4. Minutes of Meeting

MINUTES OF MEETING
FOR
TOPOGRAPHIC MAPPING
OF
SOUTHERN PART OF THE REPUBLIC OF GHANA
AGREED UPON
BETWEEN
SURVEY DEPARTMENT OF GHANA,
MINISTRY OF LANDS AND FORESTRY
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

ACCRA, GHANA
December 18th, 1997

NAA Alhaji Iddirisu Abu
Director of Surveys
Survey Department of Ghana
Ministry of Lands and Forestry

宇根 寛

Mr. Hiroshi UNE
Leader
Advisory Committee,
Japan International Cooperation Agency

The advisory Committee (hereinafter referred to as "the Committee") for Topographic Mapping of Southern Part of the Republic of Ghana (hereinafter referred to as "the Study") organized by Japan International Cooperation Agency (hereinafter referred to as "JICA") headed by Mr. Hiroshi UNE visited the Republic of Ghana from 14th of December to 19th of December, 1997, and had a series of discussions with the Ghana side, represented by the Survey Department of Ghana, Ministry of Lands and Forestry (hereinafter referred to as "SDG") headed by NAA Alhaji Iddirisu Abu. The list of participants is shown in Appendix-1.

The Study, a five-year plan, started in January, 1996, as a technical cooperation program of JICA in compliance with the Scope of Work agreed upon between SDG and JICA on 17th of March, 1995.

In October 1997, the SDG requested that the digital data be added to the final products and delivered to the SDG. Furthermore, little progress was made in the aerial photography on account of unexpected unseasonable weather even though the study team extended the schedule and tried four times.

As a result of the said discussions, both sides came to share a common understanding on the changes of the process of the Study.

Main items discussed by both sides are as follows:

1. The SDG and the Committee agreed that the digital topographic data of the study area will be added to the final products and delivered to SDG. The data will be installed into CD-ROMs. The format of the data will be designed so as to be compatible with the existing digital topographic data produced by SDG under the Ghana Environmental Resources Management Project. (hereinafter referred to as "existing digital data"). 10 copies of CD-ROMs which contain digital topographic data for all the study area shall be supplied as final products. Digital plate making method will be applied instead of manual scribing, and the scribed sheets shall be deleted from the list of the final products to be submitted. The plates for reproducing paper maps will be delivered to the SDG after finishing the Study.

2. The Committee and the SDG agreed that Japanese side can retain some sets of CD-ROMs which will be produced as a result of the Study as long as they are not given to third parties without approval of the Government of Ghana represented by SDG.

3. The Committee explained the state of aerial photo-shooting. The work of aerial photograph shooting did not progress as much as it was planned. Even if it is continued, the work will not be completed within a reasonable time frame. Therefore, the Committee proposed that the work of 1:60,000 aerial photo-shooting will be limited to the work done up to the end of the year 1997 and terminated. The SDG accepted the proposal.

4. The Committee proposed that the new digital mapping work for 20 sheets (as shown in Appendix 2) will be conducted to produce topographic maps with a scale of 1:50,000 using newly taken photographs. The SDG accepted the proposal.

5. The Committee proposed an updating work be conducted for the area where aerial photographs were not fully taken to conduct a new digital mapping. In this work, ground features will be updated to produce revised topographic data with a scale of 1:50,000 from existing digital data, using

available satellite images. Field verification shall be done more intensively than the new digital mapping work. Other possible materials such as existing aerial photos provided by the SDG may be used. Adding to it, a large scale aerial photo shooting will be conducted for the limited area where planimetric change is great. The SDG accepted the proposal.

6. The SDG and the Committee agreed that all the digital data that will come from both the new digital mapping work and the updating work will be structured topologically. The structure will be harmonized with the structure of existing digital data.

7. The SDG requested that the contour interval of the new mapping is applied to the updating work.

8. The SDG requested for technology transfer on operation and maintenance of the digital topographic data. The Committee accepted the request.

PARTICIPANTS FROM GHANA SIDE (SURVEY DEPARTMENT OF GHANA)

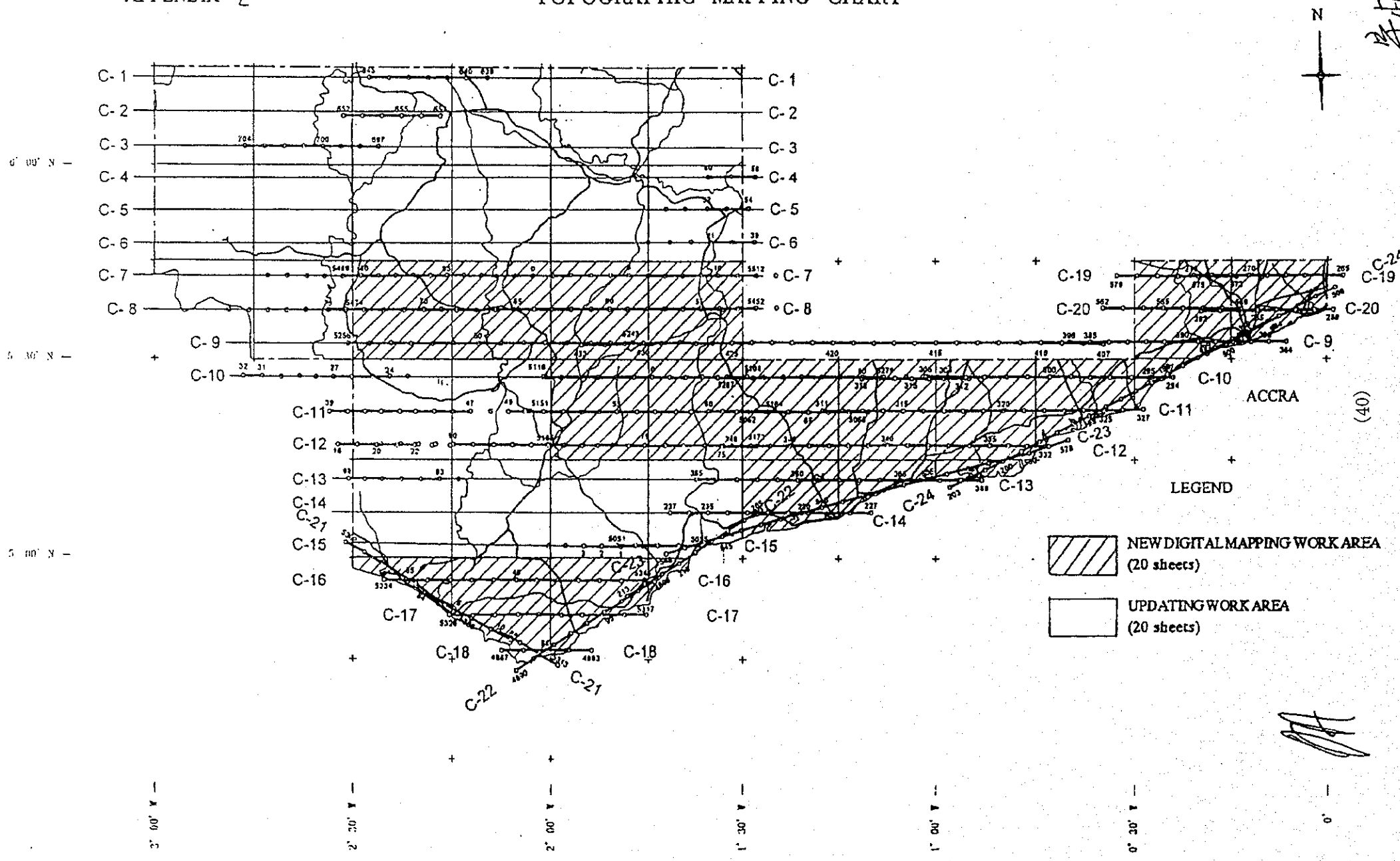
	NAME	POSITION/SECTION
1.	Naa Alhaji Iddirisu Abu	Director of Surveys
2.	E. S. Sai	Ag. Deputy Director of Surveys
3.	J. Dotse	Coordinator, Mapping Project
4.	R.Brimah	Assistant Director
5.	J.A. Abbosey	Headquarters Staff
6.	E.R. Tetteh	Chief Lithographer
7.	Marcus A. Tabil	Examiner
8.	S. Oppong-Antwi	Digital Mapping Unit
9.	E. Addo-Tawiah	Digital Mapping Unit.
10.	Kofi N. Arku-Lawson	Chief Cartographer
11.	I. Andoh-Kesson	Photogrammetrist
12.	E.A. Quaye	Headquarters staff (In-charge of Cadastral Survey)
13.	J.C. Acquaah	Geodesy Unit (G.P.S)
14.	K. D. Ewusi-Ampah	Headquarters staff (Accountant)
15.	Jones Ofori-Boadu	Data Examiner
16.	John Ayer	Officer-in-charge of training
	Ian K. Isaacs	Terra Surveys (Observer).

PARTICIPANTS FROM JAPANESE SIDE (JICA)

1.	Hiroshi UNE	Team Leader, Head of International Affairs office, Geographical Survey Institute, Ministry of Construction, Japan
2.	Hozumi KATSUTA	Study Planning, Development Specialist, JICA
3.	Tokihiko KAMINISHI	Consultant Team Leader, (Infrastructure Development Institute, Japan)
4.	Christopher NUOYEL	Programme Officer, JICA/Ghana Office

APPENDIX 2

TOPOGRAPHIC MAPPING CHART

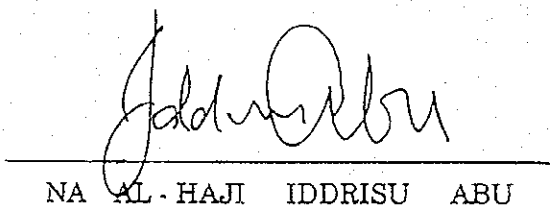


5. ガーナ国測量局との協議議事録

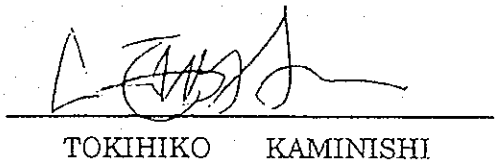
5－1　第1年次現地作業開始時の協議議事録

MINUTES OF MEETINGS
FOR
THE STUDY ON TOPOGRAPHIC MAPPING
OF
SOUTHERN PART OF THE REPUBLIC OF GHANA
BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY
AND
SURVEY DEPARTMENT OF GHANA

ON
FEBRUARY 9, 1996
ACCRA, GHANA



NA AL - HAJI IDDRISU ABU
DIRECTOR OF SURVEYS
SURVEY DEPARTMENT OF GHANA
MINISTRY OF LAND AND FORESTRY



TOKIHIKO KAMINISHI
LEADER
JICA STUDY TEAM

The JICA Study Team headed by Mr.Tokihiko KAMINISHI visited the Republic of Ghana from 30th January, 1996 to carry out the first year work for the Study on Topographic Mapping of Southern Part of the Republic of Ghana.

Prior to the commencement of the first phase survey work, a series of meetings were held from 1st to 9th February, 1996 and following items have been confirmed and agreed by Survey Department of Ghana (SDG) and JICA Study Team.

1. The Plan of Operation proposed by JICA Study Team was discussed and agreed as appendix.
2. Study Team received the Geodetic Data to be applied in the Study area from SDG.
3. SDG requested to Study Team that the following annotation should be printed at the lower margin of every map;
   "This map was prepared jointly by Japan International Cooperation Agency (JICA) under the Japanese Government Technical Cooperation Programme and Ministry of Lands and Forestry, Survey Department of the Government of Ghana"
   Study Team took note this request and confirmed to convey this request Tokyo JICA Head Office.

LIST OF ATTENDANTS

GHANAIAN SIDE

(SDG)

1.	Na Al-haji I. Abu	Director of Surveys	Headquarters
2.	R. Brimah	Asst. Director	Headquarters
3.	J. Dofse	Asst. Director	Greate Accra Region
4.	J. Abbossy	Stuff Surveyor	Headquarters
5.	E. A. Quaye	Asst. Chief Cartographer	Headquarters
6.	J. T. Odametey	Asst. Staff Surveyor	Headquarters
7.	H. A. Kuffo	Asst. Staff Surveyor	Headquarters
8.	J. C. Acquaah	Technician Engineer	Greater Accra Region
9.	Andoh Kessey	Technician Engineer	Photogrammetric Section
10.	E. R. Tetteh	Chief Lithographer	Lithographic Section
11.	J. Ofori Boadu	Asst. Staff Surveyor	Examination Section
12.	K. Wemegah	Technician Engineer	Examination Section
13.	Marcus Tabil	Asst. Staff Surveyor	Examination Section
14.	Arku Lawson	Asst. Staff Surveyor	Cartographic Section
15.	C. R. K. Anyaah	Snr. Technician Engineer	Examination Section

JAPANESE SIDE

(JICA Study Team)

1.	Tokihiko KAMINISHI	Leader
2.	Koichi MIKI	Deputy Leader
3.	Kozo OKUMURA	Mapping Planner
4.	Yutaka KYAKUNO	Chief Surveyor
5.	Hideaki SAKAI	Coordinator

(Advisory Committee Team)

1.	Yoshimi TAKITA	Technical Staff, Geographical Survey Institute
2.	Toshihisa HASEGAWA	Staff, JICA Headquarters

(Ghana Office, JICA)

1.	Toshiharu KAI	JICA Deputy Resident Representative

ATTACHMENT

PLAN OF OPERATION

FOR

TOPOGRAPHIC MAPPING OF SOUTHERN PART

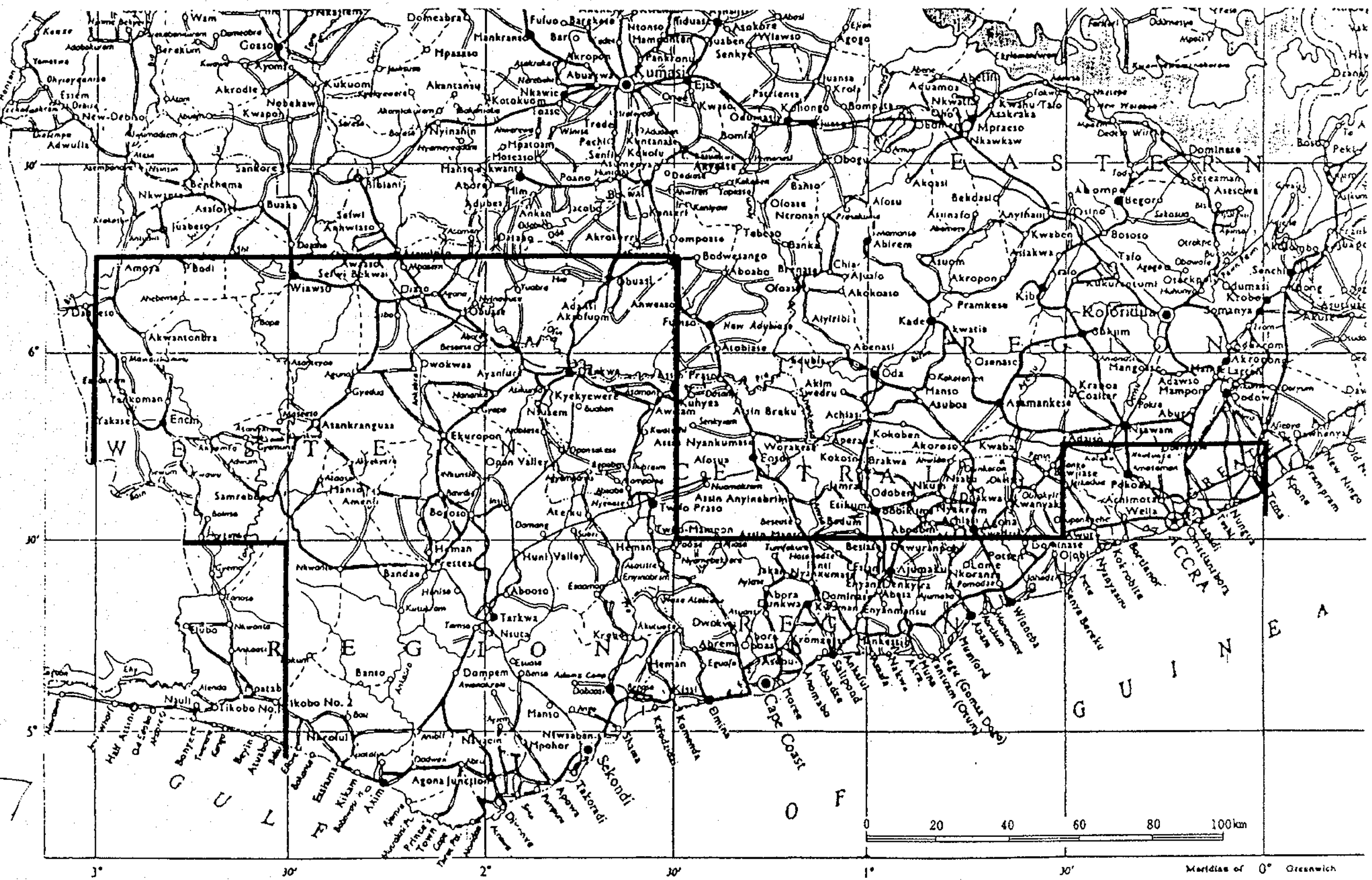
OF

THE REPUBLIC OF GHANA

JANUARY, 1996

JAPAN INTERNATIONAL COOPERATION AGENCY

TOPOGRAPHIC MAPPING AREA



C O N T E N T S

I. INTRODUCTION

In response to the request of the Government of the Republic of Ghana (hereinafter referred to as Ghana), the Government of Japan (hereinafter referred to as Japan) has decided to conduct the Topographic Mapping of Southern Part of Ghana (hereinafter referred to as the Study)in accordance with the relevant laws and regulation in force in Japan.

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

Survey Department of Ghana (hereinafter referred to as SDG)shall act as the counterpart agency to the JICA Study Team (hereinafter referred to as the Team) and also as the coordinator in relation to other governmental and non-governmental organizations concerned of Ghana for the smooth implementation of the Study.

The Study shall be executed under four years plan, and the Plan of Operation (P/O) for the first year's study is proposed with tentative schedule for succeeding years.

II. OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the 1/50,000 Topographic Map covering an area of approximately 25,500 square kilometers (see attached map) and to transfer technology to the counterparts personnel of Ghana.

III. OUTLINE OF THE STUDY

In order to achieve the above mentioned objective, the Study will cover the following items in accordance with the Scope of Work (S/W), minutes of meetings (M/M), JICA procedural rules for overseas surveying (base mapping).

1. Aerial Photography

Panchromatic vertical aerial photographs shall be taken at a scale of

1/60,000 covering the entire study area using super-wide angle camera.

2. Ground Control Point Survey

Control points for aerial triangulation shall be executed by Satellite Geodesy, applying Global Positioning System (GPS) for horizontal and vertical control. Additionally, vertical control points for aerial triangulation shall be increased by direct leveling of minor order using leveling instrument in principle.

3. Pricking

Pricking of above horizontal and vertical control points (including existing BMs) shall be performed on the enlarged aerial photos.

4. Aerial Triangulation

Aerial triangulation shall be performed based on the ground control points survey data. Adjustment computation shall be made analytically by the block adjustment method.

5. Field verification

The topographic features, land use, vegetation and other information necessary for terrain representation shall be identified in the field. Place names to be adopted shall be confirmed on site referring to the information provided by SDG. Cooperation of SDG is sought for collection and recording of geographic and administrative names that are necessary for topographic map.

6. Stereo-plotting

Stereo-plotting shall be carried out at a scale of 1/50,000 by stereo plotting machine with contour interval 10m (mountainous area 20m).

7. Compilation

Compilation shall be carried out based on the restitution manuscript and field verification data. Map symbols and specifications shall be used in accordance with pre-agreed between the Study team and SDG.

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 (To complete the original manuscript). Administrative boundaries and geographical names shall be verified and indicated on the paper copy of the compilation sheet by SDG.

Additionally, subsequent drafting and map-reproduction treatment shall be discussed and agreed between the Study Team and SDG.

9. Drafting

Based on the original manuscripts, scribing shall be carried out on stable polyester base for several color separation plates. Map style and symbols shall be those adopted by SDG. And the contents of map shall comply with the standards of SDG.

10. Printing

Printing plates shall be prepared by photo lithography using 1/50,000 scribing negatives. Color applied for printing shall be five, and 1,000 final copies shall be printed for each sheet.

11. Recommendations

Recommendations for improvement of management and operation systems and maintenance system of control points and maps shall be provided.

Work volumes and standards for respective work items are shown in Tab.1 and Tab.2.

Tab. 1 Work volume of the Study

ITEM	VOLUME	REMARK
1. Aerial photography	approx. 25,500 Km^2	Scale 1/60,000 (super-wide)
2. Ground control survey	approx. 74 points	GPS survey method(including existing control points).
3. Leveling	approx. 1,080 Km	Minor order leveling.
4. Pricking		
GPS point	approx. 74 points	40 points for horizontal & vertical, 34 points for vertical control.
New leveling point	approx. 1,080 Km	approx. 270 points
5. Aerial triangulation	approx. 680 models	
6. Field verification	approx. 25,500 Km^2	
7. Stereo-plotting	approx. 25,500 Km^2	Scale 1/50,000 (40 sheets)
8. Compilation	approx. 25,500 Km^2	Scale 1/50,000 (40 sheets)
9. Field completion	approx. 25,500 Km^2	
10. Drafting	approx. 25,500 Km^2	Scale 1/50,000 (40 sheets)
11. Printing	40 sheets	1,000 copies each

Tab. 2 Standard of the Study

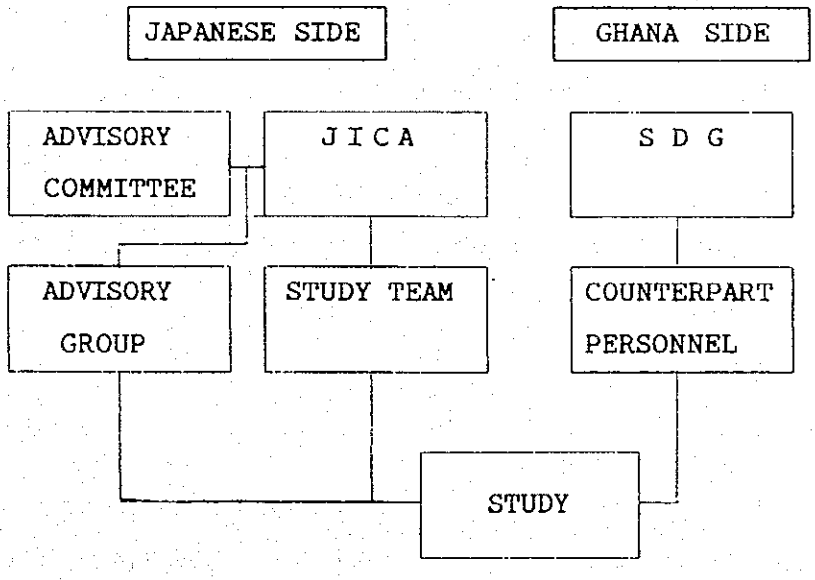
Reference ellipsoid :	Clarke 1880
Map projection :	Ghana Modified Transverse Mercator
Datum of height :	M. S. L. (Based on the existing BMs)
Map scale :	1/50,000
Neat line :	15′ x 15′
Contour interval :	10meters (Mountainous area 20meters)
Map style & application rule :	One adopted by SDG
Ground control point survey :	1/100,000 (Relative accuracy)
Leveling :	5cm$\sqrt{s}$ (s:Km)
Number of colors :	5 colors

IV. UNDERTAKINGS

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

1. Ghana side:
   - -Necessary arrangement 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 to bring in and out of Ghana.
   - -Assistance to facilitate issuance of permit necessary for implementation of the Study.
2. Japanese side:
   - -Implementation of the Study in Ghana and Japan.
   - -Technology transfer through the execution of the Study.
3. Organization:

   Parties involved in this Study shall be organized as follows;



V. STUDY SCHEDULE

The Study shall be planned four years from January, 1996 to June, 1999 as shown in Fig. 1. The flowchart for the production of topographic map is as shown in Fig. 2.

VI. REPORT AND FINAL PRODUCTS

Annual report shall be prepared by Study team at the begining of field survey stage II, III and IV. The report on the final year (fiscal) shall cover all of the activities in this Study.

The final products to be delivered to the Government of Ghana are as follows;

(1) Original negatives ---------- 1 set
(2) Aerial triangulation diapositives---------- 1 set
(3) Contact prints(including aerial triangulation photos)--- 2 sets
(4) Photo-index map ---------- 1 set
(5) GPS control points descriptions & results ---------- 1 set
(6) Vertical control (Leveling) results ---------- 1 set
(7) Pricked and annotated aerial photographs ---------- 1 set
(8) Aerial triangulation results ---------- 1 set
(9) Color separation scribed sheets ---------- 1 set each
(10) Color separation combined negatives or positives --- 1 set each
(11) 1/50,000 topographic maps ----------1,000 copies each

VII. DETAILED WORK PLAN FOR FIRST YEAR (PHASE 1)

The field work for the first year (aerial photography, ground control survey I) shall be carried out for a period from January, 1996 to March 1996. The members of the Study team and their assignment in the first year are as shown in Table-3.

1. Preliminary Work in Japan

Prior to the start of the work as above, chief engineer together with other responsible engineers shall be prepared a detailed plan and equipments for each work process so as to facilitate the field work.

2. Preliminary Work in Ghana

Upon arrival in Ghana, while Study Team shall start preparing for field operations. Team Leader and his staff shall meet with SDG to discuss following administrative matters.

(1) Explanation of P/O.

(2) To secure permissions to take aerial photographs.

(3) Security of Survey Team Members. Issuance of ID card/pass permits.

(4) Notifying relevant government agencies and request for assistance by the military, if necessary.

(5) Appointment of SDG counterparts for each survey team activity.

(6) Permission to take out the original negative films and other related materials from Ghana to Japan and also back into the Ghana.

(7) Office space & photo-processing facilities of SDG for Study Team.

(8) Permits for entering public/private land for cutting trees as necessitated by the survey work.

(9) Assistance in hiring vehicles and drivers.

(10) Assistance in setting sub-camps.

(11) Supply of survey data of existing control points.

(12) Other items relevant to S/W.

3. Aerial Photography

Aerial photography shall be contracted out to a foreign aerial photography company. One Japanese engineer is assigned to Ghana to supervise the operations and check the results.

3-1 Specifications for aerial photography

Main specifications for the aerial photography shall be as follows;

- Camera : Super wide angle camera
- Photo scale : approx. 1/60,000
- Coverage : approx. 25,500Km²
- Flight course : 24 courses
- Flight length : approx. 3,500km
- Film : Panchromatic film
- Forward overlap: 60 ± 5%
- Lateral overlap: 30 ± 10%
- Crab : Less than 10 degree
- Tip & tilt : Less than 5 degree
- Cloud coverage: Amount of cloud shall not exceed 3% in successive 5 photograph. However, important areas for orientation and cartography shall not be covered with clouds.

3-2 Implementation of photography

- Base air port : The flight plan shall be made with Accra Airport as the base.
- Test flight : Test flight and test photographing shall be made over the site before launching the scheduled operations.
- Checking : Supervisor for aerial photography inspect developed photos to ensure sidelaps, overlaps and see the specifications are followed. If the results do not fulfill the specifications, the aerial photography company shall be carried out to re-fly same portions.
- 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 SDG.
- Index map : The index map is prepared on the existing 1/500,000 topographic map by assigning principal points of photos.

4. Ground Control Point Survey I

In order to ensure the planimetric relative accuracy (1/100,000) for the horizontal control point survey as agreed to in S/W, horizontal control point survey shall be conducted by satellite geodesy using GPS units. Observation shall be made simultaneously via plural units of GPS equipment to form an observation network connected to existing control points. The results shall be computed by network adjustment in Japan. Check observation shall be made over a distance between known points to ensure the accuracy. It shall be so planned as to receive signals from more than four different satellites. The elevation of Phase-1 GPS control points shall be determined by direct or indirect leveling method using leveling instrument or EDM/theodolite on Phase-2.

4-1 Observation plan

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

GPS observation (newly set up) : approx. 36 points
GPS observation (existing control point): approx. 4 points

If the location of a new point happens to have no access even by vehicle, it may be moved to an easier location.

4-2 Observation

In GPS observation, attention shall be paid as follows ;

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

4-3 Computation & accuracy

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

Ⅶ. TENTATIVE WORK PLAN FOR SUCCESSIVE WORK (PHASE 2~5)

Following is the work plan covering successive work. 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 (see Fig.1).

1. Ground Control Point Survey II

Additional ground control points(approx. 34 points) shall be increased in this stage for vertical control for aerial triangulation. It shall be done same as Phase-I specification, but the height shall be computed by interpolation method by referring to the geoidal slope of the study area based on the difference between Phase-I GPS results/leveling.

2. Leveling

Bench marks are applied for vertical control, but existing bench marks as distributed in the study area are do not satisfy the required specifications for aerial triangulation, so that minor order leveling shall be carried out to set up additional vertical control for aerial triangulation.

The survey shall be made by direct leveling in principle but for areas where access is difficult, indirect leveling may be applied using EDM/theodolite.

(1) Observation

- The leveling shall be start at an existing bench mark and to close other existing one. Also bench marks to be applied are selected after check surveying in relation to neighboring existing bench mark.
- For routes with no closure route, double-run(back & fore) observation shall be executed.
- Vertical control points for aerial triangulation shall be set up about 3 to 4 Km intervals at location where pricking is possible on photos.

(2) Accuracy

- Allowable error for both closure and double-run shall be within 5cm/s (s=Km).

3. Pricking

Pricking shall be performed for above mentioned GPS points, existing BMs and new leveling points using two times enlarged photos. Eccentric points for horizontal control shall be selected and pricked at clearly identifiable points on the aerial photos, and the eccentric elements shall be measured using EDM, theodolite etc.

Pricking of new leveling points shall be done at the same time of observations, if possible.

4. Map Symbols Consultation

To facilitate the Third year field work (field identification), SDG shall be consulted on the following items ;

(1) Map symbols and their application rule.

(2) Collection of materials related to above.

5. Aerial Triangulation

Based on the ground control point survey and the scale of 1/60,000 aerial photos, coordinates of pass points and tie points necessary for stereo-plotting shall be determined by aerial triangulation.

Pass-points, tie-points and control points as pricked on the diapositives are measured using stereocomparator or equivalent for their coordinates.

Adjustment computation shall be performed using block adjustment program based on the independent models. Orientation elements on the plotter are also computed.

Control points and model layout are as shown on Fig.4. The tolerance (discrepancy) for pass-points, tie-points, and also the limits of residuals of ground controls as used for adjustment shall be less than JICA procedural rules.

6. Field Verification

Field verification shall be conducted using 2-times enlarged aerial photos. Map symbols and application criteria shall be set as agreed to by SDG.

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 land-use/vegetation, 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 informations to be supplied by SDG.

7. Stereo-plotting

Based on the results of aerial triangulation and field identification, all items to be shown on the scale of 1/50,000 topographic maps shall be measured from 1/60,000 aerial photos and delineated at 1/50,000 by plotting machine to produce restitution manuscript.

Detailed terrain features and vegetations shall be carefully measured, and also contour lines shall be drawn every 10 meters (mountainous area 20 meters).

8. Compilation

Restitution maps shall be compiled according to the field identification findings and made into compilation manuscripts with the symbols and specifications as agreed between the Study team and SDG.

Sheet size of the compiled topographic maps shall be 15′ x 15′ and number of the map sheets shall be 40 sheets.

9. Field Completion

Field completion shall be carried out on the items which are unidentified in the process of plotting and compilation. Also important changes that have happened in the meantime, if any, shall be incorporated and modified.

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

10. Drafting

Based on the final manuscripts, original drafting maps shall be prepared for making 5-color printing plates. For drafting, color separation negative scribing method shall be applied.

The original drafting maps shall consist of scribed sheets, masking sheets, annotation/marginal information sheets.

Annotation shall be in English (Latin alphabet). Every map sheet to be product in this survey work shall have the following annotation printed at the lower margin the following ;

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

11. 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. Specification of printing paper to be used shall be determined through talks with SDG.

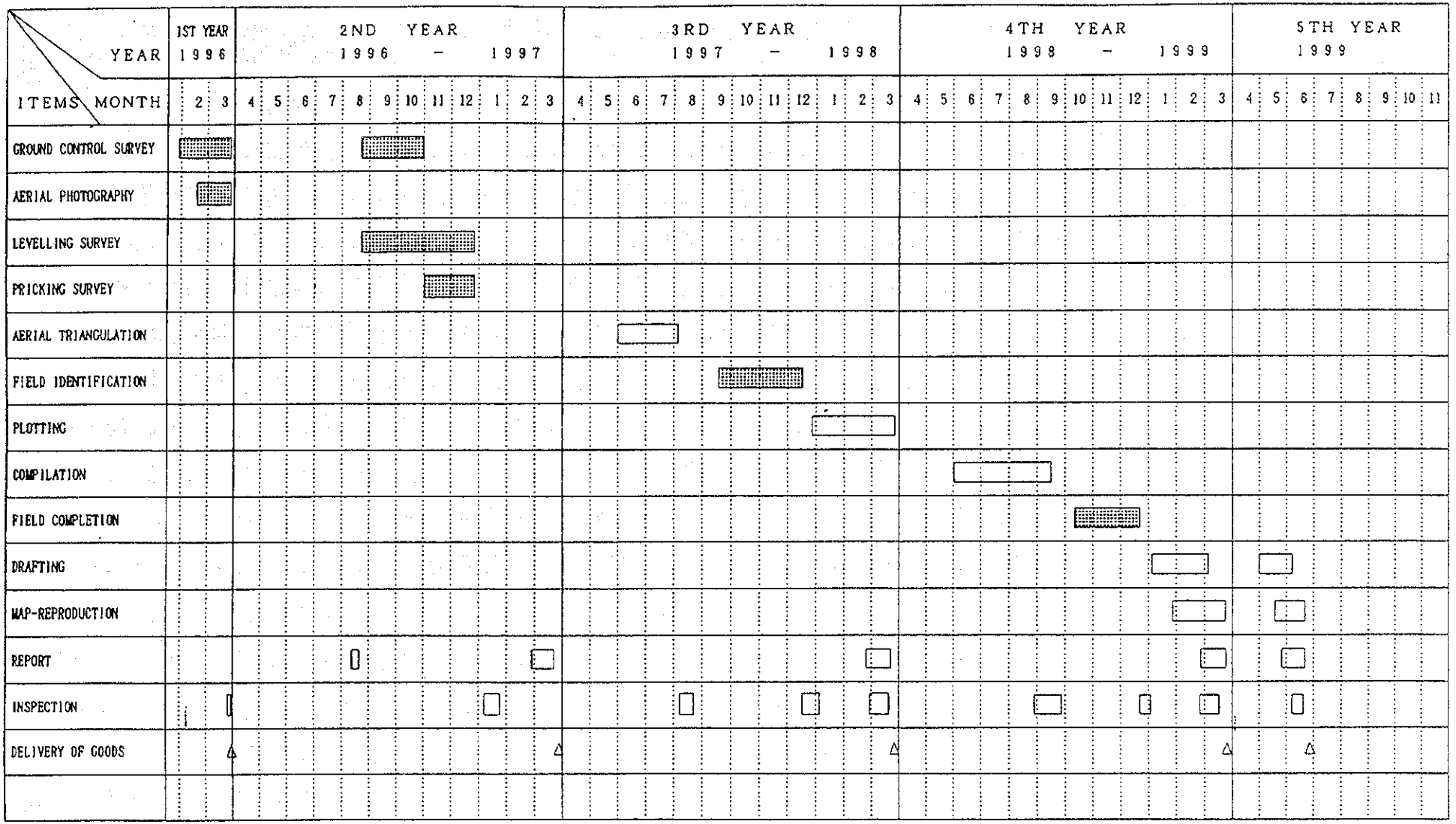
12. Work Flow

The flow of the entire work is schematically shown on the Fig. 1.

TABLE. 3 MEMBERS OF STUDY TEAM AND THEIR ASSIGNMENT IN THE FIRST YEAR (PHASE 1)

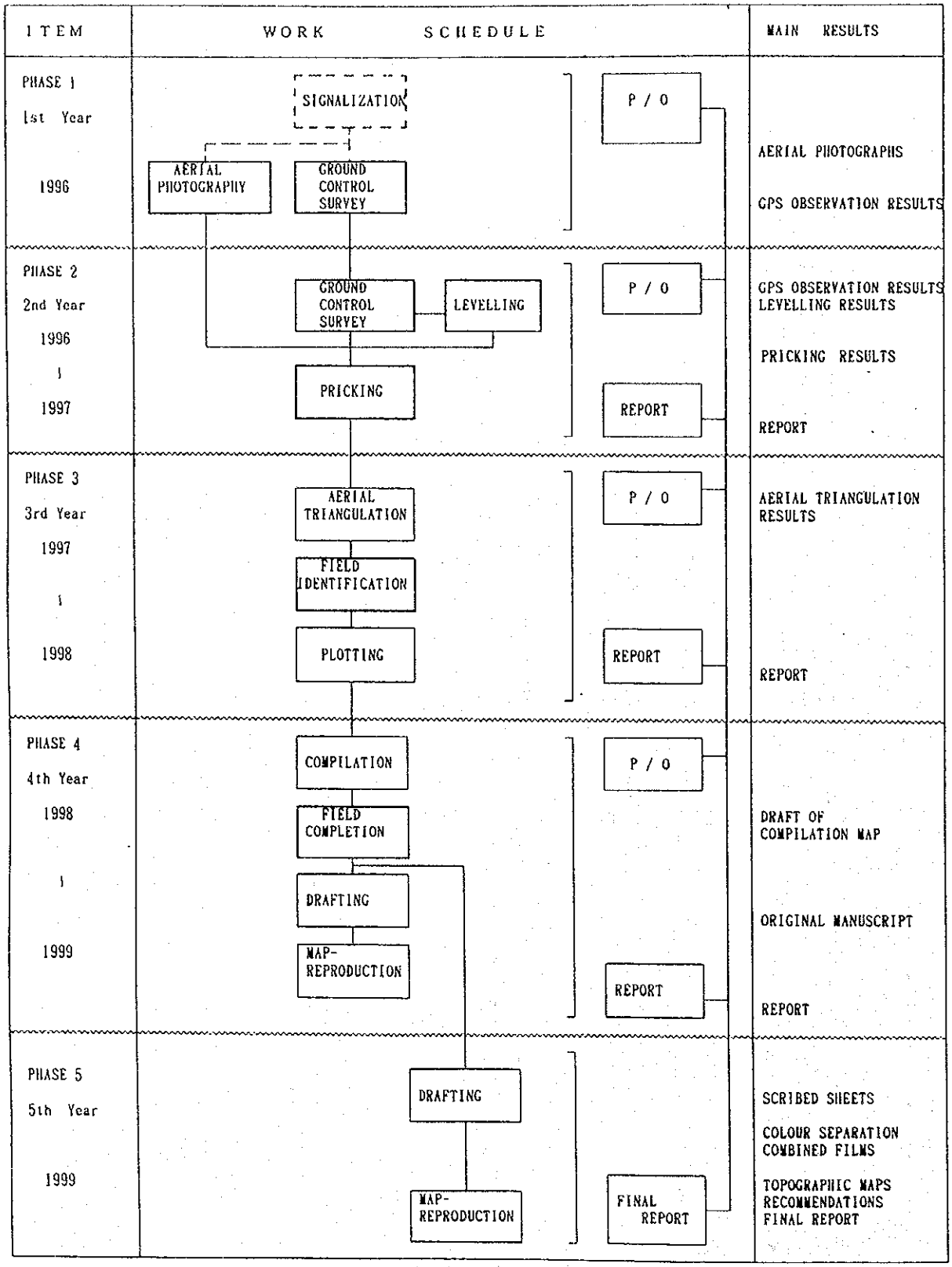
NAME	ASSIGNMENT	DURATION	CONTENTS
Tokihiko KAMINISHI	LEADER	29th Jan--17th Feb, 1996 8th Mar--25th Mar, 1996	1. TOTAL MANAGEMENT 2. GENERAL DISCUSSION
Koichi MIKI	SUBLEADER	29th Jan--25th Mar, 1996	1. SUB MANAGEMENT 2. GENERAL DISCUSSION 3. ASSISTANCE OF LEADER 4. GENERAL SUPERVISION
Kouzou OKUMURA	MAPPING PLANNER	29th Jan--25th Mar, 1996	1. FUNDAMENTAL MAP PLANNING 2. GENERAL COORDINATION 3. REPORTING
Yutaka KYAKUNO	CHIEF SURVEYOR	29th Jan--25th Mar, 1996	1. PLANNING OF IMPLEMENTATION 2. SUPERVISION OF WORKS 3. COORDNATION OF WORKS 4. QUALITY CHECKING
Shinpei ISHIWATA	MECHANICAL ENGINEER	29th Jan--25th Mar, 1996	1. MANAGEMENT OF VEHICLE 2. MAINTENANCE OF VEHICLE
Yutaka KOKUFU	PHOTOGRAPHER	19th Feb--25th Mar, 1996	1. INSPECTING OF PHOTOGRAPH AND PHOTO PROCESS
Masahiko OHASHI	SURVEYOR	29th Jan--25th Mar, 1996	1. G.P.S. OBSERVATION 2. G.P.S. ANALYZING
Yasuo GOTO	"	"	
Seiichi FUKUTOMI	"	"	
Tuyoshi YAMASAKI	"	"	
Kouichi WAKISAKA	"	"	
Makoto TSUJIMOTO	"	"	
Masaru TERADA	"	"	
Sadao MATSUMOTO	"	"	
Tomohiro MURAKAMI	"	"	
Kensuke KIMURA	"	"	
Yuichi TABIKAWA	"	"	
Kazutomo NAKANISHI	"	"	
Kouji FUKAZAWA	"	"	
Kouzou YAMAYA	"	"	
Hideaki SAKAI	COORDINATOR	29th Jan--17th Feb, 1996 16th Mar--25th Mar, 1996	1. Coordination

FIGURE 1. TENTATIVE WORKING SCHEDULE



LEGEND —— PREPARATION FIELD SURVEY WORK IN JAPAN

FIGURE 2. FLOWCHART FOR THE PRODUCTION OF TOPOGRAHIC MAPS



Remarks: 1. Field works in Uganda 2. Works in Japan

Fig. 3 FLIGHT COURSE

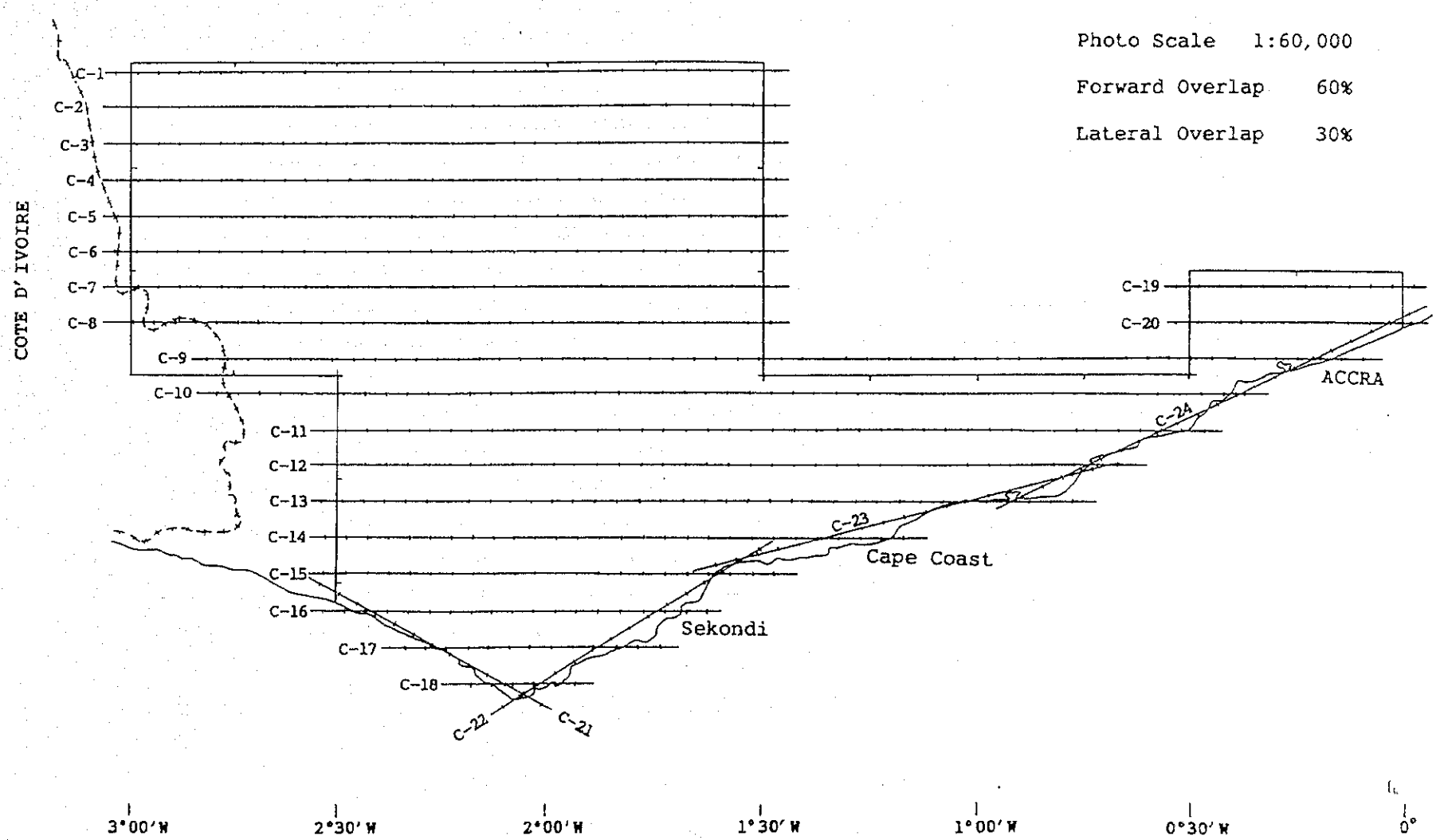


Fig. 4 GROUND CONTROL INDEX (DRAFT)

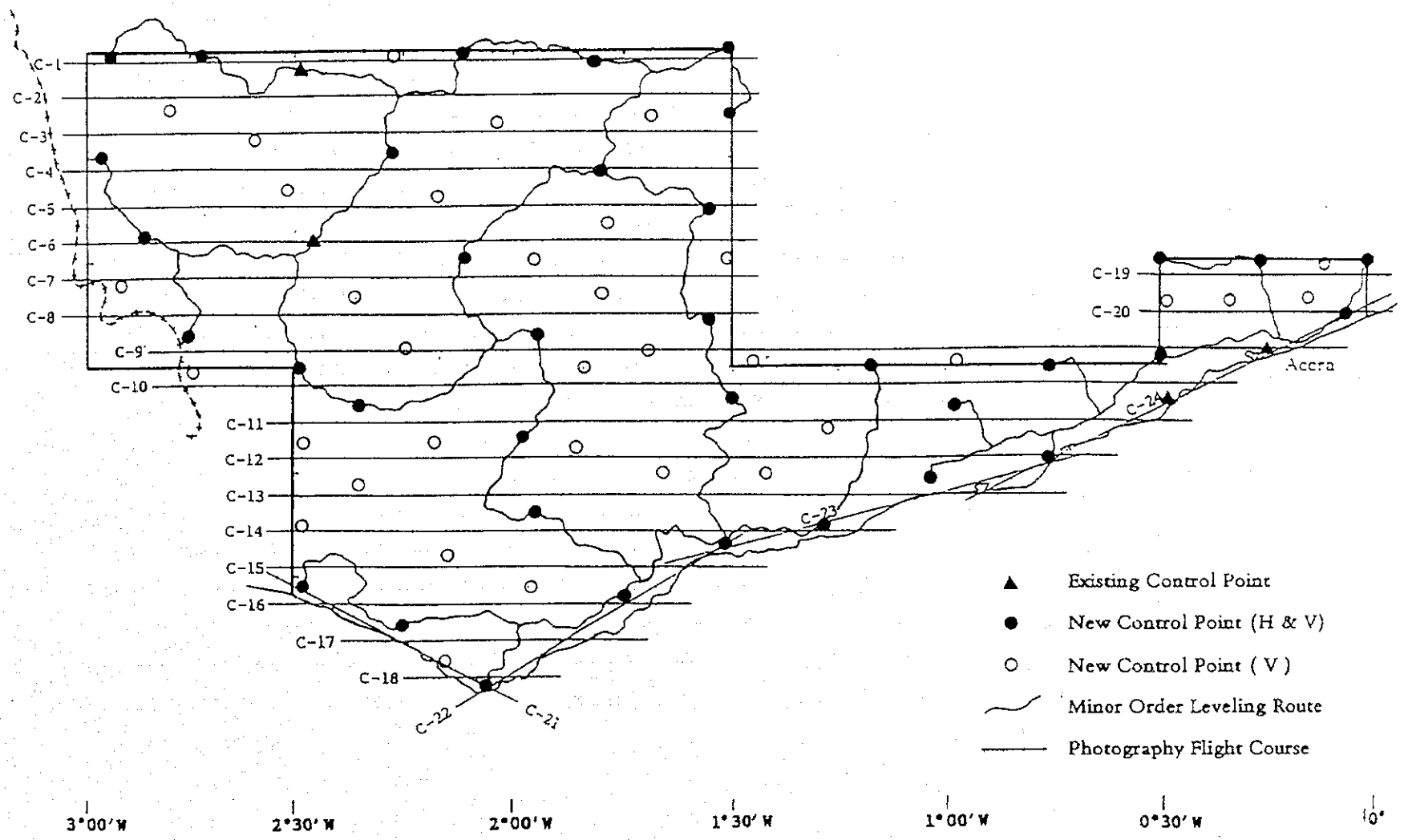
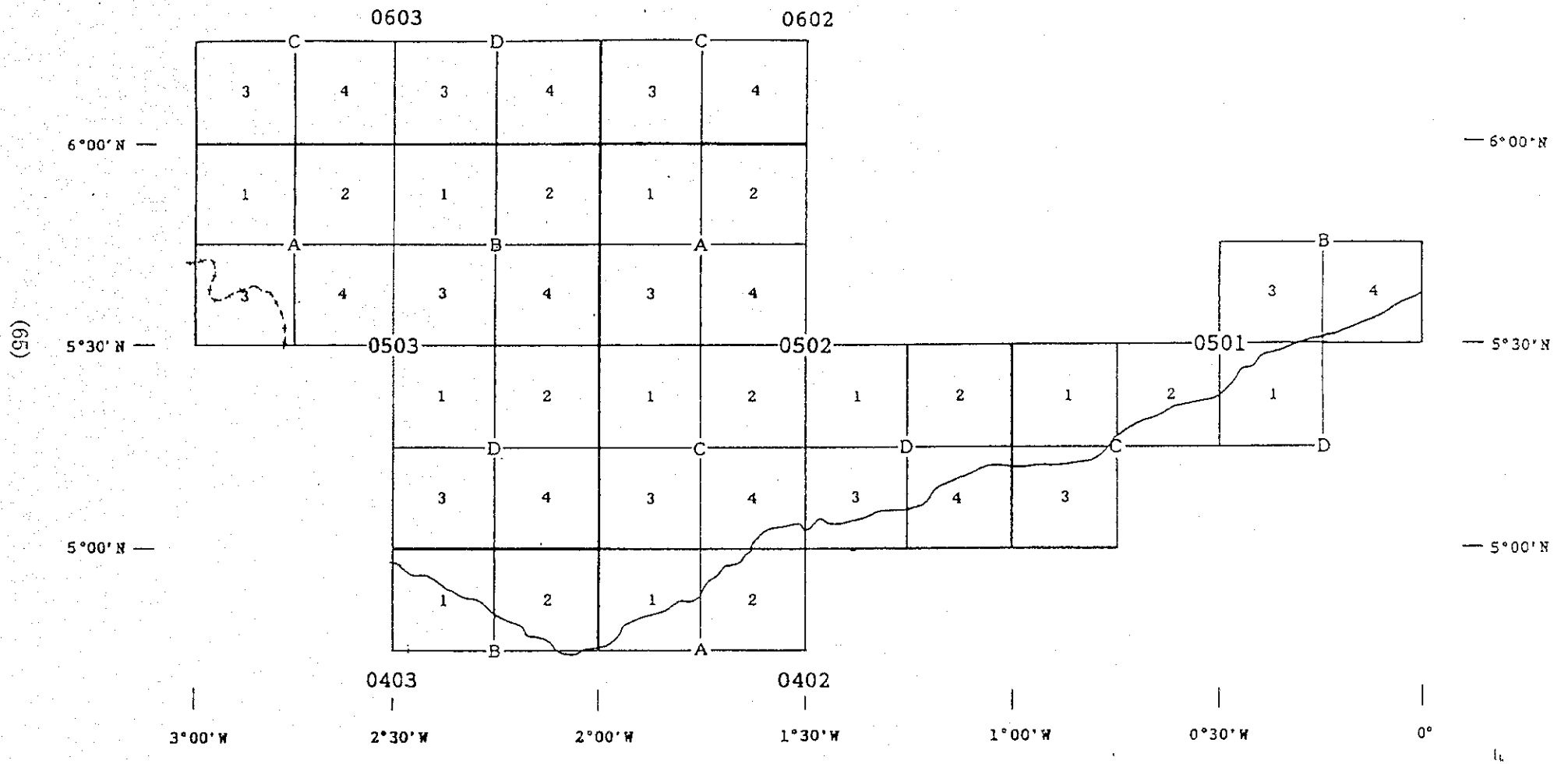


Fig. 5 SHEET INDEX MAP



5－2　第1年次現地作業終了時の協議議事録

MINUTES OF MEETINGS

AT

THE END OF THE FIRST YEAR'S FIELD SURVEY WORKS

FOR

THE TOPOGRAPHIC MAPPING

OF

SOUTHERN PART OF REPUBLIC OF GHANA

BETWEEN

SURVEY DEPARTMENT OF GHANA

AND

JICA STUDY TEAM

ACCRA GHANA, 21ST MARCH 1996

ALHAJI IDDIRISU ABU
DIRECTOR OF SURVEYS
SURVEY DEPARTMENT OF GHANA
MINISTRY OF LANDS AND FORESTRY

MR. TOKIHIKO KAMINISHI
TEAM LEADER
JICA STUDY TEAM

SURVEY DEPARTMENT OF GHANA(SDG) and JICA STUDY TEAM(Team) had a series of meetings at the end of the first year's field works for the TOPOGRAPHIC MAPPING OF SOUTHERN PART OF THE REPUBLIC OF GHANA from March 19th to 21st 1996.

At the meetings the following items were confirmed by both sides.

1. The Team submitted 'Progress Report of the First Year's Field Work for the Topographic Mapping of the Southern Part of the Republic of Ghana (Appendix) in which the progress of the field work is briefly described.

   SDG was informed on the progress of the work and results at the meeting, and SDG accepted the Progress Report.

   Concerning the form of annotation and numbering on each frame of the aerial photograph, the engineers in charge of both sides especially agreed as shown in the progress report.

2. The Team requested to take the maps and surveyed materials such as processed negative films, contact prints and survey results out of Republic of Ghana to Japan. SDG had no objection to the request.

3. The aerial photoraphy work has not been completed on account of the unseasonable weather. SDG has strongly requested the Team to complete all the rest of aerial photography work in the next phase. Team promised to convey the request of SDG to Tokyo JICA Head Office.

ATTENDANTS:

1) SDG side

Na Al-haji Iddirisu Abu	Director of Surveys.	Survey Dept. (Headquarters)
Mr. R. Brimah	Asst. Director of Survey Dept.	Survey Dept. (Headquarters)
Mr. J. Dotse	Asst. Director of Survey Dept.	Survey Dept. (Greater Accra Region)
Mr. J. Abbosey	Staff surveyor	Survey Dept. (Headquarters)
Dr. G. Zarzycki	Adviser	Survey Dept. (Headquarters)

2) The Team Side

Mr. Tokihiko KAMINISHI	Team Leader
Mr. Koichi MIKI	Deputy Leader
Mr. Kozo OKUMURA	Mapping Planner
Mr. Yutaka KYAKUNO	Chief Surveyor
Mr. Makoto TSUJIMOTO	Surveyor
Mr. Hideaki SAKAI	Coordinator

PROGRESS REPORT
OF
THE FIELD WORK OF THE FIRST YEAR
FOR
TOPOGRAPHIC MAPPING OF SOUTHERN PART
OF
THE REPUBLIC OF GHANA

March, 1996

STUDY TEAM
OF
TOPOGRAPHIC MAPPING OF SOUTHERN PART
OF
THE REPUBLIC OF GHANA

JAPAN INTERNATIONAL COOPERATION AGENCY

1. INTRODUCTION

The topographic mapping of the Southern part of the Republic of GHANA(hereinafter referred to as the "Study") started in January 1996, in a five-year plan, as a technical cooperation program of the Japan International Cooperation Agency(hereinafter referred to as the "JICA").

In compliance with the Scope of Work agreed between the Survey Department of GHANA(hereinafter referred to as the "SDG") and JICA on 17th March 1995, the JICA study team (hereinafter referred to as the "Team") arrived in Accra on 30th January 1996, for the field work of the first year. After consultation with the SDG, the Team set up the field headquarters in Accra for Ground control point survey and Aerial photography from 31st January 1996, to 22nd March 1996.

The SDG counterparts personnel worked with the JICA Team.

In accomplishing the field work of the first year, hereinafter, the summary of the progress of the work is reported.

2. OUTLINE OF THE FIRST YEAR WORK

2-1 Objective

The objective of the Study are : (1) To prepare 1/50,000 topographic map covering an area of approximately 25,500㎢ in the Southern part of the Republic of Ghana, (2) To transfer technology to the counterparts personnel of SDG through the implementation of the work, and (3) TO promote the friendship between Ghana 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 control point survey (phase 1), and office work such as computation of the survey results.

2-2 Period of Survey Work

Field work

(Ground control point survey)	31 January, 1996～22 March, 1996	
(Aerial photography)	21 February, 1996～22 March, 1996	

2-3 Formation of the Study Team

Leader	Mr. Tokihiko KAMINISHI	31 Jan.'96～14 Feb.'96

Leader	Mr. Tokihiko KAMINISHI	10 Mar.'96～22 Mar.'96
Deputy Leader	Mr. Koichi MIKI	31 Jan.'96～22 Mar.'96
Mapping Planner	Mr. Kozo OKUMURA	〃
Chief Surveyor	Mr. Yutaka KYAKUNO	〃
Mechanical Engr.	Mr. Shinpei ISHIWATA	〃
Photographer	Mr. Yutaka KOKUFU	21 Feb.'96～22 Mar.'96
Surveyor	Mr. Masahiko OHASHI	31 Jan.'96～22 Mar.'96
〃	Mr. Yasuo GOTO	〃
〃	Mr. Seiichi FUKUTOMI	〃
〃	Mr. Tsuyosi YAMAZAKI	〃
〃	Mr. Koichi WAKISAKA	〃
〃	Mr. Makoto TSUJIMOTO	〃
〃	Mr. Masaru TERADA	〃
〃	Mr. Sadao MATSUMOTO	〃
〃	Mr. Tomohiro MURAKAMI	〃
〃	Mr. Kensuke KIMURA	〃
〃	Mr. Yuichi TABIKAWA	〃
〃	Mr. Kazutomo NAKANISHI	〃
〃	Mr. Koji FUKAZAWA	〃
〃	Mr. Kozo YAMAYA	〃
Coordinator	Mr. Hideaki SAKAI	31 Jan.'96～14 Feb.'96
〃	〃	18 Mar.'96～22 Mar.'96

2-4 Amount of the Survey Work (Plan and Results)

Progress in the first year are as follows

Item		Original Plan	Results
Ground control point survey(GPS)		40 points	40 points
Aerial Photography	Scale	Approx. 1/60,000	Approx. 1/60,000
	Flight line	24 lines	8 lines
	Flight length	Approx. 3,500km	475km
	Coverage	Approx. 25,500 ㎢	3,350㎢
	Photo No.	Approx. 705 photos	108 photos

2-5 Counterparts of SDG

Na Al-haji Iddirisu Abu	Director of Surveys.	Survey Dept. (Headquarters)
Mr. R. Brimah	Asst. Director of Survey Dept.	Survey Dept. (Headquarters)
Mr. J. Dotse	Asst. Director of Survey Dept.	Survey Dept. (Greater Accra Region)
Mr. J. Abbosey	Staff surveyor	Survey Dept. (Headquarters)
Mr. E. R. Tetteh	Chief Lithographer	Survey Dept. (Lithographic Section)
Mr. Marcus Tabil	Asst. Staff Surveyor	Survey Dept. (Examination Section)
Mr. Jones Ofori-Boadu	Asst. Staff Surveyor	Survey Dept.
Mr. John Quist	〃	〃
Mr. John C. Acquaah	Senior Survey Technician	〃
Mr. Kofi Wemegah	〃	〃
Mr. Quarshie Quartey	〃	〃
Mr. Jeremiah Awabigo	〃	〃
Mr. C.R.K. Anyah	〃	〃

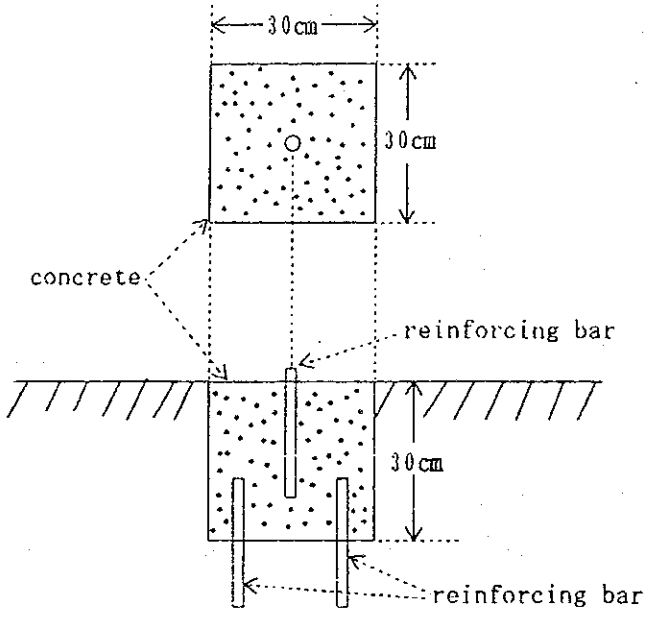
3. FIELD WORK

3-1 Ground control point survey

Ground control point survey was excuted by satellite geodesy applying Global Positioning System (GPS). Seven Trimble 4000SSE instruments of dual frequency model were used for the simultaneous observation at the control points.

(1) Placement and Monumentation

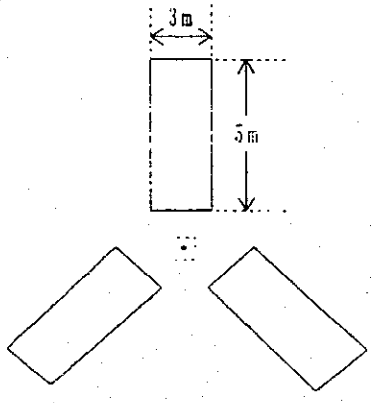
Control points selection was done in the field based on the original plan using portable GPS units and existing 1/50,000 topographic map. Each point was selected for easier location for succeeding pricking work for the aerial triangulation. The newly set up control points were monumented as follows.



(2) Signalization

In case of difficult pricking for aerial triangulation, pre-marking was done at the existing control point.

Dimension of pre-marking were as follows.



(3) Observation

GPS observation was done at six or seven points simultaneously. To take account of obtaining the height accuracy, five or six satellites were observed two hours and the elevation angle of satellites was adopted more than 15 degrees.

(4) Given points

Following points shoud be adopted as given points for computation.

CFP 245, GCS 102, GCS 112, GCS 296, W3/34/28

(5) Obsevation scheme

The network consisting of 11 observation group including 5 known points is shown in Fig.-1.

(6) 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 the Table-1.

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 19 base lines measured twice on different days, and these data were repeatedly checked and confirmed. (Table-2)

3-2 Aerial Photography.

(1) Base for aerial potography

Kotoka Airport was used for the base for the aerial photography.

(2) Aircraft and Camera

The team contracted with Aircraft Operation Company (Pty) Ltd. (AOC, South Africa) for all aerial photography.

Datails of aircraft and camera are as follows:

Aircraft	: Gates Learjet 24 No. 24-165
Camera type	: Zeiss RMK-A 8.5/23
Lens number	: No. 132019 F=85.54mm
Navigation equipment	: GPS Navigation, Trimble 2000

(3) Photographic work

Test flights were made on February 28th and 29th, 1996 and full-scale aerial photography was commenced from March 1st, 1996.

(4) Materials of aerial film

Panchromatic film was used for aerial photography, and details are as follows;

Film type : AGFA AVIOPOT PAN 200 PEI

3-3 Photo prosessing

(1) Development

The instruments and materials to be used were as follows;

Developer	: ILFORD OQ UNIVERSAL
Paper	: AGFA RAPITONE P2-2
Film development	: ZEISS REWIND S/No. 111079
Contact printer	: ZEISS KG 30
Drier	: ZEISS TG 24 S/No. 20209

(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;

Forward overlap & Lateral overlap

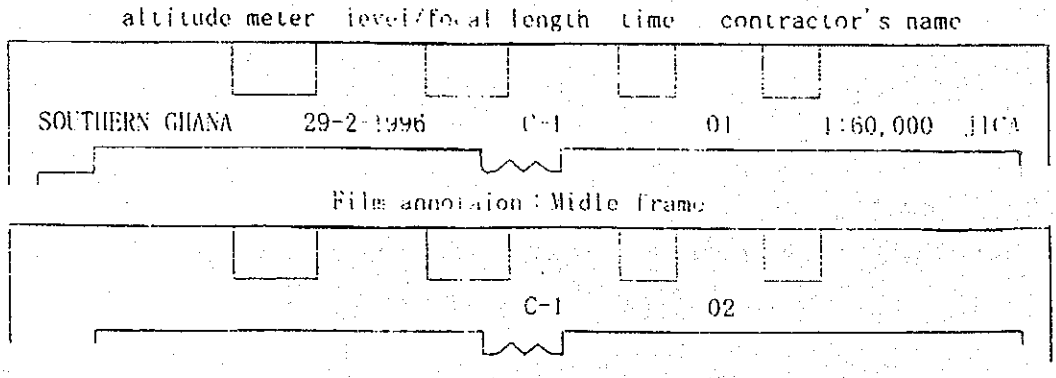
Deviation of flight course

Cloud, Cloud shadow, Uneven development, Halation, Haze, Smoke of fieldfire

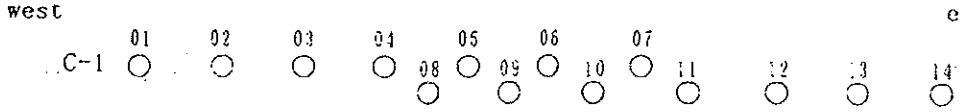
(3) Film annotation

The form of film annotaion and numbering on each frame of the aerial photograph agreed by engineers in charge of both sides are as follows.

Film annotaion : First frame and end frame



Numbering sample



The above film annotation was prepared, based upon the following specification :

FILM ANNOTATION

Start or End (as appropriate)

Contact Number and/or designation (if any)

Film Number

Date of Photography

Effective negative mumbers and run numbers

Approximate scale(s) of photography

Calibrated focal length of the lens unit

Contractor's name

(4) Amount of work

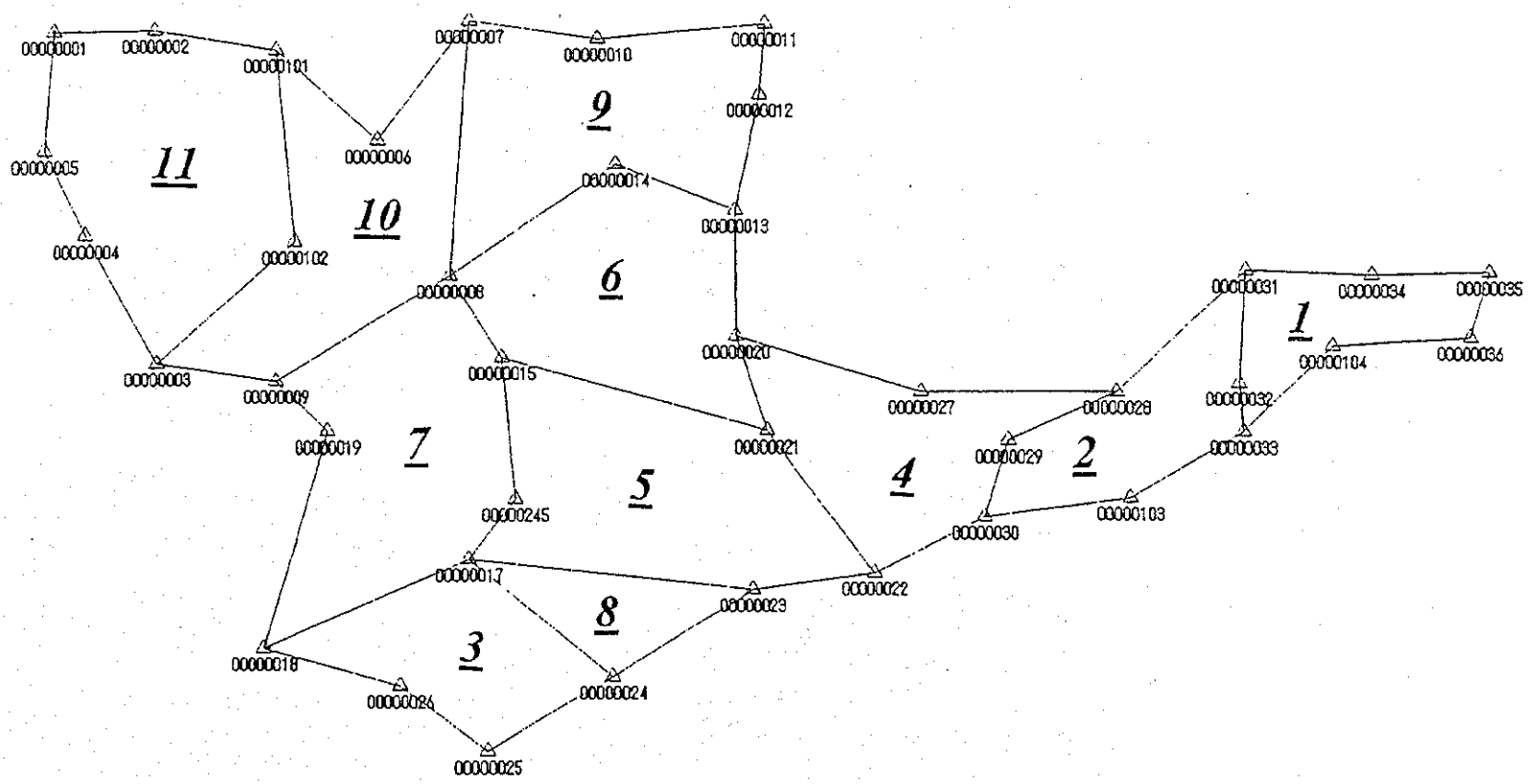
Film roll	3 rolls
Flight lines/length	8/475km (13%)
Photographs	108 photos (15%)

Number of photographs in First study is shown in Table-3.

The above progress report covered the period from 27th February to 17th March, 1996.

Fig - 1

GPS OBSERVATION GROUP



(77)

Table - 1 (1/2)

SUMMARY OF BASELINE COMPUTATION

Observation Group	Station combination for Baseline From	To	Computed Slope Distance	Accuracy
1	34	35	26,600.185 m	
	35	36	15,512.779 m	Total Dist.= 166,603.102 m
	36	104	31,177.790 m	dx = 0.011 m
	104	33	28,028.344 m	dy = -0.007 m
	33	32	11,068.947 m	dz = 0.004 m
	32	31	25,809.307 m	Ratio = 0.0782 ppm
	31	34	28,405.750 m	
2	31	32	25,809.304 m	
	32	33	11,068.958 m	Total Dist.= 183,334.081 m
	33	103	29,255.876 m	dx = -0.018 m
	103	30	32,792.588 m	dy = -0.019 m
	30	29	18,010.622 m	dz = 0.002 m
	29	28	26,505.573 m	Ratio= 0.1429 ppm
	28	31	39,891.160 m	
3	17	24	42,266.566 m	Total Dist.= 182,170.103 m
	24	25	32,369.921 m	dx = -0.009 m
	25	26	24,612.179 m	dy = 0.003 m
	26	18	32,279.166 m	dz = -0.004 m
	18	17	50,642.271 m	Ratio = 0.0567 ppm
4	27	28	44,017.974 m	
	28	29	26,505.606 m	Total Dist.= 224,501.634 m
	29	30	18,010.645 m	dx = -0.002 m
	30	22	28,176.363 m	dy = 0.001 m
	22	21	40,510.183 m	dz = -0.005 m
	21	20	22,923.419 m	Ratio = 0.0232 ppm
	20	27	44,357.443 m	
5	21	22	40,510.152 m	
	22	23	28,127.394 m	Total Dist.= 243,342.822 m
	23	17	63,772.488 m	dx = 0.017 m
	17	245	17,072.295 m	dy = -0.020 m
	245	15	32,270.384 m	dz = 0.006 m
	15	21	61,590.110 m	Ratio = 0.1103 ppm
6	14	13	28,514.502 m	
	13	20	28,382.440 m	Total Dist.= 208,046.851 m
	20	21	22,923.411 m	dx = 0.004 m
	21	15	61,590.050 m	dy = 0.000 m
	15	8	22,090.889 m	dz = 0.001 m
	8	14	44,545.559 m	Ratio = 0.0232 ppm
7	9	8	46,201.235 m	
	8	15	22,090.894 m	Total Dist.= 236,040.313 m
	15	245	32,270.329 m	dx = -0.010 m
	245	17	17,072.287 m	dy = 0.000 m
	17	18	50,642.249 m	dz = 0.001 m
	18	19	51,350.558 m	Ratio = 0.0420 ppm
	19	9	16,412.763 m	

Table - 1 (2/2)

SUMMARY OF BASELINE COMPUTATION

Observation Group	Station combination for Baseline From	To	Computed Slope Distance	Accuracy	
				Total Dist.=	142,887.825 m
	17	23	26,600.185 m	dx =	0.001 m
8	23	24	15,512.779 m	dy =	-0.001 m
	24	17	31,177.790 m	dz =	0.005 m
				Ratio =	0.0367 ppm
	10	11	37,328.922 m		
	11	12	16,235.007 m	Total Dist.=	240,028.781 m
	12	13	26,701.445 m	dx =	0.059 m
9	13	14	28,514.543 m	dy =	-0.002 m
	14	8	44,545.587 m	dz =	0.009 m
	8	7	57,832.287 m	Ratio =	0.2502 ppm
	7	10	28,870.991 m		
	6	7	33,980.954 m		
	7	8	57,832.295 m	Total Dist.=	282,511.415 m
10	8	9	46,201.298 m	dx =	-0.029 m
	9	3	27,689.071 m	dy =	0.052 m
	3	102	41,839.133 m	dz =	0.000 m
	102	101	43,774.176 m	Ratio =	0.2113 ppm
	101	6	31,194.489 m		
	1	2	44,017.974 m		
	2	101	26,505.606 m	Total Dist.=	218,988.078 m
11	101	102	18,010.645 m	dx =	0.002 m
	102	3	28,176.363 m	dy =	0.000 m
	3	4	40,510.183 m	dz =	0.002 m
	4	5	22,923.419 m	Ratio =	0.0127 ppm
	5	1	44,357.443 m		

Table - 2

SUMMARY OF REDUNDANT BASELINE

STATION No.		Slope	Component Difference		
From	To	Distance	Delta X	Delta Y	Delta Z
3	102	41,839.133 m .075 m	-0.004 m	0.043 m	0.039 m
7	8	57,832.287 m .295 m	-0.114 m	-0.021 m	-0.002 m
8	9	46,201.235 m .298 m	-0.009 m	0.065 m	0.014 m
8	14	44,545.559 m .587 m	0.065 m	-0.03 m	-0.004 m
8	15	22,090.889 m .894 m	0.051 m	0.004 m	0.015 m
13	14	28,514.502 m .543 m	-0.043 m	0.043 m	-0.009 m
15	21	61,590.110 m .050 m	-0.085 m	0.057 m	-0.038 m
15	245	32,270.384 m .329 m	-0.011 m	0.031 m	-0.054 m
17	18	50,642.271 m .249 m	-0.043 m	-0.02 m	-0.011 m
17	23	63,772.488 m .405 m	0.039 m	0.079 m	-0.021 m
17	24	42,266.566 m .530 m	-0.062 m	0.029 m	-0.029 m
17	245	17,072.295 m .287 m	0.021 m	0.016 m	-0.001 m
20	21	22,923.419 m .411 m	0.05 m	0.007 m	-0.002 m
21	22	40,510.183 m .152 m	-0.043 m	0.032 m	-0.02 m
28	29	26,505.573 m .606 m	0.032 m	0.032 m	0.011 m
29	30	18,010.622 m .645 m	-0.029 m	0.005 m	0.021 m
31	32	25,809.307 m .304 m	-0.025 m	0 m	-0.005 m
32	33	11,068.947 m .958 m	0.068 m	-0.013 m	0.017 m
101	102	43,774.176 m .133 m	0.074 m	0.023 m	-0.034 m

LIST OF AVAILABLE AERIAL PHOTOS

RUN No.	FRAME No.	PHOTO No.
C-10	294 ~ 298	5
C-11	316 ~ 327	12
C-12	332 ~ 348	17
C-13	355 ~ 369	15
C-19A	571 ~ 578	8
C-19B	264 ~ 273	10
C-20A	562 ~ 569	8
C-20B	283 ~ 289	7
C-23	541 ~ 548	8
	528 ~ 536	9
C-24	499 ~ 507	9
	TOTAL	108

APPENDIX 4

SECTION III

TECHNICAL SPECIFICATIONS

3.1 GENERAL

The Specifications mentioned hereunder have been designed in order that the Contractor shall carry out the aerial photography for the Topographic Mapping of Southern Part of the Republic of Ghana.

3.2 SCOPE OF WORK

The Work shall be executed in Ghana in accordance with the terms, conditions and requirements of this Contract and Specifications and under the supervision of the Engineer. The Work shall be aerial photographing at a scale of 1:60,000 for 3,500 line kilometers (24 courses, approx. 25,500 km2).
The Work includes the following items.

(1) Mobilization and Demobilization,

(2) Aerial photographing, and

(3) Photo processing and preparation of each one set of rush prints and the final contact prints with annotation.

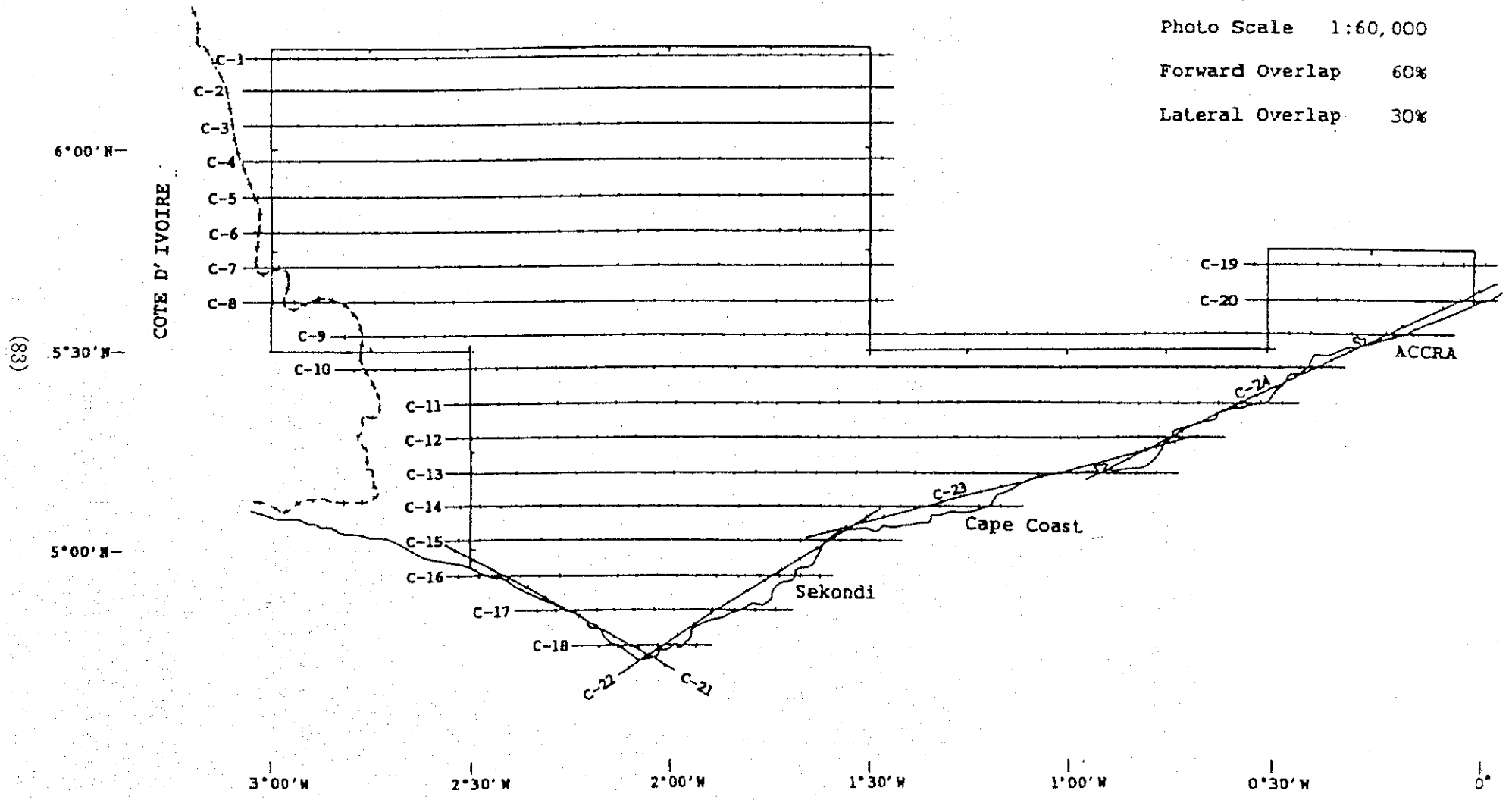
3.3 FLIGHT PLAN

The flight plan is attached as Fig. 1
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.

3.4 WORK PERIOD

The Work shall be completed by 22 March 1996.

FLIGHT COURSE



3.5 EQUIPMENT TO BE USED

(1) Aircraft

A Lear Jet 24 or equivalent jet plane, capable of the altitude flying specified in Clause 3.6 hereunder, shall be used.

(2) Aerial Camera

A Zeiss RMK-A or equivalent aerial survey camera with a super-wide angle lens cone (89 mm) shall be used.

The Contractor shall submit the calibration report for the lens tested within the past five (5) years to the Engineer. The calibration report shall contain:

(a) camera number and lens number;

(b) position of the principal point relative to fiducial marks (in 0.001 mm);

(c) calibrated focal length (in 0.01 mm);

(d) radial distortion; and

(e) observer's name and report number.

(3) Navigation Instruments

Aircraft shall be equipped with proper navigation aids, such as onboard GPS navigation system which are essential for accurate navigation.

(4) Film

Kodak double X Panchromatic Aerographic type 2405 distortion free film or Agfa film of the same quality 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

(6) Photo processing Instruments

Photo processing instruments for film development and rush prints production shall be equipped by the Contractor in Accra.

3.6 REQUIREMENTS OF PHOTOGRAPHIC FLIGHT

(1) Aerial photographing shall be performed for 3,500 line kilometers (24 courses, approx. 25,500 km2).

(2) Photo Scale, Altitude and Flight Direction

The aerial photography shall be taken at a scale of 1:60,000.

Flight altitude shall be 5,400 meters ± 5 percent above Mean Sea Level.

Flight directions shall be east/west and tie flight runs as shown in Fig. 1

Flight runs shall not be broken due to changes in terrain elevation.

(3) Flight Course

The discrepancy of flight course shall be within 800 meters from the course on the Flight Plan.

(4) Tolerable Shifting Error

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

(5) Overlaps

Forward overlaps between successive exposures in each run shall be a standard between 55 and 65 percent, and lateral overlap between adjacent runs shall be a standard between 20 and 40 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 photograph result from it.

(7) Tip and Tilt

Tip and Tilt shall not exceed 3 degrees.

(8) Haze, Mist, and Smoke

Photography shall only be flown when haze, mist or smoke, etc. does 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 (3) percent 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 the clouds.

(1 0) 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.

(1 1) Altitude of the Sun

Photographic flight shall be carried out only when the altitude of the sun is 30 degrees or more.

(1 2) Another Requirements

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

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

3.7 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 carefully done for avoiding film distortion to be caused by rapid heating, etc.

3.8 NEGATIVE NUMBERING

The following annotations shall be recorded on each frame of negative film by the Contractor in accordance with the instruction by the Engineer.

(1) Name of job

(2) Date of photography

(3) Scale of photography

(4) Run number

(5) Serial number of camera and lens

(6) Flight altitude

(7) Photo number

3.9 FLIGHT LINE INDEX

A line index shall be prepared for all flight lines and photo centers on the existing map at a scale of 1:500,000.

3.10 FINAL PRODUCTS AND MATERIALS TO BE DELIVERED

The following materials shall be delivered to the JICA Study Team in Accra, Ghana.
The Contractor shall submit to the JICA Study Team a delivery note or a list showing contents and quantity at each delivery.

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

(2) One (1) set of contact points with annotation
(Another one (1) set of rush prints is also produced by the Contractor and used by the Engineer for checking)

(3) One (1) set of original flight line index

5－3　第2年次現地作業開始時の協議議事録

APPENDIX 2

MINUTES OF MEETINGS
FOR
THE STUDY ON TOPOGRAPHIC MAPPING
OF
SOUTHERN PART OF THE REPUBLIC OF GHANA
BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY
AND
SURVEY DEPARTMENT OF GHANA

ON
OCTOBER 10th, 1996
ACCRA, GHANA

NA AL-HAJI IDDRISU ABU
DIRECTOR OF SURVEYS
SURVEY DEPARTMENT OF GHANA
MINISTRY OF LAND AND FORESTRY

TOKIHIKO KAMINISHI
LEADER
JICA STUDY TEAM

The JICA Study Team headed by Mr.Tokihiko KAMINISHI visited the Republic of GHANA from 27th September, 1996 to carry out the second year program for the Study on Topographic Mapping of Southern Part of Ghana.

Prior to the commencement of the second phase Survey work, a series of meetings were held from 1st to 9th October, 1996 and the following items have been confirmed and agreed by Survey Department of Ghana (SDG) and JICA Study Team.

1. The twenty (20) copies of First Year Reports were submited to SDG by JICA Team.

2. The Plan of Operation proposed by JICA Study Team was discussed and agreed as the appendix.

3. JICA Study Team requested SDG to prepare the following data for topographic mapping by the end of December, 1996.

    1) Values of Geodetic Datum in Ghana

    2) Map Projection to be applied to topographic map

    3) Foot value to be converted to metric value

4. Both sides have commenced the discussion on the Map Symbols and Application Rules.

LIST OF ATTENDANTS

1: GHANAIAN SIDE (SDG)

1.	Na Al-haji Iddrisu Abu	Director of Surveys	Headquarters
2.	J. Dotse	Asst. Director	Greater Accra Region
3.	R. Brimah	Asst. Director	Headquarters
4.	J.A. Abossey	Staff Surveyor	Headquarters
5.	Marcus Tabil	Asst.Staff Surveyor	Examinations Section
6.	K.N.Arku Lawson	Asst Staff Surveyor	Cartographic Section
7.	Issac Ardoh Kesson	Chief Photogrammetrist	Photogrammetric Section
8.	J. C. Acquaah	Senior Engineer	Greater Accra Region
9.	E. R. Tetteh	Chief Lithographer	Lithographic Section

2: JAPANESE SIDE (JICA Study Team)

1.	Tokihiko KAMINISHI	Leader
2.	Koichi MIKI	Deputy Leader
3.	Kozo OKUMURA	Mapping Planner
4.	Hitoshi YOSHIDA	Chief Surveyor
5.	Hideaki SAKAI	Coordinator

APPENDIX

PLAN OF OPERATION

FOR

TOPOGRAPHIC MAPPING OF SOUTHERN PART

OF

THE REPUBLIC OF GHANA

- Second Year -

SEPTEMBER , 1996

JAPAN INTERNATIONAL COOPERATION AGENCY

I. INTRODUCTION

In February 1995, the Government of the Republic of Ghana (hereinafter referred to as Ghana) made a request to the Government of Japan (hereinafter referred to as Japan) to provide technical cooperation for the Topographic Mapping of Southern Part of Ghana (hereinafter referred to as the Study) after recognizing the importance it has as basic survey for planning and implementation of various projects. In view of the heavy concentration of socio-economic and cultural activities in the Southern part of Ghana, the need for up-to-date maps and mapping data cannot be over-emphasized as the present ones are totally out of data.

In response to the request of the Government of Ghana, Preparatory Study Team was dispatched by the Japan International Cooperation Agency,the official agency responsible for the implementation of the technical cooperation programs of the Japanese Government (hereinafter referred to as JICA) in March 1995 to discuss in detail with the Survey Department of Ghana, the official agency of Ghana side (hereinafter referred to as SDG), and the Scope of Work (S/W) was agreed between JICA and SDG.

Based on the S/W, the Study is being carried out for the four years period from 1996 through 1999, or 42 months as shown in Fig.1. The flowchart for the production of topographic map is as shown in Fig.2.

II. OBJECTIVE OF THE STUDY

The objectives of the Study are:

(1) To prepare base map and aerial photography

Photo scale	1/60,000	Aerial photography	approx. 25,500 km²
Map scale	1/50,000	Topographic mapping (40 sheets, 5 colors)	approx. 25,500 km²

The mapping area is shown on the first page of the report.

(2) Technology transfer

Technology transfer of topographic mapping to SDG members through the Study.

III. SCOPE OF WORK

The scope of work to achieve the captioned objective is stated in a document entitled "Scope of Work for Topographic Mapping of Southern Part of the Republic of Ghana" agreed between SDG and JICA on 17th March 1995. It covers:

Aerial photography, Ground control point survey, Leveling, Pricking, Aerial triangulation, Field verification, Stereo plotting & Compilation, Field completion, Drafting and Printing.

The volumes of the Study and Yearly job classifications are tabulated as follows;

Table 1. Work volume of the Study

	ITEM	VOLUME	REMARK
1st Year 1996 (Phase 1)	Aerial photography I Ground control point survey I	Refer Fig.3 40 points	Scale 1/60,000(super-wide) GPS survey. Including 5 existing control points.
2nd Year 1996~1997 (Phase 2)	Aerial photography II Ground control point survey II Leveling Pricking GPS point New leveling point	approx. 25,500km² approx. 34 points approx. 1,080km approx. 74 points approx. 1,080km	Total volume I & II GPS survey for aerial triangulation vertical control. Minor order leveling. 40 points for horizontal/vertical, 34 points for vertical control. approx. 270 points.
3rd Year 1997~1998 (phase 3)	Aerial triangulation Field verification Stereo plotting	approx. 680models approx. 25,500km² approx. 25,500km²	Scale 1/50,000 (40 sheets)
4th Year 1998~1999	Compilation Field completion	approx. 25,500km² approx. 25,500km²	Scale 1/50,000 (40 sheets)
4th &5th 1999 (Phase4,5)	Drafting Printing	approx. 25,500km² 40 sheets	Scale 1/50,000 (40 sheets) 1,000 copies each

IV. STANDARD OF THE STUDY

Principal technical specifications are tabulated as follows.

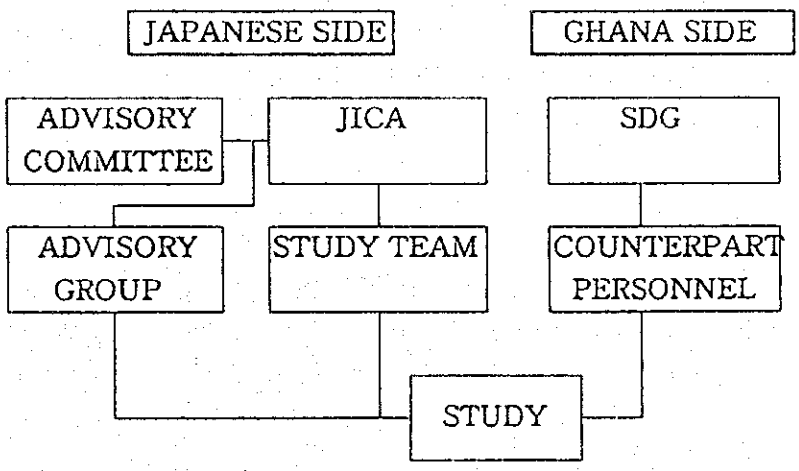
Table 2. Standard of the Study

Reference ellipsoid:	Clarke 1880
Map projection:	Ghana Modified Transverse Mercator (Local Coordinates)
Datum of height:	M. S. L.(Based on the existing BMs)
Map scale :	1/50,000
Neat line :	15′ x 15′
Contour interval:	10meters (Mountainous area 20meters)
Map symbol & application rule:	One adopted by SDG
Ground control point survey:	1/100,000 (Relative accuracy)
Leveling :	5cm $\sqrt{s}$ (s : km)
Number of printing colors:	5 colors

V. UNDERTAKING

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

1. Ghana side:
   -Necessary arrangement 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 to bring in and out of Ghana.
   -Assistance to facilitate the issuance of permits necessary for implementation of the Study.
2. Japanese side:
   -Implementation of the Study in Ghana and Japan.
   -Technology transfer through the execution of the Study.
3. Organization:
   Parties involved in this Study shall be organized as follows;



VI. REPORT AND FINAL PRODUCTS

An annual report shall be prepared by Study Team at the beginning of field survey stage Ⅱ, Ⅲ and Ⅳ. The report on the final year (fiscal) shall cover whole activities in this Study.

The final products to be delivered to the Government of Ghana are as follows.

(1) Aerial photo original negatives ---------- 1 set
(2) Aerial triangulation diapositives ---------- 1 set
(3) Contact prints (including aerial triangulation photos) ---------- 2 sets
(4) Photo index map ---------- 1 set
(5) GPS control points descriptions & results ---------- 1 set
(6) Vertical control (Leveling) results ---------- 1 set
(7) Pricked and annotated aerial photos ---------- 1 set

(8) Aerial triangulation results ---------- 1 set
(9) Color separation scribed sheets ---------- 1 set each
(10) Color separation combined negatives or positives ---------- 1 set each
(11) 1/50,000 topographic maps ---------- 1,000 copies each

Ⅶ. PROGRESS OF FIRST YEAR WORK

The progress and details of first year work are described in Report I.

Ⅷ. PLAN OF OPERATION FOR SECOND YEAR WORK

The field work for the second year (aerial photographyⅡ, ground control point surveyⅡ, leveling and pricking) shall be carried out for a period from September 1996 to January 1997. The members of the Study Team and their assignment in the second year are as shown in Table 3.

1. Preliminary Work in Japan

Prior to the start of the work as above, Chief engineer together with other responsible engineers shall prepare a detailed plan, method of execution, arrangement of data/materials and equipment for each work process so as to facilitate the field work.

2. Preliminary Work in Ghana

Upon arrival in Ghana, the Study Team shall start preparing for field operations. Team Leader and his staff shall discuss administrative matters same as first year's with SDG. Furthermore, Study Team shall discuss with SDG the conventional signs and its application rules (specifications) for the field verification to be conducted in the third year.

3. Aerial Photography Ⅱ

Aerial photography shall be executed according to the same specifications as the first year. One Japanese engineer is assigned to Ghana to supervise the operations and check the results.

3-1 Specifications for aerial photography

Main specifications for the aerial photography shall be as follows (work volume includes first year's);

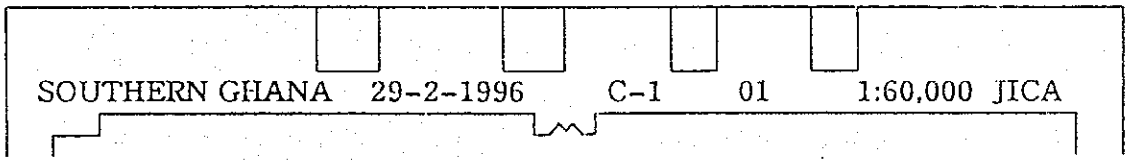
- Camera : Super wide angle camera
- Photo scale : approx. 1/60,000
- Coverage : approx. 25,500km^2
- Flight course : 24 courses
- Flight length : approx.3,500km

- Film : Panchromatic film
- Forward overlap : 60 ± 5%
- Lateral overlap : 30 ± 10%
- Crab : Less than 10 degrees
- Tip and tilt : Less than 5 degrees
- Cloud coverage: Amounts of cloud shall not exceed 3% in successive 5 photographs. However, important areas for orientation and cartography shall not be covered with cloud.

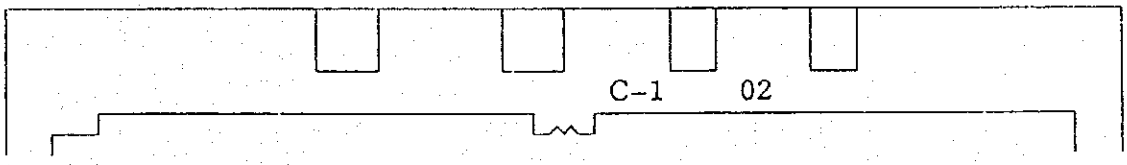
3-2 Implementation of photography

- Base airport : The flight plan shall be made with Kotoka Airport as the base.
- Test flight : Test flight and test photographing shall be made over the site before launching the scheduled operations.
- Checking : Supervisor for aerial photography inspects developed photos to ensure sidelaps, overlaps and other specified items. If the results do not fulfill the specifications, the aerial photography company shall re-fly the same portions.
- Film editing : Course numbers and photo numbers,etc. shall be annotated on the negatives as follows;

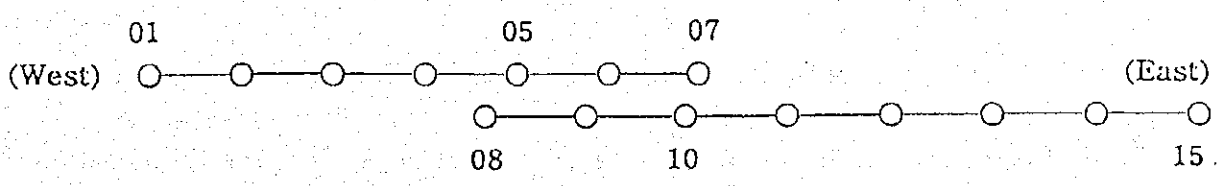
(1) Both end photographs in each strip



(2) Other inside photographs



- Index map : The photo index map shall be prepared on the existing 1/500,000 topographic map by assigning principal points of photos as follows;



4. Ground Control Point Survey II

Additional ground control points (approx. 34 points) shall be conducted for vertical control for aerial triangulation. Observation shall be made simultaneously via plural units of GPS equipment to form an observation network connected to Phase-1 new control points. The results shall be computed by network adjustment in Japan. Check observation shall be made over a distance between known points to ensure the accuracy. It shall be so planned as to receive signals from more than four different satellites. The elevation shall be calculated by interpolation method by referring to the geoidal slope of the study area based on the difference between Phase-1 GPS results and leveling.

4-1 Observation plan

New control points shall be set up in the study area to maintain the accuracy required for subsequent aerial triangulation's vertical control. The work volumes are as follows;

GPS observation (newly set up) :	approx. 34 points
GPS observation (phase-1 points) :	approx. 10 points

If the location of a new point happens to have no access even by vehicle, it may be moved to an easier location.

4-2 Observation

In GPS observation, attention shall be paid as follows;

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

4-3 Computation & accuracy

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 vector shall be kept to less than 10 ppm.
- From tentative computation results, to perform geodetic network adjustment computations and make conversion to the relevant geodetic system.
- Strict inspection shall be performed at every work process to maintain the required accuracy.

5. Leveling

Bench marks are applied for vertical control for aerial triangulation, but existing bench marks as distributed in the study area do not satisfy the required specifications for aerial triangulation, so that minor order leveling shall be carried out to set up additional vertical control. And also the elevations of Phase-1 GPS new points (35 points) shall be determined in this leveling. Appropriate leveling routes (approx. 1,080 km) shall be determined after inspecting existing bench marks in the field.

The survey shall be made by direct leveling in principle but for areas where access is difficult, indirect leveling may be applied using EDM/theodolite.

5-1 Point selection

- Vertical control points for aerial triangulation shall be set up at about 3 to 4 km intervals at location where pricking is possible on the photographs.

5-2 Observation and accuracy

- The leveling shall start at an existing bench mark and close at other existing one. Also bench marks to be applied are selected after check surveying in relation to neighboring existing bench marks.
- For routes with no closed point, double-run observation shall be executed.
- Allowable errors for both closure and double-run shall be within $5cm\sqrt{s}$ (s=km).

6. Pricking

Pricking shall be performed for above mentioned GPS points, existing BMs, and new leveling points using enlarged aerial photographs for succeeding aerial triangulation control.

6-1 Work volume

Pricking work volumes are as follows;

Horizontal & Vertical control	40 points (Phase 1 GPS points)
Vertical control points	approx. 34 points (Phase 2 GPS points)
	approx. 1,080km (leveling points)
	Existing BMs

6-2 Implementation

- Horizontal and vertical control points shall be carefully pricked on the enlarged aerial photos in the field.
- Eccentric points (photo points) for horizontal control shall be selected and pricked at clear points on the aerial photos, and the eccentric elements shall be measured using EDM, theodolite, plane table, etc..
- Pricking of new leveling points shall be done at intervals of 3~4 km for the succeeding aerial triangulation and stereo plotting orientation.

7. Map Symbols Consultation

To facilitate the third year field work (field verification), SDG shall be consulted on the following items;

(1) Map symbols and their application rules.

(2) Collection of materials related to above.

The tentative map symbols and application rules are annexed as attachment.

IX. TENTATIVE WORK PLAN FOR THIRD YEAR WORK

Following is the work plan covering third year's work. 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 (see Fig.1).

1. Aerial Triangulation

Aerial triangulation is performed based on the 1/60,000 aerial photographs taken during this study. Pass points and control points as pricked on the diapositives are measured for their coordinates and adjustment computation is performed to determine their horizontal positions and elevations. Orientation elements on the stereo plotting machine are also computed.

Aerial triangulation shall be done about 680 models for the entire mapping area using the block adjustment method of independent models as an analytical orientation procedure.

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

Control points and model layout are as shown on Fig.4. The tolerance for pass points, tie points, and also the limits of residuals of ground controls as used for adjustment shall be less than JICA procedural rules.

2. Field verification

In compliance with the specifications, necessary items to represent on the map shall be collected and identified on the enlarged aerial photos in the field. The work volume in area is 25,500km^2 at this stage. Map symbols and application criteria shall be set as agreed to by SDG.

Prior to the field work, preliminary study for interpretation shall be made to the best possible extent fully utilizing aerial photos and other available materials.

In the field, following items shall be investigated and/or confirmed.

- Confirmation of the results of pre-interpretation.
- Keys for photo-interpretation of topography and geographical features.
- Items difficult to interpret on the aerial photos.
- Items necessary for the application of map symbols, such as roads, railways,

rivers, buildings, specified areas, vegetation, etc..

Administrative boundaries and place names ,etc. necessary for annotation on the map shall be based on the information to be supplied by SDG.

3. Stereo Plotting

On the basis of the results of aerial triangulation and field verification, necessary items for representing on the map shall be measured by stereo plotting machine and plotted manuscripts of the topographic map shall be prepared. The plotting area covers approximately 25,500km^2 covered by 40 sheets as shown in fig. 5. Main specifications for stereo plotting are as follows;

- Stable polyester sheet shall be used for plotting materials.
- Neat lines, grid lines and control points for plotting orientation shall be plotted on the polyester sheet using an automatic coordinategraph.
- Neat lines shall be 7.5′ (longitude) x 7.5′ (latitude).
- Map projection shall be Ghana modified transverse mercator (Gauss-Kruger Projection) Local Datum of Ghana.
- Contour lines shall be drawn every 10 meters (20 meters for mountainous area).
- After the absolute orientation of horizontal, the discrepancy between the plotted points and their model points shall not exceed the values specified in the JICA's specifications.
- For the absolute orientation of height, vertical controls pricked on the photos shall be used as much as possible for the sake of accuracy of height in the map.
- Stereo plotting shall be executed in accordance with the map symbols and their application rules in the order of linear elements, such as roads, rivers etc., buildings, vegetation and contour lines.
- Care must be taken of the representation of micro topography, like hills, plains, forests, seasonal rivers, cultivated lands ,etc..

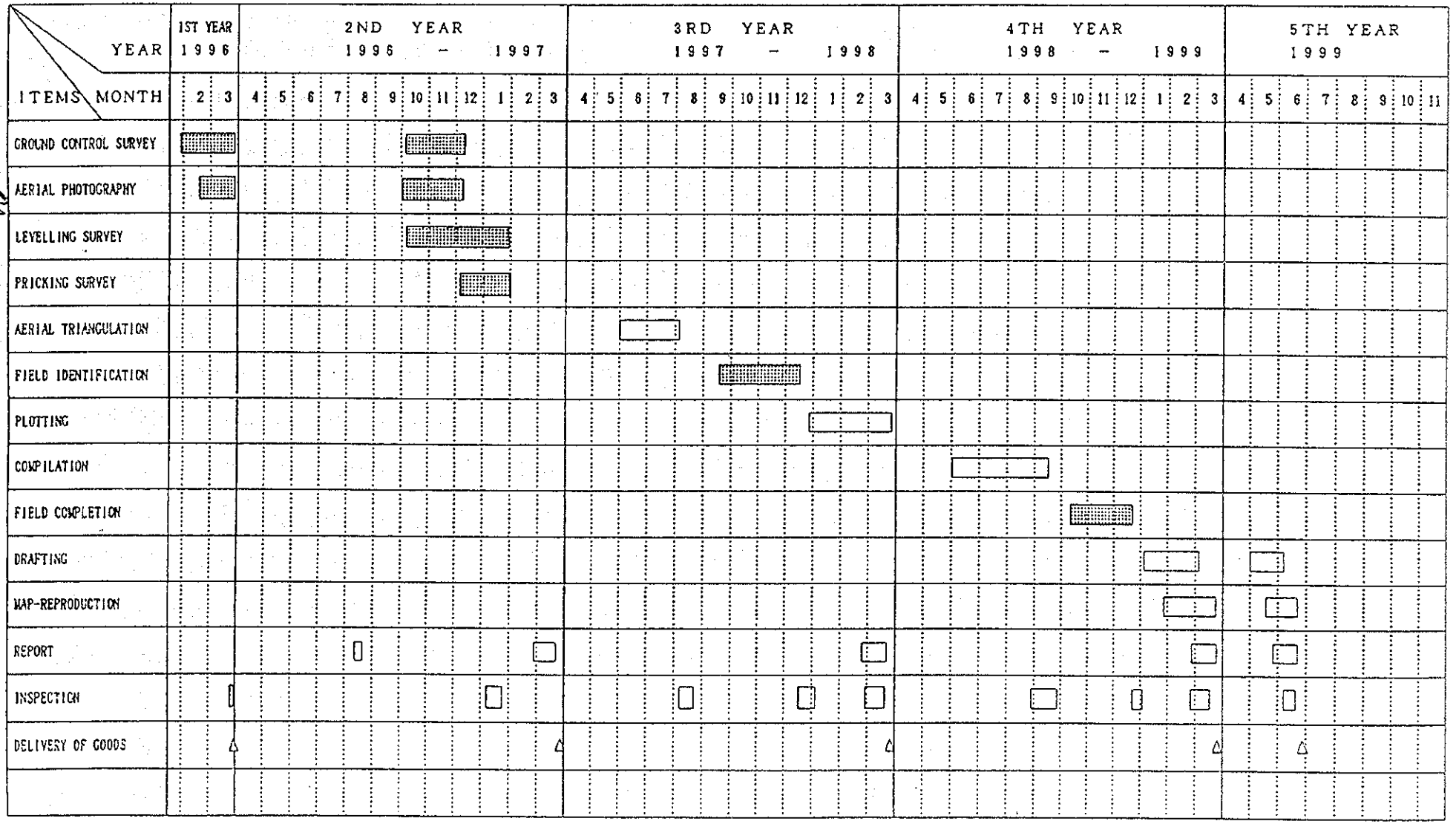
4. Work Flow

The flow of the entire work is schematically shown on the Fig. 1.

TABLE 3. MEMBERS OF STUDY TEAM AND THEIR ASSIGNMENT IN THE SECOND YEAR (PHASE 2)

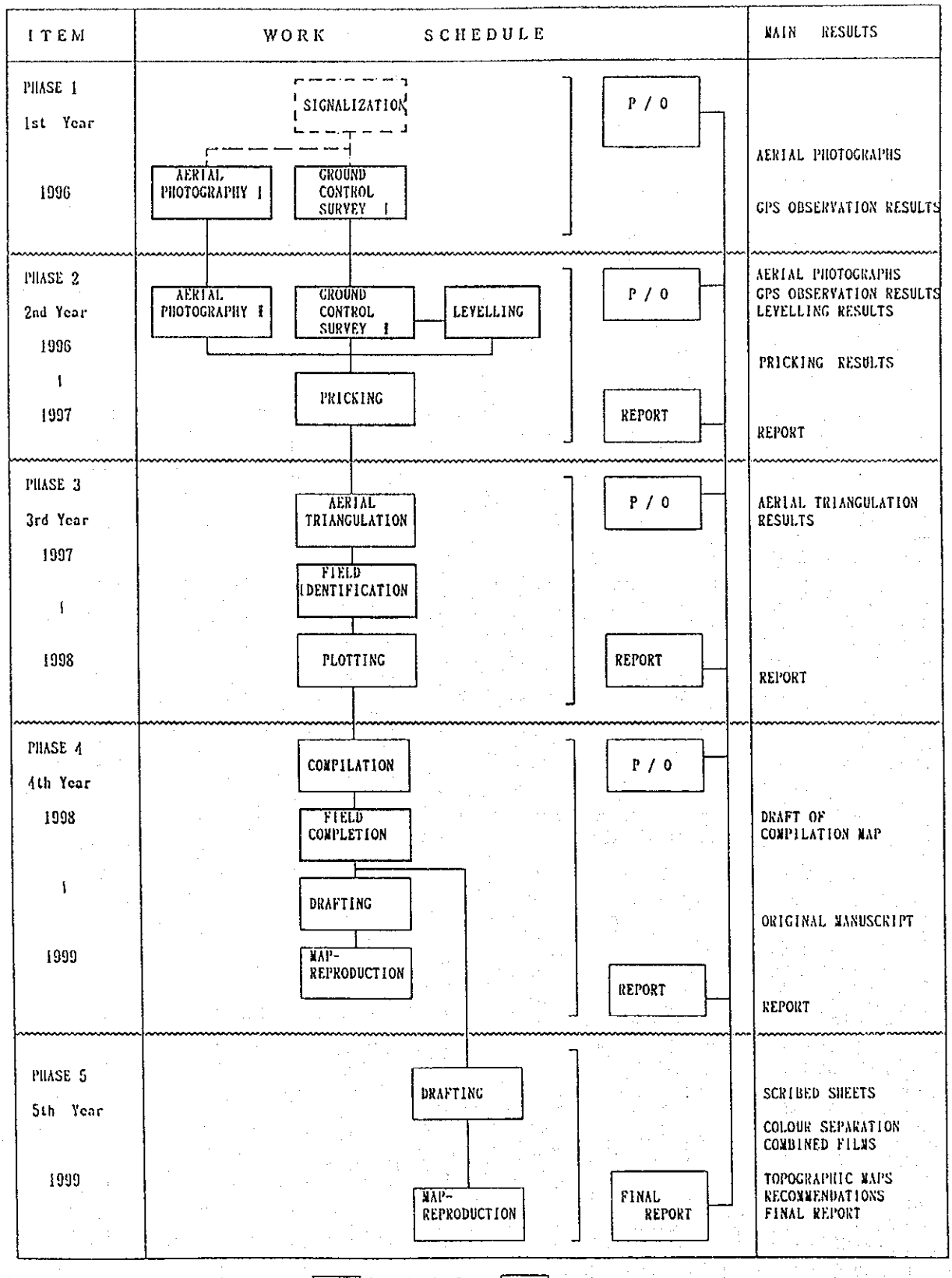
NAME	ASSIGNMENT	DURATION	CONTENTS
Tokihiko KAMINISHI	LEADER	26th Sep.'96 ~ 15th Oct.'96 14th Jan.'97 ~ 31th Jan.'97	1. Total Management 2. General Discussion
Koichi MIKI	SUBLEADER	26th Sep.'96 ~ 31th Jan.'97	1. Sub Management 2. General Discussion 3. Assistance of Leader 4. General Supervision
Kozo OKUMURA	MAPPING PLANNER	26th Sep.'96 ~ 31th Jan.'97	1. Fundamental Map Planning 2. General Coordination 3. Reporting
Hitoshi YOSHIDA	CHIEF SURVEYOR	26th Sep.'96 ~ 31th Jan.'97	1. Planning of Implementation 2. Supervision of Works 3. Coordination of Works 4. Quality Checking
Shun TAKAGI	PHOTOGRAPHER	10th Oct.'96 ~ 16th Dec.'96	1. Inspecting of Photograph & Photo Process
Shinpei ISHIWATA	MECHANICAL ENGINEER	26th Sep.'96 ~ 31th Jan.'97	1. Management of Vehicle 2. Maintenance of Vehicle
Masahiko OHASHI	SURVEYOR	3rd Oct.'96 ~ 31th Jan.'97	1. GPS Surveying 2. Leveling 3. Pricking
Kouzou ASANO	"	"	
Shigeo ONO	"	"	
Tuyoshi YAMASAKI	"	"	
Kouichi WAKISAKA	"	"	
Michio SATOJI	"	"	
Makoto TSUJIMOTO	"	26th Sep.'96 ~ 31th Jan.'97	
Masaru TERADA	"	3rd Oct.'96 ~ 31th Jan.'97	
Tomohiro MURAKAMI	"	"	
Kensuke KIMURA	"	"	
Yuichi TABIKAWA	"	"	
Kazutomo NAKANISHI	"	"	
Masaya TOKITA	"	"	
Kuniaki NOGUCHI	"	"	
Hideaki SAKAI	COORDINATOR	26th Sep.'96 ~ 15th Oct.'96 22th Jan.'97 ~ 31th Jan.'97	1. Coordination

FIGURE 1. TENTATIVE WORKING SCHEDULE



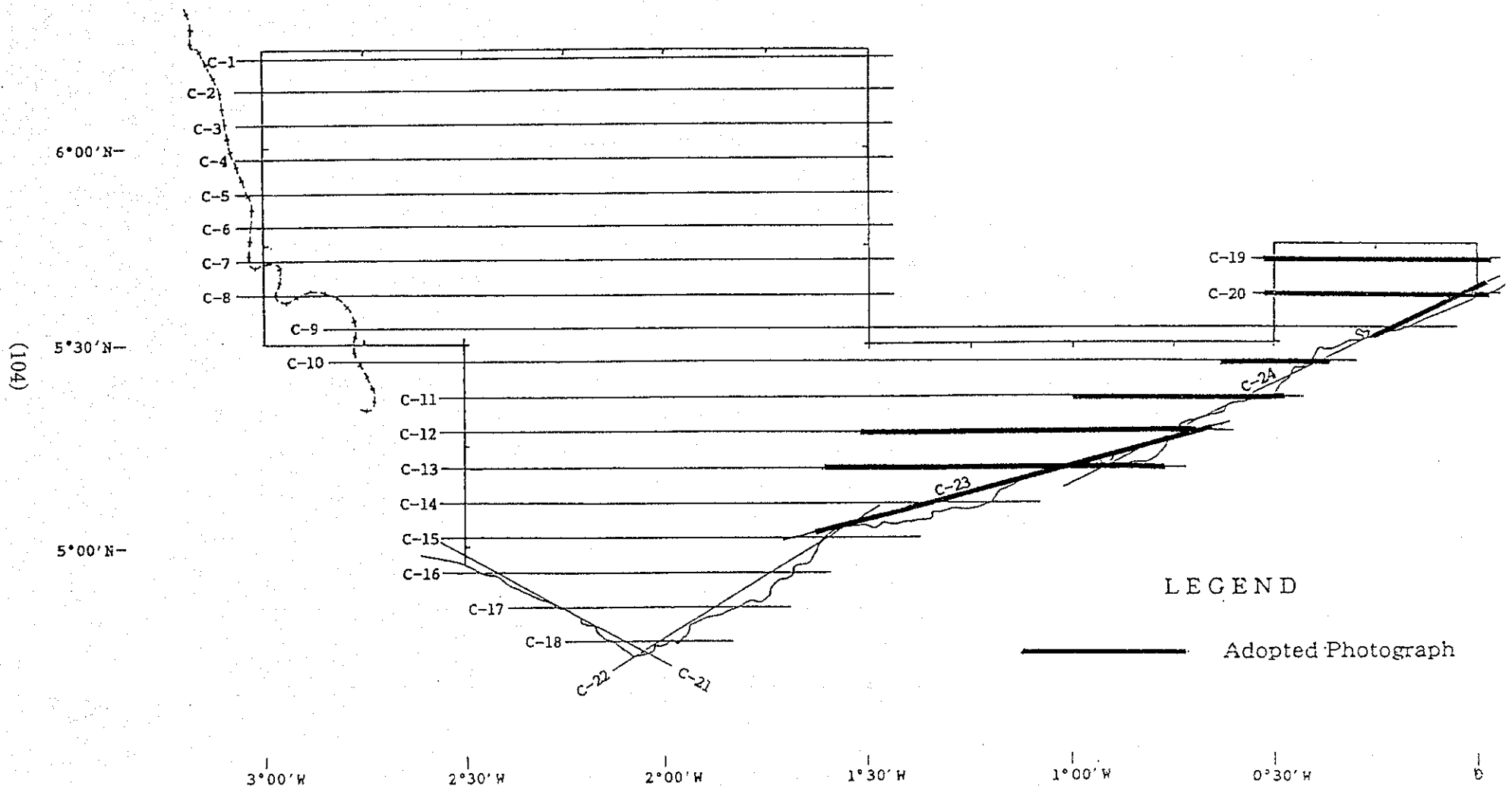
LEGEND —— PREPARATION FIELD SURVEY WORK IN JAPAN

Fig. 2 FLOWCHART FOR THE PRODUCTION OF TOPOGRAPHIC MAPS



Remarks: 1. Field works in Ghana 2. Works in Japan

Fig. 3 PHOTO INDEX (Phase-1)



(104)

Fig. 4 GROUND CONTROL INDEX (DRAFT)

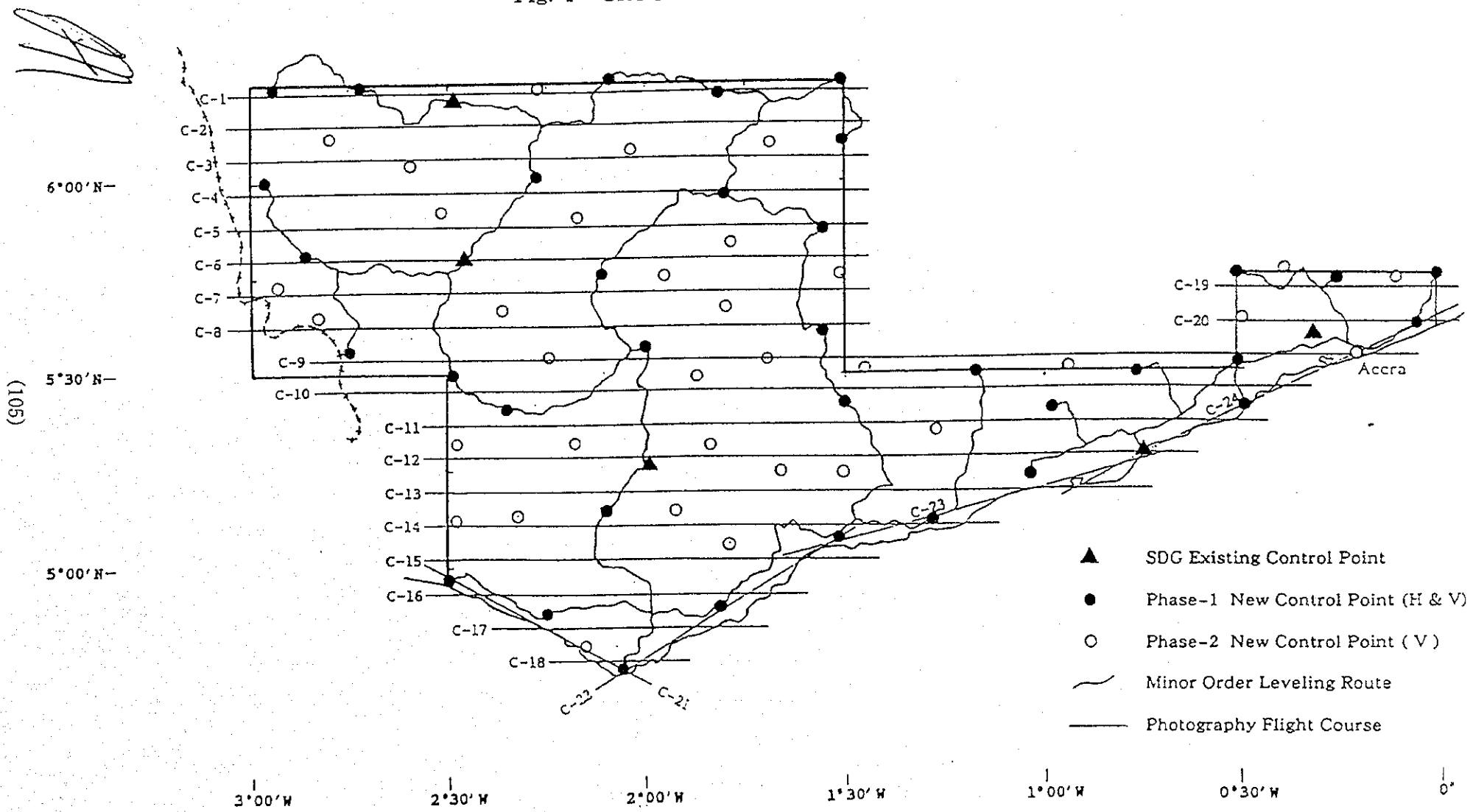


Fig. 5 SHEET INDEX MAP