for the field completion.

### 3-9-3 Preparatory work in Japan

- (1) The plan of field completion was formulated in consideration of the content of the work, the amount of correction of changes after aerial photography, the work period, the schedule of following work, etc.
- (2) The preliminary study was made precisely on the compilation manuscripts, and the uncertain items found in the course of plotting and compilation work and the items to be confirmed in the field were all marked.
- (3) The major changes after aerial photography, for which supplementary survey being considered necessary, were marked.
- (4) The matching to adjoining sheets was checked.
- (5) The sample maps were prepared for the confirmation of detailed specifications for drafting and printing, color tone, etc. as reference materials for the technical discussions with BMA.
- (6) Map sheet

The extension sample sheets were prepared by the Japanese side as a draft sheet.

- (7) The plan of operation for the field completion was prepared in consideration of the above items.

### 3-9-4 Field completion

- (1) To attain uniform map representation, the operation manual was prepared for the unified field confirmation work.
- (2) The survey work was carried out by the way of extending its work coverage from the center of the Bangkok metropolitan area to its suburban areas.

- (3) According to the detailed work plan, the copies of compilation manuscripts were carried into the field, and the check and confirmation were conducted with regard to the suitability of plotting and compilation made on the manuscripts.
- (4) As for the major changes after aerial photography (bridges, highways, parks, etc.), correction was made using TOTAL STATION (SET-111) and supplemented directly on the polyester base (#250). The correction for small changes (housing development, etc.) was made using a plain table.

#### 3-9-5 Details of field completion

- (1) The field completion proceeded according to the sheet assignment of which each party was in charge.
- (2) The annotation represented on the sheets, in particular, was checked and confirmed in the field according to the reference data and materials.
- (3) To compare the English annotation with Thai annotation, the annotation list was prepared with respect to the name, letter size and type for each sheet as shown in Table 4.
- (4) The preliminary study on the changes after aerial photography was carried out, on the basis of the information on construction work and the like, provided by BMA.
- (5) The checking survey is described in the following paragraph (3-9-6).

Table 4 Annotation List

SCALE 1/ SHEET NO. — —

NO. SIZE	THAI	SIZE	ENGLISH	CHECKING			MEMO
				ENG. THAI	TYPE	POSITION	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							



3-9-6 Checking survey

The checking survey was conducted with respect to the planimetry and heights covering 11 sheets of 1:4,000 map and 13 sheets of 1:10,000 map. As for the planimetry, 2 points being clearly identifiable were selected and the distance between the 2 points was measured by using TOTAL STATION (SET-III) and measuring tape. By comparing it with the distance measured on the map, the accuracy was checked.

Regarding heights, the spot heights and contour lines, particularly the contour lines of 0 m areas, represented on the plotting manuscripts were checked by using AUTO LEVEL in the field with respect to the accuracy. The accuracy obtained in the checking survey is as follows:

	Scale	Number of spots	Mean square error	Remarks
Planimetry	1:4,000	10 spots	0.25 mm on the map	JICA SPECS. LIMIT less than 0.5 mm on the map
	1:10,000	13 spots	0.16 mm on the map	
Height	1:4,000	91 spots	0.30 m	JICS SPECS. LIMIT less than 0.67 mm on the map
	1:10,000	77 spots	0.23 m	

Based on the results of the checking survey, the following areas are identified as the 0 m area:

Code No.	Sheet names	Number of area	Coverage
11-1-B	LAT PHRAO	1	0.003 km <sup>2</sup>
11-1-C	DIN DAENG	3	0.009
11-1-D	HUAI KHWANG	15	1.145
11-2-C	KHLONG CHAN	8	0.084
11-2-D	BANG KAPI	6	0.116
11-3-B	KHLONG SAMSEN	4	0.978
11-3-D	EKKAMAI	1	0.030

Code No.	Sheet names	Number of area	Coverage
11-4-A	RAHKHAMHAENG	4	0.408 km <sup>2</sup>
11-4-B	LAM SALI	2	0.035
11-4-C	HUA MARK	18	0.402
15-1-D	BANG CHAK	1	0.017
15-2-A	ONNUT	1	0.009
15-2-C	UDOH SUK	1	0.033
15-3-B	BANG NA	5	0.051
Total		70 areas	3.320 km <sup>2</sup>

The 0 m areas are shown in Fig. 16.

### 3-10 Drafting of 1:4,000 Map

#### 3-10-1 Outline

The drafting of 1:4,000 map was carried out by inking, based on the compilation manuscripts and the field identification data.

#### 3-10-2 Specifications

(1) Scale: 1:4,000

(2) Coverage: 300 km<sup>2</sup> (the central area of Bangkok)  
40 sheets

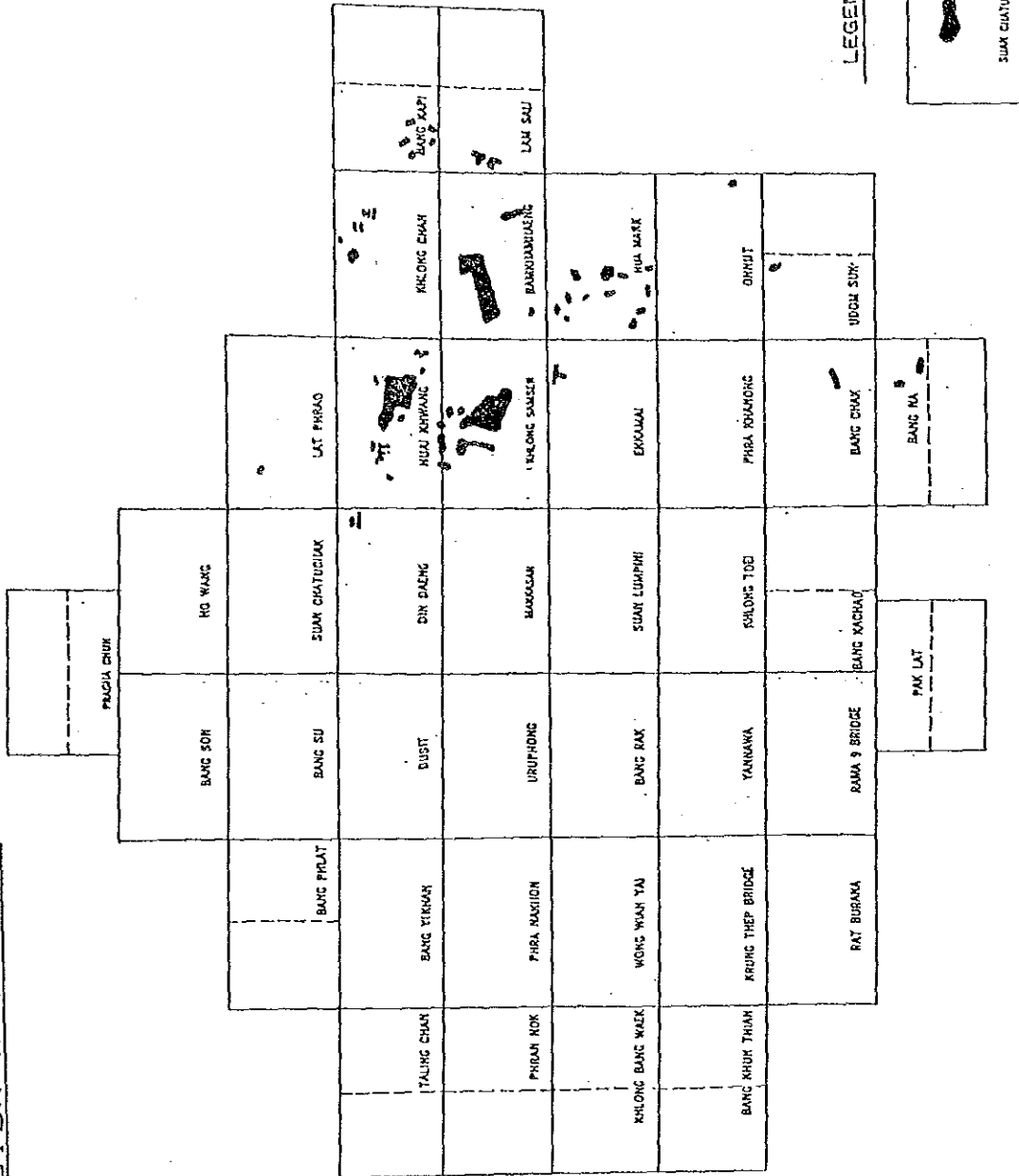
(3) Papers: Sheets for topographic and planimetric features:

polyester base #500

Sheets for annotation: polyester base #300

Composite positives: polyester base #500

ZERO METER AREA MAP



LEGEND

ZERO METER AREA  
 1:4,000  
 SHEET NAME

Fig. 16 Zero Meter Area Map

### 3-10-3 Drafting

- (1) As for the symbol specifications, those agreed upon were used.
- (2) The drafting of topographic and planimetric features was conducted so as not to avoid any discrepancies in planimetry and indistinct delineation of lines.
- (3) For the delineation of lines, attention was paid so as to keep even density in inking.
- (4) For the orientation of annotation, attention was paid so as to avoid spoiling the representation of surrounding features.

### 3-10-4 Final composite sheets

Using the composite positives, second copies of final drafting sheets were prepared for the Thai and English versions.

## 3-11 Drafting of 1:10,000 Map

### 3-11-1 Outline

The drafting of the 1:10,000 map was carried out by scribing, based on the compilation manuscripts. The color separation plates were prepared by photo-processing based on the compilation manuscripts and field identification data.

### 3-11-2 Specifications

- (1) Scale: 1:10,000
- (2) Coverage: 2,000 km<sup>2</sup> 61 sheets
- (3) Materials:

Scribe base	(0.12 mm thick)	K&E	Yellow base
Mask base	(0.12 mm thick)	K&E	Daylight peel coat
Mask base	(0.12 mm thick)	KIMOTO	Peel coat
Zip-a-tone	(0.10 mm thick)	FUJI FILM	V0 100
Nega films	(0.10 mm thick)	FUJI FILM	V0 100
Annotation sheet	(0.08 mm thick)	KIMOTO	Diamat

### 3-11-3 Scribing

- (1) For the scribing, the symbol specifications agreed upon were used.
- (2) As for the image printing on scribe base, the reversed images of compilation manuscripts were printed on the scribe bases coated with diago solution by photo-processing.
- (3) The separation plates were prepared by scribing for roads, buildings, rivers and contour lines.
- (4) The scribing was conducted in the order of black, purple, blue, red, brown and green sheets so as to avoid any misregistering.
- (5) The daylight peel coat bases were used for the mask for complicated representation of vegetation. The peel coat bases, on which printing is impossible, were employed for simple features.

### 3-11-4 Surprints

After the scribing, the final composite positives (surprints) were prepared for each the English and the Thai version, using polyester bases (#500).

These surprints can be utilized for the correction of changes brought about after aerial photographing and the like.

### 3-12 Plate Making and Proof Printing

#### 3-12-1 Outline

As for the plate making, PS plates were prepared using the composite negatives reversed from the composite positives which were made from the scribed sheets. From these PS plates, 6-color proof prints were prepared for the English and the Thai version using a proof printer.

#### 3-12-2 Instruments and materials for plate making

Main instruments: Vacuum printing frame

Automatic processor

Materials: PS plate 74.1 cm x 92.5 cm, 0.3 mm thick, 460 sheets

Developer 17 bottles (340ℓ)

#### 3-12-3 Plate making

- (1) The plate making on the PS plates was made based on the composite negatives using vacuum frame.
- (2) The plate making was done using a 4 kW metal halaid lamp.
- (3) The exposure for plate making was made at the height of 130 cm with the exposure time of 90 seconds.
- (4) For developing, an automatic processor was used.
- (5) Rinsing was conducted sufficiently with running water by lightly rubbing off the developer with a sponge so that nothing would remain.

### 3-12-4 Proof printing

- (1) The proof prints were prepared for each the English and the Thai version.

These proof prints were used for the inspection conducted in Japan and for the color matching of printing conducted in Thailand. At the proof printing, color matching and registering were carefully conducted.

- (2) The proof printing was, with the first priority given to the purple plate for which represents many linear features, made in the following order:

Purple → Black (each of English and Thai versions) → Red → Blue →  
Brown → Green

### 3-13 Transportation of Final Results

The final results were carried back by the Thai counterparts from Japan. The materials for printing were shipped to Thailand by sea and air as follows:

Sea cargo (shipped on September, 1988)

1. Printing papers
2. PS plates
3. Ink
4. Plate protective liquid
5. Blanket
6. Roll clean
7. Dryer
8. Plate cleaner
9. PS plate developer

Air Cargo (shipped on October, 1988)

1. Contact prints, diapositive films for aerial triangulation
2. Aerial triangulation results
3. Enlarged aerial photos representing spot heights
4. Plotting manuscripts (1:4,000, 1:10,000)
5. Compilation manuscripts (1:4,000, 1:10,000)
6. Drafting sheets (1:4,000)
7. Annotation sheets (1:4,000, 1:10,000)
8. Final composite positive films of topography and annotation (1:4,000)
9. Original scribed sheets (1:10,000)
10. Reference materials of field completion

Air Cargo (shipped on October, 1988)

1. Second copies of final drafting sheets (1:4,000)
2. Surprints (1:10,000)
3. Composite negative films for printing

### 3-14 Printing

#### 3-14-1 Outline

The printing was conducted in Thailand.

#### 3-14-2 Technical guidance in printing

Along with the printing conducted in Thailand, technical guidance in printing was also conducted in Thailand.

The Japanese experts were dispatched for the guidance are as follows:

Leader	Tositomo Kanakubo	November 29 - December 8, 1988
Deputy leader	Isao Ikeshima	November 29 - December 22, 1988
Plate making engineer	Hideki Yanagisawa	November 29 - December 22, 1988
Printing engineer	Zenichiro Sekiguchi	November 29 - December 22, 1988



The plate making and printing were conducted at RTSD. The printer used for plate making was ULTRAMAT, which is made in Holland, and also manual developer.

For the printing, the German-made 6-color printer, MILLER TP 36, was used.

The printing was made in the following order:

Purple → Brown → Blue → Red → Green → Black

The printing was started with the plates for purple which represent many linear features, and the plates for black were printed lastly for easy exchange of the plates between the English and Thai versions.

### 3-14-3 Color tone of printing

The color tone of printing was discussed, and based on the JIS color chart, the hue, brightness and chroma were specified as follows:

Red	2.5 R	4/12
Brown	7.5 YR	7/10
Green	5 Y	7/10
Blue	10 B	6/10
Purple	7.5 P	5/3
Black	N 2	

For each of the 6 colors, two alternatives were prepared and the final decision was made through discussions.

### 3-15 Final Confirmation of Printed Products and Technical Explanation on Printing

#### 3-15-1 Outline

The Japanese expert team made the final confirmation on the finish of the printed maps, and participated in the technical explanation seminar which was held by BMA for technical transfer.

### 3-15-2 Technical experts

The technical experts were dispatched as follows:

Leader	Tositomo Kanakubo	March 7 - 16, 1989
Deputy leader	Isao Ikeshima	March 7 - 16, 1989
Mapping planner	Chozo Obara	March 7 - 16, 1989
Chief surveyor	Yoshikazu Ibusuki	March 7 - 16, 1989

### 3-15-3 Technical explanation

The technical explanation on the Topographic Mapping of Bangkok Metropolitan Area was held on March 10 at Siam Inter-continental Hotel with the attendance of about 250.

At the beginning, the final products were presented to Maj-Gen Chamlong Srimuang, Governor of Bangkok Metropolitan Administration by H.E. Mr. Hisahiko Okazaki, Japanese Ambassador to Thailand, and the Governor presented the Plaque of Appreciation to the Japanese organizations concerned and RTSD.

Succeedingly, Mr. Tositomo Kanakubo, Team Leader, made technical explanation as to the background of project, information of map, etc., using slide projector.

Further, the present state of mapping in Japan was introduced by Mr. Kiyoshi Mimura, Head of Planning Division, Topographic Department, Geographical Survey Institute, Ministry of Construction of Japan, and matters related to the plan of mapping and the map usage were brought up by the officers of the related Thai Divisions.

### 3-15-4 Confirmation of printed materials

On March 14, the printed materials of 1:10,000 topographic map were confirmed at the RTSD printing factory.

The 500 copies of English version and the 1,500 copies of Thai version were completely printed for each of 61 sheets and the excellent finish of maps were confirmed.

## 4. Review

### 4-1 Aerial Photography

The aerial photography was conducted in March 1987 with anxiety over missing the best season (December 1986 - February 1987) for aerial photography, due to delay of the flight permission.

Favoured by abnormal conditions, however, which brought about fine weather owing to a time lag of 2 or 3 months, the entire aerial photography was successfully completed during the period from March 6 through March 31, 1987.

The flight courses were set in east-west directions totalling 17 courses, and extended as long as 80 km in length of one course. However, the photography was conducted in good conditions having no junction of 2 flights, except 4 courses (C9, C12, C13, C14).

The area photographed is flat and located at a low latitude zone of  $13^{\circ}30'N$ , and at a high solar altitude, so that particular attention had to be drawn to the problem of halation. To avoid halation, the operation was concentrated into the (15:30 - 16:00) time frame.

For future aerial photography in similar areas, it is recommended to apply suitable methods for local conditions, despite the standards adopted in Japan.

### 4-2 Third Order Ground Control Point Survey

In the project area where terrain was flat and where there were tall buildings, other than in urban districts, many trees of about 15 m high made intervisibility accordingly very poor. Therefore, high observation towers needed to be constructed for the work.

Among 7 given points and 67 newly established points, the high observation towers were constructed for 17 points. Their heights ranged from 2 m to 22 m and 14 m - 15 m on the average.

The construction of high observation towers was conducted utilizing steel pipes for construction use because of non-availability of timber. There were no particular problems as to observation accuracy and construction cost, however there was danger such as burns suffered on exposed skin, owing to the hot iron pipes heated to  $35^{\circ}C$ . The work was safely conducted using gloves.

Another danger was the seasonal lightning which frequently occurred, so it was essential to obtain weather forecasts as soon as possible to avoid danger.

For the construction of high observation towers in such areas, the use of iron pipes is suggested instead of timber, as is done in Japan.

#### 4-3 Leveling

The minor order leveling was conducted on the streets of Bangkok where motor traffic was heavy. For the safety in operations, all of the surveyors wore safety jackets.

Although there was considerable concern as to the possible effect of ground subsidence on the accuracy, the leveling was conducted within the limit of  $60 \text{ mm}/\sqrt{s}$  on every route throughout 126 routes (250 km in total).

#### 4-4 Pricking

The pricking of 400 BMA bench marks was planned. Before the operation, there was anxiety concerning the missing or destruction of many bench marks, as some bench marks were found on road sides, bridge girders, etc. However, the pricking was successfully conducted on 400 bench marks (almost 90% of the 450 original bench marks). This was partly attributed to the excellent guidance of the Thai side including RTSD counterparts.

#### 4-5 Field Identification

The field identification was carried out by 2 Japanese engineers, 1 BMA counterpart and 1 RTSD engineer for each field party.

The field work was conducted according to the symbol specifications agreed upon. The difficulty of the work was in securing uniformity of annotation of buildings and the like. There were many boards shown in English or in Thai in the field. The translation to English was made in the office by the help of BMA and RTSD counterparts whose English was good.

#### 4-6 Aerial Triangulation

In the aerial triangulation (17 courses, 425 models), simultaneous adjustment computation was carried out forming the entire project area into one block by the independent model method.

Owing to the good results of aerial photography, and to the well distribution of control points, etc., the accuracy was excellent.

Prior to the final adjustment computation, checking by the strip adjustment computation by course was conducted, whether or not re-monumented points of the ground control or leveling points existed. As a result, every point was identified as normal.

To enhance the accuracy of aerial triangulation in the future, it is important to carry out aerial photography by continuous flights from the beginning to the end of a course as much as possible as well as to distribute control points in the surroundings, particularly at the four corners of the photographs.

#### 4-7 Plotting

The stereo plotting for 1:4,000 and 1:10,000 topographic maps was conducted based on the 1:20,000 aerial photographs.

Although the Bangkok city area is congested with many buildings, the buildings were plotted one by one without generalization.

The generalized representation, was made in the compilation. However, the buildings were represented as isolated buildings in the stereo plotting so that it became possible to grasp the state of the entire area for proper representation.

#### 4-8 Compilation

After the compilation of 1:4,000 map (300 km<sup>2</sup>), the reduced compilation to 1:10,000 was conducted.

In the compilation, attention was paid to the selection of features to be shown on the map for the proper representation, which conforms to the scale of 1:4,000 as well as to the matching of the direct compilation area (1:10,000) with the reduced compilation area (from 1:4,000 to 1:10,000).

#### 4-9 Field Completion

In the field completion, checking survey was conducted to clarify the area where elevation is 0 m or less. As the results, 0 m areas were confirmed totaling 70 areas which cover 3.32 km<sup>2</sup>, as shown in Fig. 16.

#### 4-10 Drafting

The color separation drafting of 1:4,000 map and 1:10,000 map was conducted by inking and scribing respectively. The annotation sheets for the English and Thai versions were separately prepared and the superimposition method was employed.

As the annotation in English and Thai were different in letter size and length, the mask sheets were prepared so as not to vanish topographic and planimetric features by the annotation.

#### 4-11 Plate Making and Proof Printing

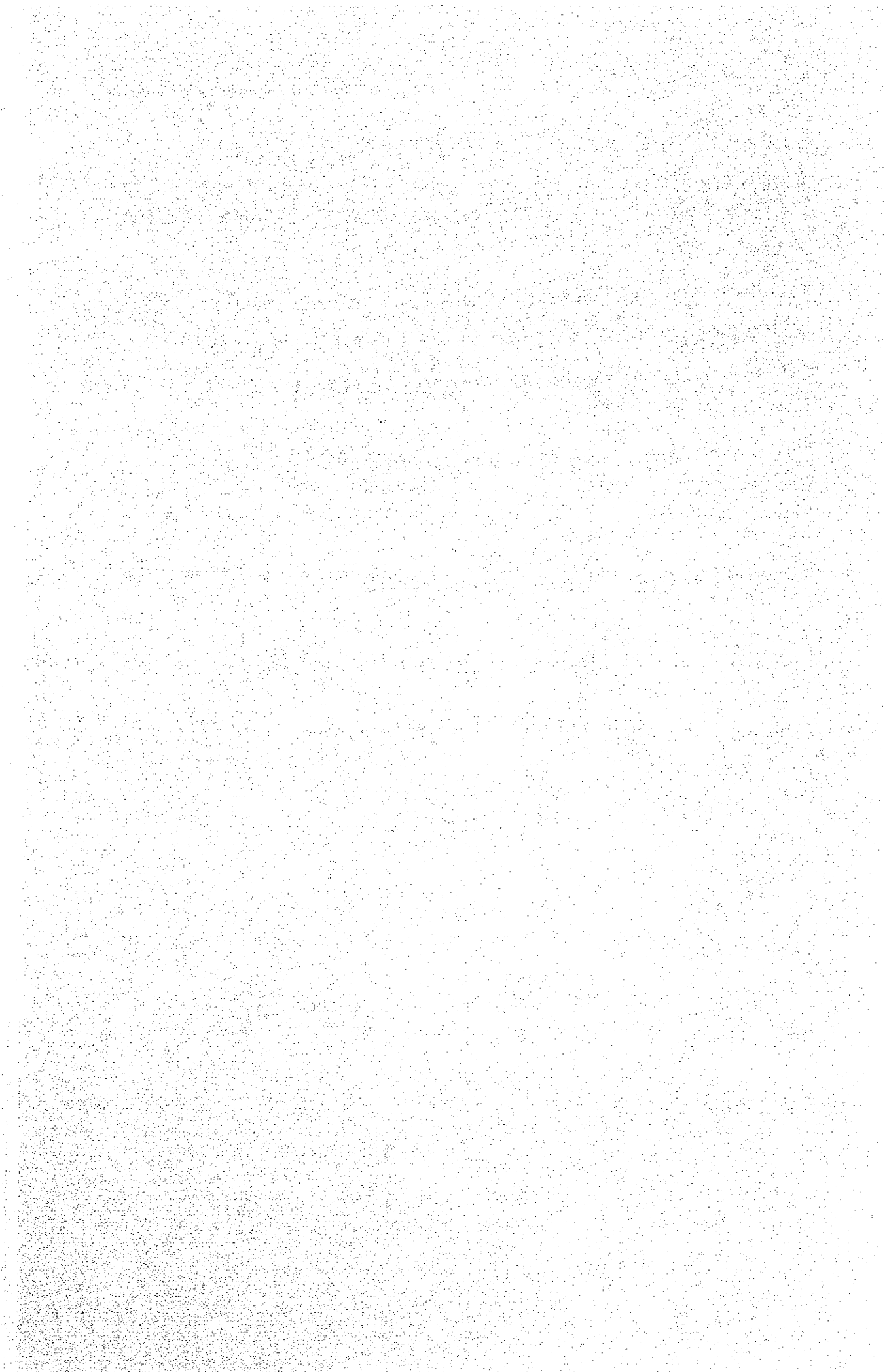
The PS plate making from the composite negatives was conducted using a 3 kW metal halide lamp with exposure time of 90 seconds at the height of 130 cm.

At the exposure, attention was paid so as to keep the glass surface clean and to keep perfect vacuum.

In the proof printing, attention was also paid so as not to make any mistake on the color tone and registering.

## APPENDICES

1. Scope of Work
2. Minutes
  - 2-1 Minutes at the initiation of field work (October 1986)
  - 2-2 Minutes at the initiation of field work (March 1987)
  - 2-3 Minutes at the termination of field work (June 1987)
  - 2-4 Minutes at the initiation of field work (December 1987)
  - 2-5 Minutes at the termination of field work (January 1988)
3. Plan of Operation (Third Year Work)
4. Technical Manual for Plate Making and Printing





1. Scope of Work

SCOPE OF WORK  
FOR  
TOPOGRAPHIC MAPPING OF BANGKOK METROPOLITAN AREA

IN  
THE KINGDOM OF THAILAND  
AGREED UPON BETWEEN  
THE BANGKOK METROPOLITAN ADMINISTRATION  
AND  
THE JAPAN INTERNATIONAL COOPERATION AGENCY

ON  
MARCH 19TH 1986

*Wicha Jiwalai*

---

DR. WICHA JIWALAI  
DEPUTY GOVERNOR  
BANGKOK METROPOLITAN ADMINISTRATION

*Kazuhiko Otake*

---

MR. KAZUHIKO OTAKE  
LEADER OF JAPANESE  
PRELIMINARY STUDY TEAM

## I. INTRODUCTION

In response to the request of the Royal Thai Government (hereinafter referred to as "RTG" ) , the Government of Japan (hereinafter referred to as "GOJ") has decided to conduct the Topographic Mapping of Bangkok Metropolitan Area (hereinafter referred to as "the Study ") within the general framework of technical cooperation between Japan and Thailand ,which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Government of Thailand, signed on November ,1981.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA") the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study ,in accordance with the relevant laws and regulations in force in Japan and in close cooperation with the authorities of Thailand. The Bangkok Metropolitan Administration (hereinafter referred to as "BMA" )shall act as counter agency to the Japanese Study Team and also as a coordinating body in relation with other relevant organizations for the smooth implementation of the Study.

The present document sets forth the Scope of Work for the Study .

## II. OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the 1/10,000 Topographic Map covering an area of approximately 2,000km<sup>2</sup> and the 1/4,000 Topographic Map covering an area of approximately 300km<sup>2</sup>.

Aerial photography will be carried out covering an area of approximately 4,000km<sup>2</sup>. (see APPENDIX I)

## III. SCOPE OF THE STUDY

In order to achieve the above mentioned objectives, the Study will cover the following items. (The technical details are as shown in APPENDIX IV)

### 1. Aerial Photography

Aerial photographs shall be taken at the scale of approximately 1/20,000 with a wide angle camera.

### 2. Ground Control Point Survey

#### 2.1 Triangulation and traversing

Minor horizontal control points, necessary for aerial triangulation and mapping work, shall be established by triangulation or traverse.

#### 2.2 Leveling

Leveling shall be carried out to obtain vertical controls necessary for aerial triangulation and mapping work.

#### 2.3 Monumentation

Monumentation of new control points shall be done if necessary.

### 3. Pricking

Pricking of control points on the aerial photographs shall be done in the field for aerial triangulation.

### 4. Field Identification

The topographic map information related to land use, vegetation, etc.

shall be verified in the field using the aerial photographs.

Geographical names to be expressed on the maps shall also be identified in the field and by the gazetteer.

#### 5. Aerial Triangulation

Aerial triangulation shall be carried out by analytical method.

Adjustment shall be carried out by block adjustment method.

#### 6. Stereo Plotting

Stereo plotting shall be carried out using stereo plotting instruments at scale of 1/10,000 and 1/4,000.

#### 7. Field Completion

Topographic features, vegetation, etc. which cannot be properly identified shall be verified in the field and plotted on the compilation sheet.

Administrative boundaries and geographical names shall be verified and indicated on the paper copy of the compilation sheet by BMA.

#### 8. Drafting

Based on the compiled sheet, scribing shall be carried out on the stable polyester base for several colors separation plates. Map style and symbols shall be those adopted by BMA.

#### 9. Printing

Plate making shall be carried out using 1/10,000 scribed negatives, and printing shall be carried out by the offset method.

### IV. STUDY SCHEDULE

The whole work will be conducted in accordance with the tentative schedule.

(see APPENDIX II)

## V. REPORTS AND FINAL RESULTS

A report shall be presented to BMA by JICA every fiscal year (from April to March).

The materials mentioned in APPENDIX III will be submitted to BMA by GOJ . These materials except original negatives will belong to BMA after having completed the whole work.

All maps produced under this project shall bear at the lower margin the following.

This map was produced under a cooperative undertaking between the Royal Thai Government and the Government of Japan.

## VI. UNDERTAKING OF RTG

1. In accordance with the Agreement on Technical Cooperation between the Government of the Kingdom of Thailand and the Government of Japan dated November 5, 1981, the Government of the Kingdom of Thailand shall accord benefits to the Japanese Study Team as follows:

- (1) to permit the members of the Japanese Study Team to enter, leave and sojourn in Thailand for the duration of their assignment therein and exempt them from alien registration requirements and consular fees;
- (2) to exempt the members of the Japanese Study Team from taxes, duties and any other charge on equipment, machinery and other materials brought into Thailand for the conduct of the Study;

- (3) to exempt the members of the Japanese Study Team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Japanese Study Team for their services in connection with the implementation of the Study;
  - (4) to bear claims, if any arises against the members of the Japanese Study Team resulting from , occurring in the course of , or otherwise connected with the discharge of their duties in the implementation of the Study , except when such claims arise from gross negligence or willful misconduct on the part of the members of the Japanese Study Team.
2. To facilitate smooth conduct of the Study , BMA shall take necessary arrangements for the Japanese Study Team and the aerial survey company which carries out the aerial photography as the following , in cooperation with other relevant organization:
- (1) to secure permission for the flight for the aerial photography and use of airports for the implementation of the Study;
  - (2) to secure permission for entry into private properties or restricted areas for the conduct of the Study;
  - (3) to secure permission for the Study Team to take all necessary data and documents related to the Study out of Thailand to Japan by the Japanese Study Team;
  - (4) to provide the medical services as needed (Its expenses will be chargeable on members of the Japanese Study Team);
  - (5) to ensure the safety of the members of the Japanese Study Team when as it is required in the course of the Study;

(6) to provide necessary facilities to the Japanese Study Team from remittance as well as utilization of the funds introduced into the Thailand from Japan in connection with the implementation of the Study.

3. The BMA shall , at its own expense , provide the Japanese Study Team with the following in cooperation with other agencies concerned

- (1) Available data and information related to the Study
- (2) Counterpart personnel
- (3) Administrative and technical support
- (4) Suitable office space with necessary office equipment , furniture and telephones in Bangkok
- (5) Credentials or identifications cards to the members of the Study Team
- (6) Available number of vehicles with drivers
- (7) Monuments for the new control points ,if necessary
- (8) Existing facilities and space of the Royal Irrigation Department for processing the aerial photographs
- (9) Information of the necessary administrative boundary and geographical names on the maps, at its full responsibility
- (10) Annotation sheets in Thai

## VII. UNDERTAKING OF JICA

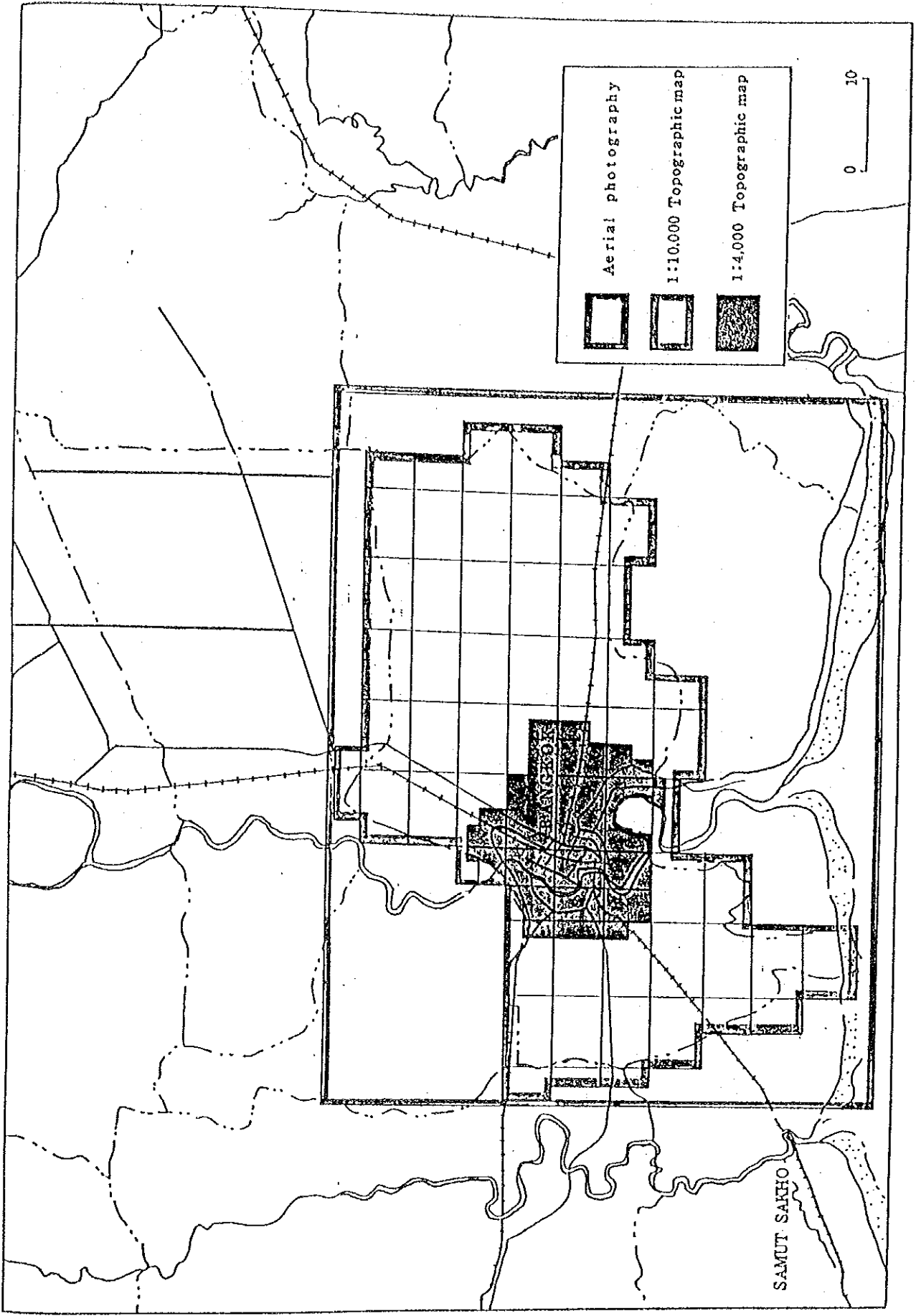
For the implementation of the Study, JICA shall, in accordance with the relevant laws and regulations in force in Japan, take the following measures.

1. To dispatch, at its own expense, the Study Team to Thailand for aerial photography, ground control point survey, pricking, field identification and field completion;
2. To carry out aerial triangulation, stereo plotting, drafting and printing in Japan;
3. To pursue technology transfer to the Thai counterpart personnel in the course of the Study.

## VIII. CONSULTATION

JICA and BMA shall consult with each other in respect of any matter that may arise from or in connection with the Study.







APPENDIX II

VENTATIVE SCHEDULE

— : Rainy Season

	1986												1987												1988											
	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	5	6	7	8	9	10	11	12	1	2	3
GROUND CONTROL POINT SURVEY																																				
PRICKING																																				
AERIAL PHOTOGRAPHY																																				
FIELD IDENTIFICATION																																				
AERIAL TRIANGULATION																																				
STEREO PLOTTING																																				
FIELD COMPLETION																																				
DRAFTING																																				
PRINTING																																				

Report

NOTE:  ... Work in Thailand  
 ... Work in Japan

## APPENDIX III FINAL RESULTS

### I. Aerial Photography

1. Original negatives (roll)
2. Contact paper prints
3. Index map

### II. Ground Control Point Survey

1. Horizontal control results
2. Vertical control results
3. Computation sheets
4. Field notes
5. Description of Points

### III. Topographic Mapping

1. Aerial triangulation results
2. Color separation scribed sheets and negative films for printing
3. 1/10,000 topographic maps in English and in Thai (500 sets each)
4. 1/10,000 topographic maps (polyester base) in English and in Thai  
(1 set each)
5. 1/4,000 topographic maps (polyester base) in English and in Thai  
(1 set each)
6. Pricked photos
7. Original manuscripts

## APPENDIX IV TECHNICAL DETAILS (1/10,000)

### I. SPECIFICATIONS

Major specifications of the Study are :

1. Ground Control Point Survey

Specifications for 3rd order control point survey in the Technical Manual of Overseas Surveying of JICA (hereinafter referred to as TM of JICA).

2. Leveling survey for minor height control point

Specifications for 3rd order leveling survey in TM of JICA.

3. Monument

Subject to the specification of BMA.

4. Mapping

A class mapping specifications for planimetry in TM of JICA.

A class mapping specifications for height in TM of JICA.

5. Reference Ellipsoid: Everest Ellipsoid

6. Datum : Indian datum 1975 , Vertical datum : Mean Sea Level at Koh Lak.

7. Projection: Universal Transverse Mercator Projection

8. Contour Lines: 2 meter contour intervals

9. Format: 50 x 75 cm

## II. ACCURACY (standard deviation)

Accuracy of above-mentioned surveys shall be :

### 1) Horizontal control survey

$$\frac{\sqrt{x^2 + y^2}}{S} = \frac{1}{25,000}$$

S: distance in km

### 2) Vertical control survey

$$12 \text{ mm } \sqrt{S}$$

S: distance in km

### 3) Mapping

Planimetry	0.5 mm on the map
Spot Height	0.7 m
Contour	1 m

TECHNICAL DETAILS(1/4,000)

I. SPECIFICATIONS

Major specifications of the Study are :

1. Ground Control Point Survey  
Specifications for 3rd order control point survey in TM of JICA.
2. Leveling survey for minor height control point  
Specifications for 3rd and lower order leveling survey in TM of JICA.
3. Monument  
Subject to the specification of BMA.
4. Mapping  
A class mapping specifications for planimetry in TM of JICA.  
A class mapping specifications for height in TM of JICA.
5. Reference Ellipsoid : Everest Ellipsoid
6. Datum : Indian datum 1975, Vertical datum :Mean Sea Level at Koh  
Lak
7. Projection :Universal Transverse Mercator Projection
8. Contour lines : 2 meter contour intervals
9. Format :62.5 x 93.75 cm

## II. ACCURACY

Accuracy of above - mentioned surveys shall be:

### 1) Horizontal control survey

$$\frac{\sqrt{X^2 + Y^2}}{S} = \frac{1}{25,000}$$

S: distance in km

### 2) Vertical control survey

3rd	12mm $\sqrt{S}$	
lower	60mm $\sqrt{S}$	S: distance in km

### 3) Mapping

Planimetry	0.5 mm on the map
Spot Height	Direct Leveling Point 0.1m
	Photogrammetric Point 0.7m
Contour	1m

2. Minutes

2-1 Minutes at the initiation of field work (October 1986)

MINUTES OF DISCUSSION

OF

TOPOGRAPHIC MAPPING PROJECT OF BANGKOK METROPOLITAN AREA

BETWEEN

THE BANGKOK METROPOLITAN ADMINISTRATION

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

ON

OCTOBER 22ND 1986

BANGKOK THAILAND

*Wicha Jiwalai*

DR. WICHA JIWALAI

DEPUTY GOVERNOR

BANGKOK METROPOLITAN ADMINISTRATION

*J. Kanakubo*

MR. TOSITOMO KANAKUBO

LEADER

JICA SURVEY TEAM



JICA Survey Team headed by Mr. Tositomo Kanakubo had meetings from 15th October to 22nd 1986 with steering committee consisted of BMA, RTSD, DOL, TCPD, CU and RID on the captioned Project.

After series of meetings, the BMA and the JICA Survey Team agreed on the following items:-

- 1) Both sides discussed on the plan of operation (see appendix-1).
- 2) Japanese side submitted to Thai side Specifications & Symbols for 1/10,000 topographic map (Draft) and Specifications & Symbols for 1/4,000 topographic map (Draft) (see appendix-2 and -3 respectively).

In reply to this, a recommendation by Thai side after checking the Specifications and the Symbols will be made by November 10, 1986.

- 3) Development of exposed serial films and reproduction of photo copies shall be conducted by using facilities at the Royal Thai Survey Department instead of using those of the Royal Irrigation Department. Materials which are necessary for photo processing shall be provided by the Japanese side.

- 4) Regarding item 3 in Minutes of Discussion made on February 6, 1986, Thai side informed that the security officers from RTSD through BMA should attend whole work on the Project in Thailand and during full working period in Japan in accordance with Thai Security Regulation which was recognized on September 11, 1986 by the Cabinet of Thai Government.

The team answered that the above information would be conveyed to the organization of JICA concerned.

*w.j.*

*J.K.*

BANGKOK METROPOLITAN 1:4,000 TOPOGRAPHIC MAP

SYMBOL AND SPECIFICATION (DRAFT)

October 1986






Japan International Cooperation Agency

Symbol design and specification of Bangkok Metropolitan topographic map are based on the following materials and principle.



I. Referential Symbols

1. Bangkok Metropolitan 1/10,000 topographic map symbols: The minutes of the conference made between JICA and BMA in March 1986.
2. Existing Thai topographic symbols: Made by RTSD of Thailand
3. 1/10,000 topographic map symbols: Geographical Survey Institute, Ministry of Construction (enacted in 1983)
4. National basic map symbols (1/2,500, 1/5,000): Geographical Survey Institute, Ministry of Construction (enacted in 1961)
5. Philippine 1/10,000 topographic map symbols: Made by JICA







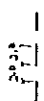
II. 1/4,000 map is used for inking expression.

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	HORIZONTAL CONTROL STATION 三角点	 112.3	mm Dot: 0.2 0.2	Black	Pricking, red Name identified	Same to symbol Name Control point material marked on overlay	Those of which first order horizontal control station, position and height are well preserved are indicated; first place of decimal rounded.
2	THIRD ORDER CONTROL STATION 3 级基准点	 15.2	Dot: 0.2 0.2	Black	Pricking, red Name identified	( " ) Name Marked on overlay	Indication of third order control station (newly established) Expression: 1st place of decimal rounded.
3	VERTICAL CONTROL STATION 水准点	 123.45	Dot: 0.2 0.2	Black	Pricking, red Name identified	( " ) Name Marked on overlay	Includes national vertical control station and the vertical control station established by B.M.A. Expression: 2nd place of decimal rounded.
4	DIRECT LEVELING POINT 直接水准点	 111.4	Dot: 0.3	Black	Pricking of actually measured points (Simple bench mark photograph utilized) Red	Black	Elevation point by direct leveling Expression: 1st place of decimal rounded.
5	SPOT HEIGHT 标高点	 4.22	Dot: 0.3	Black			Elevation point described by plotter; one point per 5cm square Unit of expression: meter with fraction rounded.
CONTROL POINT [C]							



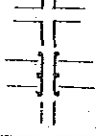
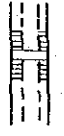

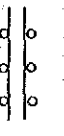
No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	CONTOUR 等高線	—2— —0—	0.15	Black		Orange	Contour line is composed of only intermediate contour (2m), and no index contour and auxiliary contour are used.
2	CUTTING 切り土		0.2	Black	Red	Black	Used to indicate artificial cuttings of 2m or more in height, or 1cm or on the map. Smaller ones may be indicated when considered necessary.
3	EMBANKMENT 盛り土		0.2	Black	Red	Black	Used to indicate artificial cuttings of 2m or more in height, or 1cm or on the map. Smaller ones may be indicated when considered necessary.
4	BANK 土堤	+++++	0.2	Black	Red	Black	Used to indicate those 2m or more in height, or 1cm or more on map.
5	SLOPES 急傾斜地		0.2	Black	Red	Black	Used to indicate steep slope made naturally by sliding of soil and sand, and those 2m or more in height, or square of 1cm or more on map.
6	QUARRY 雨裂		0.2	Black	Red	Black	Hollow of valley shape eroded by rain fall.
7	DEPRESSION 凹地		0.2	Black	Red	Black	Used to indicate land surface partially depressed to the extent that can be expressed by contour line. No arrows used.

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
8	SAND 砂地			Black	Red	Black	Used to indicate the land without vegetation, natural sand or quarry, and those 5mm or more on msp. No arrows used.
9	TIDAL FLAT 干灘		0.2	Black	Red	Black	

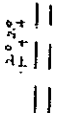
地 形 地 貌 等 LANDSCAPE (L)

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	PRIMARY NATIONAL HIGHWAY 国道		0.2	Black	Red	Black	Route number is indicated on the road line of national highway. Reference is made to materials obtained from B.M.A.
2	SECONDARY NATIONAL HIGHWAY 国道		0.2	Black	Red	Black	Route number is indicated on the road of provincial road. Reference is made to the materials obtained from B.M.A. or 1/50,000 or 1/20,000 topography.
3	DIVIDED HIGHWAY/ EXPRESS WAY 高速道路		0.2	Black	Red	Black	Indicate for car, express way, & road with divider strip. Classified divider strip, whether 0.5mm width more or less on map is symbolically expressed. Central part of rotary is included.
4	PROVINCIAL ROAD 地方道		0.2	Black	Red	Black	Used to indicate roads with width of 0.2m more. The roads less than 5mm on map may be omitted considering their importance. Name of ISO is described.
5	OTHER ROAD (TRAIL) 軽車道		0.2	Black	Red	Red	Those with width of 1.0m or more but less than 0.2m. Those of length of 1cm or less on map can be omitted.
6	OTHER ROAD (TRAIL) 徒歩道		0.2	Black	Red	Red	Roads in residential area with width less than 0.1m. Main roads passing through mountains and rice fields.
7	ROAD UNDER CONSTRUCTION 工事中の道路		0.2	Black	Red	Black	Used to indicate roads with width of 2m or more.

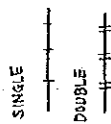
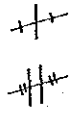
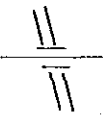
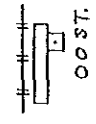
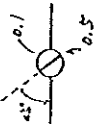
TRANSPORTATION-ROAD [ 表 ]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
8	SIDEWALK 步道		0.1	Black	Red	Black	Used to indicate roads with width 2m or more which are specific for pedestrians and bicycle.
9	GRADE SEPARATION 高架道路		0.3	Black	Red	Red	A road all of which is not elevated. When other road underpasses the elevated portion of the road, the part overlapped by the elevated road is not indicated.
10	CROSSING 立体及平面交差		0.3	Black	Red	Black	Ditto
11	PEDESTRIAN OVER PASS 步道橋		0.15	Black	Red	Black	Used to indicate a bridge used for men and bicycle to cross a road or railway. Only the bridge with size of 2mm or more in length, 0.3mm or more in width is indicated.
12	TOLL GATE 料金所		0.15	Black	Red	Black	Actual shape is indicated for those of 0.4mm, or more on map. Those less than 0.4mm is indicated by symbol. Toll Gate of toll road
13	STREET TREE 並木		Dot: 0.5	Black White	RED	Black	Actual shape is indicated for those with size of 1cm or more on map. Those with size less than 3mm are indicated as 3mm. Trees on water way are included herein.

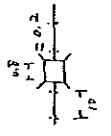



No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
14	ROAD IN PARK 庭園路		0.15	Black	Red	Black	Used to indicate those size of 2m or more. A road on which bicycles are restricted.
15	BRIDGE 橋						Bridges are not described.





TRANSPORTATION-ROAD [R.]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	NATIONAL RAILWAY 铁道	 SINGLE DOUBLE	0.25	Black	Red	Black	Used to indicate national railway. Identifies one-track line and double-track line.
2	LEVEL CROSSING 平面交差		0.25	Black	Red	Black	
3	OVERPASS 立体交差 (高架)		0.2	Black	Red	Black	
4	RAILWAY STATION 駅	 OOST.	0.15	Black	Red	Black	Indicate station for passengers, provisional station, and station for cargo. Platform is indicated as building. Station name, xxx ST is indicated.
5	TURN TABLE 転車台			Black	Red	Black	Device to turn the direction of train at marshaling yard.

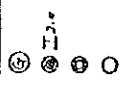



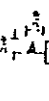
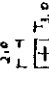
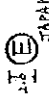
TRANSPORTATION-RAILWAY [R]








No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	POWER TRANSMISSION 送電線		0.15	Black	Red	Red	Used to indicate transmission line with high tower.
2	PIPELINE/ WATER PIPELINE 送水管		0.2	Black	Note of PIPELINE Red	Note is printed in purple.	Used to indicate pipe lines which convey oil, gas or water. Underground lines are not indicated.

TRANSPORTATION-POWER TRANSMISSION [ Re ]








No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	CONCRETE BUILDING 堅ろ建物		0.25	Black	k is marked for those of 3-story or higher. Red	k is printed in red.  Black	Concrete building of 3-story (approx. 10m) or higher.
2	PROMINENT BLDG INCLUDING GOVERNMENT AND PUBLIC BLDG 著名建物		0.15	Black	Red	Black	Famous building including public facilities (school, library, etc.). Note or building symbol is indicated.
3	INDEPENDENT BUILDING & HOUSE 独立建物		0.15	Black	Red	Black	Indicate a bldg. of which shorter latus is 0.4mm or more. Include a shed. Jagged shape of bldg. expressed by lines 0.4mm or less may be omitted for convenient.
4	FLOATING HOUSE 水上家屋		0.15		F H Red	F H Black	Houses on water

BUILDING [B]



No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
建 物 記 号 BUILDING SYMBOL [B]	1 GOVERNMENT BUILDING 官公署		0.15	Black	Classified into national agency, CHANGWAI AMPHOE and KING-AMPHOE Red	Red	Central building of national, state, prefectural or local government, local agencies of national government, city and town office. Described by symbol and note, or only symbol.
	2 POLICE STATION 警察署		0.15	Black	Red	Red	Central police and local agencies, the building in which police station is located. Note is added for large sized buildings.
	3 FIRE STATION 消防署		0.15	Black	Red	Red	Notes are given to large sized building.
	4 POST OFFICE 郵便局		0.15	Black	Red	Red	Notes are given to large sized building.
	5 SCHOOL 学校		0.15	Black	Red	Red	Kindergarten, elementary school, junior high school, high school, universities. Notes are given for large sized bldg. (Direction of flag shall be decided by consultation.)
	6 HOSPITAL 病院		0.15	Black	Red	Red	Used to indicate a hospital, infirmary clinic. Notes are given to large sized building.
	7 EMBASSY 大使館 領事館		0.15	Black	Red	Red	Notes are added to an embassy, legation and consulate.

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
8	U.N. ORGANIZATION 国連の機関		0.15	Black	Red	Red	Notes are added.
9	MONASTERY WITH TEMPLE 修道院		0.15	Black	Red	Red	A temple where priests live for ascetic practices. Notes are added for large sized buildings. Symbol is placed vertically below neatline. Indicate monasteries and temples.
10	MONASTERY WITHOUT TEMPLE 修道院		0.15	Black	Red	Red	Notes are added for large sized building. The symbol is placed vertically below neatline. Indicate monasteries.
11	CHURCH/ MISSION 教会 礼拝堂		0.15	Black	Red	Red	Used to indicate churches and chapels. Notes are added for large sized buildings. The symbol is placed vertically below the neatline. (Direction shall be decided on consultation.)
12	MOSQUE 回教寺院		0.15	Black	Red	Red	Used to indicate Islamic temple (mosque). The symbol is placed vertically below the neatline.
13	HINDU ヒンズー寺院		0.15	Black	Red	Red	Used to indicate hindu temples. The symbol is placed vertically below the neatline.
14	CHINA 中国寺院		0.15	Black	Red	Red	Used to indicate Chinese Confucius temples and Taoist temples. The symbol is placed vertically below the neatline.

BUILDING SYMBOL [ B ]








No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
15	HOTEL ホテル		0.15	Black	Red	Red	Used to indicate hotels and motels. When a part of floor is rented, selective description is made.
16	MARKET & PROMINENT デパート スーパーストア		0.15	Black	Red	Red	Used to indicate supermarket and department stores. This is used for provisional open market streets.
17	BANK 銀行		0.15	Black	Red	Red	Indicate large sized banks. This symbol is used for self-owned bldg. such as home offices and branch offices, and notes will be given if there is enough space.
18	FACTORY AND WORKS 工場		0.15	Black	Red	Red	Notes are added for large sized buildings.
19	HELIPORT ヘリポート		0.15	Black	Red	Red	Landing/taking-off place specific for helicopter
20	THEATER AND CINEMA 劇場 映画館		0.15	Black	Red	Red	Large sized theater and movie theater. When a part of floor is rented, selective description is made.
21	LIBRARY 図書館			Black	Red	Red	Omitted schools and companies concerned.

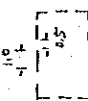

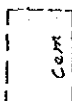




BUILDING SYMBOL. [B]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
22	POWER PLANT SUBSTATION 発電所 変電所		0.15	Black	Red	Red	Used to indicate those the size of which is 5mm square or larger on map. Notes are added for large sized facilities.
23	DRAINAGE PUMP 排水ポンプ		0.15	Black	Red	Red	Drainage/pumping facilities for agricultural or industrial use. Large sized ones only.

BUILDING SYMBOL [ B5 ]

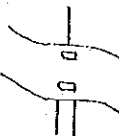
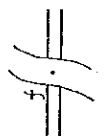
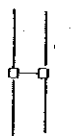








No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	STORAGE TANK 貯蔵タンク		0.15	Black	Red	Red	Only large sized and wide scope facilities are indicated. Actual shape is shown to those sizes of which are 1mm or more on map. Kind of activity is shown such as "oil" or "gas".
2	TOWER 高塔		0.15	Black	Red	Red	Used to indicate prominent land marks such as radio wave tower, water tower and chimney. Minimum size: 0.8mm. Actual shape is shown for those size of which is larger than the minimum size.
3	LIGHTHOUSE 燈台標		0.15	Black	Red	Red	Used to indicate a light house and light beacon. Used only for fixed one suitable for landmarks.
4	MONUMENT 記念碑		0.15	Black	Red	Red	Large sized one suitable for landmarks.
5	STATUS 立像		0.15	Black	Red	Red	Large sized one suitable for landmarks.
6	WALL/FENCE 塙 サク		0.15	Black	Red	Red	Those with height of 2m or more, and the length on map is 1cm or more. Smaller one may be indicated when considered necessary.
7	ANTIQUITY & FORT 遺跡 城跡		0.15	Black	Red	Green	Indicated the scope and notes when enclosed by roads, the boundary can be omitted. Ruins of castle are indicated only when they are historical and famous.

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
8	PARKS 公園		0.15	Black	Red		Indicate the boundaries, and notes are given to large sized one. Only those with the size 2 x 2mm or more are indicated. Garden trees are also indicated. Notes shall be given to large sized ones.
9	REVEMENT 被覆		0.25	Black	Red	Black	Used to indicate a structure of 2m or more in height, and surface of which is protected by concrete or stones, and those the size of which on map is 1cm or more.
10	CEMETERY 墓地		0.15	Black	Red	Green	Those sized 2 x 2cm or larger on map. Notes are given for large sized one.
11	WATER LEVEL OBSERVATION STATION 水位観測所		0.1 0.2	Black	Red	Red	Used to indicate a facilities which measure the level of tide and river water.
12	WELL 井戸			Black	Red	Red	Used to indicate a deep well.
13	INDEPENDENT TREE 独立樹		0.15	Black	Red	Red	Used to indicate a tree which is famous and suitable for landmark.
14	UNDER CONSTRUCTION 工事中		0.15	Black	Black	Red	Used to indicate an area of the size 1 x 1cm or larger on map.








No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	PIER-JETTY BREAK WATER 棧橋 防波堤		0.15 0.25	Gray	Red	Black	Pier: Length 0.2mm or more and width 0.5mm or more are indicated. Break water: A bank to control tide & waves, or jetty to prevent the erosion of coast. Line is indicated. Length 1.5mm or more & width 0.5mm or more. The revetment symbol is used for those made of iron or concrete.
2	WHARF 波止場		0.3	Gray	Red	Black	Only those of size 3mm or more in length, 0.5mm or more in width, both on map. A wharf along rivers or coast line.
3	RIVER/SEA 河川		0.2	Blue	Blue	Purple	Those with width of 2m or more is indicated as double line stream. Only those the size of which is 1cm in length on map. Shore lines shall be those at the time of photography.
4	STREAM 小川		0.2	Blue	Blue	Purple	Those with width less than 2m is indicated as single line stream. Only those with length of 1cm or more on map is indicated.
5	DITCH 用水路		0.2	Blue	Blue	Purple	Used to indicate those with width less than 2m.
6	INTERMITTENT CANAL かた川		0.2	Blue	Blue	Purple	A river or channel on which ship transportation becomes seasonally impossible.
7	CULVERT 暗渠		0.3	Gray	Red	Black	Water way of river with width of 2m or more which passes under a road or railway.

河川湖地等 [ WATER AND ASSOCIATED FEATURE ]





No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
8	FERRY 渡船場			Black	Red	Black	Ferry is indicated only where there is a boat for the purpose of transporting men or cars across the river.
9	FORD 渡渉場			Black	Red	Black	Used to indicate a place where there is no transportation facility (boat) but can be crossed on foot. This symbol is used for large sized river.
10	FLOOD GATE 水門		0.1 0.2	Black	Red	Black	Used to indicate a structure to take-in/drain water, control water level, and prevent reverse flow of water.
11	WEIR せき		0.2	Black	Red	Black	A structure placed across a water bed for the purpose of controlling water flow or for taking-in water. When such structure is 10m or longer in length, it is indicated in actual shape.
12	SWAMP/MARSH 沼 湿地			Black	Blue	Purple	Used to indicate a land which is soft always containing water and on which hydrotropic plants are growing. Used for swamp and marsh of the size 5 x 5m on map. When there is vegetation on it, appropriate symbols are used.
13	FISHPOND 養魚池		0.2	Black	fish Blue	Note of fish Purple	Used to indicate an artificial reservoir made for the purpose of cultivating fish. In principle this symbol is used for those with size of 1 x 1cm on map. Note of "FISH" is indicated.
14	SALT BET 塩田		0.2	Black	Note of salt Blue	Note of salt Divided single line is purple. Purple	In principle, those with size of 1 x 1cm on map. Note of "SALT" is indicated.

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
15	LAKE/POND 湖池		0.2	Black	Note of pond Blue	Note of pond Purple	Indicates only those with size of 5 x 5 mm or more on map.
16	FLOW ARROW 流水方向		0.2	Black	Blue	Purple	This symbol is used only when the direction of flow is clear, and also where the width of river is broad enough.

河川湖池等 WATER AND ASSOCIATED FEATURE [ W ]

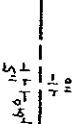
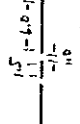
No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	LIMIT OF VEGETATION 植生界		0.2	Black	Green	Green	Used to show the boundary between vegetation. Expressed by dotted line. No boundary is shown for uncultivated land.
2	HARD WOOD FOREST 堅木林		0.2	Black	Red	Black	Indicates only those with size of 5 x 5mm on map.
3	BUSHES SCRUB かん木 雑木			Black	Red	Black	Used to indicate coppice less than about 3m.
4	RICE FIELDS 水田		0.2	Black	Red	Black	Used to indicate cultivating land with footpaths around it and water is reserved on it. Indicates only the area with size of 5 x 5mm or more on map.
5	CROPLAND AGRICULTURAL LAND 耕地		0.2	Black	Red	Black	Used to indicate land to grow dry land rice and vegetable. Indicates only the area with size of 5 x 5mm or more on map. Land for growing cassava, sugar, cane, tobacco leaf, flowers and wheat.
6	PLANTATION ORCHARD 果樹園		0.2	Black	Red	Black	Used to indicate those which grow pine-apple, mango, papaya, banana and apple. Indicates only area with size of 5 x 5mm on map.
7	MANGROVE マングローブ		0.2	Black	Red	Black	Used to indicate forest grows at the shallow place in sea or at estuary. Mangrove symbol on halftone blue.

PLANTATION [P]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
8	NIPA ニツバ	木 木	0.2	Green	Red	Black	
9	COCONUT ココナッツ		0.2	Green	Red	Black	
10	GRASS 草地		0.2	Green	Red	Black	Includes the grass in meadow.
11	BAMBOO 竹林		0.2	Green	Red	Black	Used to indicate the area where bamboo grows thick.
12	GARDEN TREES 庭木		0.2	Green	Red	Black	Used to indicate a shrub planted around houses, parks factories and in road divider strips. Used only for 1/4,000 map.
13	OPEN AREA 空地				Note Red		Area prepared for house construction. Also used for open area in cities.
14	CULTIVATION BOUNDARY 耕地界	--- --	0.1	Black	Green	Green	Indicate the area of same kind of cultivation, and segmented by squares of approximately per 2cm.

植 生

PLANTATION [P]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications
1	CHANGWAT 市界		0.3mm	Black	Red	Red	According to the material of B.M.A. Bangkok Metropolitan Administration shall be used as State boundary.
2	AMPHOE 区界		0.3	Black	Red	Red	According to the materials of B.M.A. District is divided into 24 according to B.M.A.
3							Sub-district (King Amphoe) shall be decided upon consultation with B.M.A.

OTHERS-BOUNDARY [06]



No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	
	LINE SIZE						0.10mm 0.15mm 0.20mm 0.25mm 0.30mm	

線

字

OTHERS-LINE [01]

BANGKOK METROPOLITAN 1:10,000 TOPOGRAPHIC MAP

SYMBOL AND SPECIFICATION (DRAFT)

October 1986

Japan International Cooperation Agency






Symbol design and specification of Bangkok Metropolitan topographic map are based on the following materials and principle.

I. Referential Symbols

1. Bangkok Metropolitan 1/10,000 topographic map symbols: The minutes of the conference made between JICA and BMA in March 1986.
2. Existing Thai topographic symbols: Made by RTSD of Thailand
3. 1/10,000 topographic map symbols: Geographical Survey Institute, Ministry of Construction (enacted in 1983)
4. National basic map symbols (1/2,500, 1/5,000): Geographical Survey Institute, Ministry of Construction (enacted in 1961)
5. Philippine 1/10,000 topographic map symbols: Made by JICA



II. Principle of Color Expression used in 1/10,000 Topographic Map

Bench mark, contour line, railroad, buildings, features, administrative boundary, notation, etc.	Black
Kinds of national road and highway, solidly-built buildings	Red
Classification of prominent buildings (light brown) and famous buildings (dark brown)	Brown
Sea, river, lake and marsh, swamp, etc.	Blue
Vegetation and parks, etc.	Green
Road, cutting, embankment, pier, jetty, revetment, etc.	Gray

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
1	HORIZONTAL CONTROL STATION 三角点	 112.3	Dot: 0.2 0.2	Black	Pricking, red Name identified	Same to symbol Black Control point material marked on overlay	Those of which first order horizontal control station, position and height are well preserved are indicated; first place of decimal rounded.	No change
2	THIRD ORDER CONTROL STATION 三等水准点	 15.2	Dot: 0.2 0.2	Black	Pricking, red Name identified	( " ) Name Marked on overlay	Indication of third order control station (newly established) Expression: 1st place of decimal rounded.	New
3	VERTICAL CONTROL STATION 水准点	 123.45	Dot: 0.2 0.2	Black	Pricking, red Name identified	( " ) Name Marked on overlay	Includes national vertical control station and the vertical control station established by B.M.A. Expression: 2nd place of decimal rounded. (O → □)	Change
4	DIRECT LEVELING POINT 直接水准点	 111.4	Dot: 0.3	Black	Pricking of actually measured points (Simple bench mark photograph utilized) Red	Black	Elevation point by direct leveling Expression: 1st place of decimal rounded.	No change
5	SPOT HEIGHT 标高点	 432	Dot: 0.3	Black			Elevation point described by plotter; one point per 5cm square Unit of expression: meter with fraction rounded (Unit: 0.1 → 1m)	Change
CONTROL POINT [C]								

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
1	CONTOUR 等高線	—2— —0—	0.15	Black		Orange	Contour line is composed of only intermediate contour (2m), and no index contour and auxiliary contour are used. (Brown + Black)	Change
2	CUTTING 切り土		0.2	Gray	Red	Black	Used to indicate artificial cuttings of 2m or more in height, or 1cm or on the map. Smaller ones may be indicated when considered necessary. (Brown + Gray)	Change
3	EMBANKMENT 盛り土		0.2	Gray	Red	Black	Used to indicate artificial cuttings of 2m or more in height, or 1cm or on the map. Smaller ones may be indicated when considered necessary. (Brown + Gray)	Change
4	BANK 土堤	+++++	0.2	Gray	Red	Black	Used to indicate those 2m or more in height, or 1cm or more on map. (Brown + Gray)	Change
5	SLOPES 急傾斜地		0.2	Gray	Red	Black	Used to indicate steep slope made naturally by sliding of soil and sand, and those 2m or more in height, or square of 1cm or more on map. (Brown + Gray)	Change
6	QUARRY 雨裂		0.2	Gray	Red	Black	Hollow of valley shape eroded by rain fall. (Brown + Gray)	Change
7	DEPRESSION 凹地		0.2	Gray	Red	Black	Used to indicate land surface partially depressed to the extent that can be expressed by contour line. No arrows used. (Brown + Gray)	Change

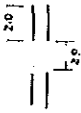



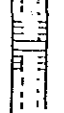


LANDSCAPE [1]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
8	SAND 砂地			Gray	Red	Black	Used to indicate the land without vegetation, natural sand or quarry, and those 5mm or more on map. No arrows used.	New
9	TIDAL FLAT 干灘		0.2	Gray Blue net	Red	Black	Symbol is overlapped on blue net of river or sea.	New

LANDSCAPE [1]

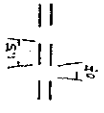
No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
1	PRIMARY NATIONAL HIGHWAY 国道		0.2	Red net (60%) Road border: Gray	Red	Black	Route number is indicated on the road line of national highway. Reference is made to materials obtained from B.M.A. (Road border: Red + Gray)	Partly added/revised
2	SECONDARY NATIONAL HIGHWAY 国道		0.2	Red net (5 ~ 10%) Road border: Gray	Red	Black	Route number is indicated on the road of provincial road. Reference is made to the materials obtained from B.M.A. or 1/50,000 or 1/20,000 topography. ( " )	Partly added/revised
3	DIVIDED HIGHWAY/ EXPRESS WAY 高速道路		0.2	Solid red Road border: Gray	Red	Black	Indicate for car, express way, & road with divider strip. Classified divider strip, whether 0.3mm width more or less on map is symbolically expressed. Central part of rotary is included. ( " )	Partly added/revised
4	PROVINCIAL ROAD 地方道 (4m以上)		0.2	Solid red Road border: gray	Red	Black	Used to indicate roads of width 4m or more (real width). The roads less than 5mm on map may be omitted considering their importance. Name of ISO is described. (Red + Gray)	Change
5	PROVINCIAL ROAD 地方道 (2 ~ 4m)		0.1	Gray	To be discriminated from road width Red	Black	The real width of 2m or more but less than 4m is expressed by 0.4mm width on map. The road less than 5mm on map may be omitted.	New
6	OTHER ROAD (TRACK) 軽車道		0.2				Used to indicate the width less than 1.0 - 2.0m. Those less than 5mm on map may be omitted. (3 + 2m) (Red + Gray)	Change
7	OTHER ROAD (TRAIL) 徒歩道		0.2	Gray	Red	Black	Road with width of less than 1m and those trespassing and connecting residential area. Main roads trespassing mountings and swamps.	Change

TRANSPORTATION-ROAD [ R<sub>3</sub> ]

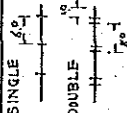

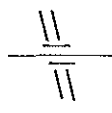
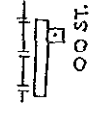
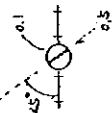
No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
8	ROAD UNDER CONSTRUCTION 工事中の道路		0.2	Gray	Red	Black	Used to indicate roads with width 4m or more. (Red + Gray)	Change
9	SIDEWALK 歩道		0.1	Gray	Red	Black	Road with width 4m or more and those specific for pedestrians and bicycles ( " )	"
10	GRADE SEPARATION 高架道路		0.3	Gray	Red	Red	The road total length of which is elevated. When there is another road under the elevated road, the portion overlapped by the elevated road is not described.	New
11	CROSSING 立体及び平面交差		0.3	Gray	Red	Black	Ditto (Red + Gray)	Change
12	PEDESTRIAN OVER PASS 歩道橋		0.15	Black	Red	Black	Bridges for men and bicycles to overpass a road or railway. Those length of which on map is 2mm or more, and the width of which is 0.3mm or more on map. (Step way)	"
13	TOLL GATE 料金所		0.15	Black	Red	Black	Used to indicate a toll gate. Symbolized according to the map symbol. on map. (Symbolized 2 + 1 line)	"
14	STREET TREE 並木		Dot: 0.5	Solid green	Red	Black	Those of 1cm or more on map. Only important ones from the view point of urban scenery, including trees on water way. (Red + Solid green)	"

TRANSPORTATION-ROAD [ Ra ]

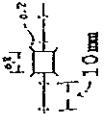



No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
15	ROAD IN PARK 陸園路		0.15	Gray	Red	Black	Road in park, pathway inside a factory premise. Described by real width. Used to indicate roads with width of 4m or more. Pathway where automobiles are restricted. (Gray)	No change
16	BRIDGE 橋						Bridges are not described.	Deleted






TRANSPORTATION-ROAD [ R-1 ]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/R
1	NATIONAL RAILWAY 铁道	 SINGLE RAILWAY DOUBLE RAILWAY	0.25	Red	Red	Black	Used to indicate national railway. Identifies one-track line and double-track line.	No change
2	LEVEL CROSSING 平面交差		0.25	Red	Red	Black		"
3	OVERPASS 立体交差 (高架)		Line 0.2	Black	Red	Black		"
4	RAILWAY STATION 駅	 O O ST.		Station: Dark brown Platform: Gray	Red	Black	Indicate a station for passenger, provisional station for passenger, station for cargo. Platform is expressed as bigg. Min. bigg. is 0.4mm on map. (Black + Dark brown, Black + Gray)	Change
5	TURN TABLE 転車台			Black	Red	Black	Device to turn the direction of train at marshaling yard.	New

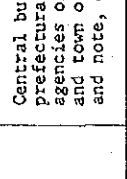
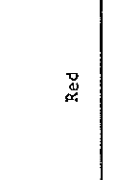
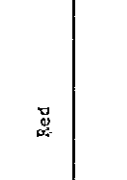
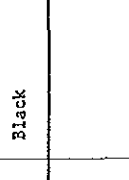
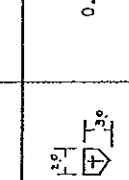
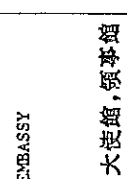

TRANSPORTATION-RAILWAY [R]








No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
1	POWER TRANSMISSION 送電線		0.15	Black	Red	Red	Used to indicate transmission line with high tower.	No change
2	PIPELINE/ WATER PIPELINE 送水管		0.2	Black	Note of PIPELINE Red	Note is printed in purple.	Used to indicate pipe lines which convey oil, gas or water. Underground lines are not indicated.	"








TRANSPORTATION-POWER TRANSMISSION [ Re ]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
1	CONCRETE BUILDING 堅ろう建物		0.25	Red frame	k is marked for those of 3-story or higher. Red	k is printed in red.  Black	Concrete building of 3-story (approx. 10m) or higher. Indicated together with famous building or independent building.	New
2	PROMINENT BLDG INCLUDING GOVERNMENT AND PUBLIC BLDG 著名建物			Dark brown	Red	Black	Famous building including public facilities (school, library, etc.). Those for which "note" or building mark is described in 1/4,000 map. (Gray + Dark brown)	Change
3	INDEPENDENT BUILDING & HOUSE 独立建物			Light brown	Red	Black	Indicate a bldg. of which shorter latus is 0.4mm or more. Include a shed. Jagged shape of bldg. expressed by lines 0.4mm or less may be omitted for convenient. (0.5 + 0.4mm, Gray + L. brown)	"
4	CONGESTED HOUSING AREA 絡描建物			Light brown	Red	Black	When congested housings are located close less than 0.4mm each other, famous buildings and independent buildings are separately indicated. (Gray + Light brown)	"
5	FLOATING HOUSE 水上家屋			Light brown	ma Red	ma Black	Houses on water. Light brown on blue. The symbol is overlapped on blue net of river or sea.	New



BUILDING [ B ]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
1	GOVERNMENT BUILDING 官公署		0.15	Black	Classified into national agency, CRANGWAT AMPHOE and KING-AMPHOE Red	Red	Central building of national, state, prefectural or local government, local agencies of national government, city and town office. Described by symbol and note, or only symbol.	New
2	POLICE STATION 警察署		0.15	Black	Red	Red	Central police and local agencies, the building in which police station is located. Note is added for large sized buildings. (Red + Black)	Change
3	FIRE STATION 消防署		0.15	Black	Red	Red	Notes are given to large sized building.	"
4	POST OFFICE 郵便局		0.15	Black	Red	Red	Notes are given to large sized building.	"
5	SCHOOL 学校		0.15	Black	Red	Red	Kindergarten, elementary school, junior high school, high school, universities. Notes are given for large sized bldg. (Direction of flag shall be decided by consultation.) ( " )	"
6	HOSPITAL 病院		0.15	Black	Red	Red	Used to indicate a hospital, infirmary clinic. Notes are given to large sized building. ( " )	"
7	EMBASSY 大使館, 領事館		0.15	Black	Red	Red	Notes are added to an embassy, legation and consulate. ( " )	"

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
8	U.N. ORGANIZATION 国の機関		0.15	Black	Red	Red	Notes are added.	New
9	MONASTERY WITH TEMPLE 修道院と寺院		0.15	Black	Red	Red	A temple where priests live for ascetic practices. Notes are added for large sized bldgs. Symbol is placed vertically below neatline. Indicate monasteries and temples. (Red + Black)	Change
10	MONASTERY WITHOUT TEMPLE 修道院		0.15	Black	Red	Red	Notes are added for large sized building. The symbol is placed vertically below neatline. Indicate monasteries. ( " )	"
11	CHURCH/MISSION 教会 礼拝堂		0.15	Black	Red	Red	Used to indicate churches and chapels. Notes are added for large sized buildings. The symbol is placed vertically below the neatline. ( " )	"
12	MOSQUE 回教寺院		0.15	Black	Red	Red	Used to indicate islamic temple (mosque). The symbol is placed vertically below the neatline.	New
13	HINDU ヒンズー寺院		0.15	Black	Red	Red	Used to indicate hindu temples. The symbol is placed vertically below the neatline.	"
14	CHINA 中国寺院		0.15	Black	Red	Red	Used to indicate Chinese Confucius temples and Taoist temples. The symbol is place vertically below the neatline.	"








No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
15	HOTEL ホテル		0.15	Black	Red	Red	Used to indicate hotels and motels. When a part of floor is rented, selective description is made.	No change
16	MARKET & PROMINENT デパート スーパーストア		0.15	Black	Red	Red	Used to indicate supermarket and department stores. This is used for provisional open market streets. (Red + Black)	Change
17	BANK 銀行		0.15	Black	Red	Red	Indicate large sized banks. This symbol is used for self-owned bldg. such as home offices and branch offices, and notes will be given if there is enough space. ( " )	"
18	FACTORY AND WORKS 工場		0.15	Black	Red	Red	Notes are added for large sized buildings.	No change
19	HELIPORT ヘリポート		0.15	Black	Red	Red	Landing/taking-off place specific for helicopter (Red + Black)	Change
20	THEATER AND CINEMA 劇場 映画館		0.15	Black	Red	Red	Large sized theater and movie theater. When a part of floor is rented, selective description is made. ( " )	"
21	LIBRARY 図書館			Black	Red	Red	Omitted schools and companies concerned. Symbol Red + Black	"








BUILDING SYMBOL [ B ]

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
22	POWER PLANT SUBSTATION 発電所 変電所		0.15	Black	Red	Red	Used to indicate those the size of which is 5mm square or larger on map. Notes are added for large sized facilities. (Red + Black)	Change
23	DRAINAGE PUMP 排水ポンプ		0.15	Black	Red	Red	Drainage/pumping facilities for agricultural or industrial use. Large sized ones only.	No change

建築物記号 BUILDING SYMBOL (B-1)



No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
小 物 体	1	STORAGE TANK 貯蔵タンク		0.15	Black	Red	Only large sized and wide scope facilities are indicated. Actual shape is shown to those sizes of which are 1mm or more on map. Kind of activity is shown such as "oil" or "gas".	No change
	2	TOWER 高塔		0.15	Black	Red	Used to indicate prominent land marks such as radio wave tower, water tower and chimney. Minimum size: 0.8mm. Actual shape is shown for those size of which is larger than the minimum size.	"
	3	LIGHTHOUSE 燈台標		0.15	Black	Red	Used to indicate a light house and light beacon. Used only for fixed one suitable for landmarks.	New
	4	MONUMENT 記念碑		0.15	Black	Red	Large sized one suitable for landmarks.	No change
	5	STATUS 立像		0.15	Black	Red	Large sized one suitable for landmarks.	New
	6	WALL/FENCE 塀サク		0.15	Black	Red	Those with height of 2m or more, and the length on map is 1cm or or more. Smaller one may be indicated when considered necessary.	No change
	7	ANTIQUEITY & FORT 遺跡 城跡		0.15	Solid 20 ~ 30% Black	Red	Green	Indicated the scope and notes when enclosed by roads, the boundary can be omitted. Ruins of castle are indicated only when they are historical and famous. (Solid green)

No.	Name of Symbol	Symbol	Line Size	Color	Land Identification	Compilation	Specifications	S/W
8	PARKS 公園		0.15	Green net 40 ~ 60%	Red	Green	Indicates the boundaries, and notes are given to large sized one. Only those with the size 2 x 2mm or more are indicated. Garden trees are also indicated. (Green net).	Change
9	REVENMENT 被覆		0.25	Gray	Red	Black	Used to indicate a structure of 2m or more in height, and surface of which is protected by concrete or stones, and those the size of which on map is 1cm or more. (Brown + Gray)	"
10	CEMETERY 墓地		0.15	Black net Black	Red	Green	Those sized 2 x 2cm or larger on map. Notes are given for large sized one.	No change
11	WATER LEVEL OBSERVATION STATION 水位観測所		0.1 0.2	Black	Red	Red	Used to indicate a facilities which measure the level of tide and river water.	New
12	WELL 井戸			Black	Red	Red	Used to indicate a deep well.	"
13	INDEPENDENT TREE 独立樹		0.15	Black	Red	Red	Used to indicate a tree which is famous and suitable for landmark.	"
14	UNDER CONSTRUCTION 工事中		0.15	Black	Black	Red	Used to indicate an area of the size 1 x 1cm or larger on map.	No change

MISCELLANEOUS LANDMARK FEATURE [M]