3-7 Field identification

3-7-1 Outline

Confirmation and investigation of various expressions and names specified by map symbols were conducted, with cooperation of NGD counterparts, referring to the results of preliminary interpretation. The results of the study were described on two time-enlarged aerial photographs to be used as data for succeeding plotting and compilation work.

3-7-2 Planning and preparation

Prior to the implementation of field identification, following works were carried out:

- Listing of data items to be provided by NGD,
- Preparation of two time-enlargement photos for the field work,
- Pre-interpretation using the existing maps and photos.

3-7-3 Technical discussion with NGD

In Laos, map symbols and their application rules for 1/25,000 topographic maps are not available, but there are some existing 1/25,000 topographic maps which were made in 1980, with the cooperation of the former Soviets. To respect NGD's request, these map symbols were modified for the field verification, plotting and compilation. The application rules were made with reference to the existing maps. New map symbols and application rules were introduced by the Team and NGD agreed to them after discussions.

Agreed map symbols for the field verification, plotting and compilation were shown at the end of the progress report for the second year.

The sheet names and numbers were applied as provided by NGD (See Fig.10).

3-7-4 Implementation

5 Laotian engineers and 9 Japanese engineer in 5 teams were deployed for the field identification. The following items were surveyed and verified in the field according to the map symbols and their application rules:

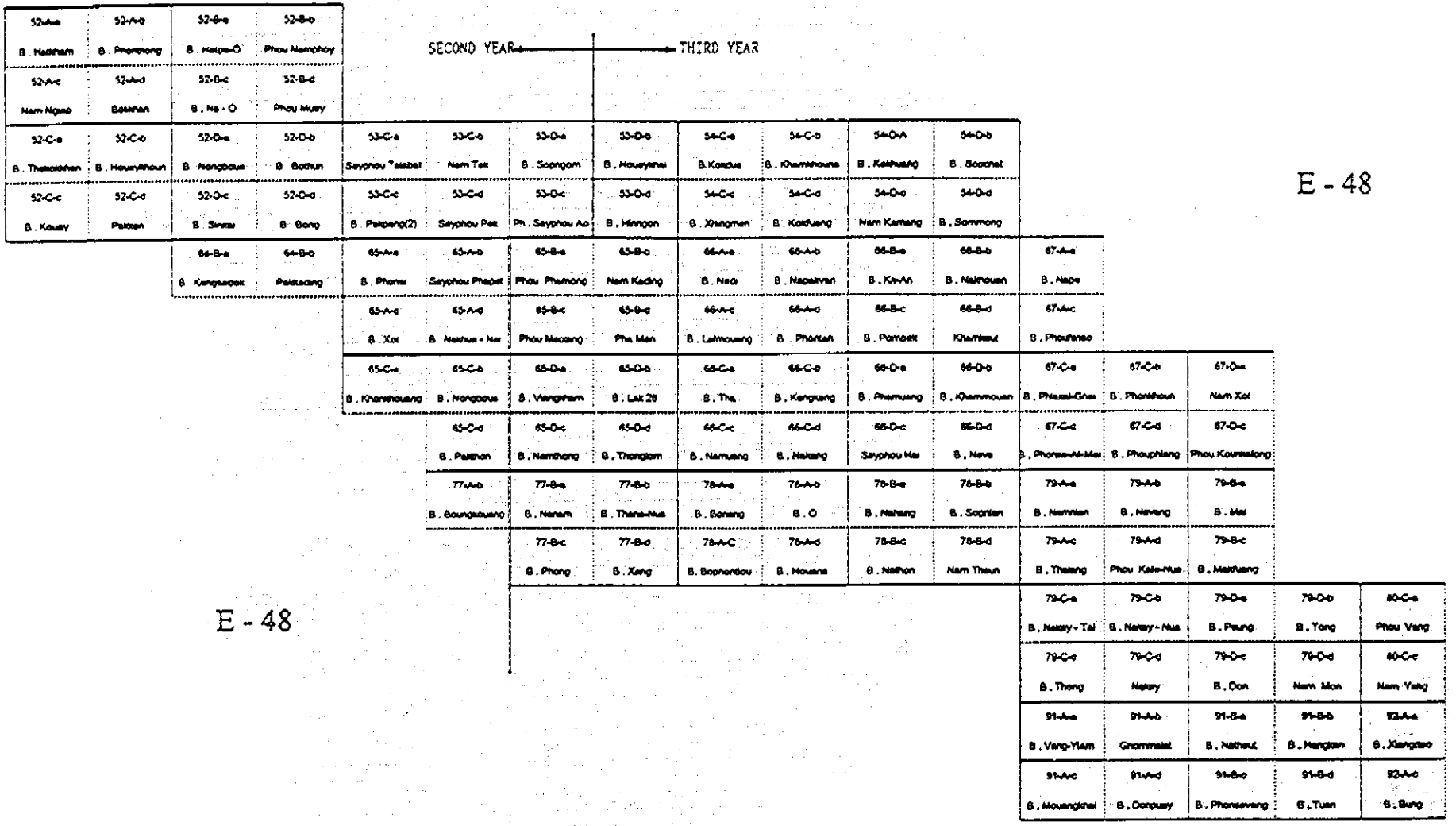
- Confirmation of the results of pre-interpretation,
- Keys for photo-interpretation of topography and ground feature,
- Items difficult to interpret on the aerial photograph including small features and objects such as water facility, control points and etc.,
- Road classification.
- Items necessary for map symbols, such as public buildings, temples,

schools, rivers, vegetation, topography, etc.,

- Collection of toponym and administrative names necessary for annotation on the maps.

Fig. 10

INDEX MAP FOR SHEET NAMES AND NUMBERS



3-7-5 Arrangement of the survey results

The results of the field identification were checked and adjusted on two time-enlarged aerial photos and the collected toponyms were adjusted on the toponym sheets by NGD.

3-8 Stereo plotting

3-8-1 Outline

Based on the results of aerial triangulation and field surveys, geographical data and information to be represented in the topographic maps were measured and delineated by stereo plotting machine to produce restitution manuscripts, plotting was done in Japan. The area to be mapped was in total 13,000 km^2 (second and third year, see Fig.10).

3-8-2 Specifications

Plotting scale	: 1:25,000	
Plotting area	: 13,000 k m^2	
Number of sheets	: 112 sheets	
Projection	: UTM (Zone 48)	
Neat lines	: 7.5' (longitude) × 5' (latitude)	
Contour interval	: 10 m (Index contour 50 m)	
Map sheet material	:Polyester base #500 (Planimetric & contour line)	
	#300 (Control point data sheet)	
Instrument employed	: Coordinategraph XP1100	1 unit
	Autograph A8 (wild), and others	10 units

3-8-3 Preparation of mapping sheets

Neat lines, grid lines, longitude/latitude lines, control points, pass points and tie points were plotted by coordinategraph, with plotting errors not to exceed 0.15mm on the map.

3-8-4 Orientation

Relative orientation was performed by using 6 pass points, with residual parallax not to exceed 0.02mm on the contact film positives.

Absolute orientation was made using pass point and tie point results from aerial triangulation as well as control points and pricked bench marks. Tolerances of

absolute orientation were on the basis of JICA Specification B.
For the sake of accuracy and the orientation of height, as many as pricked leveling points possible in the model were used .

3-8-5 Restitution

From a pair of aerial photographs set on a plotting machine, restitution was executed in accordance with above-mentioned specification. Planimetric features such as road, rivers and topographic features such as contour line were delineated on the same base sheets in accordance with the conventional signs and their application rules as agreed between the Team and NGD in the second year. For the area not verified in the field, keys for photo-interpretation to be applied in restitution work were developed from the existing map 1:100,000 and 1: 50,000 topographic maps, reference materials, survey results of surrounding areas, as well as from the experience gained during the second year.
For restitution, care were taken for the representation of topography such as hill, plain, forest, cultivated land, etc. and the land mark object such as temple, well, school, etc. Since contour lines were very congested especially in distorted surface of karst area, special care were taken for restitution.
In order to keep uniformity among operations, instructions were given to plotting machine operators by preparing operational manual on map symbols and their application rules.

(1) Color allotment of the restitution

Several color ball point pens or pencils were used for restitution and the items to be plotted were classified by color. The color allotment on the manuscript is as follows:

Black - Man made objects (double line roads, houses, buildings),index contour lines, conventional signs of vegetation, embankment and cut, water falls (oblique), indication point, etc.,
Red - Roads (provincial road less than 5m), foot paths, enclosures, small objects, revetment, cave. etc.,
Green - Vegetation boundary, swamp boundary, plants, head line of cutting, etc.,
Blue - Landmark objects, lines related to water, water shore lines, rivers, ponds, etc..
Orange - Principal and intermediate contour lines.

(2) Planimetry and topography sheet

In reference to the field identified aerial photographs, linear objects such as roads, rivers, etc., at the beginning and then houses and buildings, vegetation, etc., in that order, were measured and delineated in compliance with the specifications on the plotting sheets.

-Houses and buildings shall not be generalized because of no congested area such as Vientiane.

-Water shore lines shall be represented as they appear on the aerial photograph.

-In cases of Mekong River, the water shore line shall be measured and delineated on the opposite shore. That is any objects were not represented in the Thailand.

-Contour lines were drawn with care to keep the height accuracy. The interval of the principal contour lines being 10m. It happened that contour lines were too much congested in distorted surface of karst area and steep slope. Even though such case, contour lines were not omitted to represent the topographic characteristics.

(3) Tying to adjacent map sheets

A plotting manuscript was tied with surrounding map sheets. Measurement was made in comparison of the edge area of a map sheet with the corresponding edge area of adjacent map sheets measuring by stereo plotting machine.

(4) Measurement of spot heights

Spot heights were measured photogrammetrically two times and their mean values were adopted for representation in meters at the following conspicuous points. Density of these points were 5-10 points in 100cm^2 on the map as same as in specifications.

-Principal mountain summits and cols,

-Junctions of main roads,

-Distinct kick points of topography,

-Bottoms of depressions,

-Other Points representing local topographic features.

(5) Control point data sheet

Control points and spot heights shall be represented by conventional signs. These names, numbers and the heights were inscribed.

The positions of pricked bench marks shall be measured using stereo plotting machine and their numbers and heights shall be inscribed.

3-8-6 Checking the quality control

After finishing the restitution work, the plotting manuscripts were checked with field identified aerial photographs and collected materials, as well as the examination of their conformity with the map specifications.

3-9 Compilation

3-9-1 Outline

Compilation was carried out in accordance with the map style and its application rule. Map style and its application rule was newly made to modify based on the existing 1/25,000 topographic map by the Team and NGD.

Based on the restitution manuscripts, by incorporating the findings of the field identification and research of existing data, existing map representations were compiled into the compiled manuscripts.

3-9-2. Specifications

Specification of the compilation work (second and third year) are as follows.

Compilation scale	: 1:25,000
Area	: 13,000 km²
Number of sheets	: 112 sheets
Neat lines	: 7.5' (longitude)× 5' (latitude)
Map sheet material	: Compiled manuscript Polyester base #500
	Other data sheets Polyester base #300

3-9-3 Preparation of compilation sheets

Compilation sheets were prepared to plot necessary items such as neat lines, control points and grid lines by an automatic coordinategraph. And also, annotation sheets, road sheets and vegetation sheets were prepared.

3-9-4 Compilation work

Overlay method was applied for compilation work. Putting a compilation sheet over the plotting manuscript, planimetry and topography were compiled on the same sheet.

(1) Allotment of colors

Different colors are allotted on the compilation manuscript as follows:

Black :Man made objects (double line roads, houses, buildings), index

contour lines, conventional sings of vegetation, embankment and cut, water falls (oblique), indication point, etc.

Red :Roads(provincial road less than 5m), foot paths, enclosures, small objects, revetment, cave, etc.

Green :Vegetation boundary, swamp boundary, plants, head line of cutting. etc.

Blue :Landmark objects, lines related to water, water shore lines, rivers ponds, etc.,

Orange :Principal and intermediate contour lines.

(2) Execution of compilation

Compilation was carried out in accordance with the map symbols and their application rules and manners agreed on in mutual technical discussions in the second year. When doubtful points arose during compilation, they were recorded on an overlay in order to give instructions to the study team at the time of field completion. Details of execution are as follows:

<Road>

-Route number boxes put 1 or 2 at appropriate position on each national road, Route 8, 12 and 13.

-For the provincial road, all weather and seasonal road were classified.

-Contour lines in the double line roads was not interrupted.

<Electric power line>

-Allow sign put on the turning point, junction and around tower sign which located near neat line.

<Water tank>

-Neighboring plural water tanks were represent to typical one.

<Water pool and well>

-Public use with permanent water only were represented.

-Neighboring plural wells were represent to typical one.

-Fountain in the villages was shown as same as pump up well.

<Bridge>

-Bridge data (length, width and capacity) collected in the field and provided by

NGD were indicated, but in case of no data, annotation was not indicated.

<Buildings symbol>

-Symbolized buildings such as temple, school, hospital, etc. were not represented in their true shapes, with the symbols put in their centers.

-Directions of symbols were indicated to north.

-In case there were some obstacles, symbols were removed to appropriate positions.

<National boundary>

-The national boundary was indicated on the compilation manuscripts by NGD.

<Forest data>

- Forest data were not indicated in accordance with the technical discussion in the second year.

<Annotation>

- Annotation of the neighboring country was put into administration box of the marginal information sheet. There was no need to annotate for neighboring country on the map inside.
- Abandoned villages were annotated with "B. Hang". In case of no abandoned houses, any annotation was not made at suspected areas.
- Identified villages and area names in the second year's field work were adopted.
- Sub-village(Khoum)was not annotated.
- Public house (called "Hn.L."in Lao) was not annotated.
- Annotation for the destination of road was indicated in Latin at margin.

<Contour line>

- On account of the steep topography, if contour lines were too much congested and it was difficult to represent them, compilation was executed in accordance with the rules and manner as agreed in the second year.

<Spring>

- Hot spring was annotated as "B.N.H"

<Isolated stick rock>

- Isolated stick rocks were symbolized for remarkable ones and others in accordance with the rules and manner agreed in the second year.

<Marginal information>

- Basic design was prepared to modify the existing marginal information of 1/25,000 topographic map in reference to the proposed style agreed in the second year and proposed to NGD in the field completion work.
- Magnetic declinations to be noted on each map sheet were computed by the international formula using the latest international magnetic distribution coefficients.

(3) Preparation of various kinds of data sheets

At the time of compilation, various kinds of data sheets were prepared in order not to rise questionable points while drafting by cartographers.

<Road data sheet>

The roads were classified by colors as follows:

Paved national road	: Red solid line
Unpaved national road(more than 5m width)	: Red broken line
Unpaved national road(less than 5m width)	: Red dot and dashes
Paved provincial road(all seasons with more than 5m)	: Yellow solid line
Unpaved provincial road(-ditto-)	: Yellow broken line

<Vegetation data sheet>

A vegetation data was classified for such items as dense forest, thin forests, bamboo, plantation, etc., that require preparation of mask sheets. Vegetation data were painted in colors on the positives copies of the compiled manuscripts according to the following color scheme.

Dense forests	:Green	Shrub	:Blue
Thin forests	:Yellow	Swamp(a)	:Light blue(a)
Rice field	:Orange	Swamp(b)	:Lightblue with oblique line
Upland rice field	:yellow	Sand terrain	:Brown
Grass, weeds land	:Pink	Gravel	:Brown with oblique line
Plantation (a)	:Red(a)	Rocky terrain	
(b)	:Red(b)	(bare)	:Gray
(c)	:Red(c)	(thin forest)	:Gray with oblique line
Orchard	:Blue with oblique line	Sharp karst topography	:Purple
Bamboo	:Green with oblique line	Isolated stick rock	:Gray

<Hydrography data sheet>

Hydrograph data were shown in blue color for such items as rivers, ponds. Their range covered and breadth shall be shown as well as whether they are permanent or temporary. They were required to prepare the mask sheets as well as the mask of vegetation.

The hydrology data were classified by color as follows:

Double line stream	:Blue paint
Single line stream(more than 5m width)	:Black paint
Single line stream(less than 5m width)	:Green paint
Intermittent stream(more than 10m width) and pond	:light blue paint
Intermittent stream (more than 5-10m width) and pond	:Black broken line
Intermittent stream (less than 5m width) and pond	:Green broken line
Canal, ditch	:Yellow paint

(4) Tying

A map sheet was tied to adjoin sheets.

3-9-5 Checking and quality control

After finishing compilation work, checking was made to find out errors or omissions in representation by the comparison of compilation manuscripts with field identified aerial photographs, to ensure conformity of contour lines with spot heights, map specifications, etc.

3-10 Field Completion

3-10-1 Outline

The field completion involved field survey and verification of important features such as topography, ground features, toponym, that were shown in the compiled manuscripts and data sheets as well as clarification of the questions raised in the process of plotting and compilation. Significant changes that took place after aerial photography were also surveyed in the field.

3-10-2 Planning and preparations

Field completion was planned to make the original topographic manuscripts of the entire areas of 13,000 km^2 for the succeeding work of drafting. Planning and preparation were made as follows.

(1) Preparation of map symbols and their application rules for drafting

To discuss of the final map symbols for drafting with NGD, a draft of map symbols and their application rules were prepared.

(2) Preparation of equipment and materials

Duplication of items listed below were prepared in necessary numbers and by several material types such as polyester type, color copies, chemical paper(SSP).

Compiled manuscript	:ten sets each
Composite of compilation manuscript & annotation	:three sets each
Annotation sheets	:two sets each
Road data sheet	:one set each
Vegetation data sheet	:one set each
Water system sheet	:one set each

(3) Arrangement of unclear and questionable points to duplicates of the completion manuscripts.

(4) Magnetic declination

Magnetic declination for the marginal information was computed from the empirical formula "International Geomagnetic Reference Field' with the latest coefficients and their values were submitted to NGD and discussed.

(5) Preparation of sample trial map

According to the Minutes of Meetings in December 1994, in order to facilitate discussions with NGD on drafting and printing, several sample maps were drafted and printed on a trial. Those were used for the discussions of detail design for the final drafting and printing. Prepared sample maps were as follows:

Sheet No. :65-D-b(BLAK28)

Sheet No. 52-C-d(PAKXAN)

3-10-3 Implementation

Field completion was done with NGD counterparts on site in the following manner, equipped with duplicate sheets of compiled manuscripts.

- Checking of the compilation manuscript to find out the omission, misconception of important items at the time of stereo plotting and/or compilation.
- Clarification of questionable points at the time of stereo plotting and compilation. When necessary, supplemental surveying was executed by

using surveying instruments.

- Confirmation of uncertain points were verified in the field.
- Revision of secular changes.
- Land mark objects not shown on the aerial photographs were surveyed supplementary.
- For supplemental surveying, handy type GPS receiver and plane table were employed to survey the following : objects hidden under trees, newly constructed roads, small objects such as wells, bench marks, water supply systems, etc..

-Checking and supplementing of annotations.

The following were carried out chiefly by NGD in Their Vientiane office.

-Studies and inscription of administrative names and boundaries.

-Preparation of proper toponyms in Lao alphabet and Latin.

-Collection of supplemental data (electric power lines, bridge data, etc..)

3-10-4 Technical meeting with NGD

Technical meetings with NGD were held during the field work. The following topics were discussed between two sides.

-Methodology of the field survey.

-Questionable and unclear items.

-Map symbols and their application rules of the final drawing.

-Marginal information and annotation for drawing.

-Data for administrative boundaries

-Data for annotation(including road classification, road number, destinations, etc.)

-Preparation of proper toponym in Lao alphabet and Latin.

-Specification of colors for printing.

-Others

As a result of discussion about above-mentioned topics, the records of technical discussion were made and accepted as well as a progress report on 20th of December, 1994. (See appendix).

3-10-5 Preparation of original manuscript of the map

After returning from the field to Japan, the original manuscripts for the final drafting were prepared by revising and adjusting the compilation manuscripts by respecting the records of technical discussions.

3-10-6 Checking and quality control

Original manuscripts of topographic maps were closely examined for quality control was prepared.

3-11 Scribing / drafting (cartography)

3-11-1 Outline

Drafting was executed by the scribing method.

In the scribing process, originals scribed base were prepared for each of the five colors based on the draft original maps.

3-11-2 Map symbols and marginal information

Map symbols and marginal information sheet were prepared in accordance with "Map symbols and their application rules for drafting " which was discussed and mutually agreed between The JICA Study Team and NGD.

3-11-3 Material for drafting

Following materials were used depending on the kind of products to be prepared.

Table - 13 Materials

Material	Quantity	Remark
Scribing sheet	112 sheets x 5	Scribed sheet(Red, Black , Blue, Brown, Green)
Polyester sheet	112 sheets x 4	Annotation sheet (Red, Black Blue, Brown)
	112 sheets x 2	Symbol sheet (Black, by manual method)
	112 sheets x 4	Hold out mask(Red, Black, Blue, Brown)
Peel coat	112 sheet x 9	Mask *Red for two kinds of road and congested area *Blue for water area and two kinds of swamp *Brown for a sharp karst topography *Green for vegetation (thin forest, plantation, etc.) *Green for vegetation (dense forest, plantation, etc.)
Strip coat	112 sheets x 9	Mask *Red for two kinds of road and congested area *Blue for water area and two kinds of swamp *Brown for a sharp karst topography *Green for vegetation (thin forest, plantation, etc.) *Green for vegetation (dense forest, plantation, etc.)
Negative film	112 sheets x 7	4 annotation sheets(Red, Black, Blue, Brown) 2 Symbol sheets (Black, Blue) 1 Grid sheet (Black)
Positive film	112 sheets x 3	2 Symbol sheets (Black, Blue) 1 Grid sheet (Black)

3-11-4 Implementation

Drafting was done by the scribing method and, to make color separation plates for 5-color printing, it was performed for each color to produce scribed sheets, mask sheets, and positive film sheets. The color separations were as follows. Composite film was generated to have everything in one sheet for each for the convenience of subsequent plate making.

<u>For black</u>

Scribing sheet : Neat line, ground features (roads, linear features, boundaries, etc.)

Polyester sheet : Annotation (for Latin alphabet)
: Vegetation symbols (putting by manual)
: Hold out mask
Positive film : Grid, symbol sheets
Negative film : Annotation, symbol, grid sheets

For blue
Scribing sheet : Water systems (rivers, lakes, etc.)
Polyester sheet : Annotation of water system (for Latin and Lao alphabet)
: Hold out mask
Mask sheet : Water surface, swamps, aquatic plants
Positive film : Symbol sheets
Negative film : Annotation, symbol sheets

For red
Scribing sheet : Houses, buildings
Polyester sheet : Annotation (for Lao alphabet), and hospital symbol
: Hold out mask
Mask sheet : Roads (national roads and paved provincial roads), congested area
Negative film : Annotation sheet

For green
Scribing sheet : Vegetation boundaries
Mask sheet : Forests, bushes, bamboos, orchards, plantations

For brown
Scribing sheet : Contour lines, undercut slopes, topographic features and their symbols
Polyester sheet : Contour values, relative heights of undercut slopes and topographical symbols
: Hold out mask
Mask sheet : Sharp karst topography
Negative film : Contour values, relative heights of undercut slopes and topographic symbols

(1) Printing of manuscript images

Reverse images of the original manuscripts were printed on diazo coated scribing

sheets. Register holes were punched beforehand for matching of original manuscripts and scribing sheets to serve as guides.

(2) Preparation of marginal information sheet and its duplication

On the marginal information sheet, there are parts common to all the map sheets and parts peculiar to each sheet. The common parts were prepared as a prototype and its duplicates were made for each sheet. Its duplicates were used to make up for the parts peculiar of each sheet.

(3) Scribing

In reference to the images of the original manuscript exposed on a scribing sheet, printed images were scribed separately for each color scribing sheet to obtain the images corresponding to a negative film in photography. When the lines or figures were scribed, different width of lines were scribed in compliance with the specification by using the many kinds of scriber needles.

(4) Preparation of mask sheet

The mask to be used to expose only the part necessary to print half-tone screen or zip-a-tone on the printing plate was prepared. The material was stable polyester sheet coated with shielding film easy to peel off. There were two kinds of coated sheets namely strip coat and peel coat. Either of them was selected depending on the complexity of the figures to deal with.

Strip coat

After laying the strip coat over the scribed sheet, necessary enclosed area was peeled off by hands. This coat was used when the picked-up area was not complicated.

Peel coat

When the peel coat was exposed to light with the scribed sheet, the exposed part was eroded and the coat of this part was washed off while processing. In reference to these eroded lines, the enclosed parts were peeled off by hands. Unnecessary lines were painted out. This sheet was used when the area to be picked up is complicated.

(5) Sticking up of annotations and symbols

Specified types and sizes of letters and numerical figures were prepared by photo-composing machine and they were stuck up on a polyester sheet at specified

place in accordance with the specifications of the annotation sheet of the original manuscript of the map.

Two kinds of annotation sheet were prepared separately to Latin and Lao alphabet for black and red color. In case of the annotation of water parts, it was made in one sheet for blue color.

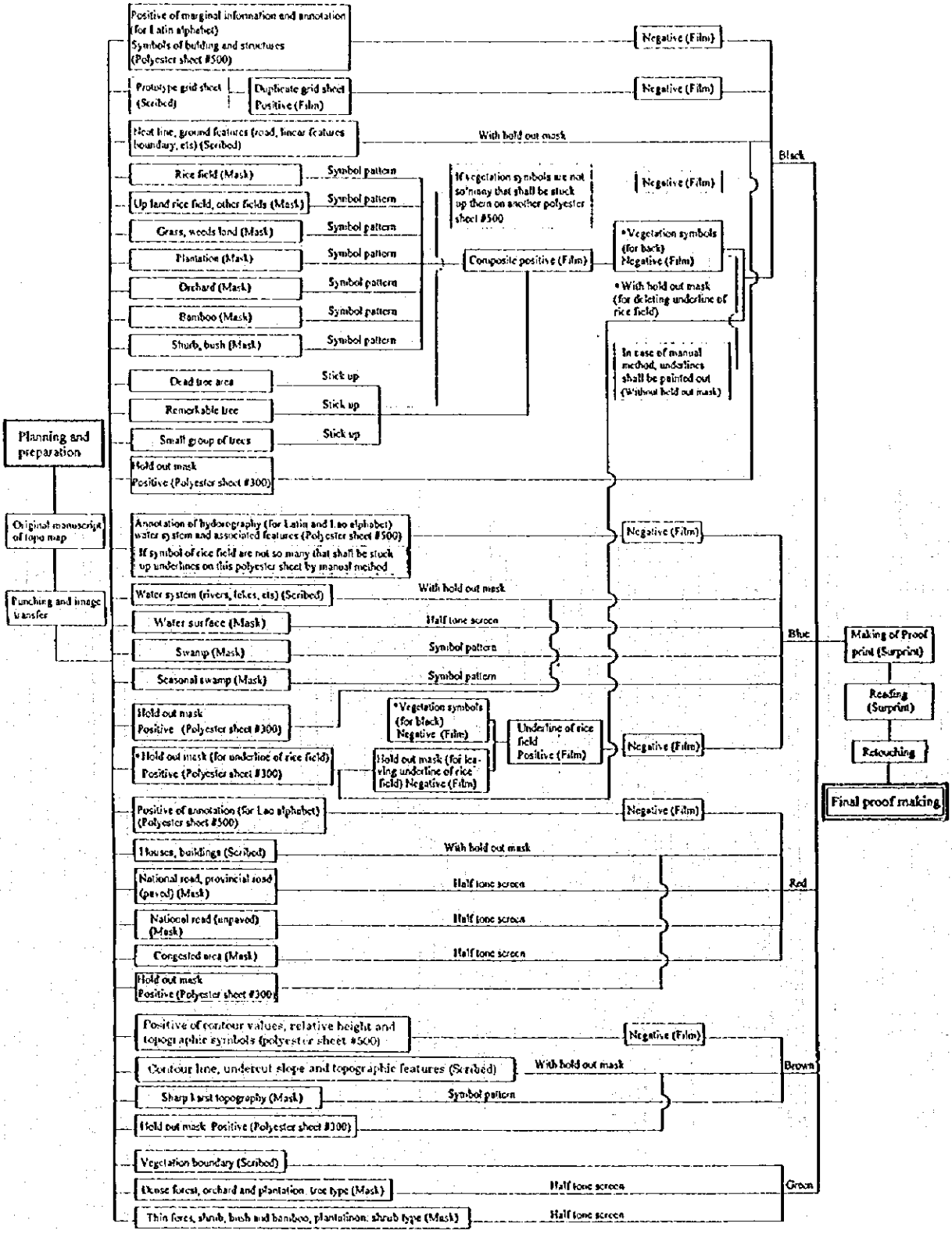
(6) Preparation of positive and negative films

Depending on the preparation procedure of respective sheets, some sheets were prepared in positive type of normal image. However, it was necessary to transform them into of negative type of reverse images for the sake of making printing plates after completion of the work.

3-11-5 Preparation of proof prints and inspection

After finishing the work, proof prints (surprint) were made for drafting final check. Inspection was executed by both JICA Study Team and NGD members in Japan from September to October 1995.

Flow chart of Drafting



Symbol of rice field is shown by two colors, upper arrow part is black, lower underline part is blue

Symbol pattern ≪ ≫ *Zip a tone*

3-11-6 Making of comprehensive positive films

Comprehensive positive films focusing on linear elements were made on the polyester base so as to permit efficient revision of the topographic maps by NGD to keep up with changes over years.

3-12 Printing

3-12-1 Outline

The topographic maps were printed in 5 colors by offset printing method. Printing is the final process of map making. Before going to the press for final printing, proof prints were made and read, and also inspected by Mr. Boualay SAIGNASANE, Deputy Director and Mr. Thongchnh MANISAY, Chief of Planning Section of NGD, who were visiting in Japan.

3-12-2 Plate making

From the negative film for each color based on the scribed draft originals, printing plates were made by photo lithography using aluminum Pre-sensitized plates.

3-12-3 Proof prints

Proof prints were made from printing plates by a flat bed printing machine. The proof prints were checked carefully for the quality of coloring, matching, dimensions, linear elements. Defective sheets were corrected against the scribed originals and re-made. After final proof reading, map sheets were printed to make final products.

3-12-4 Printing paper

Map printing paper of about B0 in size and 90g/m^2 in basis weight was used. The paper was chosen for its quality that is resistant to folding, tension, bursting, and free from contraction/expansion. The test results of the paper performed by an authorized public institution are given in Table 14.

3-12-5 Printing

1,002 copies each of the map sheets were printed by offset printing.

Table 14 Physical and Chemical Characteristics of Printing Paper

Results of Testing					
Item			Average	Maximum	Minimum
Basis Weight (g / m²)			91.0	-	-
Thickness (mm)			0.113	0.115	0.111
Tensile Breaking Strength(kg)	Dry	T	12.0	12.3	11.6
		Y	8.27	8.50	8.00
	Wet	T	3.66	3.90	3.25
		Y	2.89	3.05	2.80
Bursting Strength (kg / cm²)	Dry		4.11	4.45	3.85
	Wet		1.87	2.05	1.70
Tearing Strength (g)		T	117	118	114
		Y	98.0	100.0	96.0
Folding Strength (Time) (M I T Type Tester)		T	1,700	1,900	1,500
		Y	1,900	2,500	1,600
Surface Strength (A)		F	16	16	16
		W	16	16	16
Smoothness (sec)		F	46	54	41
		W	49	56	43
Brightens (%)			85.2	85.2	85.1
Opacity (%)			89.6	90.0	89.4
Degree of Sizing (second)			61	69	57
P H			6.4	-	-
Expansion (%) (RH60~80%)		T	0.067	0.068	0.064
		Y	0.247	0.248	0.244

Note : Wet means the condition in which the specimen has been immersed in water at 20℃ and is soaked with superfluous water.

Room Temperature : 20 ℃

Humidity : 60 %

3-13 Review Comments

3-13-1 Aerial photography

The study area is located between Vietnam and Thailand and, therefore, aerial photography of the border areas required permissions of the governments of the two countries. The permission from the Thai government, however, could not be obtained in time, forcing the survey team to partially change the original plan and add another flight course along the Mekong River to cover the entire study area. As a result if and when NGD wants to do some plotting work based on these photographs in the future, there is a possibility of this additional flight course running along the Mekong River oblique to the normal east-west flight courses making it difficult to select necessary models for plotting when working on portions where it connects with the normal courses, but there was no other recourse to take.

The work of aerial photography progressed smoothly from the start in early January 1993 when the overcast weather continued for about three weeks giving rise to concern that the remaining small area might not be finished in time but, fortunately enough, towards the end of January the weather cleared up permitting the entire planned area to be photographed successfully.

In terms of the navigation system, since the conventional system of flying by referring to the topographic map can sometimes cause a lack of sidelaps thus necessitating re-flights, the GPS navigation system which has come into increasing use in recent years was employed for this project.

As a result, deviations of the flight courses all fell within the specified limits of errors and good results were obtained. No problem was experienced either with respect to photographic intervals and photographic resolution. The only constraint was that photography took place in December to January when the angles of the sun were at the lowest levels of a year causing large shadows in the photos on the northern side of the sharply rising mountains. Care was taken in the photographic processing to soften the effects of these shadows so that they posed no problem in the plotting stage.

The six roles of negative film from this photography were turned over to NGD at their strong request with the permission of JICA head office at the time of the third year field survey.

3-13-2 Control point survey

The control survey was conducted during the dry season so that there was no problem experienced in air transportation by helicopter and land transportation by vehicle. Some of the points as originally planned on the topographic maps turned out to be in the mountains where there were problems of security and government enforcement. As a consequence three of them had to be moved from the originally planned locations to some extent.

The accuracy of GPS observations was less than half of the specified limit of 10^{-5} for every session and therefore good enough for 1/25,000 scale topographic mapping. This was substantiated by the fact that subsequent aerial triangulation proved sufficiently accurate. Pricking of the control points was performed without usual aerial monumentation because in GPS surveying identification of objects in the photographs is easier. This again proves that GPS is a feasible surveying method.

GPS observation results were tested by connecting to nine existing second order traverse points between Vientiane and Thakhe which were part of those established along National Roadway No. 13 by the former Soviet Union in 1981. After confirming there was no incomformity, adjustment computations were performed of the control points with coordinates based on the Everest spheroid. For network adjustment computation, a newly developed program, PAG-U(Universal Program for Adjustment of Any Geodetic Network), was used.

At a strong request of NGD, a side from the prescribed control points survey, a total of six new control points were additionally set up, two each in Pakxan, Lak Xao and Nikkom, all considered to be areas with great potential for future development, located within the study area. They were monumented as follows.

Size: 25 × 25 × 60cm
Material: Ferro-reinforced concrete
Riveting: Cross-shaped riveting

3-13-3 Leveling

Minor order leveling was conducted for areas where there were not enough existing bench marks for aerial triangulation and plotting of 1/25,000 topographic mapping. Namely, by using the bench marks on National Roadway No.13, major inland roads were surveyed for leveling. Observations to connect the newly

established control points to the bench marks were made in as much as possible to determine their elevations. Based on the results of those observations, geoidal correction values were computed for those control points which could not be related to the bench marks.

In accordance with the request of NGD as in the case of the control point survey, 20 points were permanently monumented on the route of Thakhek–Lak Xao–Ban Lao, an area with high potential, at intervals of about 5km to 8km and minor order bench marks were installed. Leveling was made in conformity with the $50mm\sqrt{S}$ (S in the unit of km) as specified in S/W. Judging from the computation results, the accuracy's of third order leveling ($10mm\ \sqrt{S}$) was maintained. The resulting data along with those of the afore-mentioned six newly established control points are kept by NGD and it is hoped that they will be fully utilized in future development projects for the region.

3-13-4 Pricking

Pricking was made of all the control points clearly and successfully on the photographs reflecting the favorable point selection made in the process of the GPS observations. For sections of the leveling route along National Roadway No.13, where there were many missing bench marks, supplementary leveling was conducted so as not to cause inconvenience in aerial triangulation. The minor order bench marks set up on the existing inland roads were pricked at clearly identifiable locations on the 2-time enlarged photographs at intervals of about 2km and utilized for height control in aerial triangulation.

3-13-5 Aerial triangulation

Aerial triangulation was made according to the specifications set to suit the mapping scale of 1/25,000. Thanks to the consistent efforts made to improve accuracy, the standard deviations of the residuals of horizontal positions and elevations at the control points were less than approximately 1/10 of the specified limit.

Reasons for such excellent results include the good quality of the photographic images and properly performed measurement of image coordinates in addition to successful performance of GPS observations and pricking work.

3-13-6 Field verification

The field verification involved identifying names and items to be represented according to the map symbols using aerial photographs in the field and it was conducted with cooperation of NGD counterparts. There were far more contacts with local officials and residents than there were at the time of control point surveying and leveling. Assisted by the NGD counterparts to effectively communicate to keep cooperative relations with the local people , the work proceeded without any trouble.

The map symbols were originally based on the 1/25,000 maps produced in the 1980s covering limited areas with some modifications made later. So there was a constant need to reconsider them in their application and each time such need arose, new rules were set for their applications after serious discussion and repeated consultations with the counterparts.

3-13-7 Plotting and Compilation

No technical problem was encountered in detail plotting. Every effort was made to represent the existing conditions as accurately as possible. In delineation of contour lines for areas with unusual rock and land formation due to karst in particular, every care was taken to reflect fine ups and downs in the surface.

Similarly for karst landform with steep slopes, it was attempted to represent such landform with contour lines without using any symbols such as for rock walls and the attempt proved to be most effective because it led to the best results.

With regard to housing, since villages were scattered in the study area including the provincial capital of Pakxan, all housing units were represented individually. In compilation, care was taken to maintain uniformity and consistency between map sheets so that there would be no such sheets that were different from others in levels of detail representation.

3-13-8 Field completion

Field completion a process of critical importance for making draft topographic maps. Color copies of the compiled draft maps were most effectively used because they showed different colors of lines and symbols exactly as they appeared in originals to help avoid confusion otherwise possible in black and white.

Changes that had occurred in the terrains and geographical features after the

time of aerial photography were incorporated by making necessary modifications according to the survey specifications. With respect to the sections of National Roadway No.13 and the Nam Theum bridge section of National Roadway No.8 which were both under construction at the time of this surveying were represented by assuming they were completed as requested by NGD which provided necessary information for doing so.

Annotations of names of places and villages including those of Lao letters were confirmed by referring to the existing data and checking with local people with cooperation of the NGD counterparts.

The national boundaries with Thailand and Vietnam were incorporated based on data and information made available by government agencies concerned at the request of NGD. The provincial boundaries were based on the data and information which NGD counterparts gathered from the municipal offices and supplied to the survey team.

3-13-9 Drafting and Printing

The map symbols and their application rules and marginal information that were applied in this project were determined after due consultations with NGD based on the existing 1/25,000 scale maps. It is hoped that these map symbols and their applications will be further organized and compiled into a new set of standard for use in future projects of larger nationwide scales.

ATTACHMENTS

Scope of Work

SCOPE OF WORK

FOR

THE TOPOGRAPHIC MAPPING OF BOLIKHAMXAI PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

AGREED UPON BETWEEN

NATIONAL GEOGRAPHIC DEPARTMENT

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Vientiane, August 12th, 1992

Mr. Thongpene SOUKLASENG
General Director of
National Geographic
Department

Mr. Yoshio Baba
Leader of the Preparatory
Study Team,
Japan International
Cooperation Agency (JICA)

I. INTRODUCTION

In response to the request of the Government of Lao People's Democratic Republic (hereinafter referred to as "Laos "), the Government of Japan decided to conduct the Topographic Mapping of Bolikhamxai Province in Lao People's Democratic Republic (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan, will undertake the Study, in close cooperation with the authorities concerned of the Government of Laos.

The National Geographic Department (hereinafter referred to as "NGD") shall act as counterpart agency to the Japanese study team (hereinafter referred to as "the Team") and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

The present document sets force the Scope of Work with regard to the Study.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the 1/25,000 Topographic Maps covering the area of approximately 13,000 km² (Appendix-1).

III. SCOPE OF THE STUDY

In order to achieve the above mentioned objective, the Study will cover the following items. (The Technical details are shown in Appendix-IV.)

1. Aerial Photography

Aerial photographs shall be taken at the scale of approximately 1/40,000. Setting of air-photo signals shall be done, if necessary, prior to commencement of the aerial photography.

2. Ground Control Point Survey

Although existing control points will be used for the topographic mapping, establishment of new control points shall be carried out, if necessary.

2.1 Horizontal Control Point Survey

Supplementary horizontal control points necessary for aerial triangulation and mapping work shall be established by GPS survey.

2.2 Vertical Control Point Survey

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

3. Pricking

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

4. Field Identification

The topographic map information related to land use, vegetation, etc. shall be verified in the field using aerial photographs.

International and administrative boundaries and geographical names shall be prepared and verified.

5. Aerial Triangulation

Aerial Triangulation shall be carried out by analytical block adjustment method.

6. Stereo Plotting

Stereo Plotting shall be carried out using stereo plotting instruments.

7. Compilation

Compilation shall be carried out based on restitution manuscripts and field identification data.

8. Field Completion

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

9. Drafting

Based on the compilation sheet, scribing shall be carried out on stable polyester base for several color separation plates. Map style and symbols shall generally be based on those adopted by NGD.

10. Printing

Plate making shall be carried out using 1/25,000 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 attached tentative schedule (Appendix – II).

V. REPORTS AND FINAL RESULT

A progress report in English shall be presented to NGD by JICA every fiscal year (from April to March) except the final year, and the final report in English shall be presented upon completion of the Study.

The materials mentioned in Appendix- III will be submitted to NGD by JICA. These materials will belong to the Government of Laos after having completed the whole of work.

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

This map was prepared jointly by Japan International Cooperation Agency (JICA) under the Japanese Government Technical Cooperation Program and the Government of Laos.

VI. UNDERTAKING OF THE GOVERNMENT OF LAOS

1. To facilitate smooth conduct of the Study, the Government of Laos shall take necessary measures;
   (1) to secure the safety of the Team,
   (2) to permit the members of the Team to enter, leave and sojourn in Laos for the duration of their assignment therein, and exempt them from foreign registration requirements and consular fees,
   (3) to exempt the members of the Team from taxes, duties and other charges on equipment, machinery and other materials brought into Laos for the implementation of the Study,
   (4) to exempt the members of the Team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to them for their services in connection with the implementation of the Study,
   (5) to provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into Laos from Japan in connection with the implementation of the Study,
   (6) to secure permission for entry into all necessary areas for the implementation of the Study,
   (7) to secure permission for the Team to take all necessary data and documents, including original negatives of aerial photos, related to the Study out of Laos to Japan, and,
   (8) to provide medical services as needed and its expenses will be chargeable on the members of the Team.

2. The Government of Laos shall bear claims, if any arises against the members of the 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 Team.

3. To facilitate smooth conduct of the Study, NGD shall take necessary arrangements for the Team as follows, in cooperation with other relevant organizations;
   (1) to secure permission for the flight for the aerial photography and use of an airport for the implementation of the Study,
   (2) to secure permission for the use of communication facilities including transceiver, and,
   (3) to obtain the agreement of adjacent countries for the implementation of the aerial photography and survey work along the international boundary.

4. NGD shall, at its own expense, provide the Team with the followings in cooperation with other related organizations;
   (1) available data and information related to the Study,
   (2) counterpart personnel (staff of NGD),
   (3) suitable office space with necessary equipment, in Vientiane,

(4) credentials or identification cards to the members of the Team,

(5) administrative and technical support,

(6) existing facilities and space of NGD for processing aerial photographs,

(7) information of necessary administrative boundary and geographical names on the maps at its full responsibility, and,

(8) annotation materials.

VII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures.

1. To dispatch, at its own expense, the Team to Laos for Aerial Photography, Ground Control Point Survey, Pricking, Field Identification and Field Completion.
2. To carry out Aerial Triangulation, Stereo Plotting, Compilation, Drafting and Printing in Japan at its own expense.
3. To pursue technology transfer to Laos counterpart personnel in the course of the Study.

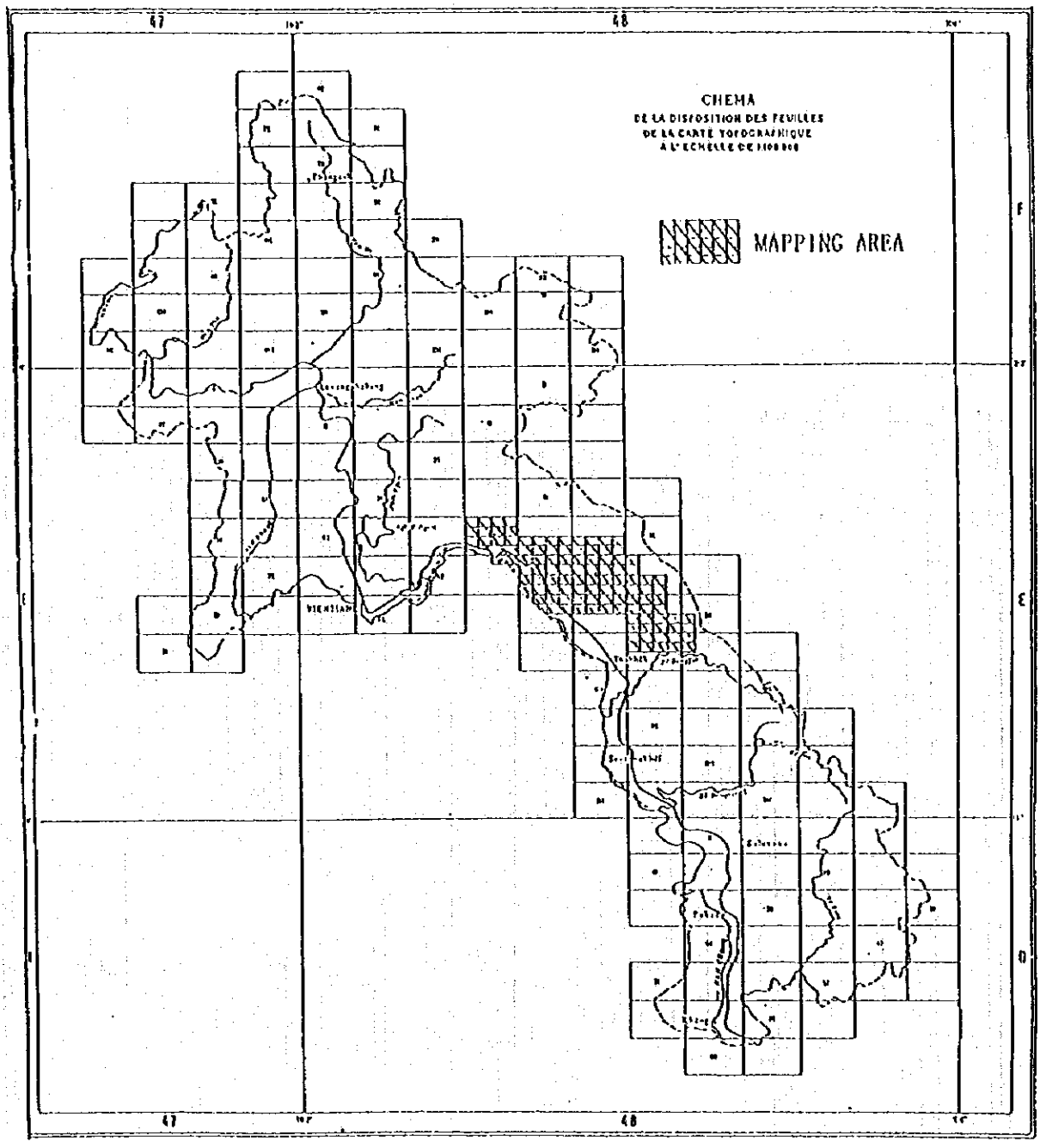
VIII. CONSULTATION

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

APPENDIX-I

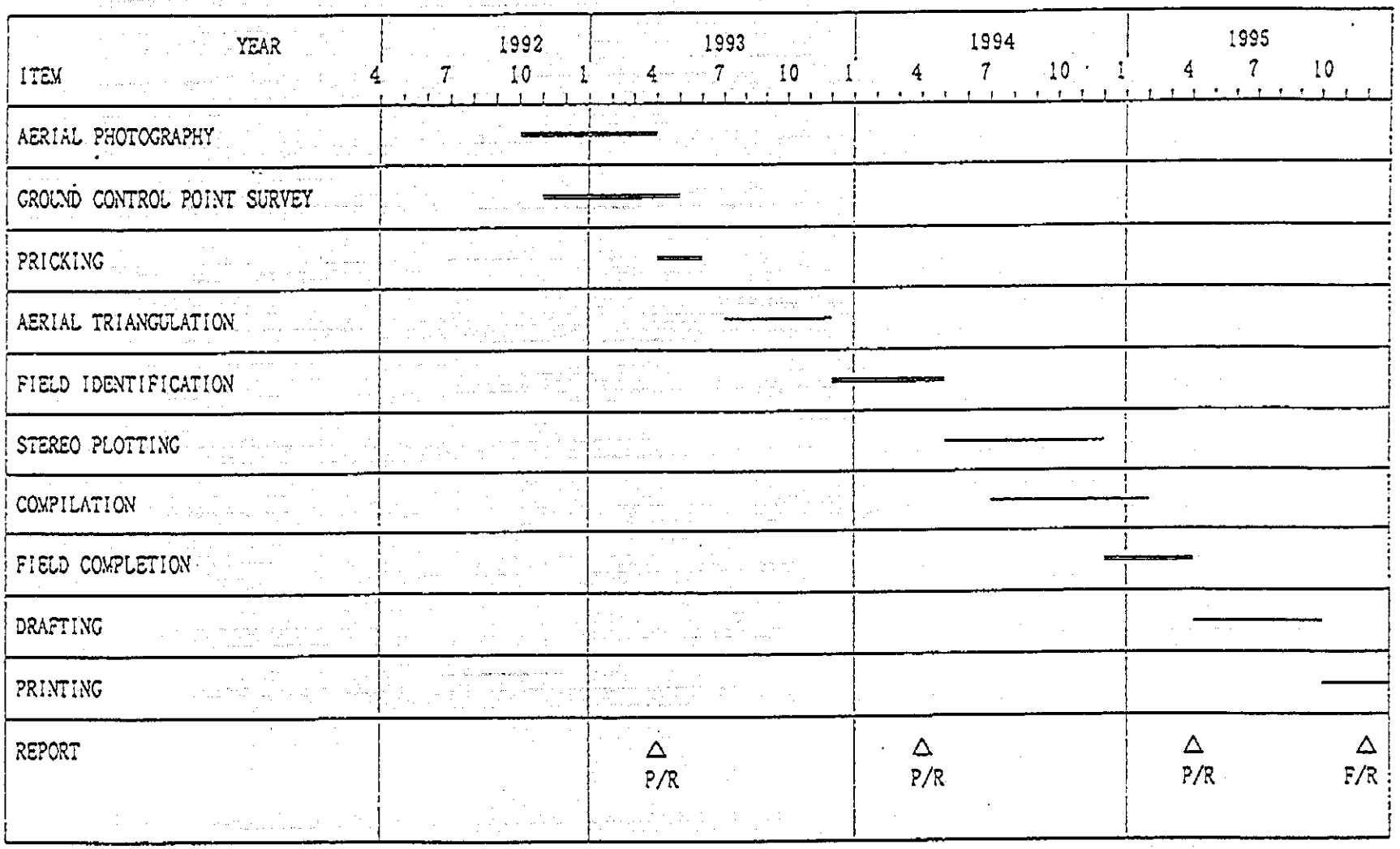
MAPPING AREA

REPUBLIQUE DEMOCRATIQUE POPULAIRE LAO



APPENDIX-II

TENTATIVE IMPLEMENTATION SCHEDULE



NOTE: ——— WORK IN LAOS
——— WORK IN JAPAN
P/R PROGRESS REPORT
F/R FINAL REPORT

APPENDIX- III

FINAL RESULTS

1. Aerial Photography

(1) original negative-film (1set)

(2) contact positive prints (1set)

(3) index map of aerial photographs

2. Ground Control Point Survey

(1) final result tables

(2) distribution and route diagram

(3) computation sheets

3. Pricking

(1) description of pricking

4. Aerial Triangulation

(1) final result table

(2) diapositive films (1set)

5. Topographic Mapping

(1) original manuscripts

(2) separate scribed sheets

(3) combined negative films for reproduction

(4) printed maps (1000 copies for each sheet)

APPENDIX- IV

TECHNICAL DETAILS

1. Aerial photography : wide angle camera

2. Control Point Survey

(1) Planimetric relative accuracy : 10^{-6}

(2) Levelling accuracy : $5cm\sqrt{s}$ s:km

3. Mapping

(1) Projection: UTM Projection

(2) Sheet Line: 5' x 7.5' in Latitude and Longitude

(3) Contour Interval: 10m

(4) Number of Colors: 5 colors

4. Map Accuracy

(1) Planimetry : 1.0 mm on the map

(2) Spot Height : 2/3 of contour interval

(3) Contour Line : 1/1 of contour interval

MINUTES OF MEETING

ON

SCOPE OF WORK

FOR

THE TOPOGRAPHIC MAPPING OF BOLIKHAMXAI PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

AGREED UPON BETWEEN

NATIONAL GEOGRAPHIC DEPARTMENT

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Vientiane August 12th, 1992

Mr. Thongpene SOUKLASENG
General Director of
National Geographic
Department

Mr. Yoshio BABA
Leader of the Preparatory
Study Team,
Japan International
Cooperation Agency (JICA)

The meeting on the Scope of Work for the Topographic Mapping of BOLIKHAMXAI Province in LAO PEOPLE'S DEMOCRATIC REPUBLIC (hereinafter referred to as "the Study") were held in Vientiane, on August 3th through to August 12th, 1992, between Japanese Preparatory Study Team (hereinafter referred to as "the Team") headed by Mr.Yoshio Baba and the National Geographic Department (hereinafter referred to as "NGD") headed by Mr.Thongpene SOUKLASENG.

The list of attendants is shown in APPENDIX.

Both teams agreed to the Scope of Work and it was signed on August 12th, 1992. In addition to the Scope of Work, the following are main items discussed between both sides.

(1) NGD requested to change the mapping area, and the Team agreed it because the mapping area is within approximately 13,000km².

(2) The area of taking aerial photographs is approximately 13,000km².

(3) The procedure necessary for the permission of taking aerial photographs shall be undertaken by NGD.

(4) The arrangement of taking aerial photographs along the boundary between Laos and adjacent countries shall be undertaken by NGD. If the arrangement cannot be attained before the stage of aerial photography in the Study, aerial photographying and plotting near the boundary shall not be conducted.

(5) NGD requested that Monumentation shall be conducted, and both agreed that Monumentation shall be conducted by NGD, if necessary.

(6) The Team explained that in case the control points cannot be set in proper positions due to the security problem and the difficulty of access, the accuracy of maps shall decrease in

some parts of mapping area, and NGD agreed.

(7) The investigation of the geographical names, international and administrative boundaries shall be undertaken by NGD.

(8) NGD requested that the geographical names should be written in both Latin and Lao alphabet, and both agreed that annotation shall be written in both alphabets, and annotation plate in Lao alphabet shall be prepared before the stage of drafting by NGD.

(9) The Team requested that JICA will keep two sets of printed maps, and NGD agreed.

(10) NGD requested that JICA prepare the vehicle for the Study because NGD does not have appropriate vehicles for the Study, and the Team agreed.

(11) NGD requested to include the calibration data of aerial camera into final results, and the Team agreed to submit it to NGD if JICA can get it from the company who takes aerial photographs.

(12) The procedure necessary for the permission of using transceiver shall be undertaken by NGD.

(13) NGD requested to add in the objective of the Scope of Work as the second point "Technology transfer to Lao stuff".

(14) NGD requested the Counterpart training in Japan, and the Team promised to convey the request to Japanese authorities concerned.

APPENDIX Attendants of Meetings

(JAPAN SIDE)

The Preparatory Study Team

Mr. Yoshio BABA	Director of Map Management Department Geographical Survey Institute, Ministry of Construction
Mr. Hiromitsu MARUYAMA	Head, Photogrammetric Engineering Research Office, Topographical Department Geographical Survey Institute, Ministry of Construction
Mr. Yasuo IDE	Technical Management Officer, Topographical Department Geographical Survey Institute, Ministry of Construction
Mr. Hiroshi MAGOME	Japanese Association of Surveyors
Mr. Toshiaki TANIGAWA	Japanese Association of Surveyors
Mr. Kazushige ENDO	First Development Study Division, Social Development Study Department, Japan International Cooperation Agency
Mr. Kiyoshi OMAMEUDA	Second Secretary, Embassy of Japan

APPENDIX Attendants of the Meetings

(LAOS SIDE)

Mr. Thongpene SOUKLASENG	General Director of National Geographic Department
Mr. Khamkhong DETCHANTHACHACK	Deputy Director of National Geographic Department
Mr. Thongchanh MANIXAI	Chief of Planning Section National Geographic Department
Mr. Bounkong SOUGNATTY	Chief of Survey Division National Geographic Department
Mr. Bouasol SOUVANNAKOUMMANE	Chief of Photogrammetry Section National Geographic Department
Mr. Neuang XAIPANGNA	Chief of Cartography Division National Geographic Department
Mr. Sy SENGDARA	Chief of Equipments and Materials Supply Division National Geographic Department
Mr. Phouangphanh SAYASANE	Deputy Chief of Cartography Division National Geographic Department

Minutes of Meetings

on

Plan of Operation

(December 24, 1992)

MINUTES OF MEETINGS

FOR

THE TOPOGRAPHIC MAPPING

OF

BOLIKHAMXAI PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

BETWEEN

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM

AND

NATIONAL GEOGRAPHIC DEPARTMENT

The JICA Study Team (referred to as the Team hereafter)headed by Mr. Tositomo KANAKUBO visited Laos on 12th of December, 1992 to carry out the First Year Work for technical cooperation of the Topographic Mapping of Bolikhamxai Province in Laos.

A series of meeting were held at the National Geographic Department (referred to as the NGD hereafter) on the 14th,15th,16th and 22nd of December, 1992 and the following items were discussed and mutually agreed upon between the NGD and the Team.

The list of the Attendants is shown in Annex.

1. The Plan of Operation proposed by the Team was discussed and agreed by the NGD, and is attached in Appendix I.

2. The monumentation of the ground control points were discussed by the NGD and the Team.

The Team explained that the ground control points for the photogrammetric work of this Mapping Project will be temporary monuments, in accordance with the Scope of Work agreed upon for this project.

The NGD strongly requested to the Team to establish some monument of control point at important area.

In conclusion,the Team accepted to establish the permanent monuments of six(6) ground control points in the Study area.

T.K.

3. The Team informed NGD that flight plan shall be modified along the national boundary, if the flight parmission of neighbor country would not obtain before the stage of aerial photography in the Study, and The NGD agreed.

4. The Team explained to NGD that the parameter is required for the transfer of requested spheroid (Evelest 1830) and used spheroid (krassovsky), and requested to supply the necessary data.

The NGD left the method for transfer of the spheroid to the Team because of no available data, and the Team agreed.

5. Concerning the adjustment between existing topographic map (1/50,000) and expecting new map (1/25,000) ,both side confirmed it is not necessary to adjust between both maps.

6. The NGD requested the Team and JICA Advisory Group to provide a technical training in Japan for the NGD counterpart personnel for each stage of the Works.

The Team replied that they would convey the request to the JICA Headquarters.

At Vientiane, 24th Dec.1992

Mr.Boualay XAIGNASANE
For General Director of National
Geographic Department

Tositomo Kanakubo

Mr.Tositomo KANAKUBO
Leader of the JICA study
Team

ANNEX: List of the Attendants of the Meeting

Laos side

Mr.Thongpene SOUKLASENG	General Director of National Geographic Department
Mr.Boualay XAIGNASANE	Deputy Director of National Geographic Department
Mr.Khamkhong DETCHANTHACHACK	Deputy Director of National Geographic Department
Mr.Thongchanh MANIXAY	Chief of planning Section
Mr.Bounkong SOUGNATY	Chief of Survey Division
Mr.Bouasoth SOUVANNAKOUMMANE	Chief of Photogrammetry Section
Mr.Phouangphane SAYASANE	Deputy Chief of Cartography Division

Japanese side

Mr.Tositomo KANAKUBO	Leader
Mr.Koichi MIKI	Deputy Leader
Mr.Yasuo TANAKA	Mapping Planner
Mr.Fujio ITO	Chif Surveyor
Mr.Hideto HOSODA	Photo-Inspector
(Advisory Group)	
Mr.Hideo SHOJI	Geographical Survey Institute
Mr.Kazushige ENDO	Japan International Cooperation Agency

TK.

PLAN OF OPERATIONS

FOR

THE TOPOGRAPHIC MAPPING

OF

BOLIKHAMXAI PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

---------- 1st Year ----------

December 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

PLAN OF OPERATIONS
FOR
THE TOPOGRAPHIC MAPPING OF BOLIKHAMXAI PROVINCE
IN
LAO PEOPLE'S DEMOCRATIC REPUBLIC

I. INTRODUCTION

In June 1991 the government of Lao People's Democratic Republic (referred to as Laos hereinafter) made a request to the government of Japan to provide technical cooperation for the topographic mapping of Bolikhamxai Province (referred to as the Study hereafter) after recognizing the importance it has as basic survey for planning and implementation of various projects.

In response to the request and acting on behalf of the Japanese government, the Japan International Cooperation Agency (referred to as JICA hereinafter) sent a Preparatory study team to Laos over a period of mid-August to late August 1992 to have talks with the National Geographic Department (referred to as NGD hereinafter), the counterpart agency on behalf of the Laotian government.

After a series of talks and studies the two governments agreed to the Scope of Work on the Topographic Mapping of Bolikhamxai Province (referred to as S/W hereinafter).
The Study as agreed based on the S/W as above involves the topographic mapping of Bolikhamxai Province of Laos taking four years (37 months). JICA dispached a study team(referred to as the Team hereinafter) for the inplementation of the Study for the first year starting December 1992 lasting until February 1993.

II. OBJECTIVE OF THE STUDY

1.Base Map Preparation

Based on the request from the Laotian government, the topographic maps as specified below are to be produced to serve as basic material for planning of development/conservation projects in Bolikhamxai Province.

Scale : 1:25,000. Neat lines : 5' X 7.5'

A total of 112 maps sheets in 5 colors.

2.Technology Transfer

Technology transfer is to be made of map making technology through the Study to Laotian counterparts.

III. STUDY AREA

The study area in central Laos encompassing some 13,000Km² defined by north latitudes ranging from 17' 30' to 18' 40' and east longitudes from103' 30' to 105' 37.5' as shown in the map at the head of this document.

IV. STUDY GUIDELINES

The study will be conducted in accordance with S/W, minutes of meetings,JICA procedural rules for overseas surveying work(base mapping).

1.Aerial photography: Panchromatic vertical aerial photo graphy shall be taken at a scale of 1:40,000 covering the entire study area using a wide angle lens.

2.Ground control point survey: Control points for aerial triangulation and plotting are observed and pricked on the aerial photos for both horizontal and vertical control points.

3.Pricking: Pricking of above points and identified established horizontal and vertical control points shall be performed on enlarged photos.

4.Aerial triangulation: Aerial triagulation shall be performed based on the ground control point survey data. Adjustment computations shall be made analytically by the block adjustment method.

5.Field identification: Ground features that need to be represented in the maps such as landuse, vegetation, etc. on the aerial photos shall be identified on site.Place names to be adopted shall be confirmed on site referring to the information provided by NGD. Cooperation of NGD is sought for collection and recording of geographic and administrative names that are necessary for compilation.

6.Stereo plotting : Stereo plotting shall be made at a 1:25,000 scale by stereo plotting machine.

7.Compilation : Compilation shall be performed taking field survey findings into consideration.

8.Field completion: Those features that are not indentifiable on maps shall be verified on site and shown on compilation manuscripts. Administrative boundaries and national borders are delineated by NGD on compilation manuscripts or their copies.(To complete the original manuscripts)

9.Drafting : Based on the original manuscripts prepared above, original draft maps shall be producted for plate making and printing. A color separate negative scribing method shall be applied for this process. Map symbols and marginal information for use shall be determined through the discussions between the Team and NGD. Annotations in Laotian letters to be shown along with romanized ones shall be provided NGD.

10.Printing: Printing plates shall be prepared by photo lithography from original draft maps, 1002 copies for each map sheet shall be produced by offset printing machine in five colors.

Work volumes and standards for respective work items is shown table 1 and 2.

Work volume of the Study (Table 1)

ITEM	VOLUME	REMARK
1.Aerial photography	approx.13,000km^2	scale 1/40,000(approx.920 pcs.)
2.Ground control survey by GPS	approx.29 points	including 3 known points
3.Leveling	approx.580km	
4.Pricking		
GPS point	29 points	including 3 known points
Travers point	7 points	
Established B.M.	approx.143km	
New leveling line	approx.580km	
Aerial triangulation	approx.817 model	
Field identification	approx.13,000km^2	
Plotting	approx.13,000km^2	scale 1/25,000(112 sheets)
Compilation	approx.13,000km^2	scale 1/25,000(112 sheets)
Field completion	approx.13,000km^2	
Drafting	approx.13,000km^2	scale 1/25,000(112 sheets)
Printing	112 sheets	

Standord of the Study(Table 2)

Reference ellipsoid	: Everest 1830
Map projection	: U.T.M Zone 48
Datum of height	: Mean sea level of South China sea at Viet Nam
Map scale	: 1:25,000
Neat lines	: 5' x 7.5'
Contour line	: Intermediate contour 10m Supplementary half cntour 5m, subject to topography.
Map style and its application rule	: Those adopted by NGD
Ground control point survey	: 1/100,000
Leveling	: 5cm$\sqrt{s}$ s:km
Number of colors	: 5 colors
Map accuracy	
a.Planimetry	:not more than 1.0mm on the map
b.Spot height	:not more than 2/3 of contour interval
c.Contour	:not more than 1/1 of contour interval

V. DIVISION OF WORK

The Study shall be conducted in close cooperation between the two countries of Laos and Japan. Responsibilities of each side set forth in S/W (as attached) are summarized as follows:

1.Laotian side:
- -Necessary arrangements to ensure the entry, exit and stay of the team members as well as personnel of an aerial photography company contracted by the Team for the Study together with related materials and equipment (collectively referred to as Survey Team) to bring in and out of Laos.
- -Assistance to facilitate issuance of permits necessary for implementation of the survey work.

2.Japanese side:
- -Implementation of the Study in Laos and Japan.
- -Technology transfer through the execution of the Study.

VI. WORK PLAN

The Study shall be planned for four years from December 1992 to July 1995 and implemented in the following five phases.

1.Phase 1 (First Year :1992)

Aerial photography and Ground control point survey-1(horizontal control point survey)

1-1.Aerial photography

Aerial photography shall cover the entire study area of approximately 13,000Km² at a 1:40,000 scale using a wide angle lens (f=15cm) and panchromatic film.

1-2.Ground control point survey-1(horizontal control survey)

For the horizontal control of the aerial triangulation, GPS surveying shall be conducted to ensure the accuracy of aerial trianguration. Some of such points shall be tentatively monumented to be completed later by NGD.

Prior to the control point survey, existing control points shall be surveyed in order to connect the survey results to the Vientiane Datum.

2.Phase 2 (Second Year, Part 1:1993)

Ground control point survey-2 (vertical control point survey),pricking and aerial triangulation

2-1.Ground control point survey-2 (vertical control point survey)

Existing bench marks are concentrated along No.13 National Road and therefore not good enough in number and distribution for control of elevations in aerial triangulation . In order to secre the accuracy of height control of aerial photos, minor order leveling shall be conducted along other roads. The survey shall be made by direct leveling in principle but for mountainous areas and those routes where access is difficult,indirect leveling may be applied using theodolite,EDM(Electric Distance meter) and other related equipment or GPS units.

2-2.Prickng

Pricking shall be performed for above mentioned GPS control points, existing second order traverse points and bench marks well as for minor order leveling points. Eccentric points are set and pricked at clearly identifiable points on 2-time enlarged aerial photos and elements of eccentricity shall be measured to compute coordinate values. Pricking of minor order leveling points is done at the time of observations.

2-3.Aerial triangulation

Based on the field survey results and the 1:40,000 aerial photos, coordinates of pass points and tie points necessary for plotting shall be determined. Adjustment computation shall be performed for about 817 models using PAT-M43, a block adjustment program based on independent models.

Descrepancies between pass points of adjacent models and tie points of adjacent flight courses should be within:

Flight altitude X 0.8 ‰ (6,000 X 0.8 ‰ ≒ 4.8m) for both vertical and horizontal coordinates.

3.Phase 3 (Second Year, Part 2: 1993)

Field identification,stereo plotting and compilation

3-1.Field identification

Field identification shall be conducted using 2-time enlarged aerial-photos Map symbols and application criteria shall be set as agreed to by NGD.

Prior to the survey, preliminary study for interpretation shall be made to the best possible extent fully utilizing aerial-photos and other available materials. In the field, key for photo interpretation of landuse/vagetation, for example shall be collected and confirmed.

Roads linking,scattering villages and communities shall be identified. And items for map representation are selected.

Administrative boundaries and place names shall be based on data and information to be supplied by NGD.

3-2.Stereo plotting

Based on the results of aerial triangulation and field identification, all items to be shown on 1:25,000 topographic maps shall be read out from the 1:40,000 aerial photos and delineated at 1:25,000 by plotting machine to produce restitution manuscripts. Detailed terrain features and vegetation shall be carefully measured/interpreted.

Intermediate contour lines shall be drawn every 10 meters and, as necessary, half interval contours at 5 meters.

3-3 Compilation

Restitution maps shall be compiled according to the field identification findings and made into compilation manuscripts with specified symbols.

The neat lines shall be 5'X 7.5'. The stereo plotting and compilation processes shall partly be continued to the third year.

4.Phase 4 (Third Year:1994)

Stereo plotting, compilation, and field completion

4-1.Stereo plotting and compilation

They shall be continued from the Second Year to be completed in the first half of this year.

4-2.Field completion

Terrain features, ground features, place name as represented on the compilation manuscripts as well as those features that were not clear enough in the stereo plotting and compilation processes shall be checked and verified on site. Important changes that have happened in the meantime,if any, shall be incorporated and modified.

At the time of the field completion,test-printed sheet shall be prepared for discussion with NGD to finalize the colors and other matters.

5.Phase 5 (Fourth Year:1995)
Drafting and printing

5-1.Drafting

Based on the original manuscripts complete in the field, original draft shall be prepared for making 5-color printing plates.
For drafting,color separation negative scribing method shall be applied. The original draft shall consist of scribed sheets,masking sheets,annotation/marginal information sheets.
Annotation shall be in both Latin&Lao alphabet. Laotian versions shall be prepared by the Laotian side. Every map sheet to be produced in this survey work shall have the following annotation printed in the blank space below the map.

This map was prepared jointly by Japan International Cooperation Agency (JICA) and Lao National Geographic Department(NGD), Lao People's Democratic Republic under the Technical Cooperation Programme of the Japanese Government

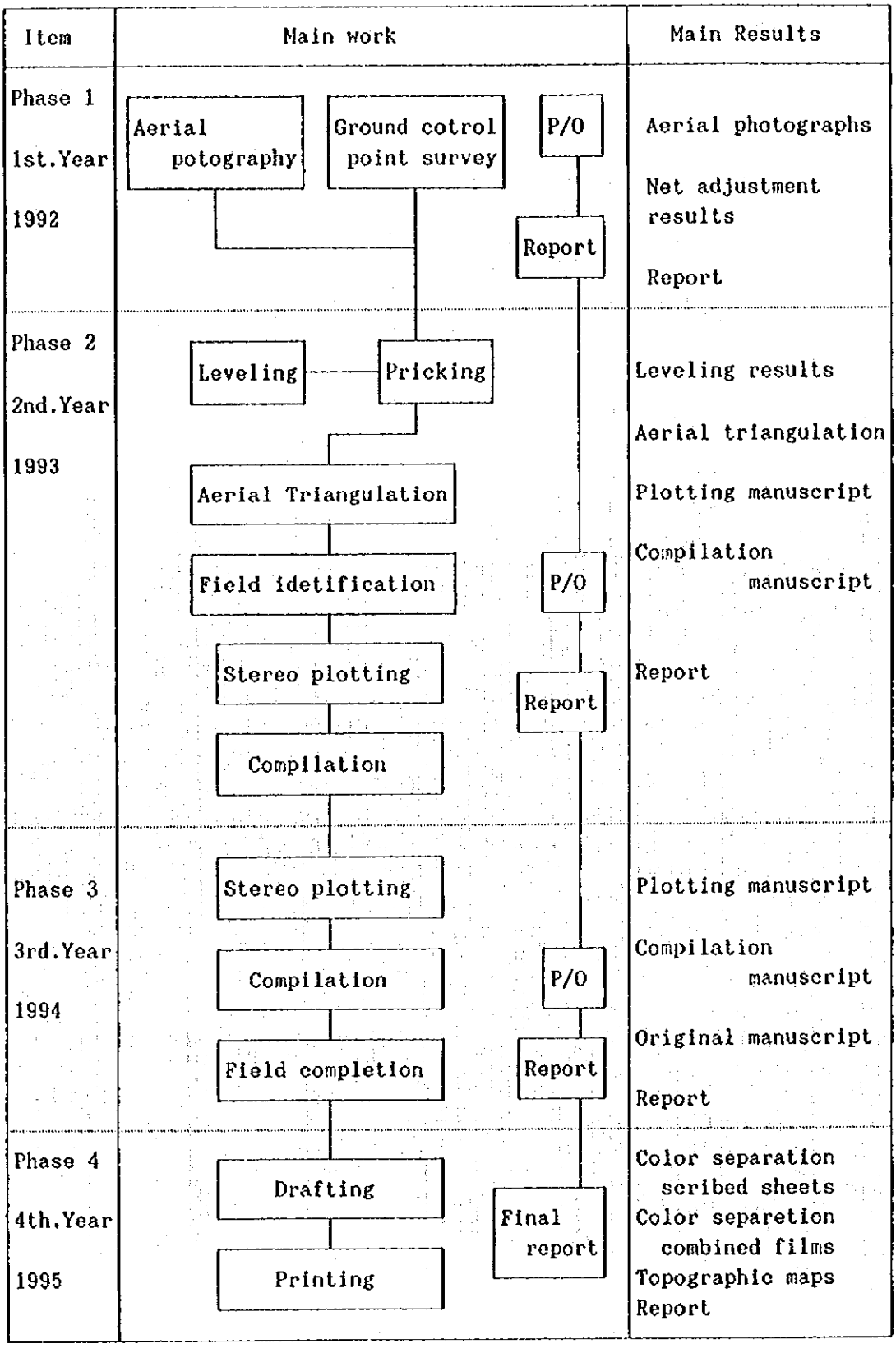
5-2.Printing

Printing plates shall be made from the original draft maps by photo lithography. Printing shall be done in five colors by an offset printing machine. 1,002 copies shall be printed for each map sheet, of which 2 copies each shall be kept in Japan. Specifications of printing paper to be used shall be determined through talks with NGD.

6.Work Flow

The flow of the entire work is schematically shown on the table 3.

Flowchart for the production of topographic maps



RE: Work in Laos Work in Japan

VII. WORK PLAN FOR PHASE I(FIRST YEAR)

The field work for the First Year (aerial photography and ground control point survey-1) shall be carried out for a period from December 11,1992, to February 10,1993 (62 days).

1.Preliminary work in Japan

1-1 Planning of survey work

Prior to the start (departure time) of the year's work as above Chief Engineer together with other responsible engineers shall work out a detailed plan for each work process so as to facilitate the field work.

1-2 Aerial photography

Aerial photography shall be contracted out to a company outside of Laos. Necessary paper work including specifications for contracting and selection of such a company shall made subject to the approval of JICA. Necessary information for permit (type of aircraft, flight personnel's records,etc.) shall be made available for submission.

1-3 Advance notification to NGD

NGD shall be notified in advance of requests to be made to relevant Laotian government agencies on the following matters.

(1) Permits and exemptions pertaining to the entry, exit, and stay, in and out of Laos by JICA team members and a contracted aerial photography company's personnel (collectively referred to as the Survey Team Member).
- Permits for entry, stay and exit. (immigration)
- Import tax exemption and assistance for customs clearance for materials and equipment for the Study to be brought into the country by Survey Team Members.

(2) Permits for flying and photographing over Laos and neighboring countries. Permit to use Vientiane Airport.

1-4 Preparation of materials and equipment

Materials and equipment necessary for survey work in Laos shall be procured, checked, and calibrated before shipping to Laos.
At the same time, the Laotian side shall be notified by the JICA Headquarters in Tokyo of the shipment of such materials and equipment. Upon the approval of the Laotian side, export-import procedures shall be started at the earliest possible date.

2.Field Work

The Team consisting of a 9-member GPS work group in 5 units of about 2 members each, along with Team Leader, Depty Leader, Mapping planner, Chief Engineer,Mechanic and Supervisor for Aerial photography, totaling 15 members, shall be sent to Laos for about two months. Additionally

one person shall be sent to Laos for coordination during the first half and the latter half of the field work period for about a half month each or a yearly total of one month.

2-1.Preliminary work in Laos

The whole member of the team shall depart Japan on the same day. Upon arrival in Vientiane, while a field group shall start preparing for field operations,Team Leader and his staff shall meet with NGD to discuss following administrative matters.

(1) Explanation of P/O.
(2) Follow-up on the requests made in advance. (Refer to VII-1-3)
(3) Use of photo-processing facilities of NGD.
(4) Boading of a security officer on the photography aircraft.
(5) Security of Survey Team Members - Keeping people, mountain tribes in particular, informed about this survey work; issuance of ID cards and pass permits.
(6) Notifying relevant government agencies and request for assistance by the military.
(7) Appointment of Laotian counterparts for each work unit.
(8) Permission to take out the original negative films and other related materials from Laos and them back into the country.
(9) Office space and facilities for vehicles and their management.
(10) Permits for entering public/private lands and for cutting trees as necessitated by the survey work.
(11) Assistance in hiring vehicles, drivers, and interpreters.
(12) Assistance in setting sub-camps.
(13) Supply of survey data of existing control points.
(14) Other items relevant to S/W.

2-2.Aerial photography

Aerial photography shall be contracted out to a foreign aerial photography company. One Japanese engineer is assigned to Laos to supervise the operations and check the results. The area to be covered shall be about 130 km long (north-south) and about 240 km wide (east-west) encompassing some 13,000 km^2 and therefore, flight courses shall be planned in the east-west direction. Due to wide differences in elevation, there is concern that a regular flying plan would result in insufficient sidelaps for central and eastern mountainous area. Since sharply rugged topography occurs often across the study area, flight courses shall be set at narrower intervals than normal, i.e., 5.5 km (sidelaps averaging 40%). In case flight permission cannot be obtained from neighboring countries, the flight courses need to be reconsidered.

2-2-1 Specifications for aerial photography

Main specifications for the aerial photography shall be as follows:

Period : From December,1992 to January,1993
Camera : Wide angle camera with calibration record
Photographic scale : Approximately 1/40,000
Flight height : 6,900m±5%(datum plane 900m)
Area to be covered : Approximately 13,000km²
Flight length : Approximately 2,900km
Flight course : 25 courses
Flight direction : East to west
Forward overlap : 60%±5%
Lateral overlap : More than 10%
Crab(κ) : Not more than 10°
Tip and Tilt(ϕ and ω) : Not more than 5°
Cloud coverage : Amount of cloud shall not exceed 3% in successive 5 photographs.However,important areas for orientation and cartography shall not be covered with clouds.
Film : Panchromatic

2-2-2 Implementation

Base airport:The flight plan shall be made with Vientiane Airport as the base.
Test flight :Test flight and test photographing shall be made over the site before launching the scheduled operations.
Checking :The supervisor for aerial photography inspect developed photos to ensure side laps, overlaps, and see the specifications are followed.
If the results do not fulfil the specifications, the aerial photography company shall be instructed to re-fly the same portion.
Film editing:Course numbers and photo numbers (starting from west) shall be annotated on negatives.In details,the annotations shall be finalized after discussion with NGD.
Photo processing:NGD facilities are assumed to be made available for this purpose.
Index map :The index map is prepared on the existing 1:200,000 topographic map by assigning principal points of photos.

2-3 Ground control point survey-1(horizontal control point survey)

In order to ensure the planimetric relative accuracy (1/100,000) for horizontal control point survey as agreed to in S/W, horizontal control point survey shall be conducted by satellite geodesy using GPS units. Observations shall be made simultaneously via plural units of GPS equipment to form an observation network connected to existing second order traverse points. The results shall be computed by network adjustment in Japan. Check observations shall be made over a distance between known points (Vientiane Datum - a point inside the site) to ensure the accuracy.It shall be so planned as to receive signals from more than three different satellites.

The height of GPS points shall be determined by direct and/or indirect leveling,if it is possible to do so. If not, the height shall be computed by interpolation by referring to the geoidal slope of the study area.

2-3-1 Observation plan

Additional points shall be set up in the study area to maintain the accuracy required for subsequent aerial triangulation.

GPS observation (newly set up)	Approx. 26
GPS observation (existing control points)	Approx. 3
Total	Approx. 29

If an originally set location of a point happens in so rugged mountain as to deny access even by helicopter, it may be moved to an easier location.

2-3-2 Observation

IN GPS observation, attention shall be paid so that:

- The antenna shall be set up higher than any obstacles (metal objects in particular) in the surroundings, and overhead clearance of 80° or more of zenith angle must be ensured.
- Obsevation shall be made of more than three GPS satellites in different orbits.
- Signals shall be received from satellites as they are at 15° or higher.
- Observation shall be made in static mode at a horizontal control point.

GPS may also be used for height control in place of direct leveling or conventional leveling.

2-3-3 Computation

Computations are made of satellite observation data as obtained above:

- To obtain vectors of base lines between points.
- To calculate coordinates of observation points based on WGS-84. Then closure errors are calculated for simultaneous observation points to examine the quality of observation. Closure errors of vectors shall be kept to less than 5 ppm.
- From tentative computation results, to perform geodetic network adjustment computations and make conversion to the relevant geodetic system.

3. Accuracy control

Strict inspection shall be performed at every work process to maintain required accuracies.

4. Report writing

A report is written to describe the progress of the First Year Work.

VIII. Work Plan for Phase Two (Second Year,Part 1:1993)

Following is the work plan covering Phase 2 (Second Year,Part 1). It is tentative at this time because it is subject to change depending on the progress of a preceding process or due to unexpected reasons.

Phase 2 (Second Year, Part 1: 1993)

This phase involves ground control point survey-2(vertical control point survey), pricking and aerial triangulation.

1. Field work

1-1 Ground control survey-2(vertical control point survey)

Bench marks are applied for elevation control, but existing 2nd order bench marks as they are distributed in the study are do not satisfy the required specifications so that minor order leveling shall be carried out over 580 km to set up additional verticalcontrol points. Appropriate leveling routes shall be determined after inspecting existing bench marks in the field.

1-1-1 Planning/Point selection

By reconnaissance survey, leveling routes are planned on aerial photos shall be studied and modified if necessary.Connection shall be sought to newly set neighboring GPS control points in terms of elevation. Observation shall be conducted by direct leveling of minor order in principle but for such portions where access is difficult to mountain roads, indirect leveling replaces. For leveling routes without any bridges, reciprocal leveling or trigonometric leveling is performed.

1-1-2 Observation

Minor order leveling shall start at an existing bench mark to close to an existing bench mark. Bench marks to be applied are selected after test surveying in relation to neighboring existing bench mark. For routes with no closure point, doble-run (back and fore) observation made and its closure discrepancy shall be within 5cm $\sqrt{S}$: s km, by direct leveling. Vertical control points shall be set up approximately 2km apart at locations where pricking is possible on photos.

1-2 Pricking

Newly set control points (GPS observation points), existing traverse points, existing bench marks and minor order leveling points, as required for map making, shall be pricked on aerial photos to identify their location.

1-2-1 Work volume

Control point (GPS):	29 points (including 3 existing traverse points)
Existing second order traverse points:	About 7 points
Existing bench marks:	About 143km
new leveling route :	About 580km

Pricking of minor order leveling points is made about every 2km at the time of observation.

1-2-2 Eccentricity

At the same time as control points are pricked, eccentric points are also pricked at points clearly identifiable on photos, and by measuring elements of eccentricity, their coordinates are computed.

1-3 Others

To facilitate the Second Year Part 2 work (field work) NGD will be consulted on the following items.

(1) Map symbols and their application

(2) Collection of materials related to above.

2. Work in Japan

2-1 Aerial triangulation

Aerial triangulation is performed based on the 1:40,000 aerial photos taken during this study. Pass points and control points as pricked on the diapositive are measured for their coordinates and adjustment computations are performed to determine their horizontal positions and elevations. Orientation elements on the plotter are also computed.

2-1-1 Methodology

Aerial triangulation shall be performed using the block adjustment method of independent models as an analytical orientation procedure. The computer program to be applied for this purpose shall be PAT-M43.

2-1-2 Planning

Aerial triangulation is performed for the entire study area for the 1/25,000 mapping (Approx. 13,000km^2)

Volume: 25 courses, about 817 models.

2-1-3 Control point layout

The layout of control points is as shown on Fig.1

2-1-4 Selection of pass points, etc.

Pass points and tie points shall be selected at such locations that are adequate for photogrammetric orientation and that permit accurate determination of coordinates on photos.

2-1-5 Adjustment

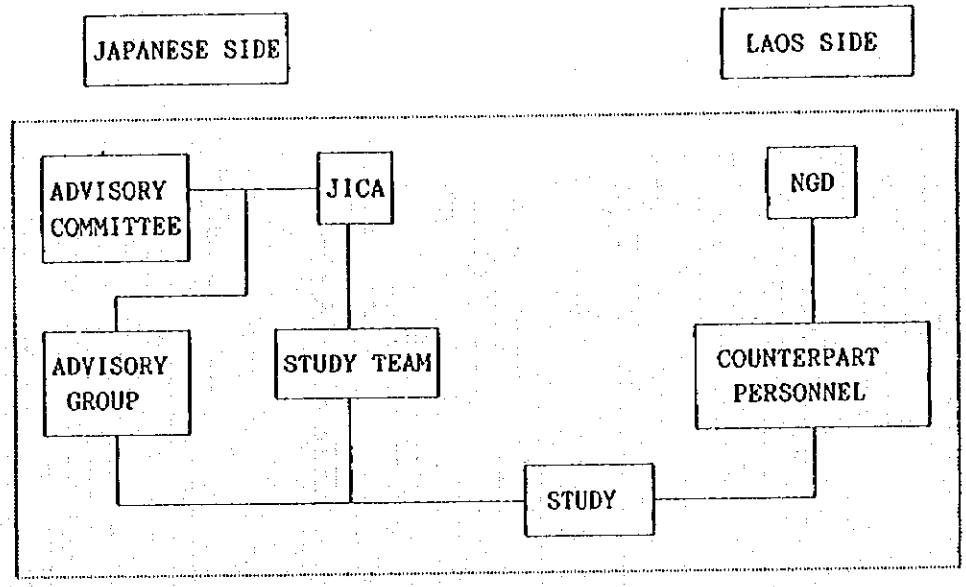
The limit of residuals of ground control points as used for adjustment with respect to horizontal and vertical shall be within 1.6‰ (9.6m) relative to flight altitude. The tolerance for pass points of adjacent models and tie points of adjacent flight courses shall be less than 0.8‰ (4.8m) relative to the flight altitude for both horizontal and vertical coordinates.

3. Accuracy control

Strict inspection shall be performed at every work process to maintain required.

4. Organization

The survey team involved in this Study is organized as follows:



IX. Tentative working schedule

see attached schdule table

X. Final products

The followings are the products for phase 1(first year:1992) and phase 2,(Second year,part 1:1993)

(1) Control point survey

a.Resultant table	: 1 set
b.Field note and computation sheet	: 1 set
c.Description of pricked point	: 1 set
d.Index map	: 1 set
e.Quality control table	: 1 set

(2) Aerial photography

a.Original negative film	: 1 set
b.Contact print	: 1 set
c.Photo index map	: 1 set
d.Flight record	: 1 set
e.Quality control table	: 1 set

(3) Pricking and leveling

a.Field note : 1 set
b.Tabulation of observed
results and adjusted values : 1 set
c.Computation note : 1 set
d.Index map : 1 set
e.Pricked photograph : 1 set
f.Quality control table : 1 set

(4) Aerial triangulation
a.Final resultant table : 1 set
b.Index map : 1 set
c.Pricked diapositive : 1 set
d.Pricked contact print : 1 set
e.Computation sheet : 1 set
f.Quality control table : 1 set

(5) report for phase I(English) : 30 sets

TENTATIVE WORKING SCHEDULE

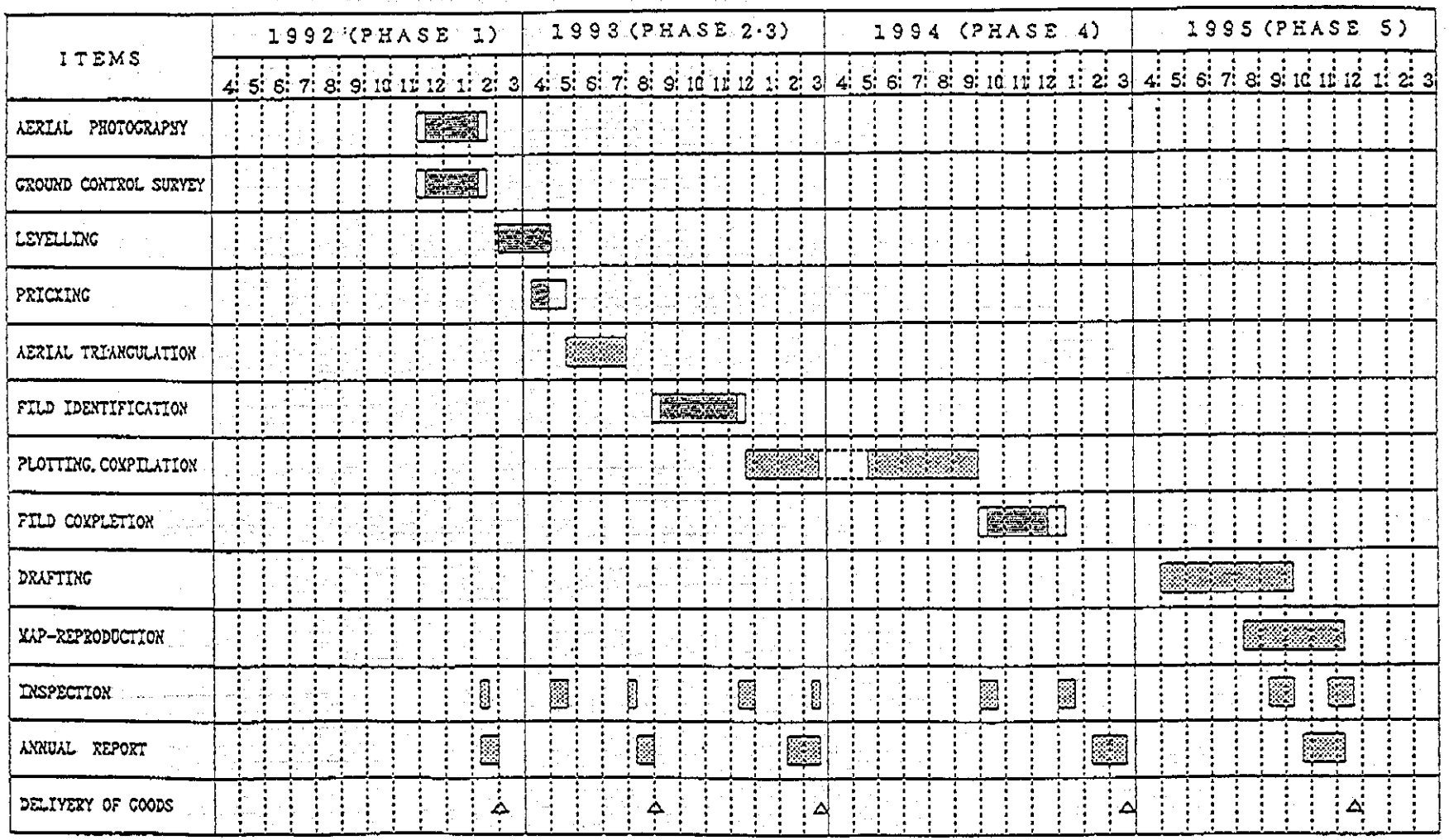


FIGURE 1. INDEX MAP FOR FLIGHT AND GROUND CONTROL POINTS PLANNING

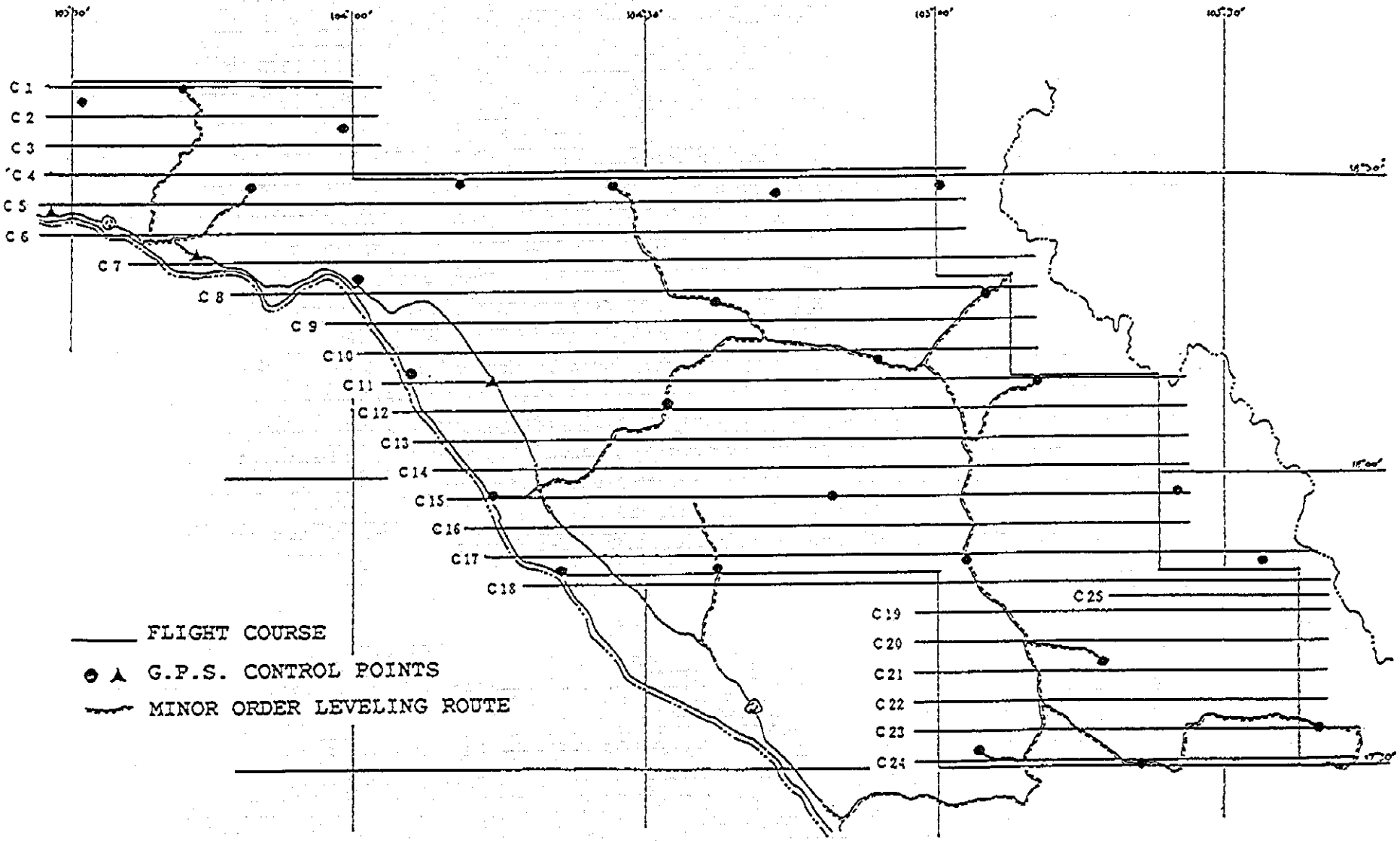


FIGURE 2. INDEX MAP FOR LEVELLING

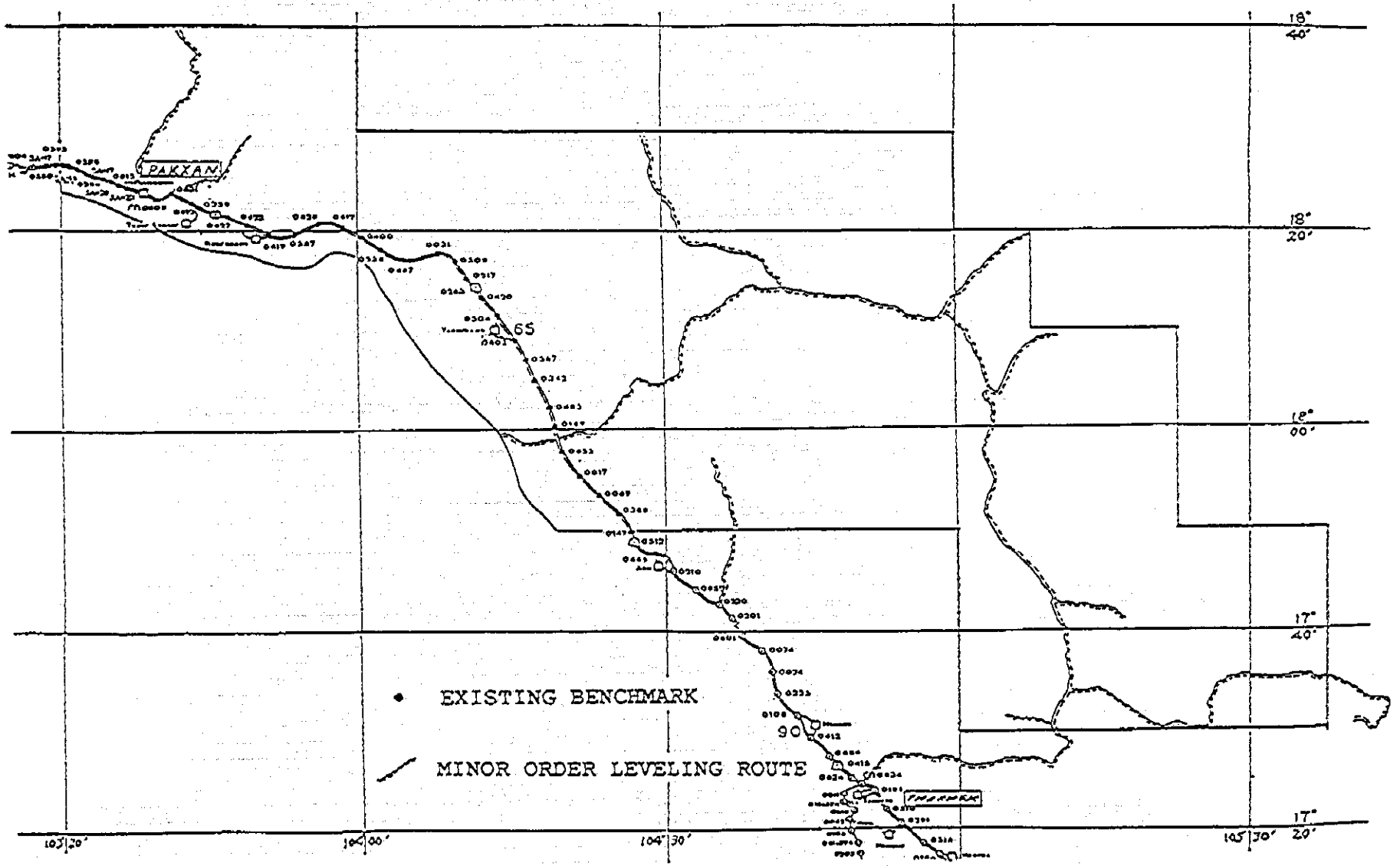
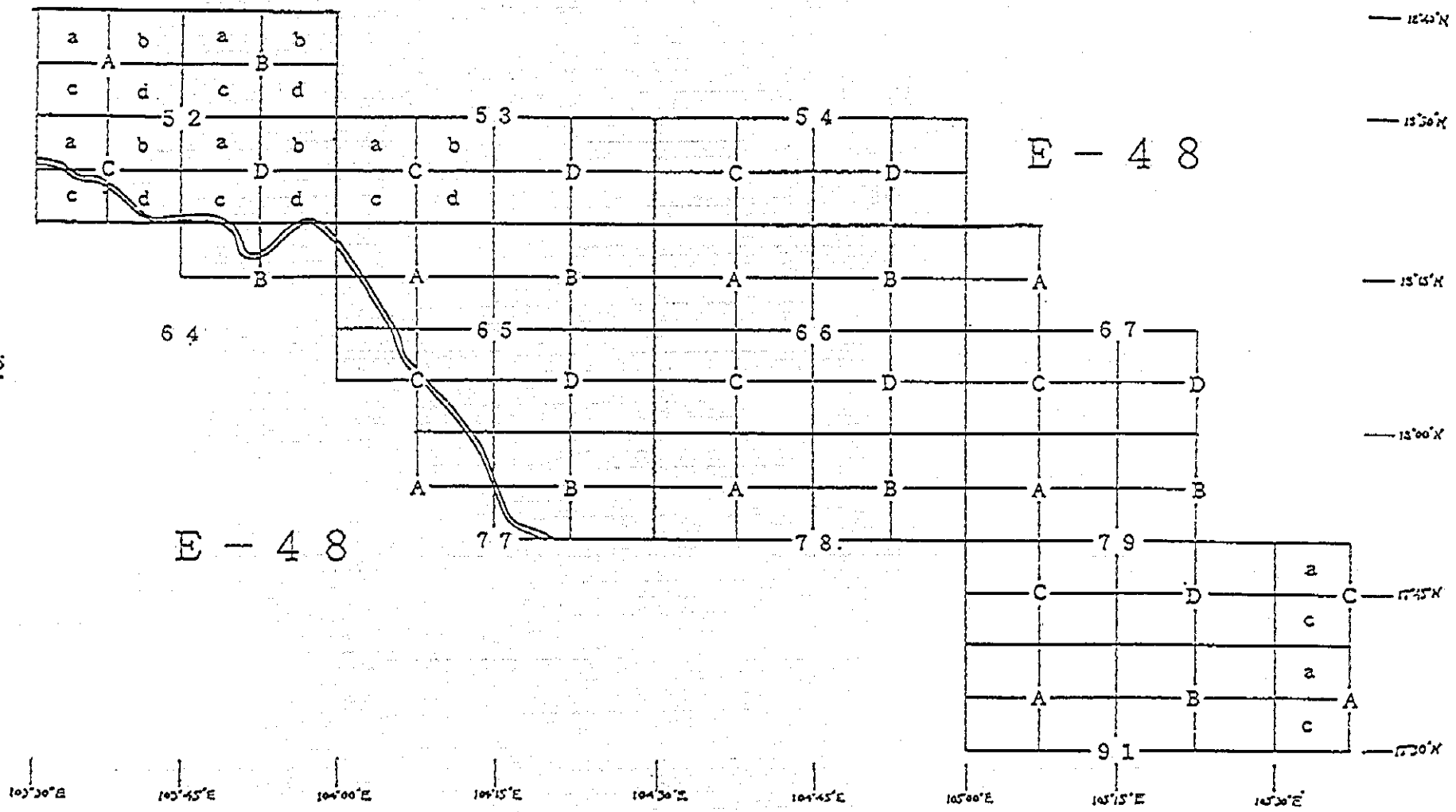
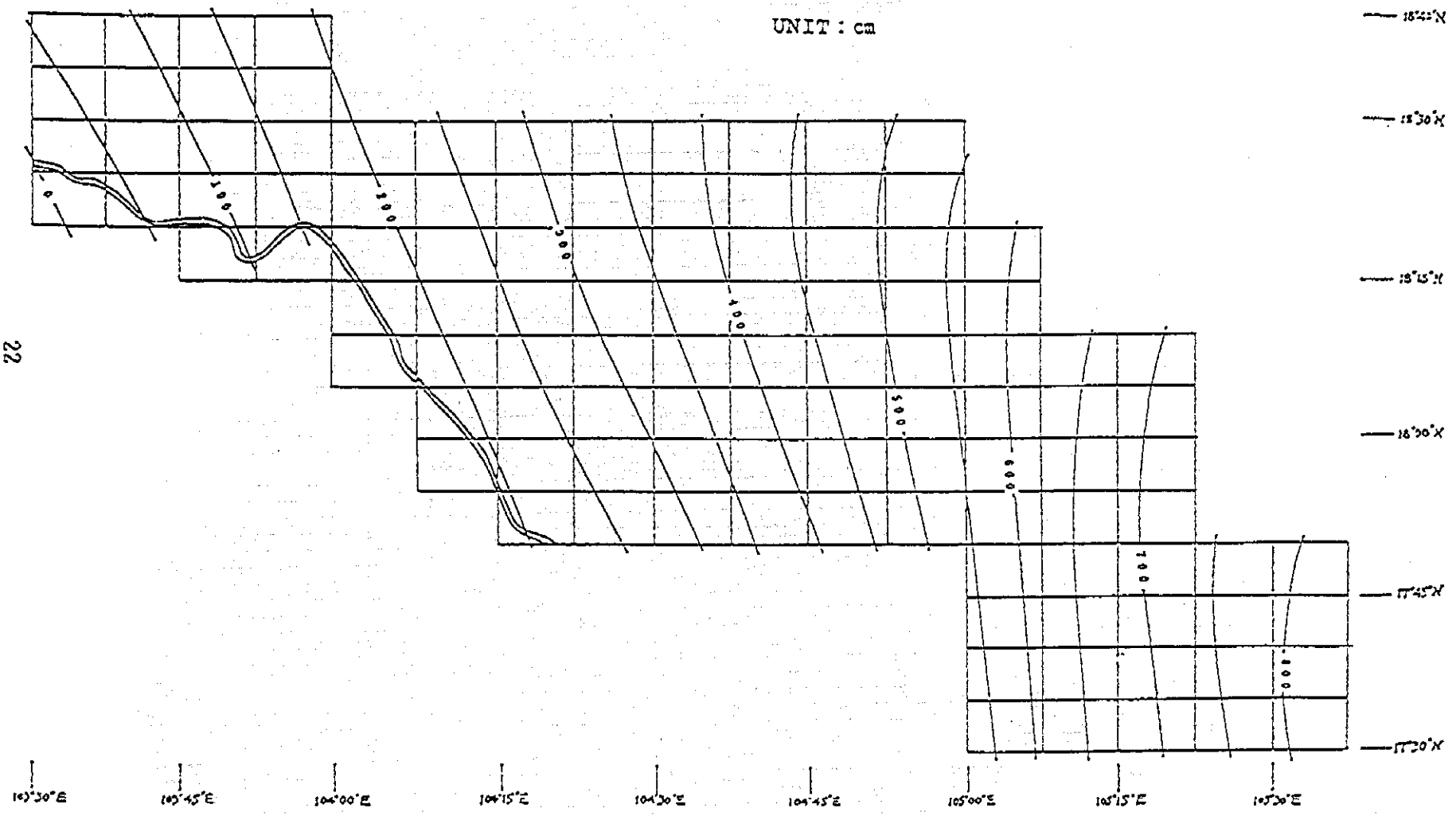


FIGURE 3. INDEX MAP FOR CARTOGRAPHING AND SHEET NUMBER



(50) 21

FIGURE 4 GEOID



* By Trimvec-Plus (TRIMBLENAVIGATION)

Minutes of Meetings

on

Progress Report of

the First Year (Former) Work

(February 5, 1993)

MINUTES OF MEETINGS

FOR

THE TOPOGRAPHIC MAPPING

OF

BOLIKHAMXAI PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

BETWEEN

JICA STUDY TEAM

AND

NATIONAL GEOGRAPHIC DEPARTMENT (NGD)

The JICA Study Team (referred to as the Team hereafter)headed by Mr. Tositomo KANAKUBO visited Lao P.D.R. on the 12th of December, 1992 to First Year Work for technical cooperation of the Topographic Mapping of Bolikhamxai Province in Lao P.D.R.

The meeting was held at the National Geographic Department (referred to as the NGD hereafter) on the 5th of February, 1993 and the following items were discussed and mutually agreed upon between t he NGD and the Team.

The list of the Attendants is shown in Annex.

1. The Team informed NGD that the monumentation of the ground control points requested by NGD was under preparation.

2. The Team reported that all the aerial photography and the ground control survey in Phase 1 were completed on schedule. Concerning the flight plan, it was, however, modified along the Thai national boundary because of no flight permission of Thai. Therefore the extra five (5) f light courses (course no. 26-30) were added.

3. The Team explained the next visiting schedule for the continuous field work (levelling and pricking).

At Vientiane, 5th of February,1993

Mr.Boualay XAIGNASANE
For General Director of National Geographic Department

Tositomo Kanakubo

Mr.Tositomo KANAKUBO
Leader of the JICA study Team

ANNEX: List of the Attendants of the Meeting

Laos side

Mr.Thongpene SOUKLASENG	General Director of National Geographic Department
Mr.Boualay XAIGNASANE	Deputy Director of National Geographic Department
Mr.Khamkhong DETCHANTHACHACK	Deputy Director of National Geographic Department
Mr.Thongchanh MANIXAY	Chief of Planning Section
Mr.Bounkong SOUGNATY	Chief of Survey Division
Mr.Bouasoth SOUVANNAKOUMMANE	Chief of Photogrammetry Section
Mr.Phouangphane SAYASANE	Deputy Chief of Cartography Division

Japanese side

Mr.Tositomo KANAKUBO	Leader
Mr.Koichi MIKI	Deputy Leader
Mr.Yasuo TANAKA	Mapping Planner
Mr.Fujio ITO	Chief Surveyor
Mr.Hideto HOSODA	Photo-Inspector
Mr.Hideaki SAKAI	Coordinator

T.K.

PROGRESS REPORT

OF

THE FIELD WORK OF THE FIRST YEAR

FOR

TOPOGRAPHIC MAPPING

OF

BOLIKHAMXAI PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

FEBRUARY , 1993

STUDY TEAM

OF

TOPOGRAPHIC MAPPING OF BOLIKHAMXAI PROVINCE

IN

LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY

I. Outline of the First Year Work

I-1 Objective

Objectives of the study are : (1) To prepare 1/25,000 topographic maps covering the Bolikhamxai Province, (2) To transfer technology to the counterparts of NGD through the implementation of the works, and (3) To promote the friendship between Lao PDR and Japan through the implementation of the Study.

The first year work of the study is to carry out the field survey including aerial photography, ground countrol survey, and office work such as arrangement of survey results.

I-2 Period of Survey Work

Field work

(Headquarters)	12 December, 1992 - 9 February, 1993
(Aerial Photography)	12 December, 1992 - 9 February, 1993
(Photo Processing)	12 December, 1992 - 9 February, 1993
(Ground Control Survey)	12 December, 1992 - 9 February, 1993

I-3 Formation of the Study Team

Leader	Mr. Tositomo KANAKUBO	11 Dec.92 - 27 Dec.92 30 Jan.93 - 10 Feb.93
Deputy Leader	Mr. Koichi MIKI	11 Dec.92 - 10 Feb.93
Mapping Planner	Mr. Yasuo TANAKA	11 Dec.92 - 10 Feb.93
Chief Surveyor	Mr. Fujio ITO	11 Dec.92 - 10 Feb.93
Mechanical Engineer	Mr. Atsusi TANAKA	11 Dec.92 - 10 Feb.93
Photo-Inspector	Mr. Hideto HOSODA	11 Dec.92 - 10 Feb.93

Ground Control Survey	Mr. Kiyofumi TAMARI	11 Dec.92 - 10 Feb.93
"	Mr. Hideya SAWAKI	11 Dec.92 - 10 Feb.93
"	Mr. Takao TERAJI	11 Dec.92 - 10 Feb.93
"	Mr. Masashi NARUMI	11 Dec.92 - 10 Feb.93
"	Mr. Nobuyuki SASAKI	11 Dec.92 - 10 Feb.93
"	Mr. Kohshi MASADA	11 Dec.92 - 10 Feb.93
"	Mr. Hiromi INAGAKI	11 Dec.92 - 10 Feb.93
"	Mr. Hiroshi SHIMAMURA	11 Dec.92 - 10 Feb.93
"	Mr. Kouji FUKAZAWA	11 Dec.92 - 10 Feb.93
Coordinator	Mr. Hideaki SAKAI	6 Dec.92 - 20 Dec.92 27 Jan.93 - 10 Feb.93

1-4 Amount of the Survey Work (Plan and Results)

Work in the first year are shown in the following Tablo:

Item		Original Plan	Results
Aèrial Photography	Coverage	13,000 SQ/Km	13,000 SQ/Km
	Scale	1:40,000	1:40,000
	Courses	25 Lines	30 Lines
	Sheets	920 sheets	924 sheets
Ground Control Survey		29 points	30 points

1-5 Co-operation of Counterparts of NGD

Headquarters	Mr. Thongpene SOUKLASENG
	Mr. Boualay XAIGNASANE
	Mr. Khamkhong DETCHANTHACHACK
	Mr. Thongchanh MANIXAY
Gound Control Point Survey (Including GPS analyses)	Mr. Bounkong SOUGNATY
	Mr. Bouasoth SOUVANNAKOUMMANE
	Mr. Phouangphane SAYASANE
	Mr. Khampheng
	Mr. Khamchan PHOXAI
	Mr. Nikon KANLAGNA
	Mr. Michit TAVONG
	Mr. Savath LUANGGNOTHA
	Mr. Khampheva
	Mr. Chanthon
	Mr. Thongma VONGPASITH

2. Field Work

2-1 Aerial Photography

(1) Base for Aerial Photography

Vientiane Airport was used for the base for the aerial photography. In the flight, the security officers of Mapping Army Section were accompanied at the time of aerial photography.

(2) Aircraft and Camera

The Team contracted with Kevron Aerial Surveys Pty.Ltd., for all aerial photography.

Details of aircraft and camera are as follows:

Aircraft	: Gates Learjet 35A No.35-400
Camera Type	: Wild RC-20
Lens number	: UAGA-F 13149 F = 152.68 mm
Avionics Equipments	: Garmin GPS and Flight Management Navigation System

(3) Photographic Work

Test flights were made on December 13th, 1992 and full-scale aerial photography was commenced from December 14th, 1992.

(4) Materials of Aerial Film

AGFA films were used for aerial photography, and details are as follows :

Film Type	: AGFA AVI PHOTOPAN PE-50

2-2 Photo Processing

(1) Development

The instruments and materials to be used were as follows:

Developer	:	KODAK HC-110
Paper	:	AGFA & KODAK RC
Film development	:	Zeiss FE-120
Contact printer	:	Zeiss KG-30 (NGD)

(2) Printing and Inspection

After printing and inspection of the aerial photos, reflight was made, in case of necessity.
Items to be inspected were as follows;

1) Overlap and side lap

2) Cloud, cloud shadow, uneven development

3) Deviation of flight cource

4) Halation

5) Smoke of field fire

(3) Amount of work

Film roll	6 rolls
Flight Lines	30 lines
Photographs	924 photos

Number of photographs per strip is shown in Table-1.

2-3 Control Point Survey

Control point survey was executed by satellite geodesy applying Global Positioning System (GPS). Six Trimble 4000SST instruments of dual frequency model were used for the simultaneous observation at the control points.

(1) Observation

Observation was done at five or six points simultaneously. To take account of obtaining the height accuracy, five or six satellites were observed two hours from 11:00 to 13:00 at the local time of Lao PDR and the elevation angle of satellites was adopted more than 15°.

(2) Given Points

Following points should be adopted finally as given points for computation ;

TP 01
TP 05
TP 17
TP 21

(3) Observation Scheme

The Network consisting of 11 observation groups including 4 known points is shown in Fig.2 and Table 3.

(4) Results

The coordinate closures of each group were calculated to check the reliability of the observation in the field.
The result is tentatively obtained as shown in Table 2 and summarized as follows;

	Range	Mean
Base line length	16 km - 48 km	32 km
dx	0.022m - 0.428m	0:225 m
dy	0.003m - 0.141m	0.072 m
dz	0.001m - 0.246m	0.124 m

where dx,dy and dz stand for the coordinate closures of the geocentric coordinate system of ellipsoid WGS-84 to which GPS is referred.

There are 14 base lines measured twice on different days,and it data repeatability was checked and confirmed.

The precise calculation and net adjustment connecting to the known points shall be implemented in Japan.

2-4 Monumentation

In response to the request of NGD,the reconnaissance survey for monumentation was done on the site of Pakxan,Lak Xao,and Khammouan Province.
Six points will be established and observed by the Team on the next stage using GPS again.

Table 1(1/2) PHOTOGRAPHING LIST

Course	Photo Date	Photo No.	Comp No.	Number	Roll	Remarks
1	92,12,21	131 -- 147	1 -- 17	17	4	
2	92,12,21	167 -- 184	1 -- 18	18	4	
3 A	93, 1,31	72 -- 76	1 -- 5	5	6	
3 B	92,12,21	149 -- 163	1 -- 15	15	4	
4 A	92,12,21	97 -- 129	1 -- 33	33	4	
4 B	93, 1, 3	3 -- 19	1 -- 17	17	4	
5 A	92,12,27	84 -- 123	1 -- 40	40	5	
5 B	93, 1, 3	39 -- 48	1 -- 10	10	5	
6 A	92,12,21	185 -- 190	1 -- 6	6	4	
6 B	92,12,27	42 -- 74	1 -- 33	33	5	
6 C	93, 1, 3	20 -- 27	1 -- 8	8	5	
7 A	92,12,22	3 -- 9	1 -- 7	7	4	
7 B	92,12,14	87 -- 122	1 -- 36	36	1	
8 A	92,12,20	75 -- 80	1 -- 6	6	3	
8 B	92,12,14	123 -- 150	1 -- 28	28	1	
8 C	93, 1, 3	30 -- 36	1 -- 7	7	5	
9 A	92,12,17	129 -- 133	1 -- 5	5	3	
9 B	92,12,14	12 -- 41	1 -- 30	30	2	
1 0 A	92,12,20	69 -- 72	1 -- 4	4	3	
1 0 B	92,12,14	43 -- 73	1 -- 31	31	2	
1 1 A	92,12,27	35 -- 40	1 -- 6	6	5	
1 1 B	92,12,21	56 -- 85	1 -- 30	30	4	
1 1 C	93, 1, 3	49 -- 55	1 -- 7	7	5	
1 2 A	92,12,21	23 -- 54	1 -- 32	32	4	
1 2 B	93, 1,31	57 -- 65	1 -- 9	9	6	
1 3 A	92,12,17	124 -- 127	1 -- 4	4	3	
1 3 B	92,12;15	142 -- 150	1 -- 9	9	2	
1 3 C	93, 1, 3	72 -- 85	1 -- 14	14	5	
1 3 D	92,12,15	159 -- 172	1 -- 14	14	2	
1 3 E	93, 1, 3	57 -- 63	1 -- 7	7	5	

Table 1(2/2) PHOTOGRAPHING LIST

1 4 A	92,12,20	63 -- 66	1 -- 4	4	3	
1 4 B	92,12,15	108 -- 141	1 -- 34	34	2	
1 5 A	92,12,20	56 -- 60	1 -- 5	5	3	
1 5 B	92,12,15	80 -- 106	1 -- 27	27	2	
1 5 C	92,12,28	11 -- 18	1 -- 8	8	5	
1 6 A	92,12,20	50 -- 53	1 -- 4	4	3	
1 6 B	92,12,15	53 -- 79	1 -- 27	27	2	
1 6 C	92,12,28	3 -- 9	1 -- 7	7	5	
1 7 A	93, 1, 2	17 -- 26	1 -- 10	10	5	
1 7 B	92,12,15	28 -- 47	1 -- 20	20	2	
1 7 C	93, 1, 3	86 -- 99	1 -- 14	14	5	
1 8 A	92,12,17	91 -- 112	1 -- 22	22	3	
1 8 B	93, 1,31	24 -- 42	1 -- 19	19	6	
1 9	93, 1,31	3 -- 23	1 -- 21	21	6	
2 0 A	92,12,17	64 -- 73	1 -- 10	10	3	
2 0 B	93, 1, 2	3 -- 16	1 -- 14	14	5	
2 1 A	92,12,17	53 -- 61	1 -- 9	9	3	
2 1 B	92,12,20	19 -- 33	1 -- 15	15	3	
2 2 A	92,12,17	31 -- 39	1 -- 9	9	3	
2 2 B	92,12,20	3 -- 18	1 -- 16	16	3	
2 3 A	92,12,17	40 -- 50	1 -- 11	11	3	
2 3 B	92,12,27	18 -- 32	1 -- 15	15	5	
2 4 A	92,12,17	13 -- 24	1 -- 12	12	3	
2 4 B	92,12,20	34 -- 47	1 -- 14	14	3	
2 5	93, 1,31	43 -- 55	1 -- 13	13	6	
2 6	92,12,19	4 -- 16	1 -- 13	13	3	
2 7	92,12,17	135 -- 152	1 -- 18	18	3	
2 8	92,12,15	3 -- 25	1 -- 23	23	2	
2 9	93, 1, 4	13 -- 34	1 -- 22	22	6	
3 0	93, 1,31	69 -- 71	1 -- 3	3	6	
Total				927		

Table 2(1/3)

SUMMARY OF BASELINE COMPUTATION

Obs. Group	Station Combination for Baseline		Computed Slope Distance	Height Difference	Accuracy
	From	To			
1	0001	0005	29490.429 m	- 37.960 m	TD =107783.750 m dx = - 0.428 m dy = - 0.003 m dz = 0.102 m ratio = 4.08 ppm
	0005	0104	15955.059	- 2.948	
	0104	0102	18902.686	12.291	
	0102	0101	16206.985	1.115	
	0101	0001	27228.592	27.628	
2	0102	0104	18902.839	- 12.722	TD =134665.041 m dx = - 0.042 m dy = - 0.141 m dz = 0.018 m ratio = 1.10 ppm
	0104	0005	15955.187	3.101	
	0005	0109	30007.110	- 8.076	
	0109	0103	39203.559	110.525	
	0103	0102	30596.345	- 92.954	
3	0103	0109	39203.143	-110.502	TD =147246.139 m dx = - 0.072 m dy = 0.106 m dz = 0.066 m ratio = 0.98 ppm
	0109	0126	18256.233	- 2.661	
	0126	0017	16944.056	16.758	
	0017	0105	36336.036	123.094	
	0105	0103	36506.671	- 26.553	
4	0126	0114	27853.868	- 3.242	TD =158296.624 m dx = 0.079 m dy = 0.052 m dz = - 0.018 m ratio = 0.61 ppm
	0114	0117	26709.526	1.563	
	0117	0118	24062.635	4.029	
	0118	0127	27288.564	4.082	
	0127	0017	35437.944	10.399	
	0017	0126	16944.087	- 16.804	
5	0105	0017	36335.994	-122.852	TD =165022.474 m dx = 0.076 m dy = - 0.095 m dz = 0.008 m ratio = 0.74 ppm
	0017	0127	35438.240	- 10.264	
	0127	0110	24595.267	269.564	
	0110	0107	23154.223	90.030	
	0107	0106	28437.035	-216.724	
	0106	0105	17061.717	- 9.858	

Table 2(2/3)

SUMMARY OF BASELINE COMPUTATION

Obs. Group	for Baseline		Computed Slope Distance	Height Difference	Accuracy
	From	To			
6	0107	0110	23154.209	- 89.977	
	0110	0112	33274.610	82.076	TD =150891.751 m
	0112	0113	24694.683	32.821	dx = 0.100 m
	0113	0111	22483.685	- 9.755	dy = 0.076 m dz = - 0.005 m
	0111	0108	21243.020	408.261	ratio = 0.83 ppm
	0108	0107	26041.544	-423.382	
7	0110	0127	24595.734 m	-269.444 m	TD =137750.116 m
	0127	0118	27288.435	- 3.970	dx = - 0.040 m
	0118	0115	26318.174	25.916	dy = - 0.050 m dz = 0.004 m
	0115	0112	26272.911	329.110	ratio = 0.47 ppm
	0112	0110	33274.864	- 81.646	
8	0112	0115	26272.727	-329.294	TD =150675.188 m
	0115	0119	26313.648	337.249	dx = 0.022 m
	0119	0116	39801.513	72.373	dy = - 0.035 m dz = - 0.001 m
	0116	0113	33592.563	- 47.484	ratio = 0.27 ppm
	0113	0112	24694.736	- 32.882	
9-1	0119	0121	25182.821	18.074	TD = 98845.399 m
	0121	0116	33860.655	54.343	dx = 0.268 m
	0116	0119	39801.923	- 72.394	dy = 0.101 m dz = - 0.014 m ratio = 2.90 ppm
9-2	0121	0124	48063.975	-353.957	TD =118123.212 m
	0124	0120	33884.143	413.541	dx = - 0.610 m
	0120	0121	36175.095	- 59.495	dy = - 0.106 m dz = 0.102 m ratio = 5.31 ppm
9-3	0116	0121	33860.655	- 54.343	TD = 89345.862 m
	0121	0120	36175.095	59.495	dx = - 0.031 m
	0120	0116	19310.112	- 5.201	dy = - 0.060 m dz = - 0.003 m ratio = 0.76 ppm

Table 2(3/3)

SUMMARY OF BASELINE COMPUTATION

Obs. Group	Station Combination for Baseline		Computed Slope Distance	Height Difference	Accuracy
	From	To			
10	0119	0122	34399.818	-349.983	TD =172905.230 m dx = 0.034 m dy = - 0.070 m dz = 0.003 m ratio = 0.45 ppm
	0122	0123	35903.931	- 4.511	
	0123	0124	29354.686	18.542	
	0124	0121	48063.957	353.975	
	0121	0119	25182.821	- 18.074	
11	0021	0117	22938.839	- 17.199	TD = 59486.349 m dx = - 0.086 m dy = - 0.015 m dz = 0.027 m ratio = 1.54 ppm
	0117	0118	24063.143	4.280	
	0118	0021	12484.365	12.935	

Table 3 GPS SESSION GROUP TABLE

Group	Observed Points	Remarks
1	0001,0005,0104,0102,0101,0125	known point:0001 0005
2	0102,0104,0005,0109,0103	known point:0005
3	0103,0109,0126,0017,0105,0128	known point:0017
4	0126,0114,0117,0118,0127,0017	known point:0017
5	0105,0017,0127,0110,0107,0106	
6	0107,0110,0112,0113,0111,0108	
7	0110,0127,0118,0115,0112	
8	0112,0115,0119,0116,0113	
9-1	0119,0121,0116	
9-2	0121,0124,0120	
9-3	0116,0121,0120	
10	0119,0122,0123,0124,0121	
11	0117,0118,0021	known point:0021

Figure 1 PHOTO INDEX MAP

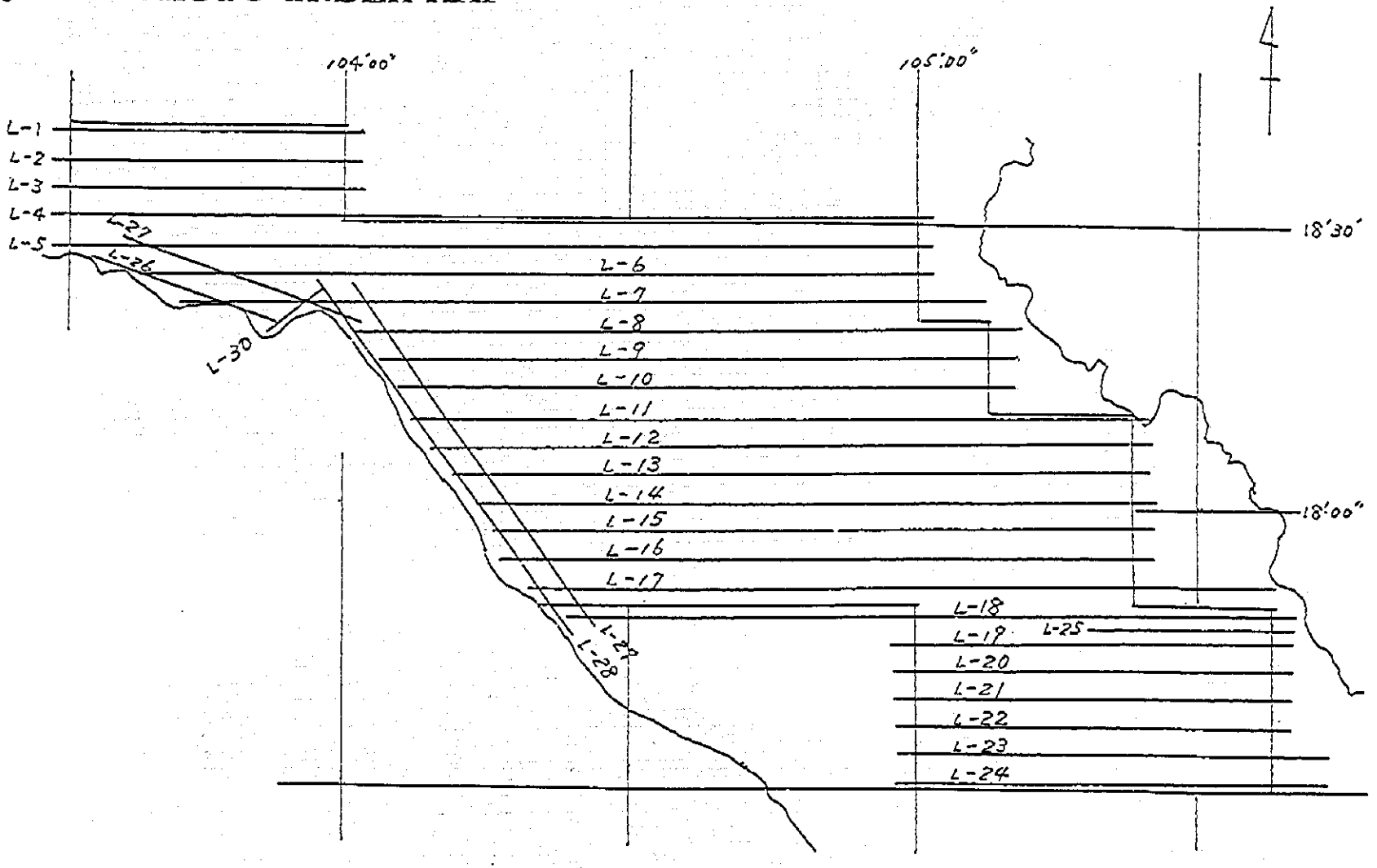
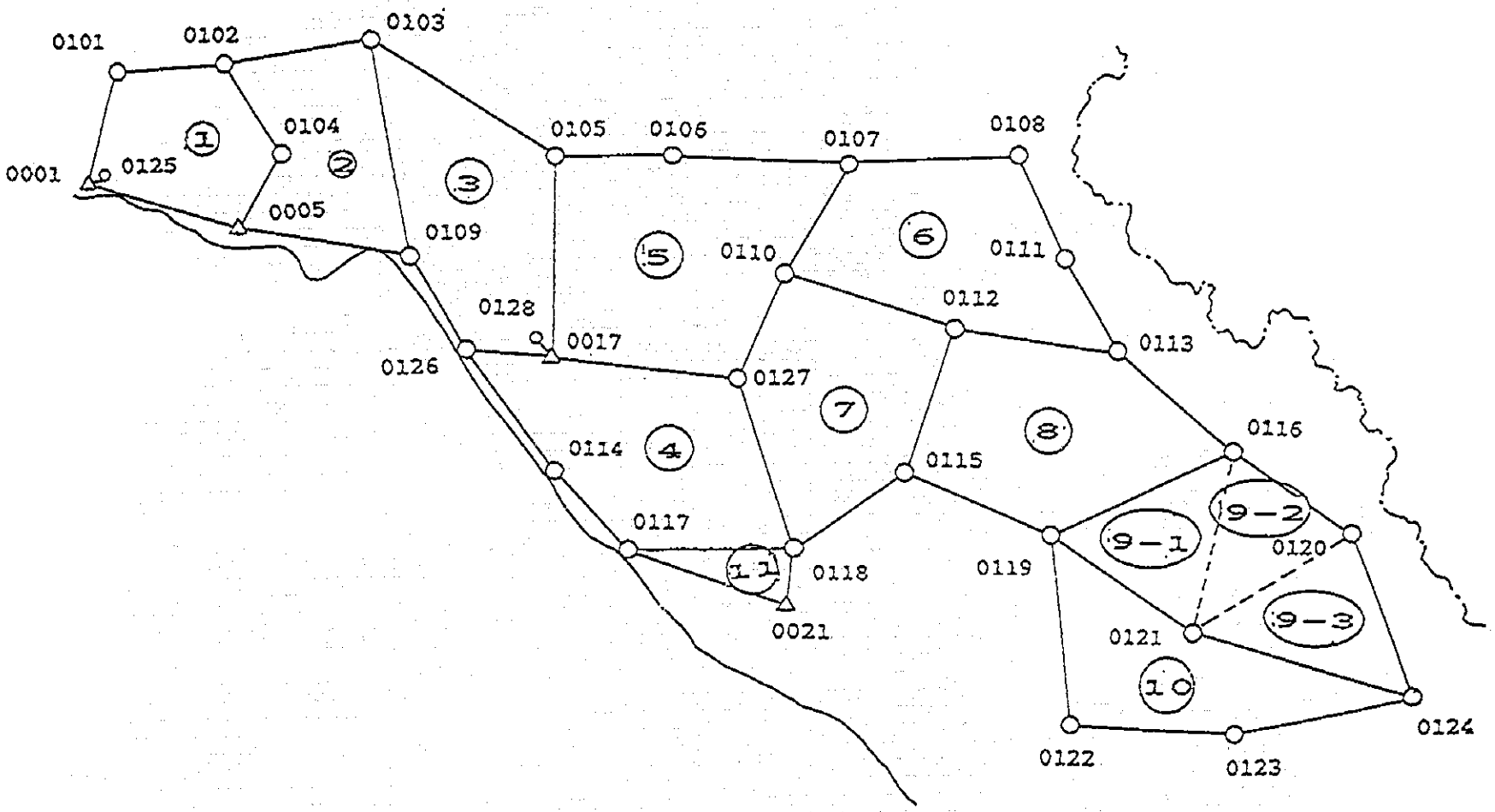


Figure 2 INDEX MAP FOR GROUND CONTRAL POINTS



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Contract and Specification

for

Aerial Photography

CONTRACT FOR AERIAL PHOTOGRAPHY

ON

TOPOGRAPHIC MAPPING OF BOLIKHAMXAI PROVINCE

LAO PEOPLE'S DEMOCRATIC REPUBLIC

This Contract made and entered into this 12 th day of the month of December the year 1992 between the consortium (hereinafter referred to as "the CONSORTIUM") consisting of International Engineering Consultants Association (Japan) acting as a representative, with its principal office of business at No.3-23, Kojimachi 5-chome, Chiyoda-ku, Tokyo, Japan (hereinafter referred to as "IECA") and Pasco International Inc. with its principal office of business at No. 7-8, Kamiuma 3-chome, Setagaya-ku, Tokyo, Japan (hereinafter referred to as "PI") and Kevron Aerial Surveys Pty. Ltd. with its principal office of business at 121 Hill Street, East Perth, West Australia 6004, Australia (hereinafter referred to as "the CONTRACTOR"). The CONSORTIUM and the CONTRACTOR are sometimes referred to herein together as the PARTIES.

WITNESSETH

WHEREAS, Japan International Cooperation Agency (hereinafter referred to as "JICA") and National Geographic Department (hereinfter referred to as "NGD") of Lao People's Democratic Republic have agreed to perform the aerial photography in Lao People's Democratic Republic (hereinafter referred to as "the WORK") as a part of the Topographic Mapping of Bolikhamxai

Province in accordance with the Scope of Work signed on 12th August 1992, and :

WHEREAS, JICA entrusted the WORK to the CONSORTIUM for the Topographic Mapping of Bolikhamxai Province, and :

WHEREAS, the CONSORTIUM desires to sublet the WORK to be done by the CONTRACTOR, and whereas, the CONTRACTOR is willing to do so.

Now, THEREFORE, the PARTIES hereby agree as follows:-

ARTICLE 1. Work

The CONTRACTOR shall perform aerial photography at a scale of 1/40,000 covering an area of approx. 13,000 sq. km. according to Flight Plan as shown on Fig. 1 of the Specifications, Exhibit A, and the CONSORTIUM shall pay the CONTRACTOR for the WORK.

ARTICLE 2. Specifications

The WORK shall be performed in accordance with the attached Exhibit A, Specifications, which is considered to be an integral part of this Contract.

ARTICLE 3. Preparation for Work

The CONTRACTOR shall make his own arrangements for the engagement of all personal (flight crew, engineers and/or laboratory technicians) necessary for the execution of the WORK. The CONTRACTOR shall submit to the CONSORTIUM a complete list of the principal staff showing names, functions, personal history and periods of assignment prior to the commencement of the WORK.

ARTICLE 4. Commencement of Work

The CONTRACTOR shall mobilize the aircraft, personal and necessary equipment to Vientiane airport and shall complete all the necessary site arrangements, checking, maintenance of equipment and test flight(s) prior to the WORK execution.
The CONTRACTOR shall commence the WORK from the date specified in ARTICLE 6. Work Period.

ARTICLE 5. Contractor's Representative

The CONTRACTOR shall appoint a competent representative from among the CONTRACTOR's personal assigned to the WORK, to superintend the execution of each work item, to attend meetings with the CONSORTIUM and make technical, administrative and financial decisions that are required during such meetings.

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2) The CONTRACTOR shall be responsible for the observance of all regulations and safety precautions imposed by the authorities in the Lao People's Democratic Republic.

ARTICLE 6. Work Period

The CONTRACTOR shall execute all the aerial photography and laboratory work within 60 days from ~~10~~ 12th December 1992
In the case that the work is not completed, article 14 shall apply.

ARTICLE 7. Representative of Consortium on Site

The CONSORTIUM designates a person to act as "the ENGINEER" during the flying period in order to coordinate the personal and promote the flight of the CONTRACTOR.

The ENGINEER also has the following assignments :-

(a) Inspection and checking of the progress and final results of the WORK by the CONTRACTOR.

(b) Instruction of re-flight and re-printing when the results are out of the Specifications.

ARTICLE 8. Inspection of Results

When each roll of film has been photographed and photo processing has been conducted thereafter, the CONTRACTOR shall give a notice of completion to the ENGINEER. The CONTRACTOR shall submit

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one (1) set of rush contact prints and a preliminary flight index to the ENGINEER immediately upon completion of photo processing for his inspection and approval. If and when such results are not accepted by the ENGINEER because of nonconformance with the attached Specifications, the CONTRACTOR shall perform re-flights and/or reprinting and submit the results to the ENGINEER for his approval.
The checking and the approval shall be carried out immediately on receipt of developed film and rush contact prints.

ARTICLE 9. Reporting

The CONTRACTOR shall submit a written weekly report, with daily flight records, of the WORK in English to the ENGINEER.
A flight record form shall be provided by the CONSORTIUM.

ARTICLE 10. Liability

The CONSORTIUM shall be exempted from or kept harmless from any claim, damage, loss and/or accident incurring or arising against the third party in connection with any activity of the CONTRACTOR during the period of the WORK.

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ARTICLE 11. Insurance

The CONTRACTOR shall be held liable for injuries to third parties resulting from the CONTRACTOR's proven negligence. The CONTRACTOR shall be responsible for holding negotiations with injured parties and implementing all necessary steps which will assure the settlement of the matter.

ARTICLE 12. Contract Price

The Contract price shall be J.Yen 44,000,000 (Say Japanese Yen Forty Four Million Only), and made up as follows;-

(a) Mob/Demob. ..... J.Yen 9,750,000
(b) Aerial Photography ..... J.Yen 26,800,000
(c) Photo Processing ..... J.Yen 7,450,000

ARTICLE 13. Actual Flying and Other Costs

Landing, parking, fuel and any other fees concerning actual flying shall be borne by the CONTRACTOR. The CONTRACTOR shall also at his own expense supply and provide all equipment and materials required for the execution and completion of the WORK.

ARTICLE 14. Payment Conditions

Payments shall be made as follows:-

(a) 30 percent of the contract price : within 7 days after the arrival of the aircraft in Vientiane, Lao People's Democratic Republic.

(b) 70 percent of the contract price : within 30 days after the completion of aerial photography and photo processing and the acceptance of results by the ENGINEER.

In the case that all the aerial photography and processing could not be completed due to reasons not responsible to the CONTRACTOR, payment shall be made for the WORK completed on a pro rata basis specified hereunder plus mobilization/demobilization fee.

$$\frac{TA}{TF} \times \text{(Total contract price minus mob/demob. charges)}$$

Note: TA is the total line kilometres of acceptable flight runs and TF is the total extended line kilometres of flight runs shown in the attached Flight Plan, Fig. 1 of Exhibit A.

Payment shall be made by telegraphic transfers to the CONTRACTOR's bank account against the invoice countersigned by the ENGINEER, or by cash or traveler's checks if the CONTRACTOR shall so request.

ARTICLE 15. Force Majeure

Any failure by the CONTRACTOR to carry out any of its obligations under this Contract shall not be deemed a breach of this Contract, if such failure is caused by force majeure or reasons beyond such party's reasonable control. For purposes of this Contract force majeure shall include wars, insurrections, civil disturbances, blockages, embargos, strikes and other labour conflicts, riots, earthquakes, epidemics, storms, floods, explosions, fires, lightening, orders or directions of any government or instrumentality or sub-division thereof, acts of God or the public enemy, and any other causes (whether or not the kind hereinabove described) over which the CONTRACTOR has no reasonable control and which is of such a nature as to make timely compliance with its obligations under this Contract impossible.

2) In this event, the CONTRACTOR shall notify the CONSORTIUM thereof in writing, stating the cause, and the CONTRACTOR and the CONSORTIUM shall do all reasonably within their power to remove such cause, provided however that neither party shall be obligated to resolve or terminate any disagreement with third parties, including labour disputes, except under conditions acceptable to it or pursuant to the final decision of any arbitral, judicial or statutory agencies having jurisdiction to finally resolve the disagreement.

3) If the CONTRACTOR is by force majeure rendered unable, wholly

or in part, to perform its obligations and meet its responsibilities of the CONTRACTOR under this Contract, then the CONTRACTOR shall be suspended to the extent of its inability to perform them, and for as long as such inability continues.

ARTICLE 16. Safety of Aircraft and Crew

The crew is subordinated to a flight captain who has the final responsibility for the safety of the aircraft and crew and also has the responsibility to carry out the aerial photography according to regulations.

ARTICLE 17. Property

All materials, results and information which will be obtained by and furnished to the CONTRACTOR under this contract shall remain the property of the CONSORTIUM and the CONTRACTOR shall not disclose them to others in whole or in part for any other purposes.

All materials, results and information of the Topographic Mapping of Bolikhamxai Province will be transferred to the government of Lao People's Democratic Republic by the government of Japan, when all of the work items are completed.

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ARTICLE 18. Replacement of Personnel and/or Equipment

The CONTRACTOR shall provide replacements for the aircraft, aerial camera or any other piece of equipment when such equipment is rendered unusable for any reason. The CONTRACTOR shall also provide replacements for the flight crew, engineers or laboratory technicians, if for any reason, they are not able to carry out their assigned work. Costs for replacements shall be borne by the CONTRACTOR.

ARTICLE 19. Assignment and/or Subcontractor

Without written consent of the CONSORTIUM, the CONTRACTOR shall not assign part or all of this Contract to a third party or subcontract any portion of the WORK.

ARTICLE 20. Termination of Contract

The CONSORTIUM has the right to terminate this Contract without any payment in the following cases:-

(a) Except as provided in Article 15, Force Majeure, if the CONTRACTOR does not mobilize the aircraft after the instruction by the CONSORTIUM or fails to commence or suspends the WORK for a certain period without justified reasons.

(b) If the WORK is not fully performed by the CONTRACTOR in

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accordance with this Contract and Specifications and not rectified without justified reason.

The CONSORTIUM may terminate this Contract when the CONSORTIUM judges it is necessary, by giving the CONTRACTOR a written notice which will be delivered at least five (5) days before the date of termination. In this event, payment shall be made on a pro rata basis, which is specified in Article 14, Payment Conditions.

ARTICLE 21. Arbitration

All disputes arising in connection with this Contract shall be finally decided under the Rules and Conciliation and Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with the Rules.

ARTICLE 22. Changes in Work Program

The CONSORTIUM has the right to change the content of the WORK at any time, if necessary, subject to agreement with the CONTRACTOR.

ARTICLE 23. Effective Date of this Contract

This Contract shall become effective on the date when this Contract is duly executed and signed by the PARTIES.

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ARTICLE 24. Fairness, Doubt or Items not Specified

In entering into this Contract, the PARTIES recognize that it is impracticable to make provision for every contingency that may arise in the course of the WORK. Accordingly, the PARTIES hereby confirm it to be their intention that this Contract shall operate between them with fairness. Any doubt in connection with this Contract or any item not specified in this Contract shall be determined amicably by mutual agreement of the PARTIES.

IN WITNESS THEREOF, the PARTIES have executed this Contract by their duly authorized representatives as of the date first written above.

On behalf of the CONSORTIUM

T Kanakubo

for
Yoshitomo OGURI
Director in Chief
INTERNATIONAL ENGINEERING
CONSULTANTS ASSOCIATION (Japan)
No. 3-23, Kojimachi 5-chome,
Chiyoda-ku, Tokyo, Japan

On behalf of Kevron
Aerial Surveys Pty. Ltd.

John Lazarus
General Manager
Kevron Aerial Surveys Pty. Ltd.
121 Hill Street, East Perth,
West Australia 6004,
Australia

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EXHIBIT A.

SPECIFICATIONS FOR AERIAL PHOTOGRAPHY

ON

TOPOGRAPHIC MAPPING OF BOLIKHAMXAI PROVINCE

LAO PEOPLE'S DEMOCRATIC REPUBLIC

1. GENERAL

The Specificatons mentioned hereunder have been designed in order that the CONTRACTOR shall carry out aerial photography for the Topographic Mapping of Bolikhamxai Province in Lao People's Democratic Republic (hereinafter referred to as "Laos.")

2. SCOPE OF WORK

The WORK shall be executed in Laos in accordance with the terms, conditions and requirements of this Contract and Specifications, and under the supervision of the ENGINEER.

The WORK shall cover aerial photography at a scale of 1/40,000 covering the area of approx. 13,000 sq. km.

The WORK includes the following items:

(1) Aerial photographing and photo processing, and

(2) Final products and materials.

3. FLIGHT PLAN

The flight plan is attached as Fig. 1, and has been prepared on the available map of the area at a scale of 1/100,000.

The flight plan shows the runs to be flown and the required coverage beyond the boundaries of the area of photogrammetry and cartography works.

The direction of the flight runs are shown as such on the flight plan.

4. WORK PERIOD

The Contractor shall carry out the aerial photography and laboratory work within the period from 12 December 1992 to 9 February 1993.

5. EQUIPMENT AND MATERIALS TO BE USED

(1) Aircraft

Gates Learjet 35A or equivalent type, capable of high altitude flying specified in Paragraph 6 of Specifications, shall be used.

(2) Aerial Camera

A Wild RC-8 camera with a wide angle lenscone or equivalent (15(mm) shall be used for aerial photography.

The CONTRACTOR shall submit the calibration report for the lers tested within the past five years.

(3 Navigation Instruments

Aircraft shall be equipped with proper navigation aids which are essential for accurate navigation.

(4) Film

Kodak double X Panchromatic Aerographic type 2405 distortion free film or equivalent sc[illegible] type shall be used for aerial photography.

(5) Printing Paper

Ilford 24M paper, Kentmere or Kodak resin coated paper or equivalent shall be used for the reproduction of prints.

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6. REQUIREMENTS OF PHOTOGRAPHIC FLIGHT

(1) Photo Coverage

Aerial photography shall be performed to cover the whole area of 13,000 sq. km.

(2) Photo Scale, Altitude and Flight Direction

The aerial photography shall be taken at a scale of 1/40,000. Flight altitude shall be 6,900 plus/minus 5% metres above the mean sea level.

Flight directions shall be as such shown in Fig. 1.

(3) Flight Course

The discrepancy of flight course shall be within 500 metres from the course of the flight plan prepared on a scale of 1/100,000.

(4) Tolerable Shifting Error

The proposed mapping area shall not be missed on stereoscopic models due to shifting error.

(5) Overlaps

Forward overlap between successive exposures in each run shall be between 55 and 65 percent, and lateral overlap between adjacent runs shall be a standard between 25 and 45 percent, except where specified otherwise.

(6) Crab

Crab shall not exceed 10 degrees when measured between the base line and a line parallel to the frame of the negative nor be such that stereoscopic gaps in the photography result from it.

(7) Tip and Tilt

Tip and Tilt shall not exceed 5 degrees.

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(8) Haze, Mist, and Smoke

Photography shall only be flown when haze, mist or smoke, etc. dose not substantially impair the tone reproduction of the negatives.

(9) Tolerable Volume of Cloud and Haze

Although cloud free photographs shall be required, in the case of unfavorable weather conditions, the tolerable volume of cloud shall not exceed three percent (3%) of the successive five (5) photographs.

However, on the effective stereoscopic photographs, the important points and/or areas for orientation and cartography shall not be covered with cloud.

(10)Dividing of Strip

If a designated run is divided into two or more runs for any reason, the overlap for the runs shall consist of at least three (3) photographs.

(11)Altitude of the Sun

Photographic flight shall be carried out only when the altitude of the sun is approximately 45 degrees or more, or approximately between 10:00am and 2:00pm local time.

(12)Another Requirement

a) Two (2) extra photographs shall be taken to cover the area outside of the mapping boundary before the run starts and after it ends in order not to miss some of the required area, and

b) Approximately one metre at both ends of the roll of film shall be left unexposed.

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7. PHOTOGRAPHIC PROCESSING

(1) The film shall be developed to ensure homogeneous tone and clear contrast in the negatives.

(2) Fixing shall be done with sufficient time to thoroughly remove unexposed emulsion.

(3) Washing shall also be done with sufficient time to thoroughly remove any remaining fixing solution.

(4) Drying shall be done carefully to avoid film distortion to be caused by rapid heating, etc.

8. ANNOTATIONS

The following annotations shall be recorded on each frame by the CONTRACTOR in accordance with the instruction by the ENGINEER. Specifications shall be finalized after discussion with NGD, Laos.

9. LINE INDEX

A line index shall be prepared for all flight lines and photo centres on the existing maps at the scale of 1:200,000.

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10. FINAL PRODUCTS AND MATERIALS TO BE DELIVERED

The following products and materials shall be delivered to the CONSORTIUM in Vientiane, Laos.

The CONTRACTOR shall submit to the CONSORTIUM a delivery note or a list showing contents and quantity at each delivery.

(1) One (1) set of original film negatives

(2) One (1) set of the final contact prints

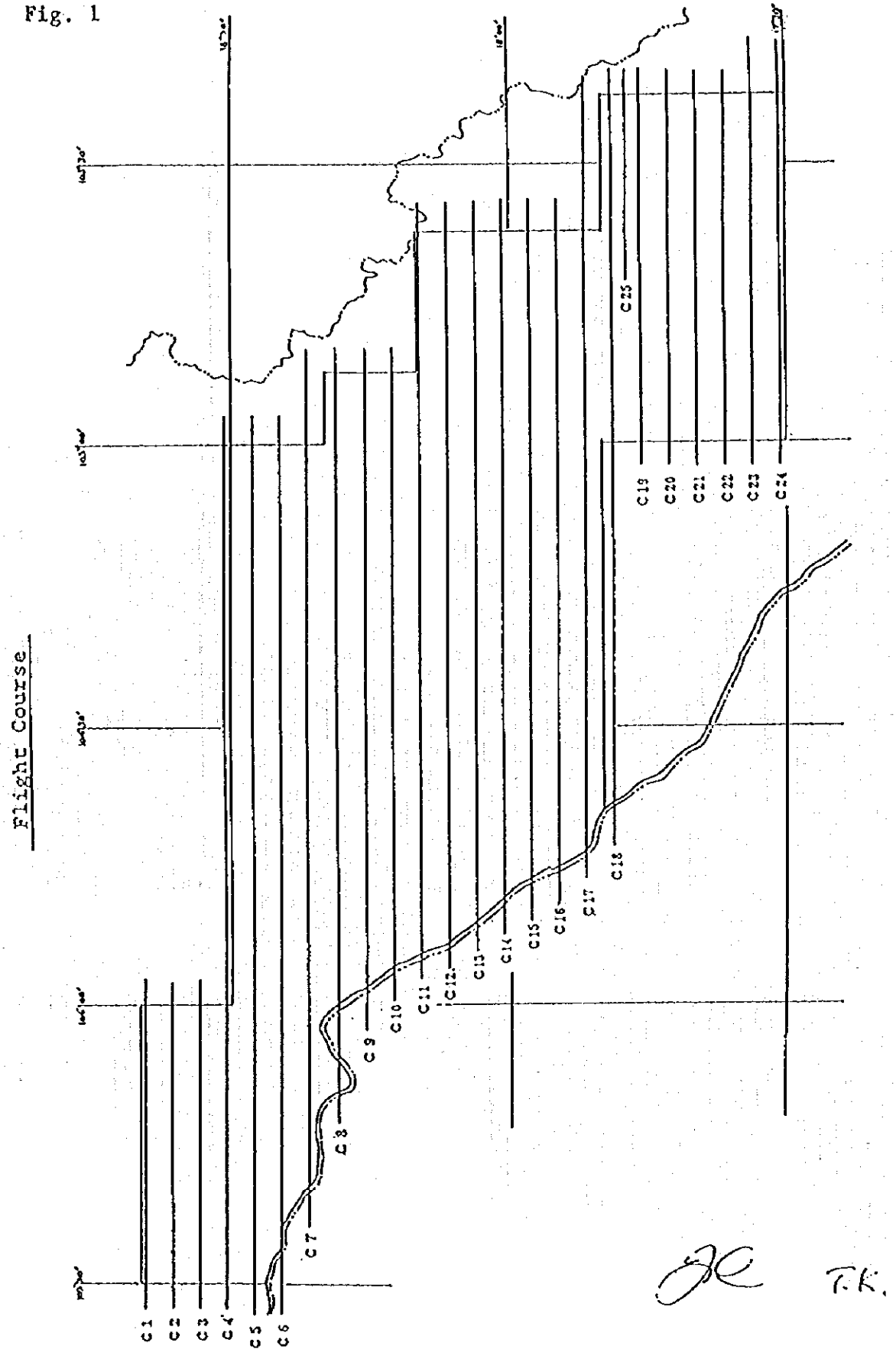
(3) A flight index map (scale 1/200,000)

(4) Flight records

(5) Weekly progress reports

(6) Final Report

Fig. 1


Flight Course
C1
C2
C3
C4
C5
C6
C7
C8
C9
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December 10, 1992

To whom it may concern :

POWER OF ATTORNEY

This is to certify that Mr. Toshitomo KANAKUBO, Leader of Japanese survey mission for the Aerialphotography of BOLIKHAMXAI Province LAO PEOPLE'S DEMOCRATIC REPUBLIC, whose signature is attested below, is fully authorized to sign all documents concerning agreements on the operation for the Aerialphotography as above mentioned province in LAOS, on my behalf.

T. Kanakubo

Toshitomo KANAKUBO
Leader,
Japanese Survey mission

Yoshitomo Oguri

Yoshitomo OGURI
Director in Chief
International Engineering
Consultants Association