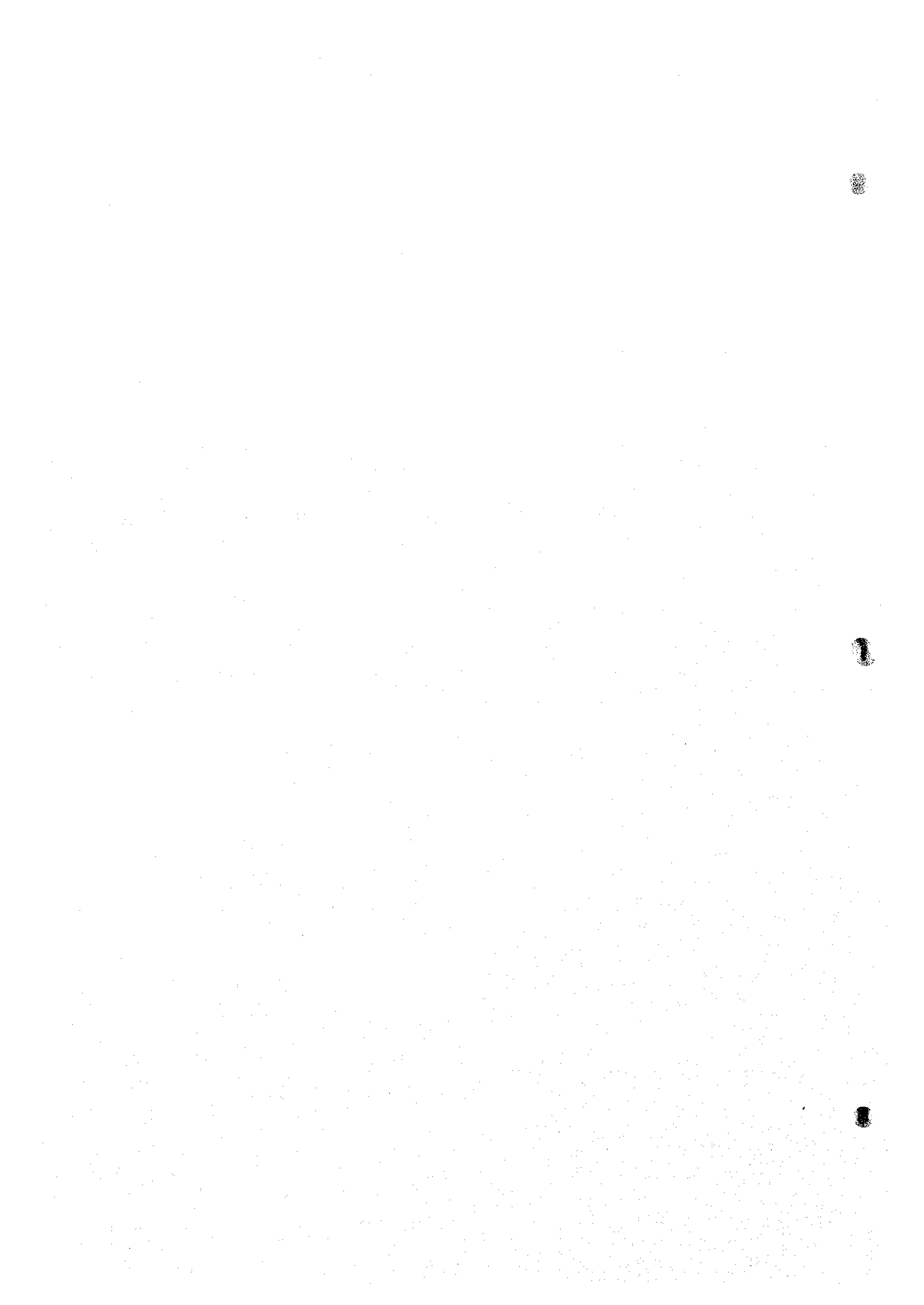
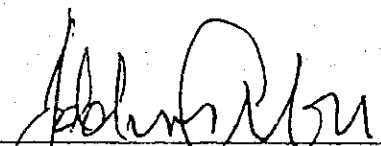



5-3 Minutes of meeting at the start-up of the 2nd year field work (Oct. 10, 1996)



**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 submitted 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. Acquah | 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

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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 km ² |
| Map scale | 1/50,000 | Topographic mapping | approx. 25,500 km ² (40 sheets, 5 colors) |

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. 25,500km ² approx. 34 points approx. 1,080km approx. 74 points approx. 1,080km | Total volume I & II GPS survey for aerial tri- angulation 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. 25,500km ² approx. 25,500km ² | Scale 1/50,000 (40 sheets) |
| 4th Year 1998~1999 | Compilation Field completion | approx. 25,500km ² approx. 25,500km ² | Scale 1/50,000 (40 sheets) |
| 4th &5th 1999 (Phase4,5) | Drafting Printing | approx. 25,500km ² 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 /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:

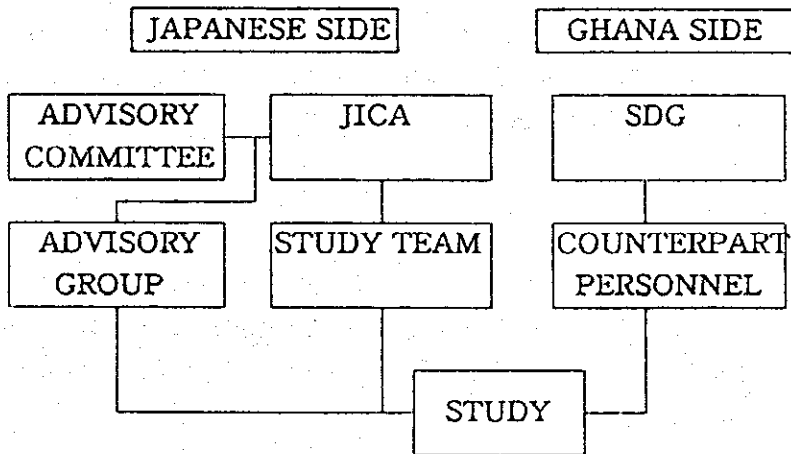
- Necessary arrangement to ensure the entry, exit and stay of the Team members as well as personnel of an aerial photography company contracted by the Team for the Study together with related materials and equipment to bring in and out of Ghana.
- Assistance to facilitate the issuance of permits necessary 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

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- (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 photography II, ground control point survey II, 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);

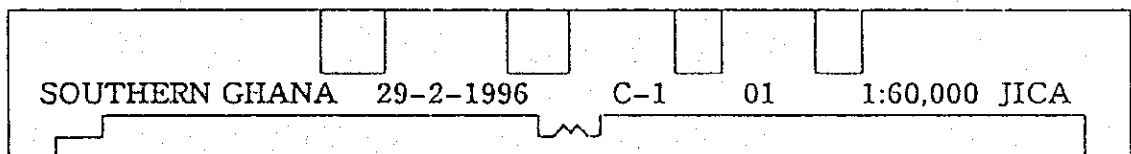
- Camera : Super wide angle camera
- Photo scale : approx. 1/60,000
- Coverage : approx. 25,500km²
- Flight course : 24 courses
- Flight length : approx. 3,500km

- Film : Panchromatic film
- Forward overlap : $60 \pm 5\%$
- Lateral overlap : $30 \pm 10\%$
- 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.

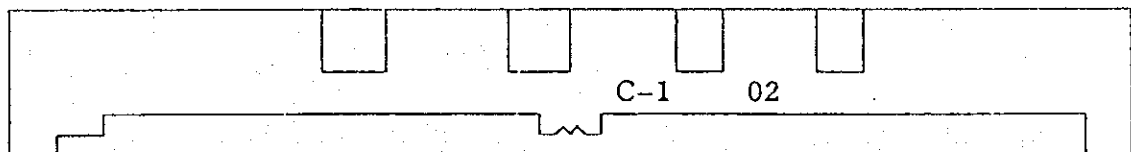
3-2 Implementation of photography

- 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:

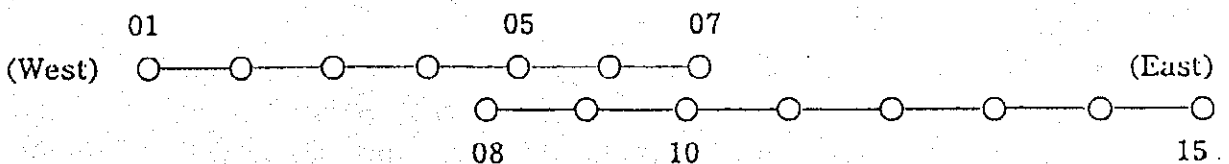
(1) Both end photographs in each strip



(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;



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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 $5\text{cm}/s$ ($s=\text{km}$).

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 25,500km² 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 25,500km² 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

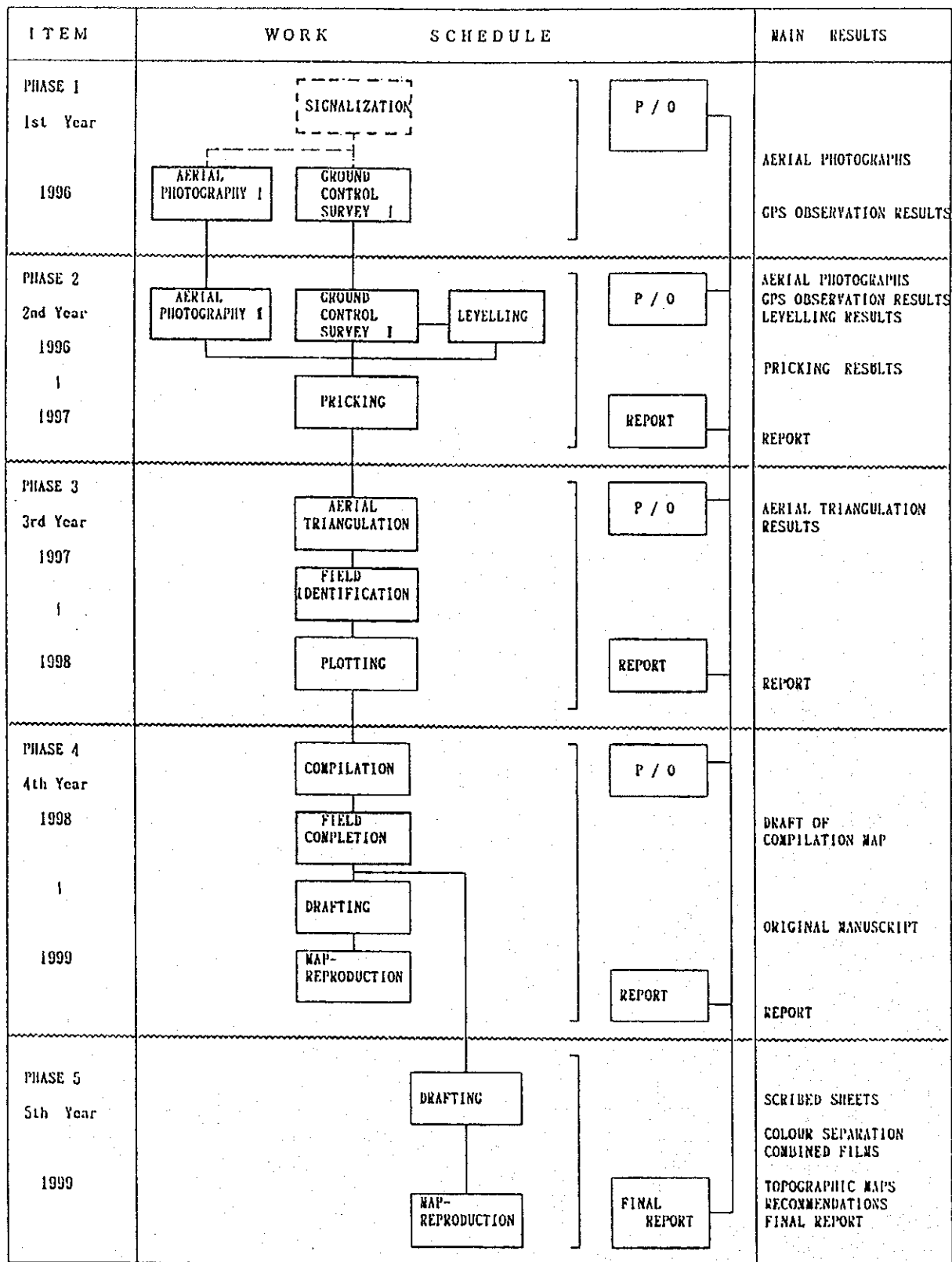
The flow of the entire work is schematically shown on the Fig. 1.

FIGURE 1. TENTATIVE WORKING SCHEDULE

| YEAR YEAR | 1ST YEAR 1996 | | | 2ND YEAR 1996 - 1997 | | | 3RD YEAR 1997 - 1998 | | | 4TH YEAR 1998 - 1999 | | | 5TH YEAR 1999 | | | | | | | | | | | |
|-----------------------|------------------|---|---|-------------------------|---|---|-------------------------|---|---|-------------------------|----|----|------------------|---|---|---|---|---|---|---|---|----|----|--|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| ITEMS MONTH | | | | | | | | | | | | | | | | | | | | | | | | |
| GROUND CONTROL SURVEY | | | | | | | | | | | | | | | | | | | | | | | | |
| AERIAL PHOTOGRAPHY | | | | | | | | | | | | | | | | | | | | | | | | |
| LEVELLING SURVEY | | | | | | | | | | | | | | | | | | | | | | | | |
| PRICKING SURVEY | | | | | | | | | | | | | | | | | | | | | | | | |
| AERIAL TRIANGULATION | | | | | | | | | | | | | | | | | | | | | | | | |
| FIELD IDENTIFICATION | | | | | | | | | | | | | | | | | | | | | | | | |
| PLOTTING | | | | | | | | | | | | | | | | | | | | | | | | |
| COMPILATION | | | | | | | | | | | | | | | | | | | | | | | | |
| FIELD COMPLETION | | | | | | | | | | | | | | | | | | | | | | | | |
| DRAFTING | | | | | | | | | | | | | | | | | | | | | | | | |
| MAP-REPRODUCTION | | | | | | | | | | | | | | | | | | | | | | | | |
| REPORT | | | | | | | | | | | | | | | | | | | | | | | | |
| INSPECTION | | | | | | | | | | | | | | | | | | | | | | | | |
| DELIVERY OF COODS | | | | | | | | | | | | | | | | | | | | | | | | |

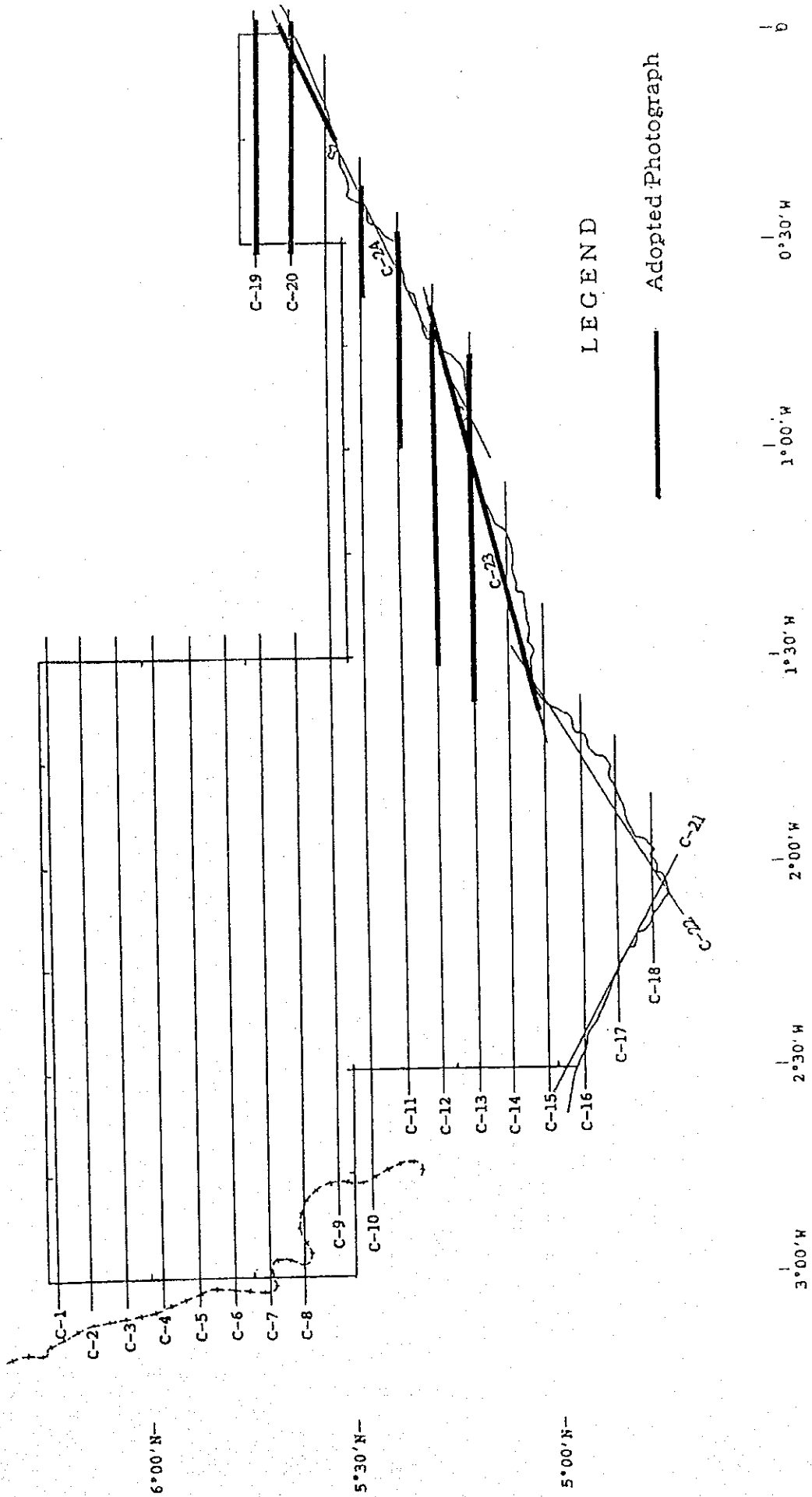
LEGEND — PREPARATION  FIELD SURVEY  WORK IN JAPAN

Fig. 2 FLOWCHART FOR THE PRODUCTION OF TOPOGRAPHIC MAPS



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

Fig. 3 PHOTO INDEX (Phase-I)



LEGEND

— Adopted Photograph

Fig. 4 GROUND CONTROL INDEX (DRAFT)

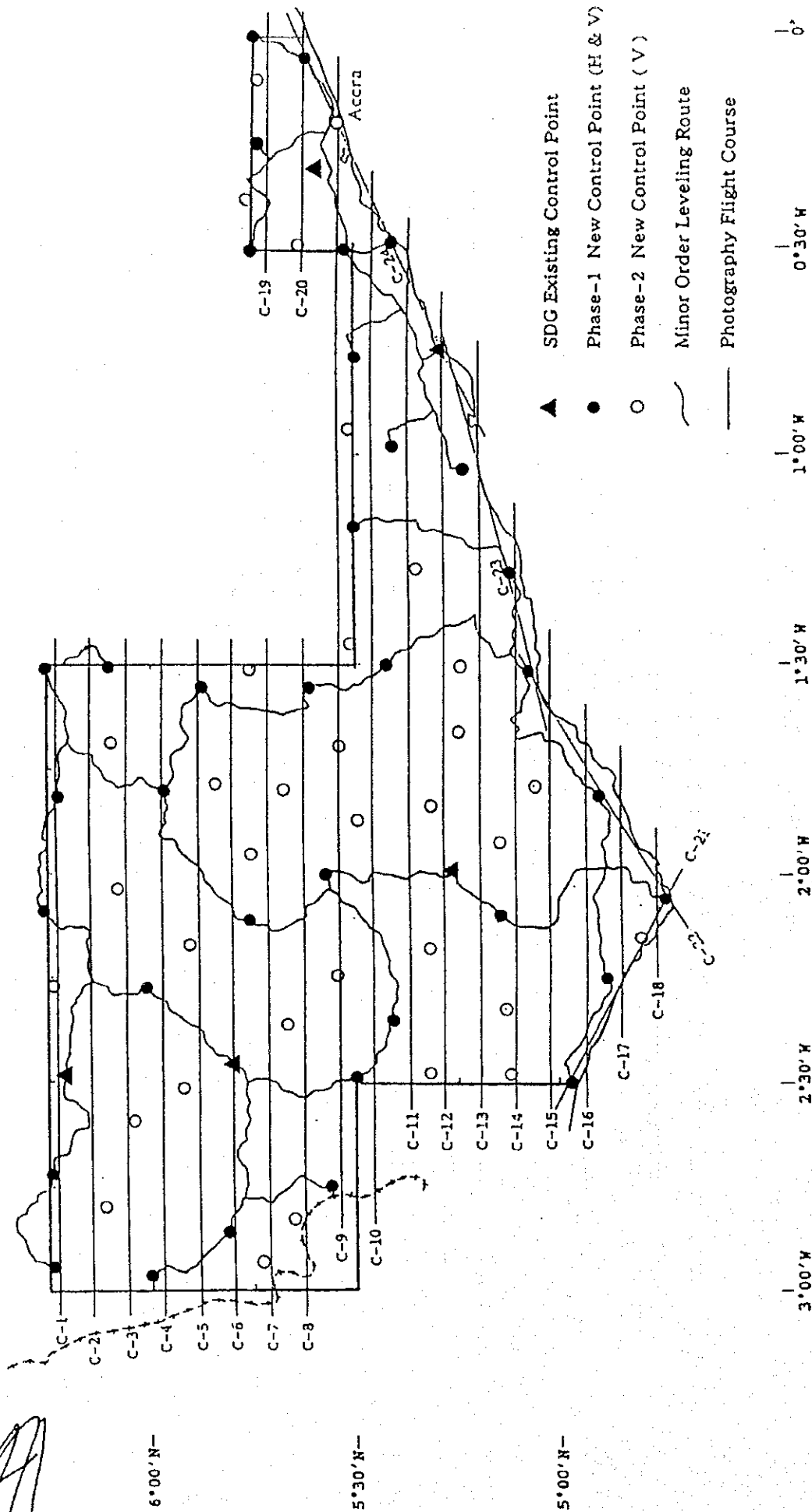
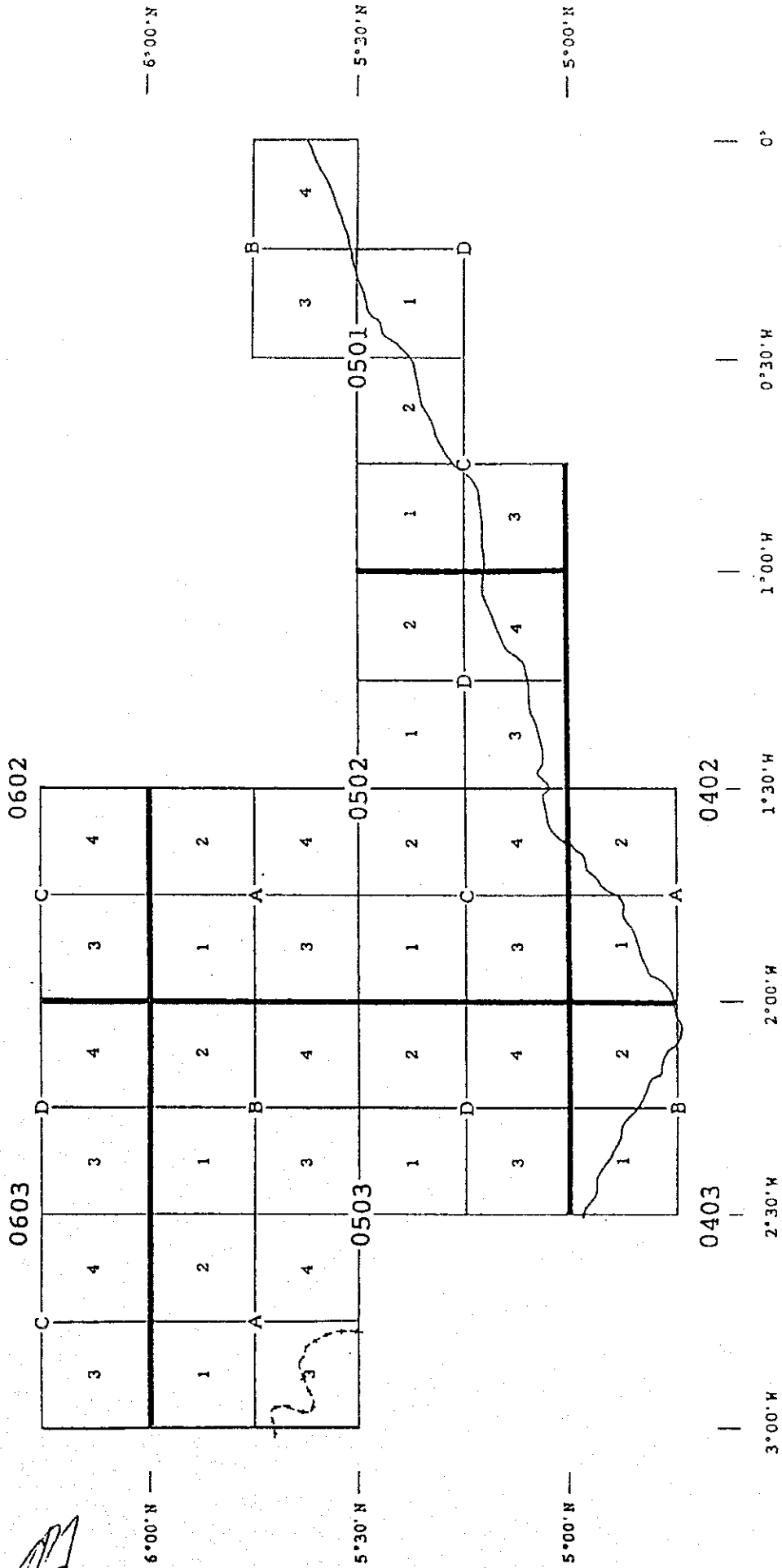


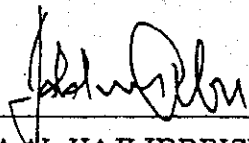
Fig. 5 SHEET INDEX MAP



5-4 Minutes of meeting at the end of the 2nd year field work (Jan. 20,1997)

MINUTES OF MEETINGS
AT
THE END OF THE SECOND YEAR'S FIELD SURVEY WORKS
FOR
THE TOPOGRAPHIC MAPPING
OF
SOUTHERN PART OF THE REPUBLIC OF GHANA
BETWEEN
SURVEY DEPARTMENT OF GHANA
AND
JICA STUDY TEAM

ACCRA GHANA, 20th JANUARY 1997



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



TOKIHIRO KAMINISHI
LEADER
JICA STUDY TEAM

SURVEY DEPARTMENT OF GHANA(SDG) and JICA Study Team(Team) had a series of meetings at the end of the second year's field works for the "TOPOGRAPHIC MAPPING OF SOUTHERN PART OF THE REPUBLIC OF GHANA" from January 16th to 20th 1997.

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

1. The Team reported briefly the progress of the second year's field work for the Study, and presented the "Progress Report of the second year for Topographic Mapping of southern part of the republic of Ghana" prepared by the Team (appendix-1), SDG accepted the report.
2. The Team received datum for topographic mapping from SDG and agreed on it.(appendix-2)
3. SDG and Team agreed on Symbols for 1:50,000 Topographic Map and their application rules.(appendix-3)

ATTENDANTS:

1) SDG Side

| | | |
|-----------------------|------------------------|-------------------------|
| Mr. J. Dotse | Asst. Director | Great Accra Region |
| Mr. Marcus Tabil | Examiner | Examination Section |
| Mr. K. N. Arku-Lawson | Chief Cartographer | Cartographic Section |
| Mr. I. Andoh-Kesson | Chief Photogrammetrist | Photogrammetric Section |
| Mr. E. R. Tetteh | Chief Lithographer | Lithographic section |

2) Team Side

| | |
|------------------------|-----------------|
| Mr. Tokihiko KAMINISHI | Team Leader |
| Mr. Koichi MIKI | Deputy Leader |
| Mr. Kozo OKUMURA | Mapping Planner |
| Mr. Hitoshi YOSHIDA | Chief Surveyor |
| Mr. Makoto TUJIMOTO | Surveyor |

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

JANUARY, 1997

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 started in January 1996, in a five-year plan, as a technical cooperation program of JICA.

In compliance with the Scope of Work agreed upon between the Survey Department of Ghana and JICA on the 17th March, 1995, the JICA Study Team arrived in Accra separately on 27th September, and 4th October 1996, to execute the second year's field work.

Meanwhile Ghana counterparts from the Survey Department of Ghana joined the work from time to time.

In accomplishing the second year's field work, the summary of the progress of the work is reported.

2. OBJECTIVE OF THE STUDY

The objective of the Study are : (1) To prepare 1/50,000 topographic map covering an area of approximately 25,500Km² 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 second year work of the Study is consisting of the aerial photography II, ground control point survey II, leveling, pricking, and office work such as computation of the survey results.

2-1. Period of Survey Work

| | |
|--------------------------------|-----------------------------------------------------------------|
| Field work | |
| Aerial photography II | 3 rd October, 1996 ~ 12 th December, 1996 |
| Ground control point survey II | 3 rd October, 1996 ~ 24 th January, 1997 |
| Leveling | ---- ditto---- |
| Pricking | ---- ditto---- |

2-2. Formation of the Study Team

| | | |
|---------------------|------------------------|-----------------------------------------------------|
| Leader | Mr. Tokihiko KAMINISHI | 26 th Sep.'96 ~ 15 th Oct.'96 |
| " | " | 14 th Jan.'97 ~ 24 th Jan.'97 |
| Deputy Leader | Mr. Koichi MIKI | 26 th Sep.'96 ~ 24 th Jan.'97 |
| Mapping Planner | Mr. Kozo OKUMURA | 26 th Sep.'96 ~ 24 th Jan.'97 |
| Chief Surveyor | Mr. Hitoshi YOSHIDA | 26 th Sep.'96 ~ 24 th Jan.'97 |
| Photographer | Mr. Shun TAKAGI | 10 th Oct.'96 ~ 12 th Dec.'96 |
| Mechanical Engineer | Mr. Shinpei ISHIWATA | 26 th Sep.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Shigeo ONO | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Masahiko OHASHI | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Michio SATOJI | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Tsuyoshi YAMAZAKI | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Koichi WAKISAKA | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Kozo ASANO | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Makoto TSUJIMOTO | 26 th Sep.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Masaru TERADA | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Tomohiro MURAKAMI | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Kensuke KIMURA | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Yuichi TABIKAWA | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Masaya TOKITA | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Kazutomo NAKANISHI | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Surveyor | Mr. Kuniaki NOGUCHI | 3 rd Oct.'96 ~ 24 th Jan.'97 |
| Coordinator | Mr. Hideaki SAKAI | 26 th Sep.'96 ~ 15 th Oct.'96 |

2-3. Amount of the Survey Work (Plan and Results)

Progress in the second year are as follows;

| ITEM | ORIGINAL PLAN | RESULTS |
|--------------------------------|-------------------------------|------------------------------|
| Aerial photography II : Scale | approx. 1/60,000 | approx. 1/60,000 |
| Flight length | 2,800km | 346 km |
| Coverage | approx. 20,400km ² | approx. 2,550km ² |
| Photo No. | approx. 563 photos | 74 photos |
| Ground control point survey II | approx. 34 points | 34 points |
| Leveling | approx. 1,080 km | 1,230 km |
| Pricking GPS point | approx. 74 points | 35 points |
| New leveling point | approx. 1,080 km | 580 km |
| SDG Existing BM | | 102 points |

2-4. Counterparts of SDG

Headquarters;

| | | |
|-------------------------|------------------------|-------------------------|
| Na Al-haji Iddirisu Abu | Director of Surveys | Headquarters |
| Mr. J. Dotse | Asst. Director | Great Accra Region |
| Mr. R. Brimah | Asst. Director | Headquarters |
| Mr. J.A. Abossey | Staff Surveyor | Headquarters |
| Mr. Marcus Tabil | Examiner | Examination Section |
| Mr. K.N.Arku-Lawson | Chief Cartographer | Cartographic Section |
| Mr. I. Andoh-Kesson | Chief Photogrammetrist | Photogrammetric Section |
| Mr. J.C. Acquah | Senior Engineer | Great Accra Region |
| Mr. E.R. Tetteh | Chief Lithographer | Lithographic section |

Field Work

| | | |
|-----------------|----------------------|----------------|
| Mr. E. K. Nkebi | Regional Surveyor | Central Region |
| Mr. E. Djokoto | Regional Surveyor | Western Region |
| Mr. P.E. Attah | Survey Technician | Central Region |
| Mr. E. Abbah | Technical officer I | Central Region |
| Mr. D. Kumasenu | Technical officer I | Central Region |
| Mr.H.Mustaphad | Technical officer II | Central Region |
| Mr. G.K. Arhin | Technical officer II | Central Region |
| Mr. A. Gatsi | Technical officer I | Central Region |
| Mr. A. Abrefa | Technical officer I | Central Region |
| Mr. K. Spong | Technical officer II | Central Region |
| Mr. B.Gustau | Survey Technician | Western Region |
| Mr. B.Adoey | Technical officer I | Western Region |
| Mr. A. Robert | Technical officer II | Western Region |
| Mr. A. Godwin | Technical officer II | Western Region |
| Mr. A. Daniel | Survey Technician | Western Region |
| Mr. E. Paul | Technical officer I | Western Region |
| Mr. S. Francis | Technical officer I | Western Region |

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3. FIELD WORK

3-1. Aerial Photography II

Aerial photography was started after the rainy season. The team contracted with Aircraft Operation Company(PTY) Ltd. (A.O.C.South Africa) same condition as first year's for all aerial photography.

(1) Base for Aerial photography

KOTOKA International Airport was used for the base aerial photography.

(2) Aircraft and Camera

Details of aircraft and camera are as follows;

| | |
|----------------------|--------------------------------|
| Aircraft | : Gates Learjet 24 No.24-165 |
| Camera | : Zeiss RMK-A 8.5/23 |
| Lens Number | : No.132014 f=85.54mm |
| Navigation Equipment | : GPS Navigation, Trimble 2000 |

(3) Photographic work

Test flight was made on 10th October 1996 and full scale aerial photography was commenced from 11th October 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 & DOUBLE X

3-2. Photo processing

(1) Development

The instruments and materials to be used were as follows;

| | |
|------------------|----------------------------|
| Developer | : ILFORD OQ UNIVERSAL |
| Paper | : AGFA RAPSTONE 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, re-flight was made, in case of necessity.

Items to be inspected were as follows;

1. Over-lap and side-lap
2. Cloud, Cloud shadow and uneven development
3. Deviation of flight course
4. Halation, smoke of field fire, etc.

(3) Film annotation

The form of film annotation and numbering on each frame of aerial photography should be same as first study.

(4) Amount of work

Film roll : 5rolls
Available photographs : 74 photos (13%)
Flight lines/length : 7/346 Km (12%)

Number of photographs in this study is shown as follows; , and total coverage shown in Figure- 1.

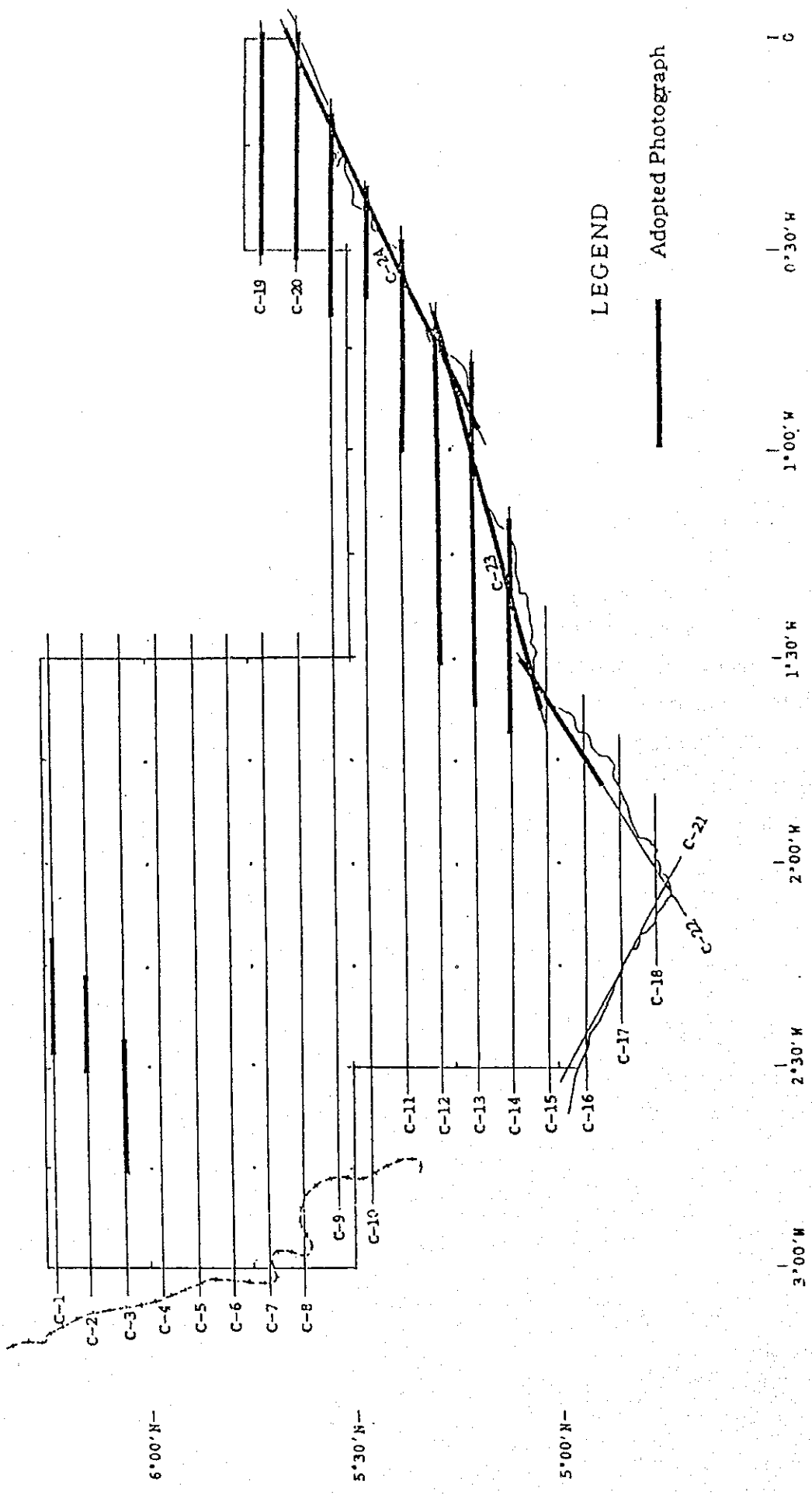
List of available aerial photos;

| RUN No. | FRAME No. | PHOTO No. |
|---------|-----------|-----------|
| C-1 | 639 ~ 645 | 7 |
| C-2 | 652 ~ 657 | 6 |
| C-3 | 697 ~ 704 | 8 |
| C-9 | 384 ~ 396 | 13 |
| C-14 | 227 ~ 237 | 11 |
| C-22 | 205 ~ 213 | 9 |
| C-24 | 184 ~ 203 | 20 |
| | | |
| | TOTAL | 74 |

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Fig. 1 PHOTO INDEX (Phase 1 & 2)



3-3. Ground Control Point Survey II

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

(1) Observation

Observation was made at four or three points simultaneously. Due to the limitation of passing hours of satellites it was made over two hours, over five satellites were observed.

(2) Observation scheme

The network consisting of 24 observation groups as shown in Fig-2.

(3) Results

The coordinate closures of each group were computed by approximate computation in the field to check the reliability of the observation. The results are tentatively as shown in table-1, where dx, dy and dz stand for the coordinate closure of the geodetic coordinate system of ellipsoid WGS-84 to which GPS is referred.

3-4. Leveling

(1) Leveling Routes

Leveling, carried out for about 1,230km (91 routes) covering the Study Area were set up as shown in Fig-3, and result table .

(2) Measurements

Existing bench marks were used for starting, ending and checking;

Check measurements were carried out with satisfactory results (See table-2). The nominal value of existing bench mark will be adopted as given.

The observation was made by closures or double observations with bar-code level and bar-code staff.

Fig - 2. GPS Observation Group

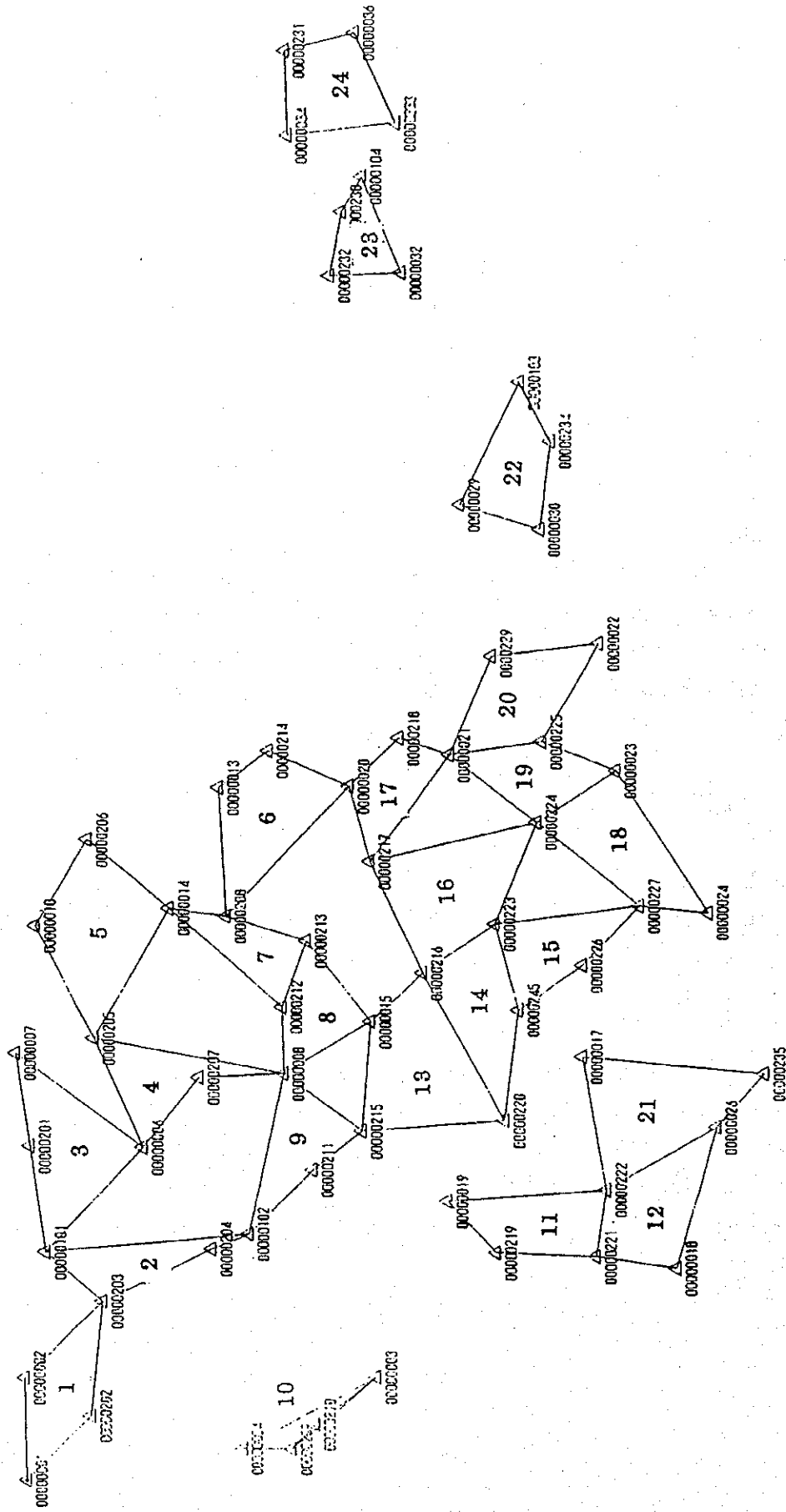


Table-1. (GPS observation result)

| Group No. | Station combination for baseline | | Computed Slope Distance(m) | Accuracy (m) |
|-----------|----------------------------------|-----|----------------------------|-----------------|
| 1 | 1 | 2 | 23,113.440 | TD= 92,806.745 |
| | 2 | 203 | 23,845.312 | dx = +0.012 |
| | 203 | 202 | 25,620.504 | dy = -0.007 |
| | 202 | 1 | 20,227.488 | dz = +0.001 |
| | | | | Ratio=0.144ppm |
| 2 | 203 | 101 | 16,161.700 | TD= 94,874.639 |
| | 101 | 102 | 43,774.179 | dx = +0.013 |
| | 102 | 204 | 8,896.978 | dy = -0.007 |
| | 204 | 203 | 26,041.783 | dz = +0.007 |
| | | | | Ratio=0.172ppm |
| 3 | 101 | 201 | 23,761.421 | TD= 109,461.531 |
| | 201 | 7 | 20,524.753 | dx = -0.006 |
| | 7 | 6 | 33,980.923 | dy = -0.001 |
| | 6 | 101 | 31,194.434 | dz = +0.001 |
| | | | | Ratio=0.053ppm |
| 4 | 6 | 205 | 26,022.469 | TD= 105,678.680 |
| | 205 | 8 | 41,530.304 | dx = -0.001 |
| | 8 | 207 | 18,619.409 | dy = -0.02 |
| | 207 | 6 | 19,506.499 | dz = 0.001 |
| | | | | Ratio=0.021ppm |
| 5 | 205 | 10 | 28,142.008 | TD= 106,454.911 |
| | 10 | 206 | 22,079.494 | dx = +0.002 |
| | 206 | 14 | 22,876.969 | dy = -0.001 |
| | 14 | 205 | 33,356.440 | dz = -0.000 |
| | | | | Ratio=0.023ppm |
| 6 | 208 | 13 | 28,224.646 | TD= 100,086.206 |
| | 13 | 214 | 13,598.048 | dx = +0.001 |
| | 214 | 20 | 19,090.226 | dy = -0.001 |
| | 20 | 208 | 39,173.286 | dz = -0.001 |
| | | | | Ratio=0.020ppm |
| 7 | 14 | 208 | 12,279.276 | TD= 79,549.148 |
| | 208 | 213 | 18,524.618 | dx = +0.007 |
| | 213 | 212 | 15,775.784 | dy = -0.002 |
| | 212 | 14 | 32,969.470 | dz = -0.004 |
| | | | | Ratio=0.102ppm |
| 8 | 212 | 213 | 15,775.784 | TD= 75,496.679 |
| | 213 | 15 | 22,703.528 | dx = +0.015 |
| | 15 | 8 | 22,090.909 | dy = -0.020 |
| | 8 | 212 | 14,926.458 | dz = +0.010 |
| | | | | Ratio=0.355ppm |
| 9 | 102 | 8 | 36,158.321 | TD= 90,800.643 |
| | 8 | 215 | 21,046.750 | dx = -0.005 |
| | 215 | 211 | 13,641.462 | dy = -0.001 |
| | 211 | 102 | 19,954.111 | dz = +0.001 |
| | | | | Ratio=0.052ppm |
| 10 | 209 | 4 | 10,843.096 | TD= 69,045.366 |
| | 4 | 3 | 33,460.337 | dx = -0.007 |
| | 3 | 210 | 17,045.525 | dy = +0.004 |
| | 210 | 209 | 7,696.407 | dz = -0.002 |
| | | | | Ratio=0.118ppm |

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| Group No. | Station combination for baseline | | Computed Slope Distance(m) | Accuracy (m) |
|-----------|----------------------------------|-----|----------------------------|-----------------|
| 11 | 219 | 19 | 15,545.705 | TD= 86,271.911 |
| | 19 | 222 | 34,296.738 | dx = -0.026 |
| | 222 | 221 | 15,009.392 | dy = +0.017 |
| | 221 | 219 | 21,420.076 | dz = +0.000 |
| | | | | Ratio=0.359ppm |
| 12 | 221 | 222 | 15,009.392 | TD= 92,412.094 |
| | 222 | 26 | 27,609.600 | dx = +0.003 |
| | 26 | 18 | 32,279.158 | dy = -0.012 |
| | 18 | 221 | 17,513.944 | dz = -0.008 |
| | | | | Ratio=0.155ppm |
| 13 | 15 | 216 | 15,690.607 | TD= 108,257.976 |
| | 216 | 220 | 37,241.843 | dx = -0.009 |
| | 220 | 215 | 30,970.201 | dy = -0.006 |
| | 215 | 15 | 24,355.324 | dz = -0.001 |
| | | | | Ratio=0.096ppm |
| 14 | 220 | 216 | 37,241.843 | TD= 101,220.363 |
| | 216 | 223 | 19,422.494 | dx = -0.015 |
| | 223 | 245 | 19,741.506 | dy = +0.014 |
| | 245 | 220 | 24,814.520 | dz = +0.007 |
| | | | | Ratio=0.214ppm |
| 15 | 223 | 227 | 31,326.789 | TD= 86,239.838 |
| | 227 | 226 | 18,319.993 | dx = -0.043 |
| | 226 | 245 | 16,851.550 | dy = +0.001 |
| | 245 | 223 | 19,741.506 | dz = +0.009 |
| | | | | Ratio=0.113ppm |
| 16 | 217 | 224 | 37,040.750 | TD= 107,424.341 |
| | 224 | 223 | 24,045.178 | dx = -0.003 |
| | 223 | 216 | 19,422.494 | dy = -0.001 |
| | 216 | 217 | 26,915.919 | dz = -0.003 |
| | | | | Ratio=0.044ppm |
| 17 | 217 | 20 | 17,134.092 | TD= 73,116.173 |
| | 20 | 218 | 15,139.772 | dx = +0.001 |
| | 218 | 21 | 11,619.305 | dy = +0.001 |
| | 21 | 217 | 29,223.003 | dz = -0.000 |
| | | | | Ratio=0.017ppm |
| 18 | 224 | 23 | 20,637.564 | TD= 100,969.858 |
| | 23 | 24 | 36,848.911 | dx = -0.002 |
| | 24 | 227 | 14,865.093 | dy = +0.002 |
| | 227 | 224 | 28,618.290 | dz = +0.001 |
| | | | | Ratio=0.023ppm |
| 19 | 21 | 225 | 20,087.100 | TD= 81,665.078 |
| | 225 | 23 | 17,167.803 | dx = -0.042 |
| | 23 | 224 | 20,637.564 | dy = +0.031 |
| | 224 | 21 | 23,772.610 | dz = +0.009 |
| | | | | Ratio=0.039ppm |
| 20 | 21 | 229 | 23,524.833 | TD= 81,672.292 |
| | 229 | 22 | 23,185.185 | dx = -0.002 |
| | 22 | 225 | 24,875.174 | dy = +0.001 |
| | 225 | 21 | 20,087.100 | dz = +0.001 |
| | | | | Ratio=0.022ppm |

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| Group No. | Station combination for baseline | | Computed Slope Distance(m) | Accuracy (m) |
|-----------|-------------------------------------|-----|-------------------------------|-----------------|
| 21 | 222 | 17 | 29,603.515 | TD= 112,497.205 |
| | 17 | 235 | 39,588.283 | dx = 0.004 |
| | 235 | 26 | 15,695.807 | dy = 0.000 |
| | 26 | 222 | 27,609.600 | dz = -0.001 |
| | | | | Ratio=0.039ppm |
| 22 | 29 | 103 | 29,990.404 | TD= 82,254.219 |
| | 103 | 234 | 14,538.416 | dx = -0.001 |
| | 234 | 30 | 19,714.790 | dy = -0.000 |
| | 30 | 29 | 18,010.610 | dz = +0.000 |
| | | | | Ratio=0.015ppm |
| 23 | 104 | 32 | 22,713.169 | TD= 61,245.116 |
| | 32 | 232 | 15,418.601 | dx = +0.000 |
| | 232 | 230 | 14,383.851 | dy = +0.000 |
| | 230 | 104 | 8,729.495 | dz = +0.000 |
| | | | | Ratio=0.007ppm |
| 24 | 34 | 231 | 18,472.580 | TD= 78,820.321 |
| | 231 | 36 | 15,470.086 | dx = +0.000 |
| | 36 | 233 | 21,465.757 | dy = +0.001 |
| | 233 | 34 | 23,411.898 | dz = -0.001 |
| | | | | Ratio=0.015ppm |

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Fig.3 INDEX MAP FOR LEVELING

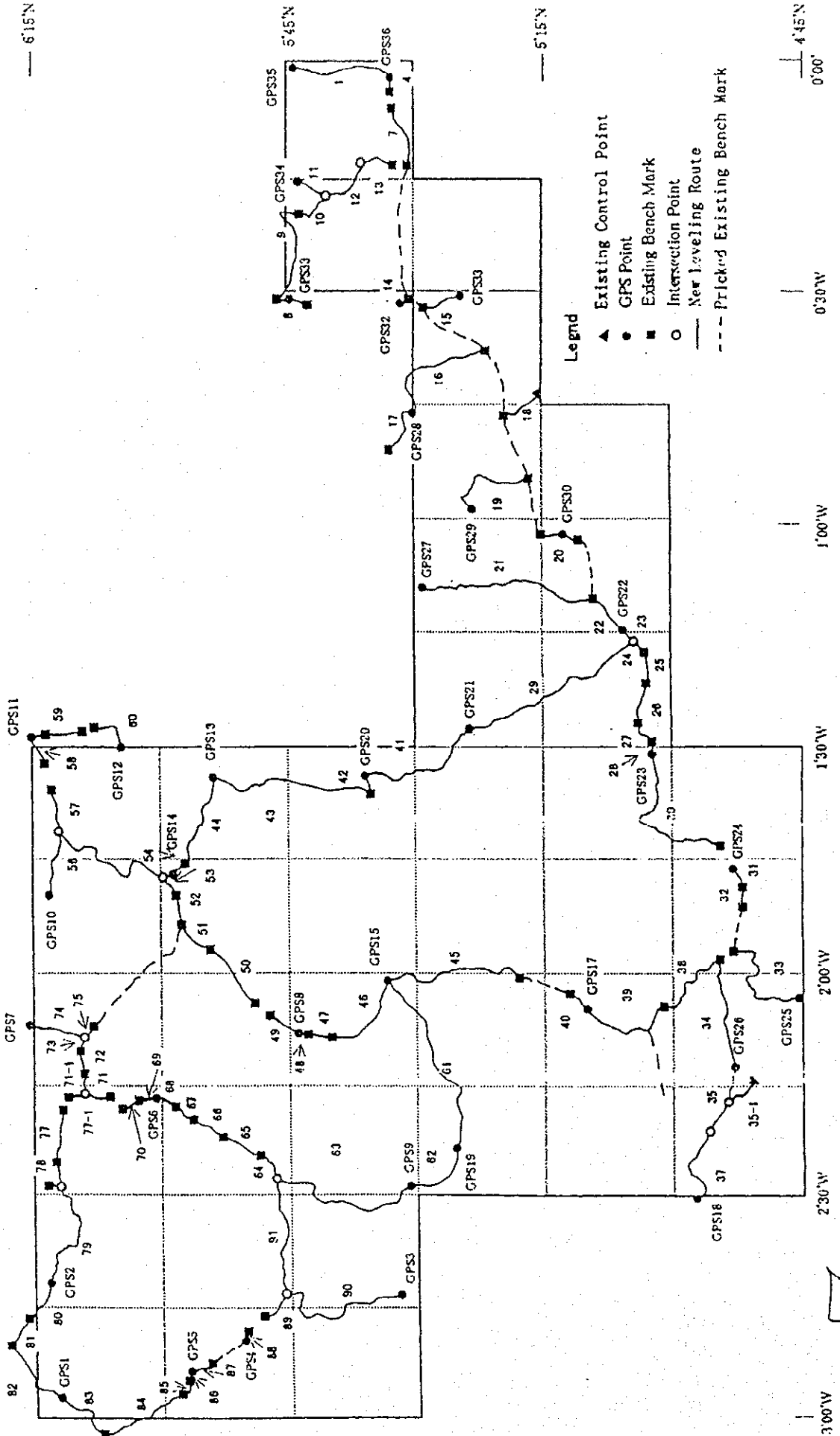


Table-2. Check measurement results

| BM No. From ~ To | Distance (km) | Closures Error(m) | Tolerance(m) |
|--------------------|---------------|-------------------|--------------|
| PL 7/325 ~ 7/324 | 0.388 | 0.003 | 0.031 |
| PL 7/324 ~ 7/322 | 0.796 | 0.006 | 0.044 |
| PS 9/ 2 ~ 9/ 4 | 1.906 | 0.020 | 0.069 |
| PS 9/33 ~ 9/32 | 0.632 | 0.004 | 0.039 |
| PS 9/35 ~ 9/34 | 1.770 | 0.001 | 0.066 |
| PS 9/45 ~ 9/52 | 1.778 | 0.027 | 0.066 |
| PS 9/65 ~ 9/ 64 | 1.818 | 0.008 | 0.067 |
| PS 3/45 ~ 3/44 | 0.800 | 0.007 | 0.044 |
| L 12/18 ~ 12/12 | 4.732 | 0.004 | 0.108 |
| L 12/33 ~ 12/35 | 1.580 | 0.052 | 0.062 |
| PS 4/10 ~ 4/ 9 | 1.652 | 0.003 | 0.064 |
| PS 4/ 2 ~ 4/ 1 | 1.586 | 0.003 | 0.062 |
| PS 2/A3 ~ 2/113 | 1.074 | 0.009 | 0.051 |
| PL 25/106 ~ 25/105 | 1.160 | 0.035 | 0.053 |
| PL 25/107 ~ 25/108 | 1.644 | 0.009 | 0.064 |
| PL 25/114 ~ 25/115 | 1.470 | 0.016 | 0.060 |
| PS 1/A2 ~ 1/A3 | 5.926 | 0.004 | 0.121 |
| PS 1/A5 ~ 1/124 | 2.524 | 0.004 | 0.079 |
| PL 17/A26 ~ 17/103 | 1.678 | 0.009 | 0.064 |
| PL 18/A5 ~ 18/A6 | 9.118 | 0.000 | 0.150 |

(3) Results

Results for the respective route sections are as follows;

| Route No. | B.M; From ~ To | Dist. (km) | Closure (m) | Tolerance (m) | Remarks |
|-----------|--------------------|---------------|-------------|---------------|---------|
| 1,4 | PL 7/ 325 ~ GPS.35 | 20.606 | 0.130 | 0.226 | double |
| 7 | PL 7/ 322 ~ PS 9/2 | 22.134 | 0.045 | 0.235 | closed |
| 8 | PL 1/ 19 ~ 1/ 17 | 5.338 | 0.006 | 0.115 | closed |
| 9 | PL 1/ 17 ~ 1/ 6 | 29.504 | 0.004 | 0.271 | closed |
| 10,12,13 | PL 1/ 6 ~ PS 9/ 4 | 25.960 | 0.013 | 0.254 | closed |
| 11 | 1002 ~ GPS.34 | 7.042 | 0.013 | 0.132 | double |

| | | | | | |
|----------|-----------------------|---------|-------|-------|--------|
| 14 | PS 9/32~ GPS.32 | 0.590 | 0.001 | 0.038 | double |
| 15 | PS 9/34 ~ GPS.33 | 10.445 | 0.017 | 0.161 | double |
| 16,17 | PL 1/29 ~ PS 9/45 | 36.810 | 0.094 | 0.303 | closed |
| 18 | PS 9/52 ~ GCS.102 | 10.618 | 0.010 | 0.162 | closed |
| 19 | PS 9/65 ~ GPS.29 | 22.038 | 0.041 | 0.234 | double |
| 20 | PS 9/77 ~ PS 9/80 | 3.798 | 0.009 | 0.097 | closed |
| 21 | PL 25/A16B ~ GPS.27 | 38.424 | 0.186 | 0.309 | closed |
| 22,23,24 | PL 25/A16B~SGW20/60/3 | 14.030 | 0.013 | 0.187 | closed |
| 25 | SGW20/60/3~FBM.5 | 7.956 | 0.046 | 0.141 | closed |
| 26 | FBM.5 ~ CFP.3141 | 11.728 | 0.024 | 0.171 | closed |
| 27 | CFP.3141 ~ PL 1/55 | 7.710 | 0.016 | 0.138 | closed |
| 28,30 | PL 1/55 ~ FBM.5A | 40.458 | 0.027 | 0.318 | closed |
| 29,41,42 | 2301 ~ PS 3/45 | 77.136 | 0.054 | 0.439 | closed |
| 31,32 | L 12/12 ~ GPS.24 | 7.147 | 0.022 | 0.133 | double |
| 33 | L 12/33 ~ GPS.25 | 26.097 | 0.243 | 0.255 | double |
| 34,35,-1 | L 12/35 ~ L12/84 | 38.912 | 0.065 | 0.311 | closed |
| 35,37 | 3501 ~ GPS.18 | 30.425 | 0.035 | 0.275 | double |
| 38 | L 12/35 ~ PS 4/25 | 20.574 | 0.090 | 0.226 | closed |
| 39,40 | PS 4/25 ~ PS 4/10 | 22.210 | 0.040 | 0.235 | closed |
| 43,44 | PS 3/45 ~ FBM.7 | 72.836 | 0.175 | 0.426 | closed |
| 45,46 | PS 4/1 ~ PS 2/106 | 55.018 | 0.353 | 0.370 | closed |
| 47 | PS 2/106 ~ PS 2/A2 | 6.540 | 0.011 | 0.127 | closed |
| 48,49 | PS 2/A2 ~ PS 2/A3 | 6.350 | 0.007 | 0.125 | closed |
| 50 | PS 2/113 ~ PS 2/A5 | 18.450 | 0.018 | 0.214 | closed |
| 51 | PS 2/A5 ~ PL 17/A33 | 9.702 | 0.020 | 0.155 | closed |
| 52 | PL 17/A34 ~ PL 17/A33 | 7.618 | 0.027 | 0.138 | closed |
| 53,54 | PL 17/A34 ~ FBM.7 | 7.608 | 0.017 | 0.137 | closed |
| 55,57 | 5301 ~ PL 25/105 | 49.358 | 0.158 | 0.351 | closed |
| 56 | 5600 ~ GPS.10 | 16.795 | 0.047 | 0.204 | double |
| 58,59 | PL 25/108 ~ PL 25/114 | 15.030 | 0.020 | 0.193 | closed |
| 60 | PL 25/115 ~ GPS12 | 7.720 | 0.019 | 0.138 | double |
| 61,62,63 | 4601 ~ 9111 | 104.862 | 0.130 | 0.512 | double |
| 64 | 9111 ~ PS 1/101 | 9.114 | 0.016 | 0.150 | closed |
| 65 | PS 1/101 ~ PS 1/108 | 12.184 | 0.055 | 0.174 | closed |
| 66 | PS 1/108 ~ PS 1/A2 | 7.462 | 0.047 | 0.136 | closed |

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| | | | | | |
|----------|-----------------------|--------|-------|-------|--------|
| 67 | PS 1/A2 ~ PS 1/A3 | 5.926 | 0.004 | 0.121 | closed |
| 68,69,70 | PS 1/A3 ~ PS 1/A5 | 16.748 | 0.003 | 0.204 | closed |
| 71,77-1 | PS 1/124 ~ PL 17/A26 | 8.156 | 0.124 | 0.142 | closed |
| 71-1 | 7111 ~ PL 17/A27 | 4.608 | 0.045 | 0.107 | closed |
| 72,73,75 | PL 17/A27 ~ PL 17/114 | 11.946 | 0.039 | 0.172 | closed |
| 74 | 7301 ~ GPS.7 | 15.813 | 0.010 | 0.198 | double |
| 77 | PL 17/A23 ~ PL 17/103 | 21.930 | 0.049 | 0.234 | closed |
| 78 | PL 17/A22 ~ PL 17/A23 | 6.370 | 0.034 | 0.126 | closed |
| 79,80 | PL 18/A6 ~ 7801 | 46.138 | 0.014 | 0.339 | closed |
| 81 | PL 18/A5 ~ PL 18/A6 | 9.118 | 0.000 | 0.150 | closed |
| 82 | GPS.1 ~ PL 18/A5 | 18.528 | 0.016 | 0.215 | closed |
| 83 | PL 18/A14 ~ GPS.1 | 20.074 | 0.016 | 0.224 | closed |
| 84 | PL 18/65 ~ PL 18/A14 | 14.454 | 0.017 | 0.190 | closed |
| 85 | PL 18/A16 ~ PL 18/65 | 1.466 | 0.016 | 0.060 | closed |
| 86 | GPS.5 ~ PL 18/A16 | 0.308 | 0.016 | 0.027 | closed |
| 87 | PL 18/A17 ~ GPS.5 | 7.100 | 0.016 | 0.133 | closed |
| 88 | PL 18/A19 ~ GPS.4 | 0.409 | 0.001 | 0.031 | double |
| 89 | PL 18/82 ~ 9000 | 5.654 | 0.017 | 0.118 | closed |
| 90 | 9000 ~ GPS.3 | 32.727 | 0.084 | 0.286 | double |
| 91 | 9000 ~ 9111 | 40.152 | 0.016 | 0.316 | closed |

3-5. Pricking

Pricking of the horizontal and vertical control for aerial triangulation was conducted using the aerial photos.

(1) Control points

Original plan of points to be pricked were 74 points, however we pricked 35 new GPS points on the aerial photo.

Elements of eccentricity for pricking were conducted using GPS and observation of Sun.

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(2) Existing bench marks and spot heights

Pricking of existing bench marks and spot heights was conducted on the aerial photos along the leveling route.

Spot heights were computed from leveling observation results. Points were pricked at every 4 to 5 km interval.

The above progress report covered the period from 26th September, 1996 to 14th January, 1997.



DATUM FOR THE TOPOGRAPHIC MAPPING OF
THE SOUTHERN PART OF GHANA

1. REFERENCE ELLIPSOID

SPHEROID : Clarke 1880
Semi axis major (a) : 6,378,249.145 m
Flattening (f) : 1/ 293.465

2. GRID SYSTEM

PROJECTION : Ghana Modified Transverse Mercator
Meridian of Origin : 1° 00' West of Greenwich
Latitude of Origin : 4° 40' North
False Coords at Origin: 300,000m Easting, Nil-Northing
Scale Factor at Origin : 0.99975

3. UNIT OF MEASUREMENT

UNIT : meter

4. CONVERT VALUE FOR FOOT TO METER

1 meter = 3.28084558 feet

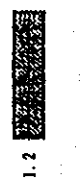


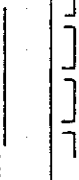
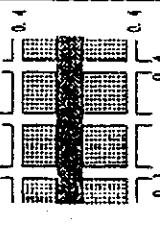
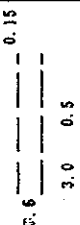
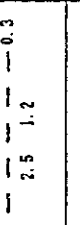
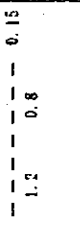
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SYMBOLS AND THEIR APPLICATION RULES
FOR
THE TOPOGRAPHIC MAPPING OF THE SOUTHERN PART
OF
THE REPUBLIC OF GHANA

2

SYMBOLS FOR 1:50,000 TOPOGRAPHIC MAP OF GHANA






| CLASS 分類 | NO | NAME 名称 | SYMBOL 記号 | ENLARGED 拡大図 | COLOUR 色 | INTERPRETATION 説明記号 | PLOTTING 図化記号 | COMPILATION 編纂記号 | APPLICATION RULES 適用規定 |
|-------------|----|----------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------|----------------------------------------------------------|------------------------|------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 1 | Motorway (dual carriageway) 自動車道 (片側2車線以上) | |  | black red-sc green 100% 黒 赤黒 緑 100% | | | | *Apply symbol to four lanes or more with central reserve. *中央分組帯を持つ片側2車線(計4車線)以上の道路に適用する *センターラインに適用する |
| | 2 | Roads: Class 1 Motorable throughout the year 1 幹道路: 通年自動車通行可 | |  | black red-sc green 100% 黒 赤黒 緑 100% | | | | *Apply symbol to paved road. *Route No. shall be indicated on both ends of each map sheet. *SDC shall provide route No. *幹線道路に適用する *路線番号を道路の両端付近に表示する *SDCが道路番号を提供する |
| | 3 | Roads: Class 2 Motorable, occasionally closed 2 幹道路: 自動車道 (時により通行不可) | |  | black red-sc green 50% 黒 赤黒 緑 50% | | | | *Apply symbol to unpaved road (maintained). *Route No. shall be indicated on both ends of each map sheet. *SDC shall provide route No. *赤黒記号であるが、維持管理されている道路に適用する *路線番号を道路の両端付近に表示する *SDCが道路番号を提供する |
| | 4 | Roads: Class 3 Motorable in dry seasons only 3 幹道路: 自動車道 (乾期のみに通行可) | |  | black 黒 | | | | *Apply symbol to unpaved road (not maintained). *SDC shall provide route No. *赤黒記号で維持管理もされていない道路に適用する *SDCが道路番号を提供する |
| | 4 | Street & main roads passing through the city and town. 街路及び主要道路 | |  | black 黒 | | | | *Apply symbol to street in the city and town. *A Street width less than 20m shall be plotted as 0.4m. The actual scale shall be plotted for a street width more than 20m. *Main roads (through the city and town shall be indicated as No. 1 or No. 2 *市街地内の道路に適用する *街路の最小幅は0.4mとするが、道幅20m以上の場合は拡大して表示する *No.1とNo.2の主要街路は記号道路で表示する |
| | 5 | Road under construction 建設中道路 | |  | black 黒 | | | | |
| | 6 | Tracks and Major Footpaths 小道及び主要な歩道 | |  | black 黒 | | | | |
| | 7 | Other Footpaths その他の歩道 (踏み込み歩道) | |  | black 黒 | | | | |

SYMBOLS FOR 1:50,000 TOPOGRAPHIC MAP OF GHANA

| CLASS 分類 | NO | NAME 名称 | SYMBOL 記号 | ENLARGED 拡大図 | COLOUR 色 | INTERPRETATION 説明記号 | PLOTTING 図化記号 | COMPILED 編纂記号 | APPLICATION RULES 適用規定 |
|-------------|----|-----------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------|---------------------------------------|------------------------|------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 8 | Railway (Standard gauge): (a) double line (b) single line (c) Discontinued railway 鉄道 (標準軌道): (a) 複線 (b) 単線 (c) 廃線 | | (a) Sta. : 6.0 0.4 2.9 Station (1:1) (b) Sta. (c) Abandoned 0.4 0.2 | Black 黒 | | | | (c) Discontinued railway shall be annotated as "Abandoned" (shall not apply annotation to temporary closed railway) (c) 廃線は Abandoned と注記をする (運行休止中の路線には Abandoned の注記はしない) |
| | 10 | Cable ways, Conveyor belt 索道, ベルトコンベア | | 0.5 5.0 0.2 | Black 黒 | | | | |
| | 11 | Power transmission line 送電線 | | (a) 10.0 1.0 (b) 0.20 (c) 0.25 | Black 黒 | | | | (a) Apply symbol to 1 or 2 line running parallel with each other. (b) Apply symbol to 3 line running parallel with each other. (c) Apply symbol to 4 line running parallel with each other. (a) 1本、又は2本の送電線が平行の場合に適用する (b) 3本の送電線が平行の場合に適用する (c) 4本の送電線が平行の場合に適用する (送電線相互の間隔は考慮しない) |
| | 12 | Telephone line 電話線 | | 0.4 0.15 5.0 | Black 黒 | | | | |
| | 13 | Boundary: International 境界: 国界 | | 2.0 0.3 1.0 | Black Red-green 黒、緑 黒、赤 緑 | | | | *SDC shall draw international border on the map (manuscript) *Red screen shall be put in the Ghana side. *現地情報時に領土が境界線図に表示する *国境は分一子図に適用する |
| | 14 | Boundary: Regional 境界: 区域界 | | 0.4 0.3 3.0 1.5 | Black 黒 | | | | *SDC shall draw boundary on the map (manuscript) if necessary. |
| | 15 | Boundary: District: (Local council) 境界: 区界 | | 0.3 2.0 2.5 2.0 | Black 黒 | | | | *現地情報時に領土が境界線図に表示する |
| | 16 | Boundary: City, Municipal or town 境界: 市界、市界、町界 | | 0.3 0.3 2.0 3.0 | Black 黒 | | | | *SDC shall draw boundary on the map (manuscript). *Annotation shall be put in the center of its area. |
| | 17 | Boundary: National park Forest Reserve Hunting area Other boundaries 境界: 国立公園、保護林、狩猟区、その他境界 | | 0.4 | Green green 緑 緑 | | | | *現地情報時に領土が境界線図に表示する *中等位置に国立公園、保護林等の注記をする |
| | 19 | Cut line 伐開線 (防火線) | | 0.1 1.0 1.0 | Black 黒 | | | | *Annotation shall fit along the lines. *測量の位置に注記する |
| | 21 | Fence Concrete or block wall 塀 (又はコンクリート塀) | | 1.5 0.3 0.15 | Black 黒 | | | | *Apply symbol to fence or wall which is more than 500m long. *長さ500m以上の塀及び壁に適用する |

SYMBOLS FOR 1:50,000 TOPOGRAPHIC MAP OF GHANA

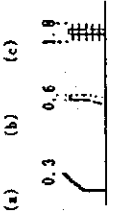




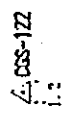
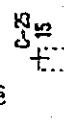
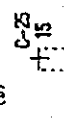
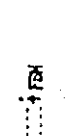


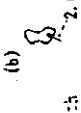
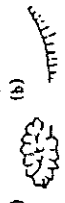
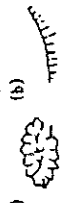
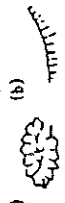
note: A.A. (Abbreviated Annotation)

| CLASS 分類 | NO | NAME 名称 | SYMBOL 記号 | ENLARGED 拡大図 | COLOUR 色 | INTERPRETATION 説明記号 | PLOTTING 図化記号 | COMPILATION 編集記号 | APPLICATION RULES 適用規定 |
|-------------|----|-----------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------------------|------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 2 | | City, Town 市街 | |  | black screen ? X 黒の網 ? X | | | | * If there is any prominent building in the congested (generalized) areas, it shall be indicated (protitted) as such. * 総括地域内に記号等を表示すべき建物等がある場合、当該建物が独立建物で表示できる場合は建物を表示し、その建物が小さい場合は十字で真位置を表示する |
| 2 3 | | Village 村荘 | |  | black screen ? X 黒の網 ? X | | | | * editto. * 総括地域内に記号等を表示すべき建物がある場合は、上記に準ずる |
| 2 4 | | (a) Compound & Hutts (b) Prominent Building (a) 小屋 (村荘跡の建物) (b) 著名な建物 | | (a)  (b)  φ 0.6 ● | black 黒 | | | | (a) Apply symbol to soil/mud house etc. (b) Apply symbol to Concrete and block house etc. (a) 土壁等の建物の建物に適用する (b) コンクリート及びブロック建築の建物に適用する |
| 2 5 | | Market 市場 | | Mkt | black 黒 | | | | * Big market shall be indicated with building. If building can't be drawn, A.A. shall be indicated on the center. * 大規模なものを表示し、独立建物を表示できない場合はその地域の中等位置に表示する |
| 2 6 | | (a) Hospital, (b) Clinic (a) 病院, (b) 医院 | | (a) + Hosp (b) + Clin | black 黒 | | | | (a) If building can be drawn, cross symbol shan't be indicated. (b) Apply A.A. also to the prominent clinic. (a) 独立建物が表示できる場合は十字を表示しない (b) 著名なものを表示する |
| 2 7 | | (a) Hotel, (b) School (c) Police Station (d) Court House (e) Barrier (a) ホテル, (b) 学校 (c) 警察署 (d) 裁判所 (e) 検問所 | | (a) H + Sch (c) + PS (d) + Ct H (e) Barrier | black 黒 | | | | (a) Apply A.A. to the prominent hotel only. (b) University, polytechnic, college, institute etc shall be indicated with building and its full name shall be annotated in principle. (b) -- (d) If building can be drawn, cross symbol shan't be indicated. (e) Barrier shall be annotated as "Barrier". (a) 著名なホテルに適用する (b) 総合大学、技術大学、専科大学、研究所等は建物を表示し原則として注記する (b) -- (d) 独立建物が表示できる場合は十字を表示しない (e) 検問所は "Barrier" と注記する |
| 27-1 | | (a) Military Station (b) Barracks (a) 軍施設 (b) 兵舎 | | (a) MS BKS | black 黒 | | | | (a) Apply A.A. also to the big chapel. (a) (b) If building can be drawn, cross symbol shan't be indicated. (c) Actual position shall be center of base line. (Symbol direction shall be set at right angle to the road. (a) 大きいChapel (礼拝堂) は教会の記号を適用する (a) (b) 独立建物が表示できる場合は十字を表示しない (c) 真位置 (下辺中央) に表示し、道路に対し直角に表示する (記号の向きは不足) |
| 2 8 | | (a) Church, (b) Mission (c) Temple (a) 教会, (b) 伝道所 (c) 寺院 | | (a) + Ch + M (c)  1:5 | black 黒 | | | | |

SYMBOLS FOR 1:50,000 TOPOGRAPHIC MAP OF GHANA

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|-------------|----|-------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------|-------------|------------------------|------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 29 | Silos サイロ | | | black 黒 | | | | |
| | 31 | Mosque イスラム教寺院 | | | black 黒 | | | | actual position shall be bottom of black circle. Symbol direction shall be set at right angle to the road. *真位置(円の右下点)に標示し、道路に対し直角に標示する(記号の向きは不定) |
| | 32 | Cemetery 墓 | | Gen | black 黒 | | | | large one: Indicate limits with black solid line. small one: Indicate its position by cross symbol. *大規模な墓は境を黒実線で表示して中央に標示し、小規模な場合は真位置を十字で示す |
| | 33 | (a) Post Office (b) Telecommunication office (c) Post & Telecommunication office (a) 郵便局、(b) 運送局 (c) 郵便・電信局 | | (a) P (b) T (c) P-T | black 黒 | | | | (a)... (c) Indicate its position by cross symbol, if building can't be drawn. * Shall apply (c) to common use of post & telecommunication. * 郵便局と電信局を兼ねている場合は(c)を適用する |
| | 34 | Electricity substation 変電所 | | | black 黒 | | | | every big one shall be drawn to actual size. |
| | 36 | Sports ground 競技場 | | | black 黒 | | | | * この記号より大きい場合は実形で表示する |
| | 37 | Shed 集荷場 | | + Shed | black 黒 | | | | * shall apply annotation to storageryard for Cocoa Coffee, etc. * ココア、コーヒー等農産物の集荷場、貯蔵所に適用する |
| | 38 | (a) Light house (b) Navigation beacon (c) Palace (a) 灯台 (b) 航海標 | | (a) (b) (c) | black 黒 | | | | |
| | 39 | (a) Fort, (b) Castle (a) 砦、(b) 城 (c) 宮城 | | (a) Fort (b) Castle (c) Pal | black 黒 | | | | * shall not apply (a) & (b) to present use. (c) Very big palace shall be annotated with full name. (a) (b) 現在は別の目的で使用されている場合でも、これを適用する (c) 大きい場合は注記する |
| | 40 | Tower 高塔 | | | black 黒 | | | | * shall apply symbol to clock tower etc. |
| | 41 | (a) Ruin, (b) Ancient wall (c) Ancient site (a) 遺跡、(b) 遺跡 (c) 遺跡 | | (a) (b) (c) | black 黒 | | | | * 時計台のような高塔に適用する |

SYMBOLS FOR 1:50,000 TOPOGRAPHIC MAP OF GHANA

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|-------------|-----------------------------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------|------------------------|------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------|
| 4 2 | (a) Jetty, (b) Quay (c) Pier (a) 防波堤 (b) 埠頭 (c) 浮橋 | | (a) 0.3 (b) 0.6 (c) 1.9  | black 黒 | | | | | |
| 4 3 | radio transmission station ラジオ送信所 | |  | black 黒 | | | | | *shall apply symbol also to TV/telecommunication tower etc. *テレビ送信塔、マイクエコーエープ、無線中継塔等にも適用する |
| 4 4 | Village 村山 | |  | black 黒 | | | | | |
| 4 6 | (a) Aerodrome, (b) Airstrip (a) 小型空港、(b) 滑走路 | | (a)  (b)  | black 黒 | | | | | *International airport shall be annotated with full name. *国際空港はフルネームを注記し、記号は表示しない |
| 4 7 | Geodetic point 測地基準点 | |  | black 黒 | | | | | *shall indicate symbol with the name and number. (no elevation) *測地基準点には標高を表示せず、点名、点番号を表示する |
| 4 8 | (a) Spot Height (b) Photo Principal Points (a) 標高点 (b) 写真主点 | | (a)  (b)  | black 黒 | | | | | (b) Line number shall be indicated on both ends of each map sheet. (b) 写真主点のコーン番号、写真番号は各コーンの両端の主点のみに表示する |
| 4 9 | Bench mark 水準点 | |  | black 黒 | | | | | *shall indicate fundamental bench mark only. (no elevation and no damaged bench mark) *基準水準点のみ表示し、標高は表示しない (故障点には表示しない) |
| 5 0 | (a) Contour line (b) Index contour (a) 等高線 (b) 計曲線 | |  | brown 茶 | | | | | |
| 5 1 | (a) Depression (b) Basin, shallow Depression (a) 凹地 (b) 浅い凹地 | | (a)  (b)  | brown 茶 | | | | | |
| 5 2 | Rocky areas: (a) Outcrop rock (b) Steep slopes (c) Cliffs 岩石地塊: (a) 露岩 (b) 急崖 (c) 断崖 | | (a)  (b)  (c)  | black 黒 | | | | | |

SYMBOLS FOR 1:50,000 TOPOGRAPHIC MAP OF GHANA

| CLASS 分票 | CLASS NO | NAME 名 称 | SYMBOL 符号 | ENLARGED 拡大図 | COLOUR 色 | INTERPRETATION 説明記号 | PLOTTING 図化記号 | COMPILATION 編纂記号 | APPLICATION RULES 適用規定 |
|-------------|----------|-------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------|----------------------------------------------------|------------------------|------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| | 5 3 | Eabankasa: 堤防 | | 1.0: 0.1 0.5 | brown 茶 | | | | |
| | 5 4 | Mine Dump ズリ捨場 | | minimum length 0.5m | brown 茶 | | | | |
| | 5 5 | Sand or Mud 砂地又は泥地 | | 内陸と海岸の砂(67)を区 分するもの | brown 茶 | | | | |
| | 5 5 | Dunes 砂丘 | | 内陸と海岸の砂(67)を区 分するもの | brown 茶 | | | | |
| | 5 7 | Quarry 採石場 | | 採石場 | black 黒 | | | | |
| | 6 0 | Water courses: (a) Indefinite streams (b) Rapids (c) Waterfall 河川: (a) 不定河川 (b) 急流, (c) 滝 | | (a) 0.5 (b) 0.7 (c) 1.0 (d) 1.0 (e) 1.0 | blue 青 Rapid water- fall black 黒 | | | | |
| | 6 1 | (a) Area liable to flood (b) Marsh or Swamp (c) 浸水し易い地域 (d) 沼地又は低湿地 | | (a) 11.0 (b) 11.0 (c) 0.7 (d) 0.7 (e) 3.0 2.5 3.5 | blue 青 | | | | |
| | 6 2 | Trench, Gutter 溝, 用水路(灌溉, 排水用) | | 0.2 | Blue 青 | | | | |
| | 6 3 | (a) Lake, (b) Pond, (c) Dam (c) 湖, (b) 池, (c) ダム | | (a) blue 100% (b) black 0.3 (c) black 0.3 | blue bl. scr. 黒, 青 青 | | | | |
| | 6 3 | Salt Ponds 塩田 | | Salt Ponds | black 黒 | | | | *Salt ponds shall be indicated with check exbankment and shall be annotated as "Salt Ponds". * 塩田はせき止め用堤防を表示し、Salt Pondsと注記する |
| | 6 4 | Waterhole, Well, Spring (borehole) 小池, 井戸, 泉 (試掘穴) | | φ 1.2 ○ | blue 青 | | | | |
| | 6 4 | Water tower 給水塔 | | φ 1.2 ⊕ screen 100% | blue 青 screen 青 青 | | | | |

SYMBOLS FOR 1:50,000 TOPOGRAPHIC MAP OF GHANA

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|-------------|------|-----------------------------------------------------------------------------------------------------------------------|--------------|-----------------|-------------------------------------|------------------------|------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 6 5 | Water pipes 送水管 | | | blue 青 | | | | |
| | 6 6 | (a) Bridges, (b) Footbridge (c) Culvert, (d) Ford (e) Ferry (a) 橋, (b) 徒歩橋 (c) カルバート, (d) 渡渉所 (e) フェリー | | | black 黒 | | | | (a) shall apply symbol also to train bridge. (b) shall apply symbol to footbridge and bridge upon double lines river on the map. (Excluding small bridge on the single line river on the map) (c) 鉄道橋にも適用する (b) 原則として、2条河川には表示するものとし、歩道橋にも適用する(1条河川には表示しない) |
| | 6 7 | Coastline (Sand or Mud) 海岸線 (砂又は泥地) | | | brown 茶 | | | | |
| | 67-1 | Flat Rock (a) Boulder Rock (b) 平らな岩石海岸 岩塊の海岸 | | | Black 黒 | | | | |
| | 6 8 | Thick Forest 樹木の多い森林 | | | Green 100% 緑 100% | | | | distants shall not be indicated. |
| | 6 9 | Light Forest 森林 | | | Green- screen 7% 緑斑点 7% | | | | * 緑斑界は表示しない |
| | 7 1 | Savannah 草原 | | Non-symbol | | | | | |

