measurement could not be applied. By selecting prickable ground objects, the eccentricity from the point was measured by GPS survey. The survey was executed incorporated in the network of the ground control point survey or independently.

However, points N5 and N7 corresponding to points TP2 and N2 respectively were identified on the twice enlargement after coming back to Japan.

The final result of the signalization is as follows:

Identified signalized points	32 points
Pricked points	3 "
Signalized point no used (TP 17)	1 "
Points to use for aerial triangulation	35 "

As points N2 and TP2 were not identified in the field, N6 and N5 were newly established by pricking as alternatives. Original points were identified on the twice enlargement after coming back to Japan. All of them were, however, used for aerial triangulation. As the alternative to TP17, N7 was pricked and used for aerial triangulation.

3-3 Aerial Photography

3-3-1 Outline

The aerial photography was executed during 3 June, 1993 and 1 July, 1993. During the operation, the weather condition was unfavorable and not many chances were blessed in taking photographs. Especially, it occurred many times that although it was fine in the morning, it became cloudy in the

afternoon preventing taking pictures. On this account loosing the lowest limit of the solar altitude of 30° , the operation was started in the early morning of 7 o'clock. The aircraft of MIAT specially equipped for aerial photography was used. The weather having been unfavorable unexpectedly, it was able to complete the operation as expected.

3-3-2 Specifications

The specifications of the aerial photography are as follows:

a.Camera	:WILD RC-10 f=88 mm
b.Photo-scale	:approximately 1:50,000
c.Flight height	:5,300 m ± 5 % (datum plane: 800 m)
d.Area to cover	:approximately 10,800 km²
e.Flight distance	:approximately 1,762 line km
f.Number of flight courses	:15 courses
g.Flight direction	:east-west
h.Overlaps	:forward overlap 60 % ± 5 % lateral overlap 33 % ± 5 %
i.Inclination of camera	:κ not more than 10° ϕ , ω not more than 5°
j.Cloud volume	:not more than 3 % on 5 photographs in succession except the important portion for the orientation of the photograph and the plotting
k.Film	:KODAK XX
l.Paper	:MITSUBISHI GEKKOU

3-3-3 Charterring of the Aircraft for Aerial Photography

For the aircraft for aerial photography, an aircraft provided with equipments for aerial photography was chartered from the Mongolian Airlines by contract.

The aircraft is Antonov An-30 (Clank). The specifications of the aircraft are the same as those of the Antonov An-24/26 in performance except the equipment for the aerial photography and for researches. The performances are tabulated as follows:

a.Engine	:turboprop 2 units, subsidiary engine 1 unit
b.Gross weight	:approximately 21,000 kg
c.Fuel	:JET-A1, loading capacity 7,100 *l*
d.Service ceilings	:8,000 m
e.Range	:2,360 km (flight height 6,000 m, velocity 440 km/h, with an emergency reserve of one hour fuel
f.Cruising speed	:540 km/h (at 6.000 m altitude)

3-3-4 Execution

For aerial photography aerial camera of WILD RC-10, f=8.8 cm, and for navigation GPS navigator were brought with the Team from Japan on account of that there would not be a suitable aerial camera of super-wide angle lens and that not distinct land marks could be expected in the field for navigation. It was the first time to use WILD RC-10 camera and GPS navigator in Mongolia. A cameraman and a navigator joined in the Team to execute the operation.

1) Navigation of the aircraft

As anticipated, there found no distinct ground features in the field to navigate the aircraft, GPS navigator was used for navigation.

2) Air base

After discussing on the allocation of the air base with persons in charge of the Mongolian Airlines, it was agreed to settle the air base at the Choibarsan Airport near the study field taking the economy of flight hours into consideration provided that the replenish of the fuel was assured. After several shots, the aircraft was to return to the Ulaanbaatar Airport for photo-processing and then go back to the Choibarsan Airport to continue the aerial photography.

3) Progress of the operation

The weather condition having been unfavorable, loosening the lower limit 30° of the solar altitude, the operation began at 7 o'clock in the morning, considering that the length of the shadow due to the gentle slope of topography in the field might not affect serious difficulty in photo-interpretation and stereo plotting.

Days, number of times and hours of photographing were as follows:

Days of photographing	:30 days
Number of times of photographing	: 6 times
Hours of photographing	:17 hours.

4) Photo-processing

The development of the exposed films and printing of contact prints were done two times during the duration of photographing and after completing the operation including reflight. The processing was carried out in the photo-lab of MSAGC in cooperation with the counterparts under the guidance of a Team member in charge of the supervision of the aerial photography.

5) Inspection of Photographs

Immediately after the photo-processing, the supervisor of the aerial photography made inspection of the aerial photographs on the following points:

(1) Inspection of the film

a. If the tone of the image is uniform and the contrast is proper,

b. If the sensitive emulsion and processing chemical are completely removed,

c. If there is no distortion in the image due to incompleteness of drying film.

(2) Inspection by rush prints

Preparing rush prints from the original negative, they were inspected on the following items:

a. Discrepancy of the flown courses from those planned,

b. Quantity of forward and lateral overlaps,

c. Cloud volume, cloud shadow and unevenness of development,

d. Halation,

e. Mist, smoke,

f. Scratches on the film.

6) Draw up of the Photo-index Map

The photo index map was drawn up by plotting the principal point of each photograph on a 1:200,000 topographic map reduced and compilated from the existing 1:100,000 topographic map.

7) Result of aerial photography

The number of courses flown is 15 and the number of photographs is 398. The details of the results are shown in Fig. 7.

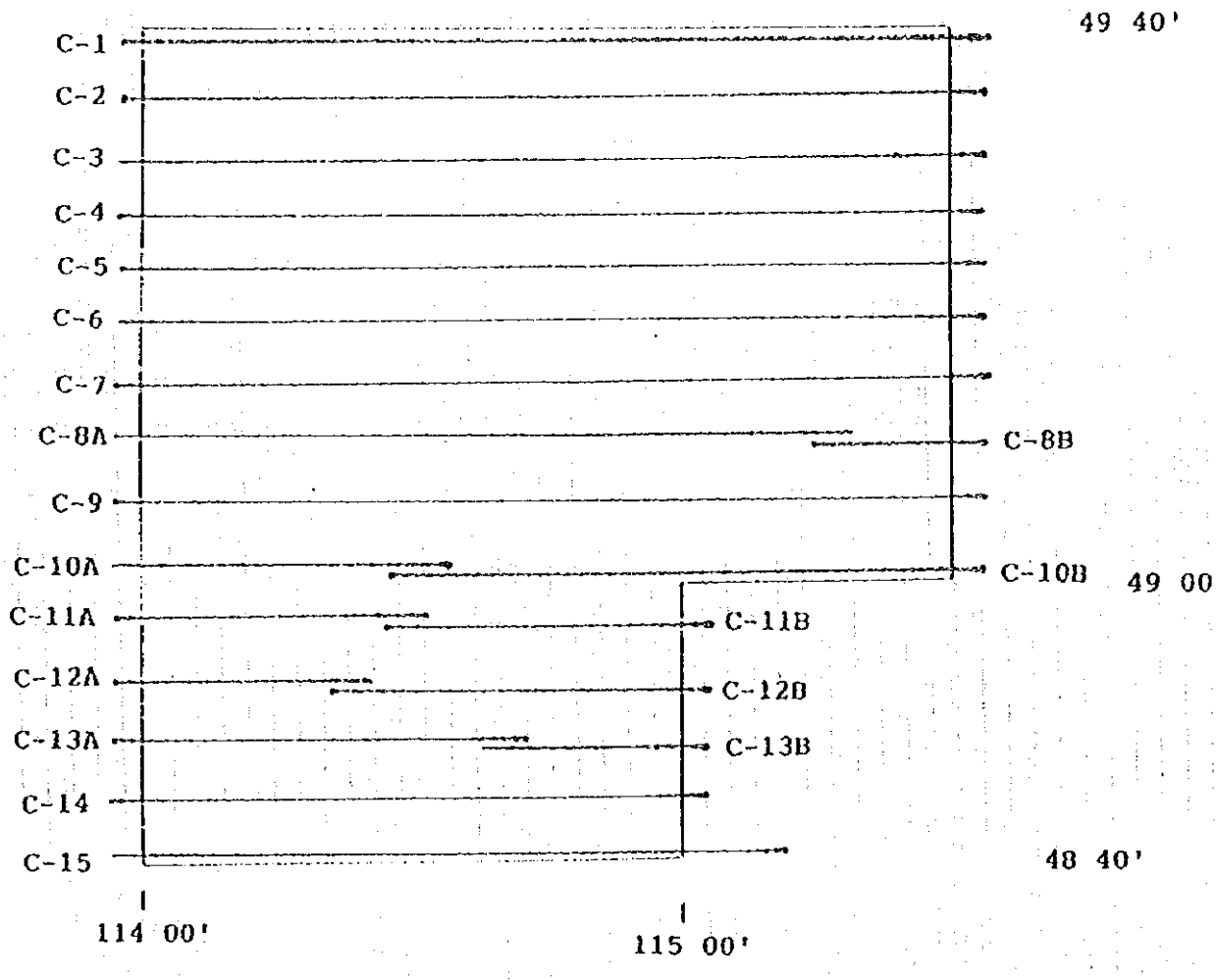
3-4 Ground Control Point Survey

3-4-1 Outline

In the study area there are triangulation points and bench marks. Selecting points out of these points, they are to use for photographic control in aerial triangulation. However, in the area where ground control points are not enough, control points were to be newly established by means of satellite geodesy using GPS receivers. It is necessary to adjust the height of the point obtained by the GPS survey (the height in reference to the reference ellipsoid) with that by leveling (the height in reference to the geoid). For this purpose, using the triangulation point of which height by leveling (the height above the geoidal surface) is known in the neighbourhood, the height obtained by GPS survey (the height above the reference ellipsoid) must be corrected.

Consequently, GPS survey was executed on the existing triangulation points to find out the relationship between the reference ellipsoidal and the geoidal surfaces.

Fig. 7 Photographic Run



3-4-2 Execution

1) Observational Mode

The satellite geodesy was applied for observation by using GPS receivers. Four Trimble 4000SSTs (two waves) were used in simultaneous observation mode.

2) Planning of Observation

Fig. 8 shows the observation network. In the figure, points shown by △ were not used for the aerial triangulation, but only for the control point survey.

3)Points used

Given points :TP 1, 3, 4, 5, 6, 17. 35. 40. 45. 50, 55, 60, 65, 70, 75

Unknown points:N1, N2, N3, N4, N5, N6, N7

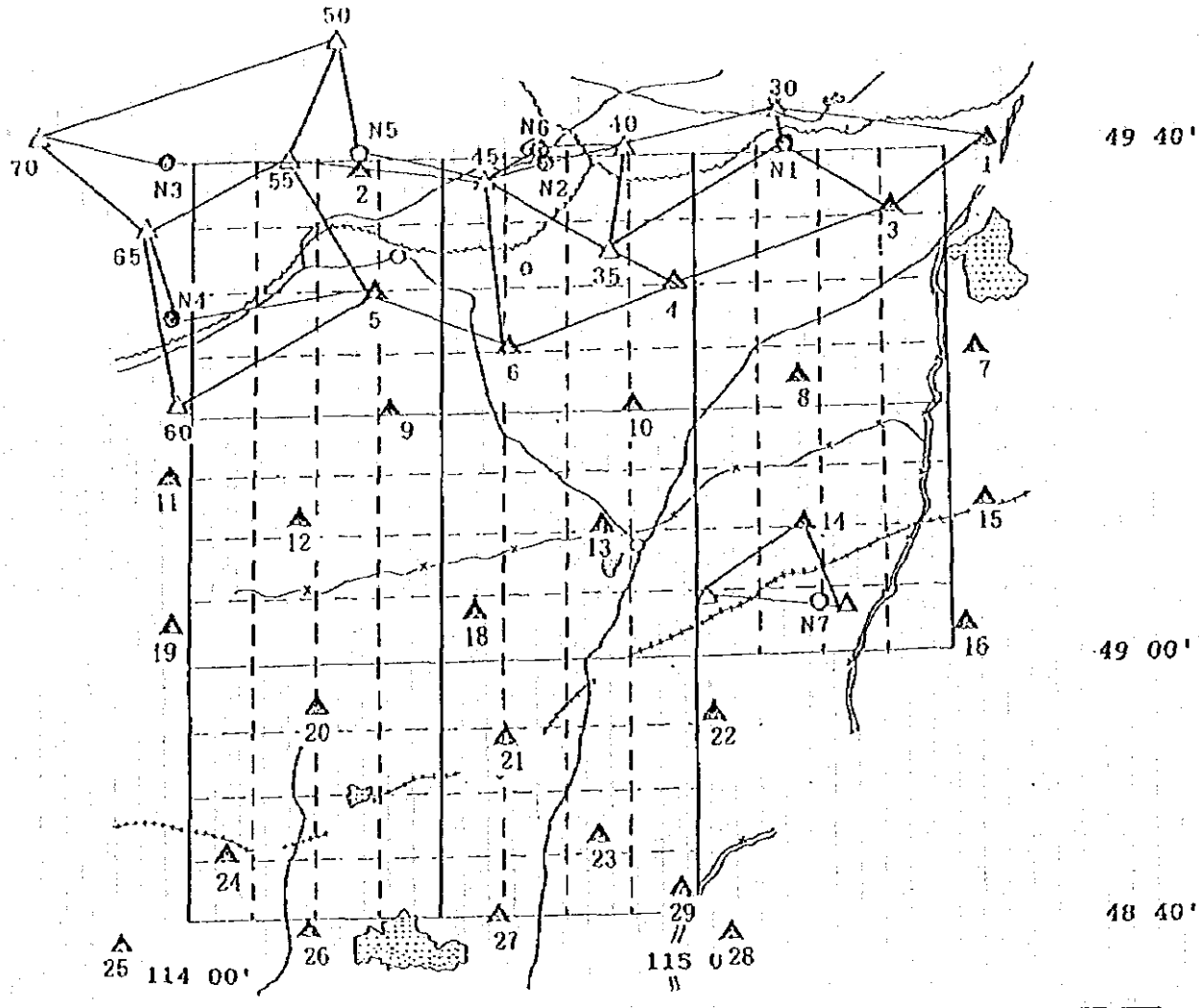
Although N2 is an existing point, it is treated as unknown, because the coordinates are missing. The existing triangulation points TP30~ 75 used only for ground control points survey without signalization.

4) Observation

Setting up four GPS receivers at the same time on the corners of each quadrangle shown in Fig. 8 the observation was made simultaneously. During the observation the signals from 6 to 10 satellites were received The antenna was set directly above the monument on the tripod. When the monument was with the iron signal tower, the antenna was set on it top measuring the eccentricity elements.

Simultaneously observed quadrangles (Fig. 8) and points involved are given in Tab. 2.

Fig. 8 Ground Control Point Survey Network



Legend	
Existing triangulation point	△
Signalized point (Existing)	▲
Signalized point (New)	●
Pricked Point	○

Tab. 2 Quadrangles Observed and Points Involved

Quadrangle	Points involved
A	1, 3. N1, 30
B	3, 4, 35, N1
C	30, N1, 35, 40
D	40, 35, 45, N2
E	4, 6, 45, 35
F	6, 5, 55, 45
G	5, N4, 65, 55
H	5. 60, 65, N4
I	55, 65, 70, N3
J	55, N3, 70, 50
K	45, 55, 50, N5
L	40, N2, 45, N6
M	17, N7, 75, 14

5) Evaluation of the Observed Values

To evaluate the reliability of the GPS survey, following computation were executed, where the distance between two points was regarded as that between the antennas of both ends and no redaction to that between the points was made.

(1) Standard Deviation of a Measurement

Number of sides measured: 78

[number of quadrangles:13 × (number of sides:4 + number of diagonals:2)]

The range of the standard deviation is given in Tab. 3.

Tab. 11 Range of the Standard deviation of the Side Measurement

Item	Range	Mean
Side length	4.0km~ 42.6km	21.0km
Standard Deviation (δ l)	0.4mm~ 15.1mm	2.3mm(0.1ppm)

The coordinates are expressed in the geocentric coordinate system and

$$(\delta\ l)^2 \approx (\delta\ X)^2 + (\delta\ Y)^2 + (\delta\ Z)^2$$

(2) Closure of a Quadrangle

The coordinate differences between neighbouring two vertices computed from a simultaneous observation are not always independent to each other, it may be estimated the reliability of the observation from the coordinate closure of a quadrangle. From the observed 13 quadrangles, the mean ratio of closure vector of each quadrangle to the total lengths of sides comes out 0.24 ppm.

(3) Comparison of the Side Length Observed Independently

Of the sides of quadrangles, there are 20 sides measured twice. The comparison of these sides are given in Tab. 4.

The discrepancy between the values of the measurement 1 and of the 2 was 39 mm in maximum, and its standard deviation was 21 mm (the mean of the absolute values was 1.6 mm).

Tab. 4 Comparison of the Side measured Independently

Side	Measurement 1	2	Difference
3 - N1	18,756.^{m}360	.^{m}353	0.^{m}007
30 - N1	3,947. 353	. 349	0. 004
N1 - 35	27,063. 169	. 140	0. 029
4 - 35	13,299. 394	. 371	0. 023
35 - 40	13,833. 630	. 631	-0. 001
35 - 45	17,421. 769	. 773	-0. 004
6 - 45	23,642. 586	. 615	-0. 029
5 - N4	28,594. 019	3. 980	. 039
N4 - 65	10,782. 689	. 700	-0. 011
65 - 55	25,935. 902	. 921	-0. 019
5 - 55	22,929. 322	. 304	0. 018
55 - N3	14,782. 415	. 410	0. 005
N3 - 70	14,767. 194	. 156	0. 038
45 - 55	30,593. 339	. 353	-0. 014
55 - 50	14,601. 715	. 733	-0. 018
40 - N2	9,354. 267	. 268	-0. 001
45 - N2	10,353. 284	. 298	-0. 014
40 - 45	19,448. 622	. 632	-0. 010
5 - 65	36,401. 336	. 297	0. 039
55 - 70	29,486. 855	. 872	-0. 017
	Mean 18 km	Standard deviation	0. 21 (0.90 ppm)

From the above analysis, it is considered that the accuracy of the length measurement of 10^{-5} specified in the S/W was secured. The evaluation of the

measurement was satisfactory and the measured length was not long (more or less 30 km). Consequently, for the final computation the correction by using two waves was not applied.

(4) Comparison of the Relative Height of a Side

The relative height of two measured points above the reference ellipsoid for two sets of mutually independent measurements is given in Tab. 5.

In the relative height, the maximum discrepancy between the two sets of mutually independent measurements is 47 mm and the standard deviation of the discrepancies is 19 mm. It is considered that it is able to apply the GPS survey for the height measurement in the ground control point survey except the problem arising from the knowledge of the geoid.

7) Adjustment

(1) Coordinate transformation of given points

The elements obtained by GPS survey are the components of the coordinate difference between two points. In order to apply the coordinates of given points expressed in Gauss-Kruegel's plane coordinates as the given elements to the net adjustment, they were transformed into B and L on the Krassovsky's ellipoid and then into the geocentric coordinate system.

(2) Plane coordinates

Zones 19 and 20 were allotted to the study area. The central meridians BO, Lo and scale factors are as follows respectively:

Tab. 5 Comparison of the Relative Height between Two Sets of Measurements

Side	Measurement 1	Measurement 2	Discrepancy (1-2)
3 - N1	-29.m699	.m714	0.m015
30 - N1	-3. 928	. 940	0. 012
N1 - 35	90. 891	. 869	0. 022
4 - 35	-64. 053	. 071	0. 018
35 - 40	22. 816	. 797	0. 019
35 - 45	6. 587	. 580	0. 007
6 - 45	-117. 070	. 053	-0. 017
5 - N4	-23. 358	. 351	-0. 007
N4 - 65	146. 832	. 828	0. 004
65 - 55	-100. 720	. 716	-0. 004
5 - 55	22. 760	. 793	-0. 033
55 - N3	49. 591	. 605	-0. 014
N3 - 70	153. 025	. 011	0. 014
45 - 55	81. 239	. 245	-0. 006
55 - 50	106. 887	. 870	0. 017
40 - N2	-22. 433	. 439	0. 006
45 - N2	6. 982	. 960	0. 022
40 - 45	29. 390	. 418	0. 028
5 - 65	123. 461	. 465	-0. 004
55 - 70	202. 632	. 585	0. 047
		Stadard deviation	0. 019

1. ZONE: 19 B_o = 0° 0′ 0″ , L_o = 111° 0′ 0″ E,
Scale factor: 1.00000000

2. ZONE: 20 B_o = 0° 0′ 0″ , L_o = 117° 0′ 0″ E,
Scale factor: 1.00000000

(3) Execution of the adjustment

The adjustments were executed for a network including 12 quadrangles and a single quadrangle including an unknown point N7 separately.

The 12 quadrangles were to adjust simultaneously. The coordinates of given points and coordinate differences of two points reduced from observation were transformed into the geocentric coordinate system and adjustment computation was executed by the method of the adjustment by coordinates in three dimensions applying a program "PUG-U (Universal Program for Adjustment of Any Geodetic Network)". The points used for the computation are as follows:

Given points: N1, N2, N3, N4, N5, N6
Unknown points: 1, 3, 4, 5, 6, 30, 35, 40, 45, 50, 55, 60, 65, 70.

Figures included in the network automatically recognized from the observed values by the program are as follows:

Kinds	Number
triangle	2
polygon	3
traverse	20
straight line	0.

Observed values are referred to the reference ellipsoid. Of the coordinate components, the vertical component (the height) of the control points from the geoid (the height obtainable by leveling) is known, but the height from the reference ellipsoid are not

obtainable. Consequently, for the adjustment computation, by fixing the horizontal component of the existing triangulation point TP 1 (TSOG OVOO) and the height assuming that its height from the geoid coincides with that from the reference ellipsoid, the free network solution was applied to obtain coordinates of all points. Then regarding the height from the reference ellipsoid thus obtained as given (Tab. 9), they were used for the adjustment.

Quadrangle M including the unknown point N7 was observed independently as a single quadrangle. The adjustment was carried out taking the existing points 14, 17 and 25 as given points. The results of the computation are given in Tabs 6a, 6b, 6c and 7.

(4) Accuracy of the network adjustment

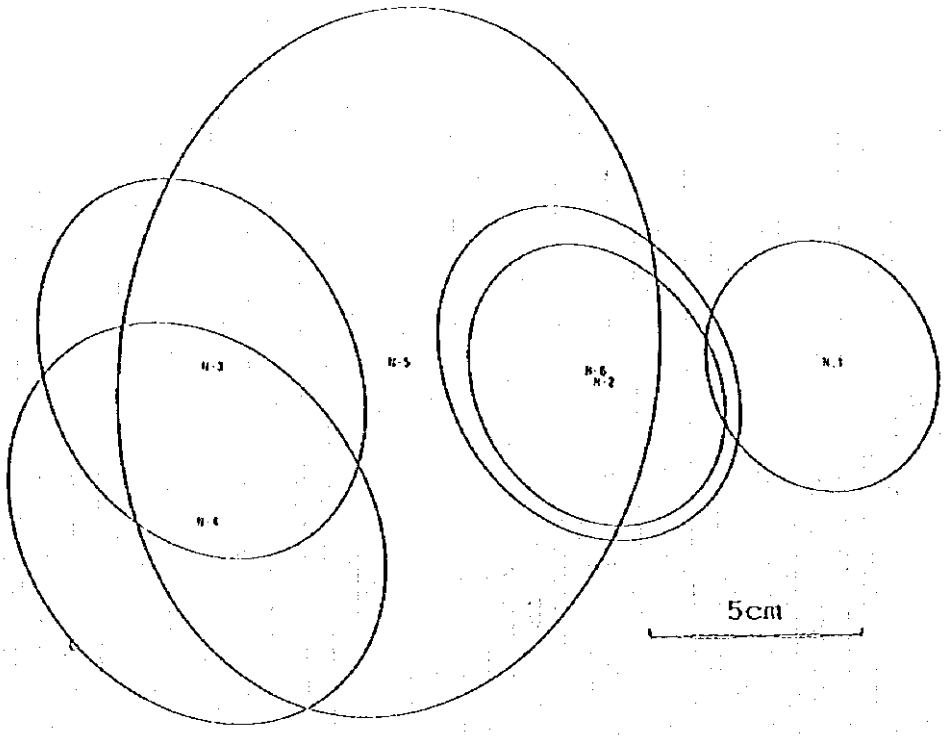
The result of the network adjustment shows the accuracy of the determination of coordinates are as follows:

Maximum correction giving to each component: 616mm
Standard deviation of observation of weight 1: 606mm

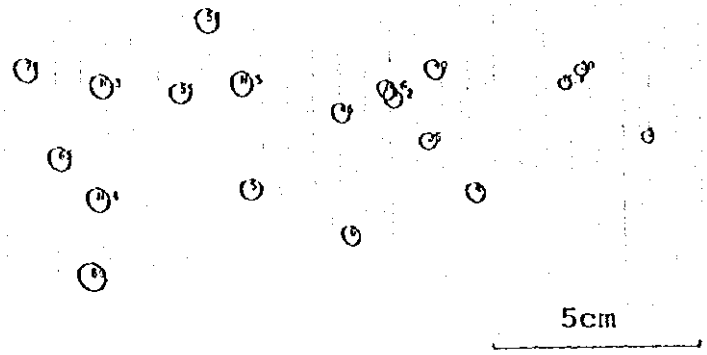
As shown in Fig. 9 (a), the maximum semi major axis of the error ellipse is about 8.3 cm. The results of computation for unknown points N 1 ~ N6 (plane coordinates) and that of N 7 separately computed are given in Tab. 6a.

Points N 3 and N 4 are in the Zone 19 (central meridian 111° E). They are converted into the Zone 20 for the sake of succeeding computation. The coordinates expressed in the Zone 19 are given in Tab. 6b.

Fig. 9 Error Ellipses



(a) All given points fixed



(b) Point 1 fixed

Tab. 6a Coordinates of Unknown Points (Zone 20)

Point	N	SD	E	SD
N1	5,508,100.^{m}433N	0.^{m}054	20,367,316.^{m}784E	0.^{m}051
N2	5,505,895. 578N	0. 062	20,335,875. 119E	0. 057
N3	5,508,631. 891N	0. 084	20,280,898. 369E	0. 072
N4	5,486,814. 666N	0. 090	20,280,243. 494E	0. 083
N5	5,508,927. 977N	0. 157	20,307,059. 125E	0. 120
N6	5,507,461. 842N	0. 074	20,334,752. 879E	0. 066
N7	5,436,822. 948N	0. 092	20,370,214. 300E	0. 069

Point name	Meridian convergence	Scale factor
N 1	-1° 24′ 08.″ 809	1.00021615
N 2	-1 43 59. 710	1.00033073
N 3	-2 18 53. 638	1.00058943
N 4	-2 18 20. 876	1.00059299
N 5	-2 02 20. 830	1.00045708
N 6	-1 44 45. 453	1.00033527
N 7	-1 20 28. 31	1.00020604

Tab. 6b Plane coordinates in Zone 19

Point name	N	E
N 3	5,508,427.598N	19,713,988.119E
N 4	5,486,814.665N	19,715,073.665N

Point name	Meridian convergence	Scale factor
N 3	-2° 15′ 38.″ 97	1.00056224
N 4	-2 15 23. 81	1.00056798

The coordinates of the unknown points on the reference ellipsoid are given in Tab. 6c.

Tab. 6c The Coordinates of the Unknown Points of the Reference Ellipsoid

Point name	Latitude	Longitude
N 1	49° 41′ 24.″ 4147 N	115° 09′ 40.″ 0637 E
N 2	49 39 45. 2571 N	114 43 35. 8585 E
N 3	49 40 10. 9089 N	113 57 52. 4650 E
N 4	49 28 24. 8769 N	113 58 03. 6647 E
N 5	49 40 52. 6288 N	114 19 35. 0889 E
N 6	49 40 34. 8097 N	114 42 37. 5661 E
N 7	49 03 00. 6517 N	115 13 28. 1760 E

8) Determination of the height

The height of a point observed by GPS survey is that from the ellipsoid of Krassovsky through WGS-84. In order to adjust this value to the result obtained by leveling, it is necessary to convert this value to that to be obtained by leveling (the height from the geoid).

For this purpose, assuming that the ellipsoidal surface and geoidal surface are planes in the neighbourhood of the point in consideration, the method of plane interpolation was applied.

Tab. 7 gives the height referred to the ellipsoid, with its standard deviation, and the height referred to the geoid obtained by applying the above mentioned correction to the former. For the adjustment computation, the height is based on that of one point (TP 1) from the geoid. The absolute value of the height from the reference ellipsoid obtained for unknown points is arbitrary or under the assumption that the height from the reference ellipsoid and that from the geoid coincide to each other at TP 1.

Tab. 7 Height of Unknown Points

Point name	Height from the ellipsoid	Standard deviation	Height from the geoid
N 1	682.m983	0.m136	683.m947
N 2	774. 502	0. 153	776. 431
N 3	898. 814	0. 182	902. 261
N 4	803. 231	0. 205	806. 271
N 5	734. 331	0. 301	737. 274
N 6	663. 214	0. 179	665. 187
N 7	755. 844	0. 179	754. 873

From the computation the accuracy of each unknown point for planimetry and total vector is given in Tab. 8 from Tabs 6a and 7.

Tab. 8 Accuracy of Unknown Points

Point name	SD_N	SD_E	SD_P	SD_H	SD_V
N 1	0.^{m}054	0.^{m}051	0.^{m}074	0.^{m}136	0.^{m}155
N 2	0. 062	0. 057	0. 084	0. 153	0. 175
N 3	0. 084	0. 072	0. 110	0. 182	0. 213
N 4	0. 090	0. 083	0. 122	0. 205	0. 239
N 5	0. 157	0. 120	0. 197	0. 301	0. 360
N 6	0. 074	0. 066	0. 099	0. 179	0. 205
N 7	0. 092	0. 069	0. 115	0. 179	0. 213

Note SD_N: Standard deviation on N-axis
SD_E: Standard deviation on E-axis
SD_P: Standard deviation on NE-plane
$(SD_P)^2 = (SD_N)^2 + (SD_E)^2$
SD_H: Standard deviation on H-axis (vertical)
SD_V: Standard deviation as vector
$(SD_V)^2 = (SD_P)^2 + (SD_H)^2$

9) Adjustment by free network solution

The same network was adjusted by free network adjustment fixing one point(TP 1). Figures in the network automatically recognized by the program are as follows:

Figure	Number
Triangle	41
Polygon	0
Traverse	52
Straight line	0

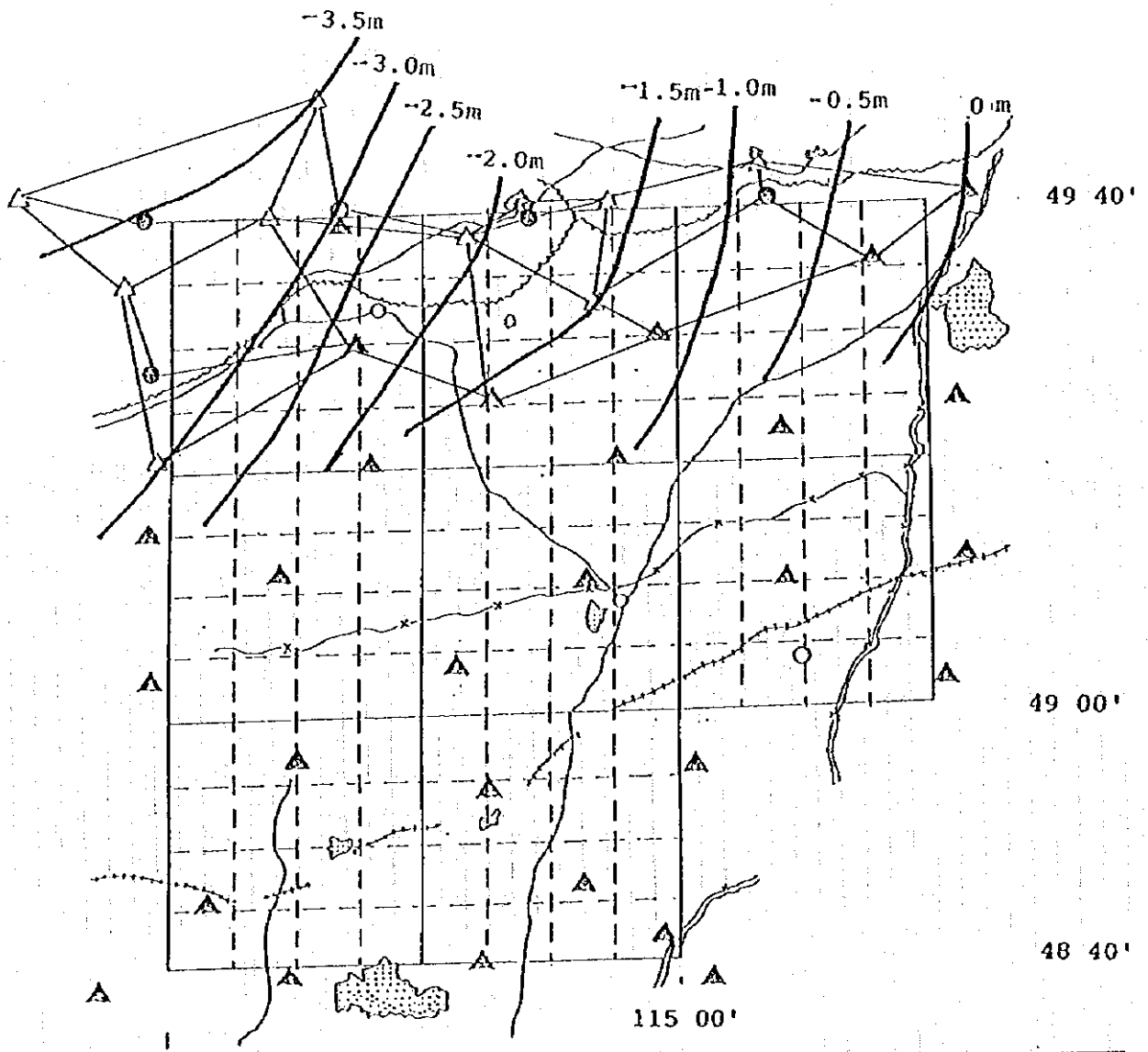
The accuracy of the determination of coordinates after adjustment is as follows:

Maximum correction to apply to each component	41.18	mm
Standard deviation of an observation of weight 1	17.020	mm
Standard deviation of the error ellipse of positioning	6.9	mm

Fig. 9(b) shows the error ellipses of positioning. The height of given control points (the height from the geoid) and that computed by free network adjustment (the height from the ellipsoid) are compared as given in Tab. 9.

The height of TP 1, registered value, is given as the height from the ellipsoid for computation. Assuming that at TP 1 the ellipsoidal and geoidal surfaces coincide to each other, the difference between the two heights is obtained as shown (A - B) in Tab. 9. From these values the inclination of the geoidal surface relative to the ellipsoidal surface shall be traced as shown in Fig.10. It is judged, from the figure, that the geoidal surface inclines to the ellipsoidal surface upwards to east-south-east at the rate of about 4 m/120 km. The inclination is thought relatively uniform which allows the plane interpolation to correct the observed height to convert it to the height from geoid.

Fig. 10 Geoidal Surface
Relative to Ellipsoid



Legend	
Existing triangulation point	△
Signalized point (Existing)	▲
Signalized point (New)	●
Pricked Point	○

Tab. 9 Comparison of Height

Point name	Height from the ellipsoid(A)	Standard deviation	Height from the geoid(B)	A - B
1	701.m400	----	701.m400	0.m
3	712. 649	0.m008	713. 000	-0. 351
4	838. 195	0. 011	839. 500	-1. 305
5	826. 352	0. 012	828. 700	-2. 348
6	884. 855	0. 012	886. 100	-1. 245
30	686. 875	0. 008	687. 800	-0. 925
35	774. 131	0. 010	775. 800	-1. 669
40	796. 827	0. 011	798. 500	-1. 673
45	767. 628	0. 011	769. 900	-2. 272
50	955. 833	0. 013	959, 300	-3. 467
55	849. 103	0. 012	852. 300	-3. 194
60	963. 795	0. 015	966. 800	-3. 005
65	950. 105	0. 013	953. 100	-2. 995
70	1,051. 930	0. 013	1,055. 700	-3. 770

3-5 Aerial Triangulation

3-5-1 Outline

In aerial triangulation, were determined the geodetic coordinates and height of the points (pass points and tie points) and other elements of the dia-posiative of the aerial photograph necessary for its control for stereo plotting. The procedure is as follows:

On the dia-positive of the aerial photograph at a scale of 1:50,000, pass points and tie points are pricked or control points pricked on the contact prints or the twice enlargement of aerial photographs are transferred and, together with the already photographed aerial signals, their photographic coordinates are measured with the precision comparator (stereo comparator). Using the observed values and coordinates and heights of given points, the aerial triangulation is executed analytically by block adjustment by means of the independent model method to arrive at the geodetic coordinates and heights of pass points and tie points. At the same time, the orientation element against the stereo plotter are also computed.

3-5-2 Work Volume and specifications

Area covered:	the whole study area (about 10,800 km²)
Photo scale:	1:50,000
Flight height:	5,300 m (above the sea level) 4,500 m (above the datum plane)
No. of courses:	20(actually, courses C8, C10, C11, C12 and C13 were divided into two courses, respectively)
No. of models:	378 models
Control points:	35 points (for both planimetry and height)
Adjustment:	Block adjustment by independent models (Program PAT-M43 is used.

3-5-3 Accuracy

At the adjustment computation, the class A of the JICA's specifications was observed for the tolerance of the residuals of control points used and of the discrepancy of pass points between adjacent models and that of tie points between adjacent courses as follows:

Residual of control points: not more than 1.4 ‰ (6.3 m) of the flight height for both planimetry and height.

Discrepancy of pass points and tie points: not more than 0.8 ‰ (3.6 m) of the flight height for both planimetry and height.

The result of the computation turned out that the standard deviation of the residuals and discrepancy were not more than 0.38 m (0,08 ‰) and the maximum was not more than 1.01 m (0.24 ‰), which was smaller than the tolerance specified by JICA.

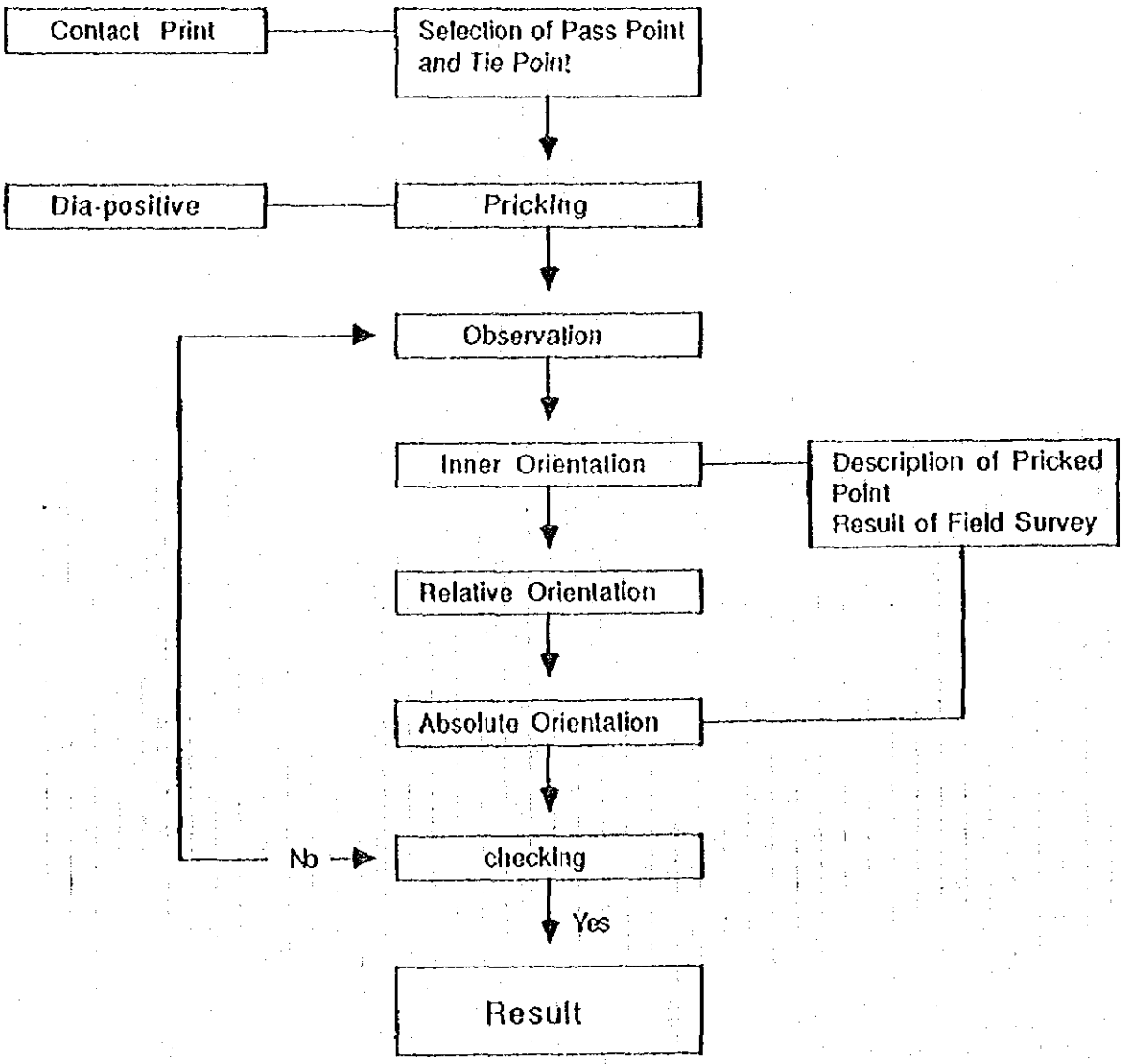
3-5-6 Execution

The procedures are shown in Fig. 11.

1) Selection and transfer of points

Pass points and tie points were selected by choosing points clearly identifiable and measurable on the contact print of the aerial photograph in accordance with the standards of point selection of the JICA's manual. Taking the computation of the block adjustment into

Fig. 11 Flow of Aerial Triangulation



consideration, were selected six pass points per model and one points per model at the overlapping zone with the model of the adjacent course.

The transfer of the control points pricked in the field onto the diapositive was done by using stereoscopic point transfer machine in reference to the materials such as pricked photographs, description of pricked points, etc.

2) Measurement of photographic coordinates

The measurement of the photographic coordinates of fiducial marks, pass points and tie points was made to the figure of μ using the stereo comparator. The measurement was made twice independently and the their mean was adopted as the observed value. If the discrepancy between the two measurements exceeds 0.02 mm, one more measurement was made and the mean of the three observed values was adopted.

3) Inner orientation

The observed values of the fiducial marks at the four corners were transformed to the coordinates of the coordinate system with the origin at the projection center of the camera. They were normalized by Helmert's transformation with the calibrated values. Using the coefficients thus obtained, all observed values were normalized.

The standard deviation and the maximum of the residuals are as follows:

Standard deviation	Maximum	Tolerance
6.0 μ ~ 20.9 μ	29 μ	30 μ in maximum

4) Relative orientation

The relative orientation was executed using all points included in a model. The correction due to atmospheric refraction was applied.

5) Adjustment computation, residuals and discrepancies

The adjustment computation was made by treating the whole Study area as one block by applying the method of independent models. PAT--M43 program was used.

The standard deviation and maximum of the residual of control points and discrepancies of pass points and tie points are given as follows:

(1) Residual of control points

No. of courses & models	No. of control points	Residual			
		(planimetry)		(height)	
		SD	Max.	SD	Max.
20 courses 378 models	35 points	0.38 m 0.08 ‰	0.76 m 0.17 ‰	0.09 m 0.02 ‰	0.29 m 0.06 ‰

Specified tolerance of the residuals of control points:

not more than 1.4 ‰ (6.3 m) of the flight height for both planimetry and height.

(2) Discrepancy of pass points and tie points

Discrepancy(Planimetry)		Discrepancy(Height)	
Standard deviation	Maximum	Standard deviation	Maximum
0.38 m 0.08 ‰	1.01 m 0.22 ‰	0.16 m 0.04 ‰	0.87 m 0.19 ‰

Specified tolerance of the discrepancies of pass points and tie points:

not more than 0.8 ‰ of the flight height for both planimetry and height.

As shown in the above tables, the accuracy of the aerial triangulaton turned out considerably lower than the tolerance designated by the specifications.

3-6 Conventional Signs and their Application Rule

On the basis of the existing conventional signs, both parties made discussions on conventional signs and their application rule from time to time in reference to the Russian text

УСЛОВНЫЕ ЗНАКИ,
для топографических карт
масштабов
1:25 000, 1:50 000, 1:100 000

in order to apply them to the Study and drew up a draft of the conventional signs and their application rule specifically to the topographic mapping of Ulaan-Tsav area. They are attached to the present report as the "Appendix 8".

3-7 Stereo Plotting

3-7-1 Outline

The manuscripts of plotting were drawn up measuring and plotting the necessary items to represent on the topographic map by means of stereo plotters using aerial photographs on the basis of the result of the aerial triangulation. The aerial photographs, however, having not been identified in the field in advance, it was necessary to pre-study the aerial photographs by photo-interpretation in reference to the documents in hand and to adjust doubtful points.

The area to cover is about 10,800 km² by 128 sheets, neat lines of each being 5.0′ in latitude and 7.5′ in longitude.

The work was completed in two phases of II and III). The area of about 8,100 km² north of latitude 49° was covered by 96 sheets in Phase II. The rest part of about 2,700 km² was completed by 32 sheets in Phase III.

The flow chart of the stereo plotting is shown in Fig. 12. Of the processes, the application of the results of the field identification made to all manuscripts of plotting after the field identification.

3-7-2 Specifications

Plotting scale:	1:25,000
Area to cover:	10,800 km²
Number of sheets:	128 sheets
Projection:	Gauss-Krueger's Projection Zone 20 (the scale factor along the central meridian 117° E shall be 1)
Contour lines:	Intermediate contours - 10 m index contours - 50 m intercalary contours - 5 m (depending upon topography)
Neat lines:	5′ (latitude) × 7.5′ (longitude)
Sheet number:	As shown in Fig. 13 where M-50 Zone number M-50-86 sheet number of 1,00,000 map M-50-97-B sheet number of 50,000 map M-50-97-Γ-a sheet number of 25,000 map
Conventional signs and their application rule:	Those discussed and approved by MSAGC
Accuracy of the Map:	to observe the class "A" of the JICA's Specifications

Fig. 12 Flow of Stereo Plotting

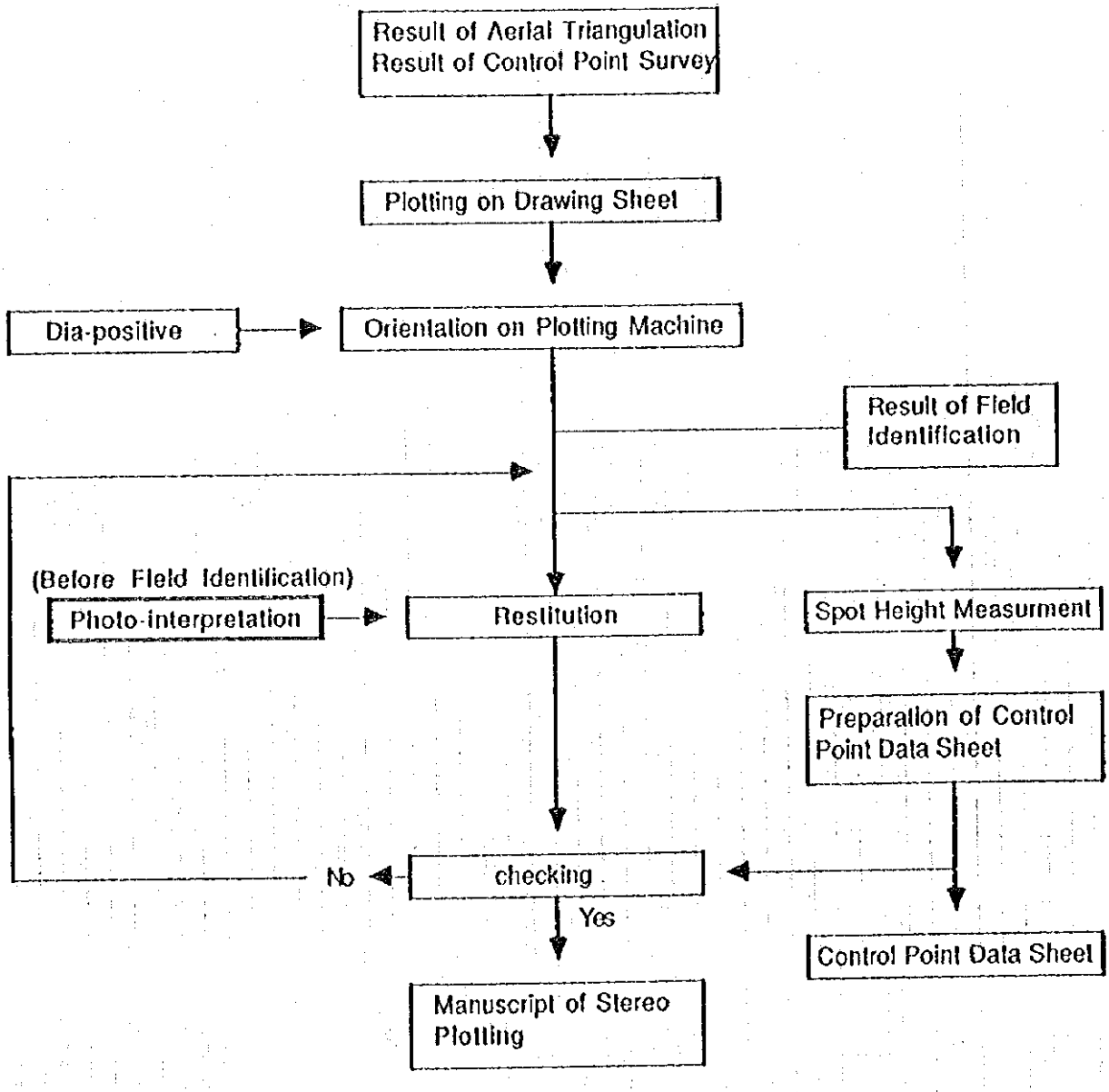
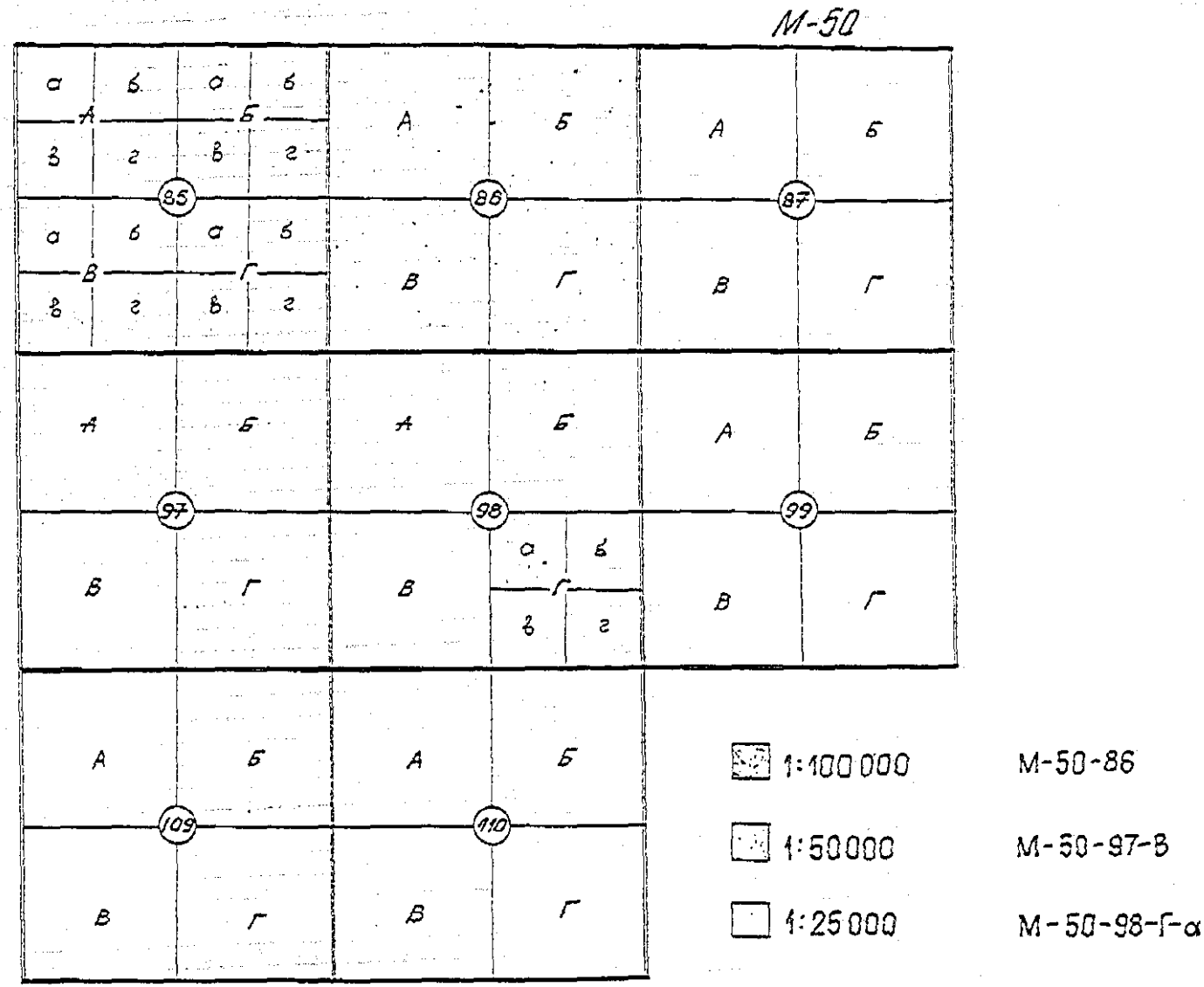


Fig. 13 Sheet Numbering



Distinct ground objects:	not more than 0.5 mm on the map
Spot height:	not more than 1/3 of the contour interval
Contour line:	not more than 1/2 of the contour interval
Plotting sheet:	polyester sheet # 500 (for manuscripts of plotting)
	# 300 (for data sheets of control point and manuscript of data sheets of annotation)
Reticule:	Drawing accuracy shall be better than 0.15 mm on the map. Tick of Grauss-Krueger's projection shall be drawn every 2 km.
Graticule:	Graticules shall be drawn every 5′ .

3-7-3 Plotting of Ground Control Points and Others

Neat lines, ticks of reticules, graticules, ground control points, pass points and tie points, etc. were plotted on the plotting sheet by coordinategraph. The plotting error was specified not to exceed 0,15 mm on the map.

3-7-4 Orientation

1) Relative Orientation

Six pass points were used for relative orientation. The residual y-parallax was not to exceed 0.02 mm on the contact positive film.

2) Absolute Orientation

The absolute orientation was carried out by using the results of pass points and tie points, geodetic control points, other ground control points and their pricked points.

3-7-5 Photo-interpretation

The stereo plotting was done before the field identification of aerial photographs. For this reason, the identification of photo images had to be done in reference to the terrestrial photographs taken, observations at the time of the field survey in Phase I, other materials in hand,etc.

On the basis of these documents the photo-interpretation was executed carefully on the twice enlargement of photographs with the effort to reduce doubtful points as much as possible.

Especially, as was requested a detailed representation of installation relative to stock raising, such as pen, ger, their traces, wells, sources, thorough attention was payed on their photo-interpretation.

3-7-6 Execution

1) Standards of Plotting

On the basis of the conventional signs and their application rule for drafting discussed with MSAGC and agreed upon by both parties.

The Team drew up an instruction on the conventional signs and their application rule for plotting, definite method of plotting, management of tying sheets and explained them to operators in order not to cause lack of uniformity among the operators.

The revision was made of the manuscript of plotting resulting from the amendments or additions following the discussions with MSAGC at the time of field operations in Phases III & IV after coming back to Japan

2) Order of Plotting

The plotting was carried out in the order of roads, rivers, railways and other linear objects, buildings, vegetation, contour lines.

3) Plotting Sheet

Polyester sheets were used for plotting.

a.Manuscript of plotting (#500):
Topography, ground features, and contour lines were drawn up.

b.Data sheet of control points(#300):
Geodetic points, ground control points, spot heights and bench marks were drawn up.

c.Manuscript of data sheet of annotation(#300):
Various kinds of annotation were represented.

4) Colour Allotment

Colours were allotted according to the application rule of conventional signs. The principal ones are as follows:

Black: artificial objects (two line roads, railways, buildings, other linear objects), vegetation signs, index contours, geodetic points, fill and cutoff (rock), isolated rocks, etc.

Orange: intermediate contours, intercalary contours

Red: unpaved roads, footpaths, indicating points, enclosures, small objects, revetment, cliffs, pens, cemeteries, isolated trees, etc.

Green: vegetation, boundary of vegetation, mines (open), aquatic plants, indefinite shore lines, fences, cliffs (soil), sandy places, etc.

Brown: dikes (soil), fill and cutoff (soil), etc.

Blue: objects relative to water (definite shore lines, rivers, lakes, etc.)

5) Restitution

(1) Roads

a. There were no paved roads in the study area except in one town (М а р д й).

b. Classification of the maintenance condition of unpaved roads was difficult by photo-intepretation. All unpaved roads were represented by black single solid line and the classification was done after the field identification.

c. Roads in forests and plains were regarded as roads passable one way or another by vehicles and represented by single red solid line.

d. Footpaths and lanes were regarded unpassable by vehicles and passable only by men and horses. They were drawn by red broken lines.

e. Roads without maintenance were not classified by the breadth. They were classified by the degree of utilization.

f. The Chigiskhan's road was represented by green solid lines and ticks in black.

(2) Hydrography

a. Shore lines were to represent as seen on the aerial photograph. Rivers were represented those longer than 10.0 mm and brooder than 1.0 mm on the map.

b. Lakes and ponds larger than about 1.0 mm × 1.0 mm on the map were represented.

c. The boundary of swamps (wadable or not) were enclosed by blue broken lines and the inside was shown by the symbol of the swamp. The classification of the wadability was studied at the time of the field identification.

d. Wells, sources, reservoirs, etc. were photo-interpreted as much as possible.

(3) Constructions

a. Distinction between general constructions (buildings, pens) and ger was clarified.

b. Even when pens and gers were missing, they were represented on the map as much as possible by photo-interpreting their traces.

(4) Vegetation

a. The boundary of vegetation (including that between uncultivated lands) is understood as to apply to the boundaries between different vegetation and distinct boundaries. Those capable of showing by range were represented as much as possible.

(5) Contour lines

a. Deformed land was drawn by contour lines as much as possible. However, in cases, the conventional sign of deformed land was used.

b. In order to prevent the omission of contour lines, the height of mountain summit, depression, mountain pass, etc. was measured and entered into the manuscript of plotting, when necessary.

c. The relative height of topography and ground features necessary to represent on the map, such as of depression, small hill, gully, soil, cliff, isolated rock, giant rock, open mine, etc., was entered into the manuscript of plotting.

(6) Data sheet of control points

a. The density of spot heights was 1 point per 2 km^2 as standard.

b. The spot height was read twice and the mean value was entered into the sheet with black ink for the ground and with blue ink for the water surface, such as of rivers, lakes, ponds, etc.

c. Ground control points, including bench marks, were shown by the conventional signs, as well as their name, number and height.

(7) Manuscript of data sheet of annotation

Using copies of the manuscripts of plotting brought with the Team, the manuscripts of data sheets of annotation was worked out for all map sheets compiling annotation data, such as place name, geographical name collected in the field. (Appendix 9)

Some of the annotations are shown on the map by abbreviating as given in Appendix 10.

(8) Abstraction of doubtful points

Items found doubtful in the stereo plotting were adjusted on an overlay (polyester sheet # 150) as one of the items to confirm at the time of the field identification.

6) Revision by the Results of the Field Identification

The amendment of the manuscript of plotting resulting from the change and addition of the conventional signs and their application rule at the time of the field operation of Phase III, as well as the revision and/or re-restitution resulting from the findings obtained in the field, were executed after the completion of the field operations as shown in the flow chart of stereo plotting in Fig. 12 and checking was repeated.

3-7-7 Checking

After finishing the stereo plotting, the checking was made on the manuscript of plotting with aerial photographs and collected materials. The omission, errors, etc. were checked and corrected.

3-7-8 Accuracy control

A list of accuracy control was prepared for all map sheets and data sheets.

3-7-9 Results and Documents

Results and documents of the stereo plotting are as follows:

1. Manuscripts of stereo plotting
2. Data sheets
    a. Control point data sheets
    b. Manuscripts of annotation data sheets
3. Records of orientation
4. A List of accuracy control

3-8 Field Identification

3-8-1 Outline

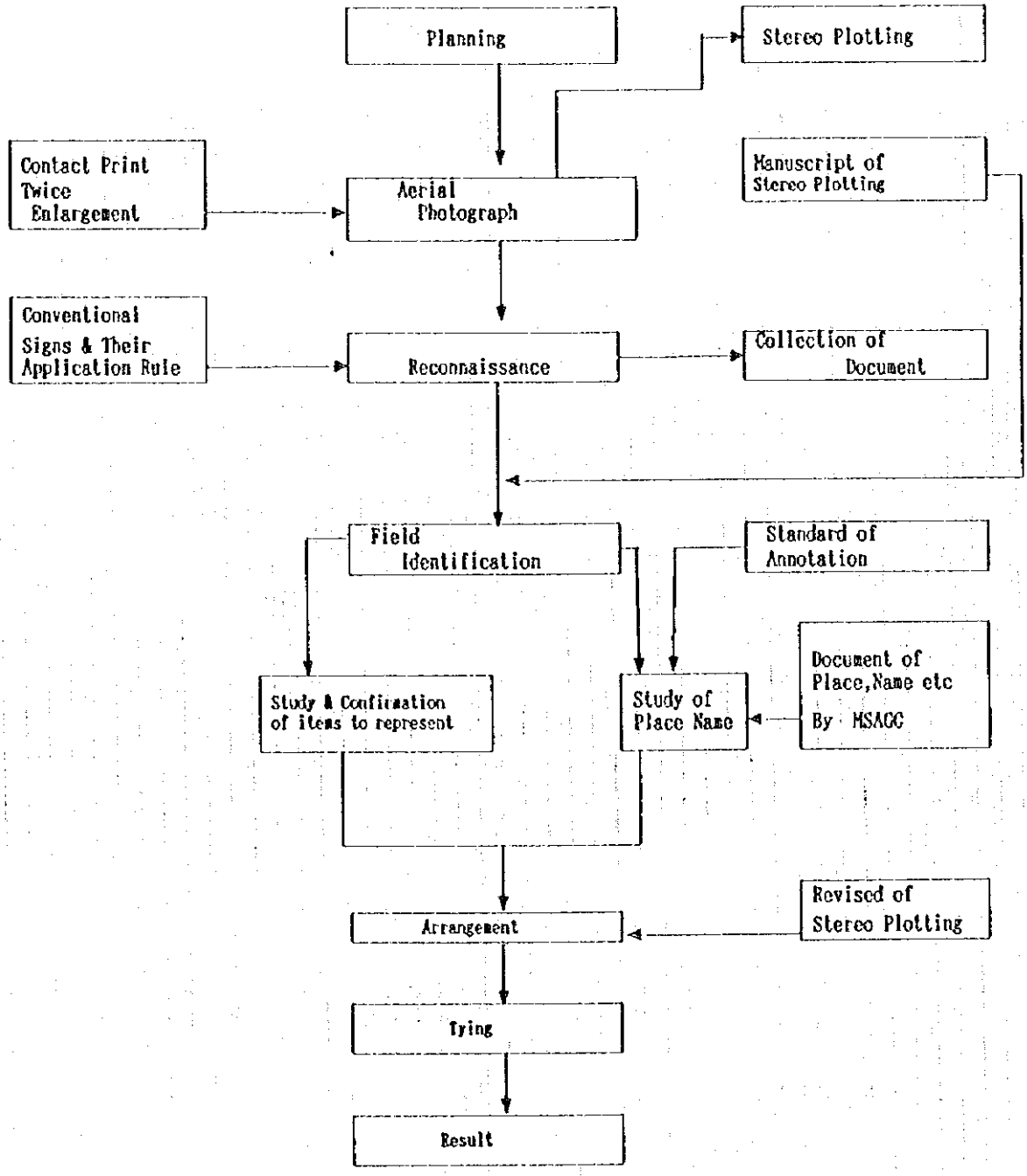
Roads, buildings, land use, topography, etc. to represent on the map were identified on the aerial photographs in reference to those in the field (preparation of the key for photo-interpretation), as well as place name, name of public buildings, etc. were also investigated on the basis of conventional signs and their application rule. Findings were inscribed on the aerial photographs or overlays to prepare documents necessary for succeeding processes of the revision of manuscripts of plotting and compilation. The area to study covered the entire area of the proposed mapping. The study flow of the field identification is shown in Fig. 14.

3-8-2 Planning and Preparations for the Field Identification

1) Planning

The chief engineer and engineers in charge of the field identification drew up a detailed plan on the procedures in the field identification, as well as made preparations so as to promote the smooth progress of the field survey.

Fig. 14 Flow of Field Identification



2) Preparations of documents and information

Following necessary pre-arrangements were made.

a. Duplication of manuscripts of plotting,
b. Inscription of study boundaries on each aerial photograph,
c. Arrangements of the results of the reconnaissance study of aerial photographs,
e. Arrangement and confirmation of the points difficult to restitute by photo-interpretation,
f. The preparation of a list of items to ask for to the Mongolian governmental agencies,
g. Study of the draft of conventional signs and rules of their application and of lettering to be used.

3-8-3 Execution

1) Items of field identification

In accordance with conventional signs and their application rule, the following were studied and confirmed in the field:.

a. Confirmation of the results of reconnaissance study and important items to represent,
b. Collection and confirmation of the key of photo-interpretation,
c. Study and confirmation of items difficult to photo-interpret and/or restitute, especially of pens, sources, etc.,
d. Collection and confirmation of place name, name of ground features, administrative name, etc., and annotation of the destination of roads, railways, etc.,
e. Study of designated boundaries (a part),
f. Collection and confirmation of documents relative to items to represent on the map,

g.Pricking and/or positioning of existing bench marks by portable GPS instruments.

3) Field Operation

(1) Aerial photograph

The twice enlargement of aerial photographs were used as follows:

a.Findings were inscribed on the odd number of the aerial photographs on the spot by blue and red pencils according to the specifications.

b.Were identified small ground features difficult or impossible to represent on the map by photo-interpretation such as wells, sources, isolated trees, small constructions, communication and power lines with wooden pillars.

(2) Coloured copy of the manuscript of plotting

Coloured copies of the manuscript of plotting were used as follows:

a.Confirmation of topography,

b.Confirmation of vegetation and its boundaries.

(3) Others

a.Positioning was made by portable GPS receivers of some of small ground features impossible to photo-interpret and not represented on the manuscript of plotting such as small wells, communication and power lines with wooden pillars, sources and confirmation of bench marks having the coordinates in terms of hundred meters.

b.Measurement of the water level of wells with tape.

(4) Studies chiefly executed by counterparts

Studies chiefly executed by counterparts were as follows:

a. Collection and confirmation of toponym and name of ground features,
b. Classification of roads and vegetation,
c. Decision of adoption of constructions, gers, pens, and their traces,
d. Wadability of swamps,
e. Classification of fresh water swamp and salt water swamp,
f. Titling of each map sheet and annotation of destination of roads and railways,
g. Inscription of administrative name and boundaries on the manuscript of plotting,
h. Study of pumping up of water of well by existing documents.

4) Arrangement of Findings in the Field

Findings in the field were arranged on coloured copies of the manuscript of plotting on the spot.

They include place name, area name, administrative name and boundary, name of ground feature, destination, as well as sheet number and name.

5) Administrative Boundaries

Administrative boundaries of aymag and sum were to be represented. They were inscribed on the copy of the manuscript of plotting by MSAGC.

3-8-4 Arrangement of data for annotation

Place name and other data for annotation were collected and plotted on polyester base in reference to the manuscript of plotting in preparation for the manuscript of the data sheet of annotation. (Appendix 9)

3-8-5 Tying

Care was taken not to miss items to study in the study area. Especially checking was made not to miss items at the edge of a photograph and keep tying between adjacent photographs. Tying was also checked between adjacent manuscripts of plotting.

3-8-6 Arrangement

Results of the field identification arranged were and compiled on aerial photographs or overlays. Using the results, manuscripts of plotting were revised for the sake of the compilation.

3-8-7 Accuracy Control

The following were studied and took note on the list of accuracy control.

a. Checking of blank space in the study area,
b. Checking of missing of items to study and fitness of arrangement,
c. Fitness of representation of annotations,
d. Fitness of tying between adjacent photographs and between manuscripts of plotting,
e. Discrepancy between the results of the survey and collected documents.

3-8-8 Results and Documents

By the field identification, following results and documents were obtained:

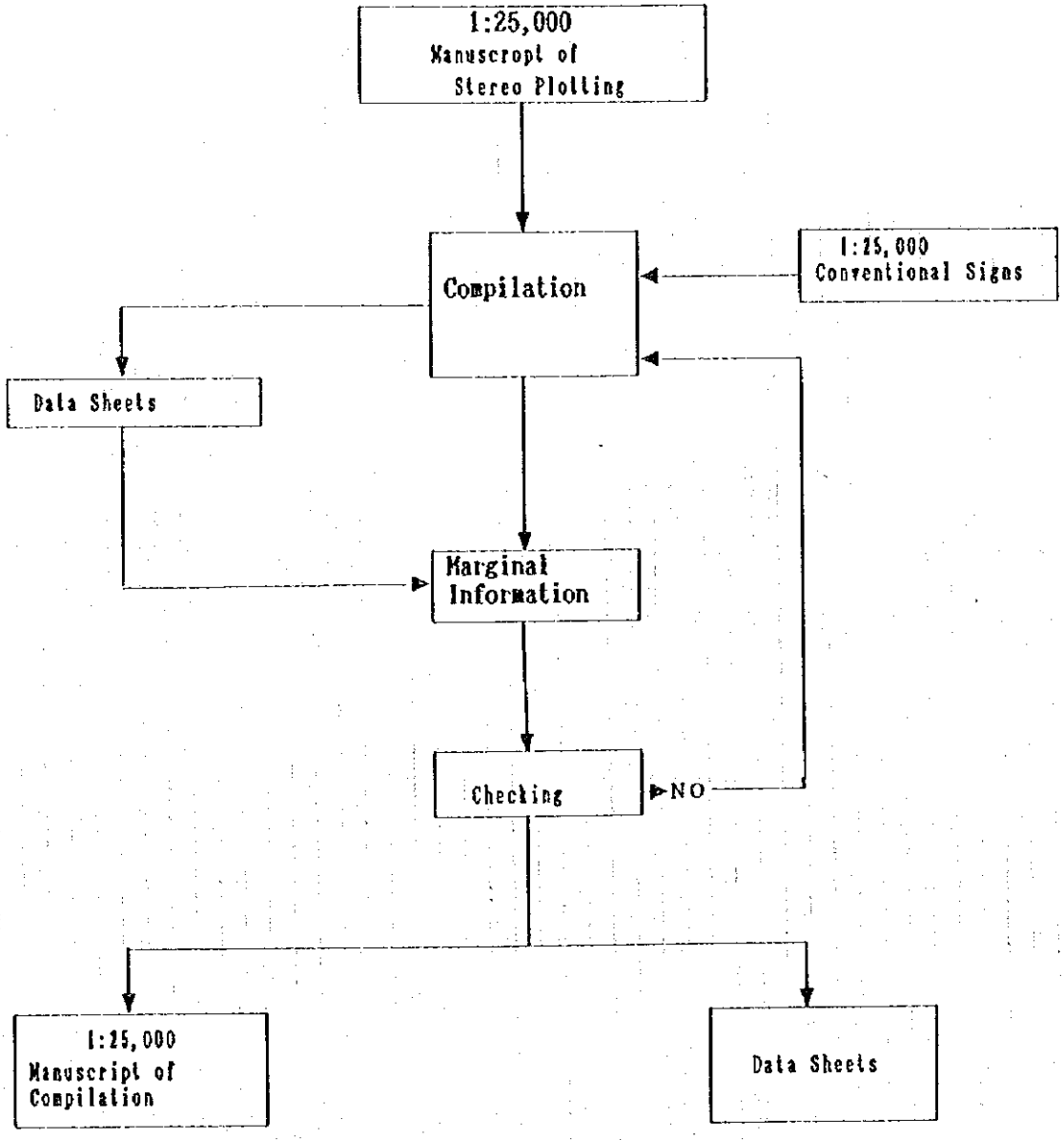
a. Aerial photographs used for the field identification with assorted overlays,
b. Copies of manuscripts of plotting used for the field identification,
c. Manuscripts of annotation data sheet,
d. List of the Accuracy control.

3-9 Compilation

3-9-1 Outline

The manuscript of plotting depicts the ground features and topography precisely from aerial photographs. To be ready for the original for publication (the drafted original) as the 1/25,000 topographic map, it is necessary to modify it by symbolizing, generalizing or omitting some of its contents to fit for the scale of publication. In some cases, displacement is necessary in accordance with the conventional signs and their application rule. Applying these procedures, the manuscript of compilation shall be prepared by arranging it as the prototype of a printed map. At the same time, various kinds of data sheets shall also be prepared for the sake of the succeeding process (drafting). The work area is approximately 10,800 km² of the whole proposed area of mapping. The number of map sheets were 128 by the specified format for each sheet. (See the map index in Fig. 1.) The flow of compilation is shown in Fig. 15.

Fig. 15 Flow of Compilation



3-9-2 Specifications

The specifications of the compilation are as follows:

a.Scale :1/25,000,
b.Area :approximately 10,800 km² (128 sheets),
c.Projection :Gauss-Krueger's projection (The scale factor along the central meridian 117° E shall be 1),
d.Neat lines :5′ in latitude and 7.5′ in longitude,
e.Allocation :as shown in Fig. 3,
f.Conventional signs and their application rule,
:Based on the discussions with MSAGC,
g.Accuracy :Class "A" of the JICA's specifications.

3-9-3 Volume of the Study

Manuscript of compilation :128 sheets,
Data sheets (annotation, marginal information, road, vegetation and hydrography)
:128 sheets each.

3-9-4 Sheet to be Used

Synthesized polyester sheet with small expansion and contraction was used.

3-9-5 Plotting on the Sheet

Neat lines shall be plotted on the sheet of the manuscript of compilation and of data sheets by an manuscript of compilation, control points, grid lines and ticks and points

of latitude and longitude lines were plotted. The plotting error against the specified position was not to be more than 0.2 mm on the map. The plotting errors of neat lines and of diagonals were not to be more than 0.3 mm and 0.4 mm on the map, respectively.

3-9-6 Implementation

Overlay method was applied for compilation in principle: putting a sheet of compilation over the manuscript of plotting, planimetry and topography were compiled on the same sheet in reference to the manuscript of plotting.

1) Manuscript of Compilation

The following is main details of compilation work:

(1) Roads broader than the conventional sign on the map were represented in real scale. The name and the number of roads, when applicable, were inscribed. In agglomeration, however, roads were represented in real scale. However, the minimum breadth was taken as 0.25 mm on the map.

(2) Railways were represented by the center line with conventional signs for both single and double tracks.

(3) Small buildings or houses represented by the conventional sign of spot type and small independent constructions were selected so that they may match the view of the topography and villages.

(4) When buildings were congested, for example, in agglomerations, they were generalized.

(5) In mountainous areas when contour lines are congested, it was necessary to try to represent the view as much as possible by omitting contour lines in compliance with the application rule of conventional signs or replacing them with the conventional sign of a cliff.

(6) When doubtful points arose while compilation, they were recorded on an overlay in order to give instruction to study at the time of the field completion.

2) Data sheets

At the time of compilation, several kinds of data sheets were prepared showing clearly items to represent on the map classifying them item by item in order not to raise questionable points while drafting by cartographers.

(1) Annotation data sheet

On the basis of the manuscript of annotation data sheet, annotation data sheets were worked out.

a. Geographical names and designation of ground features were inscribed. Administrative names shall be studied again in the field at the time of the field completion and if any change, error, and/or omission are found, they shall be inscribed later.

b. Style, size, interval, allocation, etc. of letters were fixed after discussion with MSAGC.

(2) Road data sheet

Administrative classification (representation of national roads by symbols), breadth and condition of pavement of roads were represented.

(3) Vegetation data sheet

For the sake of preparation of mask sheets for vegetation in drafting process, the range covered and the species were shown.

(4) Hydrography data sheet

Objects related to hydrography, such as rivers, lakes, etc. were shown.

(5) Marginal information data sheet

Of marginal informations, items common to all sheets were inscribed on one of the marginal information sheets at first. The duplicates of this sheet were prepared to serve as the base sheet for marginal information sheets of other sheets of maps. Items different for each map sheet were inscribed on the marginal information sheet for all map sheets: for example, sheet name, sheet number, index map in reference to neighbouring map sheets, etc.

(6) Control point data sheet

Of spot heights on the control point data sheets drawn up by the stereo plotting machine, those which were not adopted were crossed out.

3) Tying

A map sheet was tied to neighbouring sheets.

4) Checking

After finishing compilation work, checking was made to find out errors or omissions in representation by comparing manuscripts of compilation with field identified aerial photographs and to confirm the conformity of contour lines with control points, spot heights, map specifications, etc. At the same time, questionable points were picked up and recorded on overlays to give instruction to confirm in the field at the time of the field completion.

3-9-7 Accuracy control

A list of accuracy control was prepared for all sheets.

3-9-8 Results and Documents

The products of the compilation process are as follows:

a. Manuscripts of compilation
b. Data sheets: annotation, road, vegetation, hydrography, marginal information, control point.

3-10 Field Completion

3-10-1 Outline

Taking coloured copies of manuscripts of compilation, items represented on map sheets were compared with the field. The discrepancy owing to the secular change or misunderstanding in map compilation, if any, were studied to obtain data to revise the manuscripts of compilation to complete them as the original manuscripts of the map by the following studies in the field:

a. To check the represented items by reconnaissance survey of the field,
b. To confirm in the field doubtful or not clear points appeared while compilation extracted them in advance,
c. To confirm and collect supplementary place name doubtful at the time of reconnaissance survey,
d. To check and confirm administrative name and boundaries in collaboration with MSAGC,
e. To study wells not clear on the aerial photograph,
f. To study secular change after aerial photography and its supplementary survey, when necessary,

In the field, the field confirmation was done of topography, ground features, place name, etc., supplementary collection of place name and confirmation of administrative name and boundaries, etc. at administrative agencies, as well as confirmation and clarification of doubtful points appeared in plotting and compilation. The investigation of the secular change after the aerial photography was also done.

Results of the study were arranged on aerial photographs, their overlays and coloured copy of composites of manuscripts of compilation and annotation data sheets.

The study flow of field completion is given in Fig. 16.

3-10-2 Execution

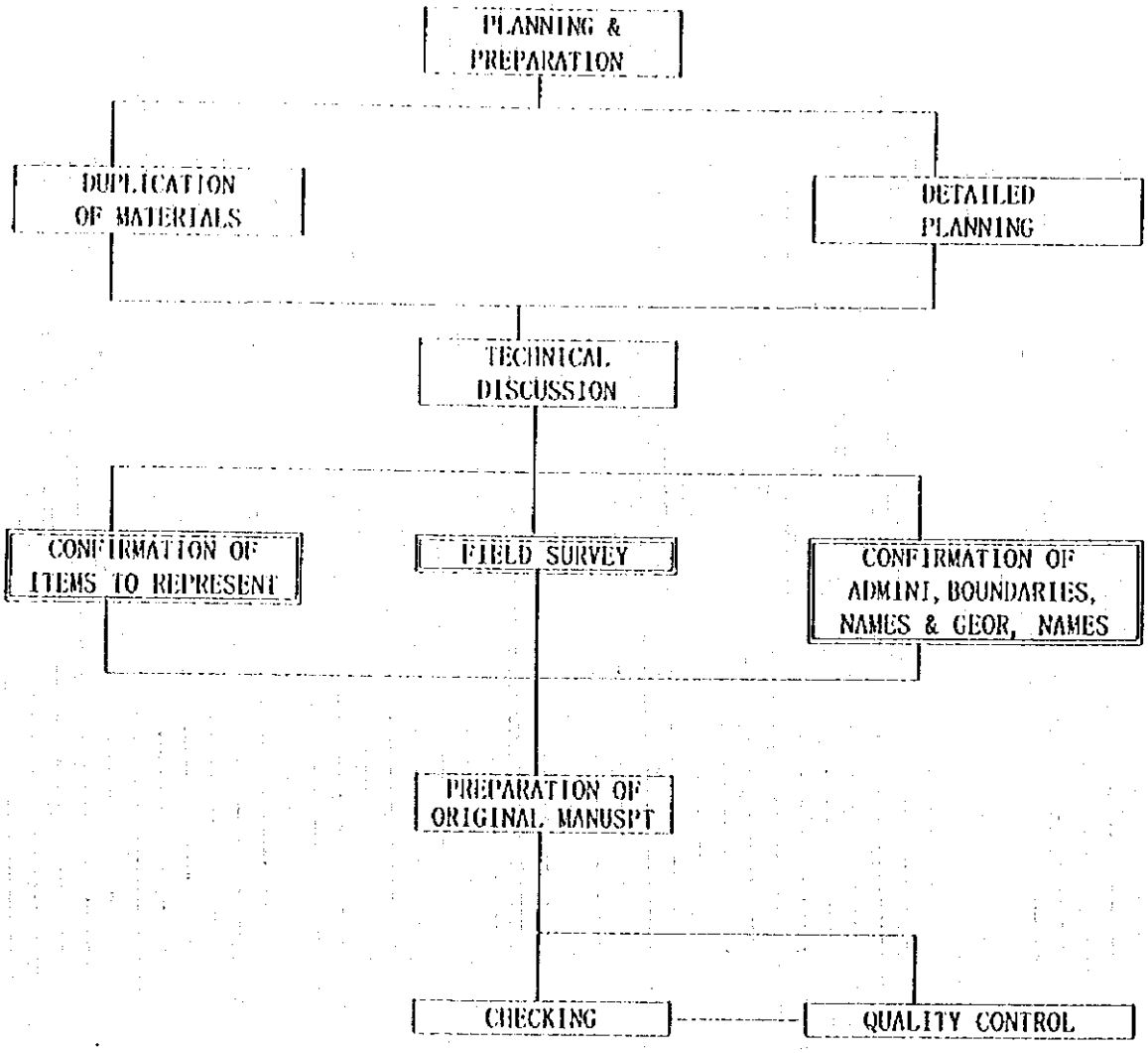
1) Outline

This process deals with checking and confirmation of important items represented on a map such as topography, ground features, place name, etc. on the spot, as well as supplementary collection of place name and study and confirmation of secular change after aerial photography. On the basis of the results of these studies, manuscripts of compilation and various data were revised to complete them as the original manuscripts of the map.

2) Items studied on the spot

Coloured copies of composite of manuscript of compilation and annotation data sheet indicating doubtful or uncertain points were brought to the field and following items were noted on them:

Fig. 16 Flow of Field Compilation



(1) Studies mainly done by the Team

a. Reconnaissance study of manuscripts of compilation

Reconnoitering the study area, the Team studied manuscripts of compilation if any important items were omitted and/or there were any error in writing and quality of compilation as well as supplementary study requested by MSAGC.

b. Clarification of doubtful points appeared while compilation

Doubtful points were clarified by comparing the manuscripts of compilation with aerial photographs on the spot.

c. Management of secular change, etc.

Of the change after aerial photography, important ones were studied. The location of small objects to show on the map but not represented on the aerial photograph owing to their size, such as wells, triangulation stations, etc. was determined by measuring the coordinates using GPS, when necessary.

(2) Studies mainly done by the Mongolian side (study and confirmation of annotation and administrative boundaries)

Comparing annotation data sheets with related documents, the Team had abstracted annotations supposed lacking in Japan. In the study field, the Team and counterparts discussed the necessity of confirmation and supplementary collection of annotation represented on the manuscript of compilation. The execution of these studies were allotted to the counterparts.

All annotation data, as well as administrative boundaries, were confirmed by local governments concerned and the committee on geographical name of Dornod aymag. The confirmation by local governments including the committee of Dornod aymag was done on revised colour copies of composites of manuscripts of compilation and annotation data sheets with lists of annotation prepared by the Team. Each sheet was signed or stamped for confirmation.

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

After returning to Japan, the Team completed the original manuscript of the map by revising and adjusting manuscripts of compilation and various kinds of data sheets, as well as preparing data sheets needed for drafting and printing. They are as follows:

(1) Field completed manuscript of map
(2) Annotation data sheet
(3) Road/water system data sheet (classification, name and destination of road, water system, etc.)
(4) vegetation data sheet
(5) Others

3-10-4 Inspection and quality control

After completing original manuscript of map, the chief engineer inspected the manuscript and worked out the list of quality control. The items inspected are as follows:

(1) Checking and confirmation of items represented
(2) Omission of items to represent
(3) Study of fitness of items represented as a map
(4) Spelling and allocation of annotation

3-10-6 Results and documents

The results of the field completion are as follows:

(1) Original manuscript of map
(2) Field completed manuscript of compilation
(3) Map of confirmation of place name and administrative boundaries
(4) Annotation data sheet
(5) Road/water system data sheet (classification, name and destination of road, water system, etc.)
(6) Vegetation data sheet

3-11 Drafting

3-11-1 Outline

Drafting is the process to prepare finally drafted original (final draft) of the map to proceed to the process of making printing plates for map publication based on the field completed and revised manuscripts of compilation and data sheets (the original manuscripts of the map). For final drafting, "negative scribing method" was applied.

For the Study, the negative photo-lithography was to apply to plate making. It was necessary to prepare the final draft

of the map in the form of the negative type of reverse images. In the course of drafting, however, some colour separation sheets were to draw up in the form of positive type of direct image, such as annotation sheets, symbol sheets, etc. They were transformed into the form of negative type of reverse images for the sake of plate making.

After finishing drafting, checking and inspection were executed with the collaboration of a counterpart staying in Japan at that time.

The study volume of the drafting is 128 sheets. The work flow of the drafting is shown in Fig. 17.

3-11-2 Map style

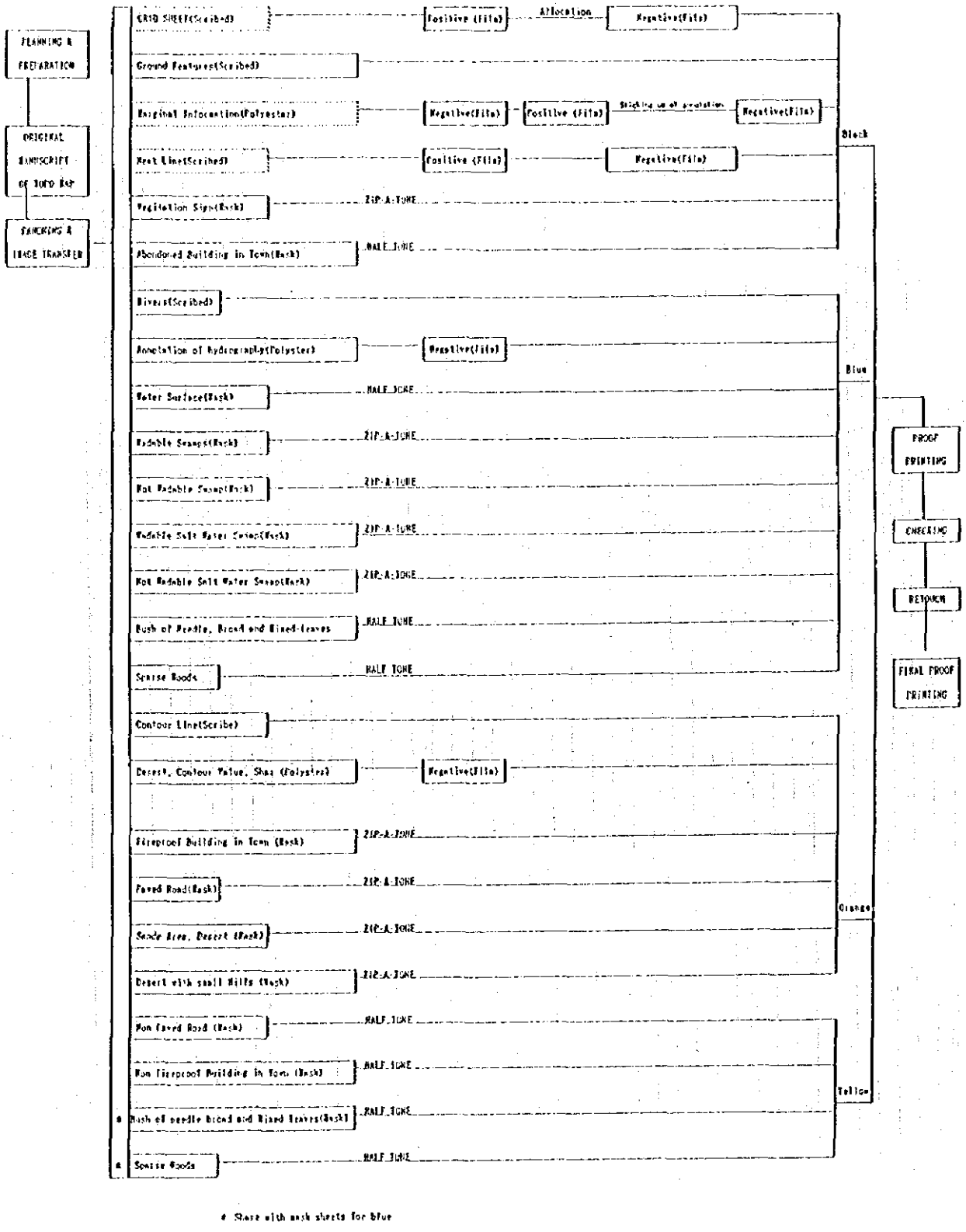
Map style and conventional signs used were those finally agreed upon by both parties. (Appendix 9)

3-11-3 Materials used and contents of colour separation

Following materials of the size A-2 (60 cm X 51 cm) were used depending on the kind of products to prepare.

Item	Manufacturer	Thickness
Scribing sheet	K & E yellow	# 500
Positive film	Fuji KUH 100	# 400
Negative film	Fuji KUH 175	# 700
Polyester sheet	Rokuou	# 500
Peel coat	Kimoto	# 750
Strip film	Kimoto	# 500

Fig. 17 Flow of Drafting



Contents of each colour separation sheet are as follows as per color and material (Fig. 17):

(1) For black

Scribing sheet	:Ground features,
Positive film	:Positive of the master negative of grid
Negative film	:Negative of grid
Polyester sheet	:Marginal information, annotation, vegetation sign and boundary
Negative film	:Marginal information, annotation, vegetation sign and boundary
Positive film	:Positive of master negative of outer neat lines
Negative film	:Negative of outer neat lines
Positive film	:Composite positive of zip-a-tone of vegetation signs
Negative film	:Negative of composite positive of zip-a-tone of vegetation signs
Mask sheet	:Abandoned buildings in town

(2) For blue

Scribing sheet	:Hydrography (rivers, lake, etc.), shore lines
Polyester sheet	:Annotation and conventional sign of hydrography
Peel coat	:Mask for Water surface
Strip coat	:Mask for wadable swamp
Strip coat	:Mask for unwadable swamp
Strip coat	:Mask for wadable salt area

(3) For brown

Scribing sheet	:Contour lines
Polyester sheet	:Contour values
Negative film	:Contour values
Peel coat	:Mask for paved roads,
Peel coat	:Mask for sandy area, dessert area with small hills,

(4) For yellow

Peel coat	:Mask for maintained but unpaved roads

(5) For brown and yellow

Strip coat	:Mask for quarter of a town with fireproofed buildings, quarter of of a town with non-fireproofed buildings

(6) For blue and yellow

Strip coat	:Mask for bush of needle-leaf, broad-leaf and mixed-leaves
Strip coat	:Mask for sparse woods

3-11-4 Execution

1) Registerring

The final draft of the map is composed of many color separation sheets, such as of scribed sheets, annotation sheets, mask sheets, etc. (more or less 20 sheets per one map sheet). For proofprinting they shall be printed on the same sheet one by one after processing and changing

color sensitizer for each color and for plate making for printing at least sheets for one color shall be printed on the same printing plate (more or less five sheets in average). To ensure matching among sheets, marks common to all sheets were registered on each sheet prior to transferring of images of the original manuscript. For its realization, the whole sheets to work on and the original manuscript were put one upon another and holes were bored with a punch (punch-hole system). By pinning them together through the holes, every sheet was matched to one another. Furthermore, registerring marks of cross type were drawn in the middle of outside of the confronting outer neat lines. These cross marks were used at the time of printing.

2) Preparation of master sheets

(1) Sheet for grid lines

The topographic map working on shall provide with grid lines showing distance. The interval of the grid lines is the same for all sheets of maps. The location is, however, difference for each sheet divided by longitude and latitude. For the sake of convenience, master sheet for grid lines was worked out by computer and a master negative was produced. From the master negative, positives for respective sheets were copied. After working on the positive, the positives were reversed to negatives for succeeding processes.

(2) Sheet for outer neat lines

The length of a map in meridian direction is nearly the same for all sheets in the unit of 0.1 mm. That in parallel direction differs according to the

distance from the origin of projection. The master sheet fixed the length of the outer neat lines in the meridian direction was prepared in negative type. The sheet of outer neat lines for each map sheet was prepared using diapositive of the master sheet. After finishing the work it was reversed to negative.

3) Transferring of images

Prior to scribing, images of the original manuscript were transferred onto scribing sheets (three sheets per one sheet of the map for black, orange and blue). Coating diazo sensitizer on a scribing sheet, it was exposed to light together with the original manuscript. Images of the original manuscript were printed photographically on it (diazo printing method of reverse images).

When printing the images, the sheets were pinned up together to ensure that the images shall be printed at the same place with respect to the holes punched in advance for all sheets.

4) Scribing

In reference to the images of the original manuscript exposed on the shielding film of a scribing sheet (three sheets per one sheet of a map), images to print in one color were scribed on a scribing sheet by a sharp edged tool (scriber or scribing tool) with different size of edges specified by the instruction to obtain the images corresponding to a negative film in photography.

5) Preparation of zip-a-tone and conventional signs of vegetation

For the sake of convenience, zip-a-tone of the conventional signs of needle leaf trees, broad leaf trees, bushes, reeds, etc. were prepared by photographic processing: a sheet of conventional signs of vegetation of the size of one sheet of a map was drawn by computer. The output in negative type was printed photographically superimposing with corresponding mask sheets to produce a necessary sheet of conventional signs in positive type. It was reduced to negative type to form a sheet of conventional signs of vegetation to be ready for printing plate making.

Following zip-a-tone sheets in negative type were prepared:

Д э р с , reed, land of short grass, land of regular grass, shrub, low shrub, swamp plant, mixture of swamp plant and shrub, mixture of low shrub and swamp plant.

6) Preparation of mask sheet

The mask is used to expose only the part necessary to print half-tone screen or zip-a-tone on the printing plate. The material is stable polyester sheet coated with shielding film easy to peel off. There are two kinds of coated sheets. Either of them can be used according to the complexity of the figures to deal with.

(1) Strip coat

Laying the coated strip sheet over the scribed sheet, necessary lines are cut with a knife and film of the area enclosed by these lines are peeled off by hands. This sheet is used when the figure is not complicated.

(2) Peel coat

The shielding film over the peel coat is sensitive to the ultraviolet light. When the sheet is exposed to the ultraviolet light with the scribed sheet, the exposed part is eroded by chemical treatment and the coat of this part is washed off. In reference to these eroded lines, the enclosed parts are peeled off by hands. Unnecessary lines are painted out. This sheet is used when the figure is complicated.

To avoid overlapping of lines on a map sheet with annotation, contour value, when it is necessary to shield a small area, a mask sheet was worked out by the method of opaque by painting shielding material on the spot to shield light using a polyester sheet.

Although four colours (black, brown, blue and yellow) were used for printing, in order to obtain orange colour for a quarter of a town with fireproof buildings, the combination of yellow and brown was applied at the time of printing, as well as to obtain green colour for forest area, the combination of yellow and blue was applied, respectively. For this purpose, special mask for yellow and that for blue and yellow and brown were prepared.

7) Preparation of sheet of marginal information · annotations · conventional signs

Marginal information, letters such as administrative and place name, height, etc. to represent on a map in black colour were prepared on a transparent film in specified types and sizes of letters and numerical figures by photo-composing machine and they were stuck up on a polyester sheet at specified place in accordance with the

instruction of the annotation sheet and the original manuscript of the map. Russian letters were used for annotation.

Of the marginal information, there are parts common to all map sheets and parts different to each sheet. The common parts were prepared as a master sheet and its duplicates were made for each sheet to inscribe items peculiar to it.

The annotation and conventional signs of water system to be shown in blue and contour value and conventional signs to be shown in brown were prepared separately.

8) Preparation of positive and negative films

Depending on the preparation procedure of respective sheet, some sheets shall be prepared in positive type of direct image: for example, marginal information sheet, annotation sheet, sheet for desert, sheet for conventional signs of vegetation, etc. However, it is necessary to transform them into of negative type of reverse image for the sake of making printing plates after completion of the work.

From sheets originally prepared in negative type, but needed to compose with halftone or zip-a-tone screen, composite positives were prepared and then they were transformed into negative.

9) Preparation of proof prints, proof reading and revision of the final draft

After finishing the work, a proof was printed and checked with the original manuscript, as well as the conformity among different sheets, and the revision was applied to all sheets, when necessary.

For checking, a counterpart staying in Japan worked together.

The proof print is prepared by "sur printing": A coupler is coated on a synthesized polyester sheet or a synthesized paper. They are exposed to light with the sheets by multiple printing and developed colour by colour. Replacing the coupler to of another colour, the same procedure is proceeded for all colours. Thus the master of a map having necessary colours was obtained. In the case of the Study, number of colours to print shall be four composing of approximately 20 sheets of colour separation sheets, number of sheets per colour being approximately five. Consequently, multiple exposure was necessary for printing of one colour.

After several times of proof printing, proof reading and revision (retouching), the final proof was printed.

10) Tying

Neighbouring sheets were tied together to each other.

3-11-5 Quality control

After completing the work, checking was made for all sheets.

3-11-6 Results and documents

The results and documents of this phase are as follows:

Final draft of the topographic map (scribed sheets, mask sheets, etc.)

Final proof

3-12 Printing

3-12-1 Outline

So far, the preparation of the original manuscript and the final draft of the map was finished. The next and the final step was, by using the final drafts, to make printing plates and print topographic map.

Prior to proceed to printing, the proof was prepared to check the matching among each colour separation sheet, colouring, etc. in collaboration with a counterpart staying in Japan. After his checking and recognition, the final printing was executed. Printing was carried out in four colours using offset printing machines. The flow chart of plate making and printing is shown in Fig. 18.

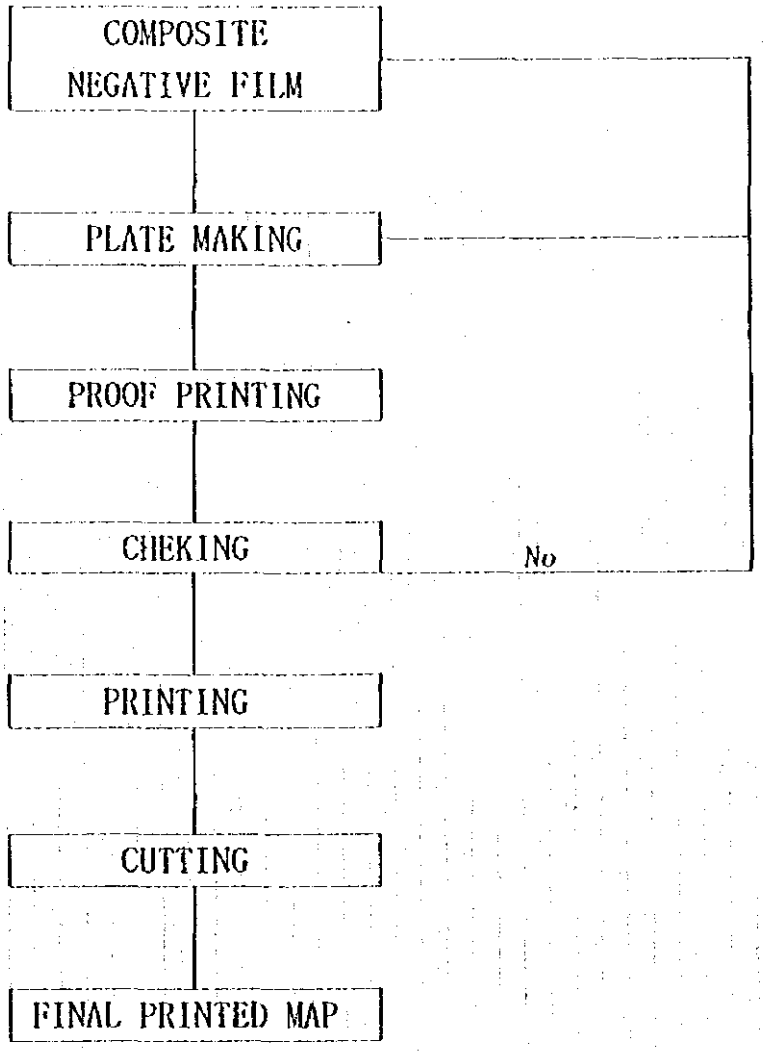
3-12-2 Plate making

Printing plates were prepared by printing the images of negative films of reverse image on the presensitized aluminum printing plates by photo-lithography for each colour as follows (four plates):

Plate for black,
plate for blue,
plate for brown,
plate for yellow

As the result of checking, when revision of the final draft is necessary, printing plates were remade.

Fig. 18 Flow of Plate Making & Printing



3-12-3 Repartition of colours

The number of colors is four and their repartition is as follows:

Color	Contents
Black	Marginal information, annotation, abandoned bldgs. in town
Blue	Water parts, annotation of water parts, swamp
Brown	Contour line, contour value, road (paved part), desert, sandy area,
Yellow	Unpaved road, scattered woods
Orange*	Quarter of a town with fireproofed bldg, quarter of a town with non-fireproofed bldgs
Green**	Vegetation

Orange* shall be the superimposition of Brown and Yellow.
Green** shall be the superimposition of Blue and Yellow.

3-12-4 Proof printing and reading

The proof print was prepared by printing plates made with the final draft of the map using a printing machine.

The map was read carefully in checking colour tone, fitness, dimensions, quality of printed lines, etc. with the collaboration of a counterpart staying in Japan. Plates were revised or remade, when necessary.

After the confirmation and acceptance of the counterpart on the final proof, the final printing of the map was carried out.

3-12-5 Printing

1) Printing was carried out by 4-colour offset printing machines in 4 colors.

2) The printing paper used was of 90 g/m² in thickness and having the sufficient quality in physical and chemical characteristics as a map paper such as in tensile breaking strength, bursting strength, tearing strength and folding endurance as well as of little expansion and contraction and reproducibility etc. The physical and chemical characteristics of printing paper was tested by an public institute with the results given in Tab. 10.

3) Printing ink used was stable against weather and of high quality in colour tone and light-resistivity.

4) Work volume
For the total of 128 sheets of topographic maps, following copies were printed in two phases of Phases IV and V.

In Phase IV:	128 shts×	60 %	≒	77 shts
	77 shts×	150 copies	=	11,550 copies
In Phase V:	128 shts×	40 %	≒	51 shts
	51 shts×	150 copies	=	7,650 copies.
		Total	=	19,200 copies

Tab. 10 Physical and Chemical Characteristics of Printing Paper

Results of testing					
Item			Average	Maximum	Minimum
Basic weight(g/m²)			91.0		
Thickness(m)			0.113	0.115	0.111
Tensile breaking strength(Kg)	Dry	Machine direction	12.0	12.3	11.6
		Cross direction	8.27	8.50	8.00
	Wet	Machine direction	3.66	3.90	3.25
		Cross direction	2.89	3.05	2.80
Bursting strength(Kg/cm²)	Dry		4.11	4.45	3.85
	Wet		1.87	2.05	1.70
Tearing strength(g)		Machine direction	117	118	114
		Cross direction	98.8	100.0	96.0
Folding enduranca(time) (MIT type tester)		Machine direction	1,700	1,900	1,500
		Cross direction	1,900	2,500	1,600
Surface strength(A)		Surface	16	16	16
		Back	16	16	16
Smoothness		Surface	46	54	41
		Back	49	56	43
Brightness(%)			85.2	85.2	85.1
Opacity(%)			89.6	90.0	89.4
Degree of sizing(sec)			61	69	57
PH			6.4		
Expansion(%) (RH60~80%)		Machine direction	0.067	0.068	0.064
		Cross direction	0.247	0.248	0.244

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

Room temperature: 20℃

Humidity: 65%

3-12-6 Preparation of Composite Films for Plate Making

Colour separation sheets composing one colour as elements of the final draft consist of several sheets as shown in Fig. 17. For the sake of reprinting in Mongolia, composite films of reverse image were prepared by photographic processing.

3-12-7 Checking of printed map

Matching, cleanness, scratch, omission, etc. were checked for all sheets and comparison with the colour pattern were made against colour tone.

3-12-8 Results and documents

The following are the results and documents of printing:

Printed map :128 sheets (150 copies each)
Composite film for plate making
:for 128 sheets.

4. POSTSCRIPT

The present report describes the processes of the 1/25 000 topographic mapping of Ulaan-Tsav area, Dornod aymag, in Mongolia executed under the overseas technical cooperation program of the Government of Japan. We should be obliged if the technology transferred to Mongolia through the Study contributes to the development of Mongoliand her geodesy and cartography.

REFERENCES

1. Report of the Topographic Mapping of Ulaan-Tsav Area in Mongolia (First Year & Second Year), March 1994, JICA

2. Reoirt if the Third Year's Study of the Topographic Mapping of Ulaan-Tsav area in Mongolia, March 1995

3. Report of the Topographic Mapping of Ulaan-Tsav Area in Mongolia (Fourth Year), March 1996

APPENDICES

SCOPE OF WORK

FOR

THE TOPOGRAPHIC MAPPING OF ULAAN-TSAV AREA IN MONGOLIA

AGREED UPON BETWEEN

MONGOLIAN STATE ADMINISTRATION OF GEODESY AND CARTOGRAPHY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Ulaan-Bator October 19th , 1992

Mr. J. SANJAAJAMTS
Director General
Mongolian State Administration
of Geodesy and Cartography

Mr. T. OOHI
Leader of the Preparatory
Study Team
Japan International
Cooperation Agency (JICA)

Mr. Y. ALTANTULGA
Deputy Director
Foreign Trade Department
Ministry of Trade and Industry

SCOPE OF WORK

FOR

THE TOPOGRAPHIC MAPPING OF ULAAN-TSAV AREA IN MONGOLIA

AGREED UPON BETWEEN

MONGOLIAN STATE ADMINISTRATION OF GEODESY AND CARTOGRAPHY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Ulaan-Bator October 19th ,1992

Mr. J. SANJAAJAMTS
Director General
Mongolian State Administration
of Geodesy and Cartography

Mr. T. DOHI
Leader of the Preparatory
Study Team
Japan International
Cooperation Agency (JICA)

Mr. Y. ALTANTULGA
Deputy Director
Foreign Trade Department
Ministry of Trade and Industry

I. INTRODUCTION

In response to the request of the Government of Mongolia, the Government of Japan decided to conduct the Topographic Mapping of Ulaan-Tsav area in Mongolia (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

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

Mongolian State Administration of Geodesy and Cartography (hereinaftec referred to as "MSAGC") shall act as counterpart agency to the Japanese study team (hereinafter referred to as "the Team") and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

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

II. OBJECTIVE OF THE STUDY

The objective of the Study is to prepare the 1/25,000 Topographic Maps covering the area of approximately 10,800 km² (Appendix-I).

III. SCOPE OF THE STUDY

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

1. Aerial Photography

Aerial photographs shall be taken at a scale of approximately 1/50,000. Setting of air-photo signals shall be done, if necessary, prior to commencement of the aerial photography.

2. Ground Control Point Survey

Although existing control points will be used for the topographic mapping, establishment of tempocary control points shall be carried out, if necessary. Supplementary control points necessary for aerial triangulation and mapping work shall be established by a GPS survey.

3. Field Identification

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

4. Aerial Triangulation

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

5. Stereo Plotting

Stereo Plotting shall be carried out using stereo plotting instruments.

6. Compilation

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

7. Field Completion

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

Administrative boundaries and geographical names shall be prepared and verified by MSAGC.

8. Drafting

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

9. Printing

Plate making shall be carried out using 1/25,000 scribed negatives, and printing shall be carried out by a offset method.

IV. STUDY SCHEDULE

The whole work will be conducted in accordance with the attached tentative schedule (Appendix - II).

V. REPORTS AND FINAL RESULT

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

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

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

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

VI. UNDERTAKING OF THE GOVERNMENT OF MONGOLIA

1. To facilitate smooth conduct of the Study, the Government of Mongolia shall take necessary measures;

(1) to secure the safety of the Team,

(2) to permit the members of the Team to enter, leave and sojourn in Mongolia for the duration of their assignment therein, and exempt them from foreign registration requirements and consular fees,

(3) to exempt the members of the Team from taxes, duties and other charges on equipment, machinery and other materials brought into Mongolia for the implementation of the Study,

(4) to exempt the members of the Team from income tax and charges of any kind imposed on or in connection with any emolument or allowance paid to them for their services in connection with the implementation of the Study,

(5) to provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into Mongolia from Japan in connection with the implementation of the Study,

(6) to secure permission for entry into all necessary areas for the implementation of the Study,

(7) to secure permission for the Team to take all necessary data and documents, including original negatives of aerial photos, related to the Study out of Mongolia to Japan, and,

(8) to provide medical services as needed and its expenses will be chargeable on the members of the Team.

2. The Government of Mongolia shall bear claims, if any arises against the members of the Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

3. To facilitate smooth conduct of the Study, MSAGC shall take necessary arrangements for the Team as follows, in cooperation with other relevant organizations;
   (1) to secure permission for a flight for the aerial photography and use of an airport for the implementation of the Study,
   (2) to secure permission for an use of communication facilities including transceiver which may be used Japanese languge, with allocated frequency, and ,
   (3) to arrange necessary number of drivers, labors and necessary watchmen in the project site.

4. MSAGC shall, at its own expense, provide the Team with the followings in cooperation with other related organizations;
   (1) available data and information related to the Study,
   (2) counterpart personnel (staff of MSAGC),
   (3) suitable office space with necessary equipment, in Ulaan-Bator (MSAGC) and project site(s),
   (4) credentials or identification cards to the members of the Team,
   (5) administrative and technical support,
   (6) existing facilities and space of MSAGC for processing aerial photographs.

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

(8) annotation materials and annotation sheets.

VII. UNDERTAKING OF JICA

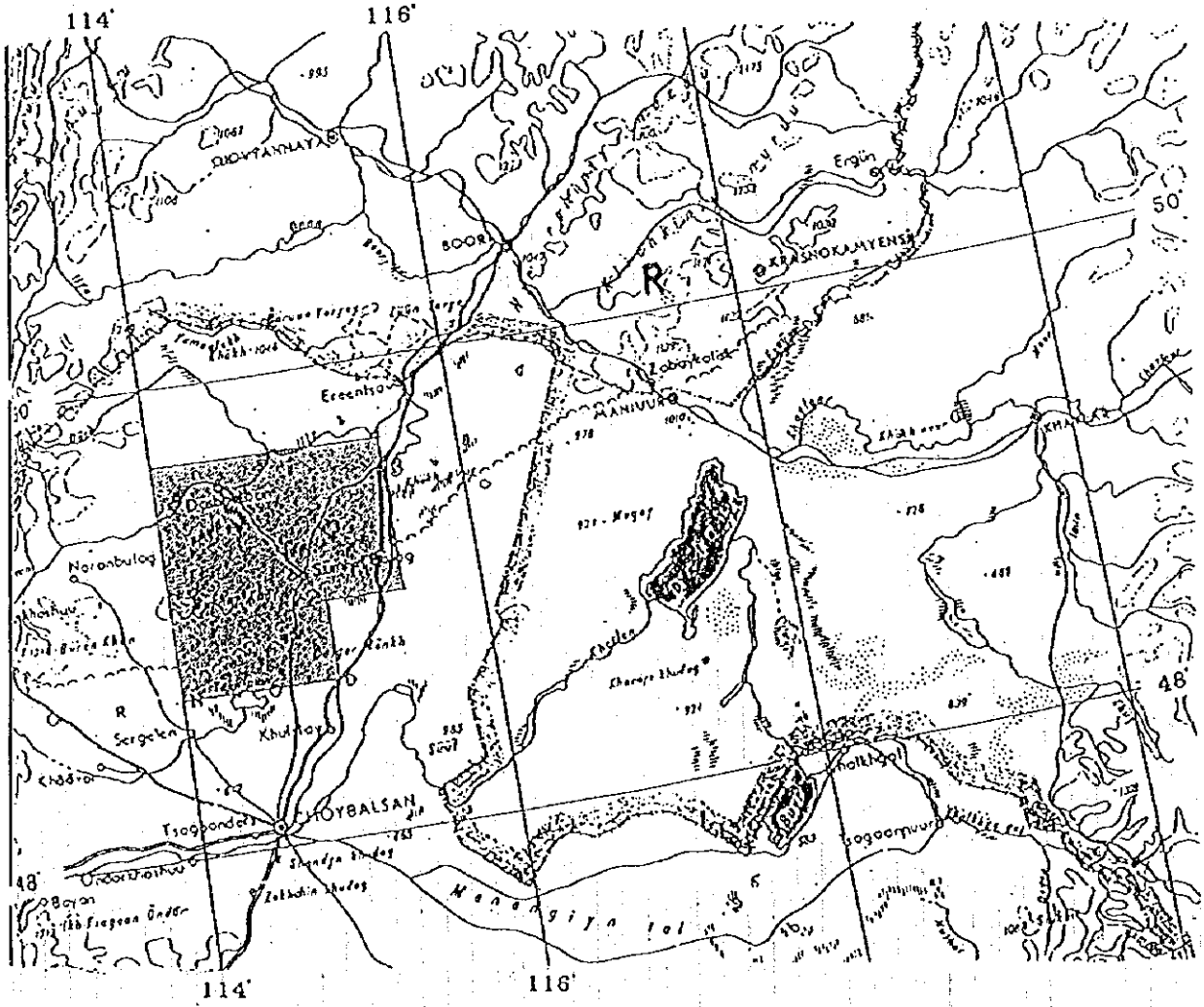
For the implementation of the Study, JICA shall take the following measures.

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

VIII. CONSULTATION

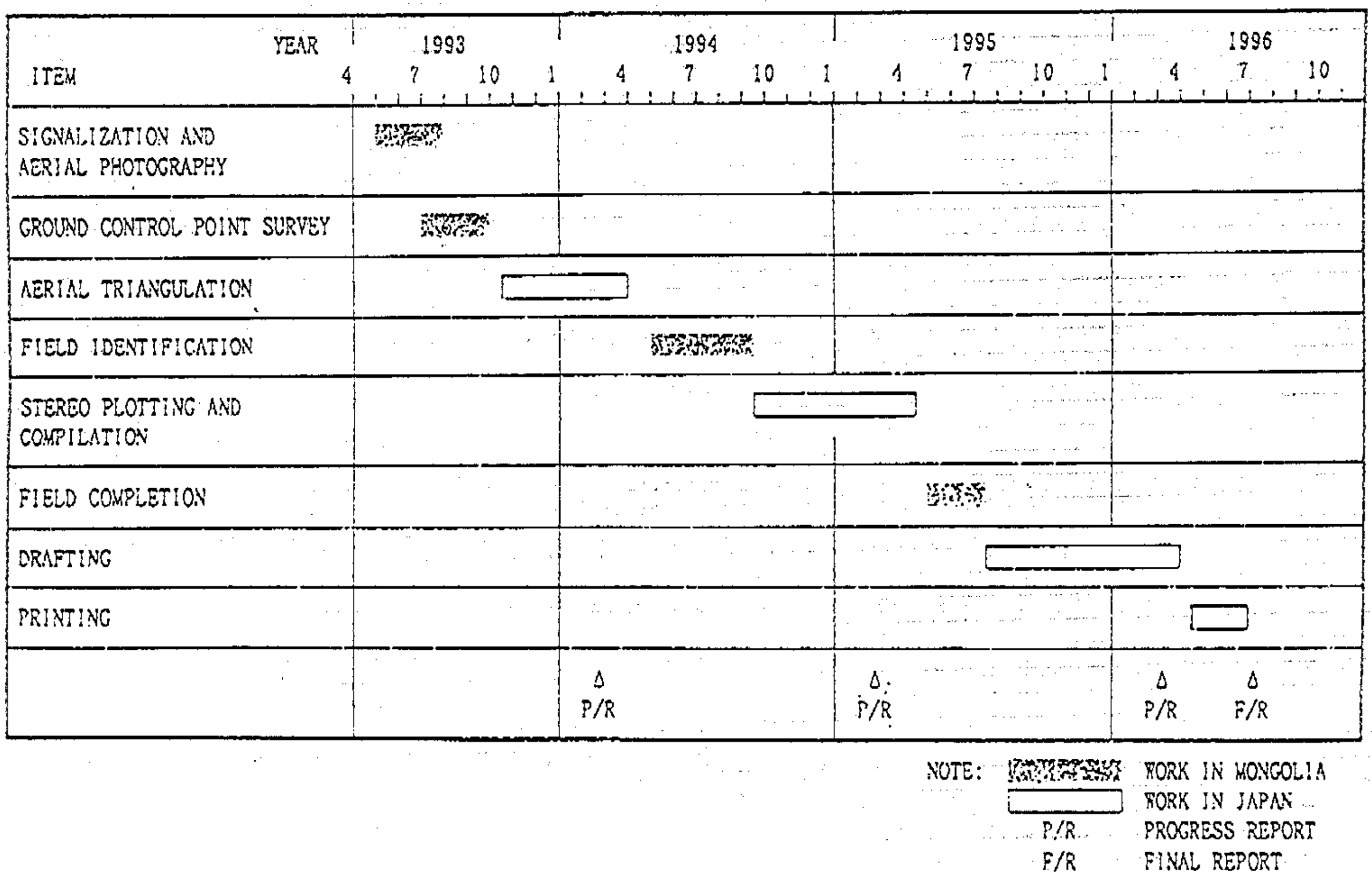
JICA and MSAGC shall consult with each other in respect of any matter that may arise from or in connection with the Study.

MAPPING AREA



M.C.

TENTATIVE IMPLEMENTATION SCHEDULE



FINAL RESULTS

1. Aerial Photography
(1) original negative-film (1set)
(2) contact positive prints (1set)
(3) index map of aerial photographs

2. Ground Control Point Survey
(1) final result tables
(2) distribution and route diagram
(3) computation sheets

3. Signalization
(1) description of signals

4. Aerial Triangulation
(1) final result table
(2) diapositive films (1set)
(3) reference contact positive photos
(4) diagram of aerial triangulation

5. Topographic Mapping
(1) original manuscripts
(2) separate scribed sheets
(3) combined negative films for reproduction
(4) printed maps (150 copies for each sheet)

TECHNICAL DETAILS

1. Aerial photography : super wide angle camera

2. Control Point Survey
   (1) Planimetric relative accuracy : 10^{-4}

3. Mapping
   (1) Projection: Gauss Cruger Projection
   (2) Sheet Line: 5' x 7.5' in Latitude and Longitude
   (3) Contour Interval: 10m
   (4) Number of Colors: 4 colors

4. Map Accuracy
   (1) Planimetry : 0.5 mm on the map
   (2) Spot Height : 1/3 of contour interval
   (3) Contour Line : 1/2 of contour interval

APPNDIX-1
ATTACHMENT 1

MINUTES OF MEETING

ON

THE TOPOGRAPHIC MAPPING OF ULAAN-TSAY AREA

IN

MONGOLIA

AGREED UPON BETWEEN

MONGOLIAN STATE ADMINISTRATION OF GEODESY AND CARTOGRAPHY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

ULAAN-BATOR OCTOBER 19th, 1992

Mr. J.SANJAAJANTS
Director General
Mongolian State Administration
of Geodesy and Cartography

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

The preparatory study team on the topographic mapping of Ulaan-tsav area in Mongolia, organized by JICA and headed by Mr.Tadao Dohi, visited Mongolia from September 23, 1992 to October 21, 1992, to carry out the preparatory study for the captioned study.

During their stay in Mongolia, the series of meetings were held between the Japan study team (hereinafter refferd to as "the Team) and the Mongolian team, headed by Mr.Sanjaajants and composed of officials from the Mongolian State Administration of Geodesy and Cartography (hereinafter refferd to as "MSAGC"), and the meetings resulted as follows.

1. The main objectives of meetings are to set forth the Scope of Work and exchange views to carry out the study in the most professional manner.

2. The final Scope of Work for the study dated October 19th, 1992.

3. The Mongolian counter of the Japanese study team shall submit the quarterly report to MSAGC in the course of the Study.

4. MSAGC shall make an effort to prepare, for the Team, office space with necessary furniture both in Ulaan-Bator and project site.

5. MSAGC shall conduct the test flight of the airplane for taking aerial photographs in the presence of the JOCV official on November, 1992 and report the result to JICA.

6. MSAGC proposed that IV 4 (3), (6) of Draft of Scope of Work which had been deleted at the previous meeting were restored and the Team agreed its proposal.

M.C.

1. About the drivers in VI 4 (9) which had been deleted at the previous minutes of meeting (signed by Mr.Otaki and Mr.Sanjaajamts on September 30th,1992), the Team requested MSAGC to arrange necessary number of drivers, so MSAGC agreed to do it.

Both sides agreed the followings;

(1) Printing maps are 150 copies for each sheets.

(2) Spot Height Accuracy is one third (1/3) of contour interval.

MSAGC requested to provide appropriate number of vehicles for smooth implementation of the Study.

Again,MSAGC earnestly requested to the Japanese side the followings ;

(1) To accept as many Mongolian counterpart personnel as possible to Japan for facilitating technical transfer in the course of the Study.

(2) To provide necessary materials for conducting the Study.

(3) To take consideration to transfer of technology, by providing necessary equipment for conducting the Study.

The Team replied that they would convey the above requests to the Japanese authorities concerned.

LIST OF ATTENDANTS

MONGOLIAN SIDE

Mr. J. SANJHAAJMTS	Director General Mongolia State Administration of Geodesy and Cartography
Mr. D. GANSUKH	Deputy Director General Mongolia State Administration of Geodesy and Cartography
Mr. Z. BATAA	Referent Mongolia State Administration of Geodesy and Cartography

JAPANESE SIDE

Mr. Tadao DOHI	Director of Topographic Department, Geographical Survey Institute, Ministry of Construction
Mr. Shigeru OTAKI	Deputy Director of Third Geodetic Division of Geodetic Department, Geographical Survey Institute, Ministry of Construction
Mr. Hiroshi KOSUGA	Technical Management Officer Topographic Division Topographic Department, Geographical Survey Institute, Ministry of Construction
Mr. Takanori JIBIKI	Director, First Development Study Division, Social Development Study Department, Japan International Cooperation Agency
Mr. Kazushige ENDO	First Development Study Division, Social Development Study Department, Japan International Cooperation Agency
Mr. Yuichi SUGANO	First Development Study Division, Social Development Study Department, Japan International Cooperation Agency
Mr. Shoji HASHIZUME	Japanese Association of Surveyors
Mr. Mitsuo MURAKAMI	Japanese Association of Surveyors
Mr. Hiroshi ABURAMOTO	International Cooperation Service Center

MINUTES OF MEETINGS ON PLAN OF OPERATIONS

MINUTES OF MEETINGS ON TOPOGRAPHIC MAPPING OF ULAAN-TSAV AREA IN MONGOLIA BETWEEN MONGOLIAN STATE ADMINISTRATION OF GEODESY AND CARTOGRAPHY AND JICA STUDY TEAM

ULAANBAATAR, MAY 24, 1993

DR. J. SANJAAJAMTS
DIRECTOR GENERAL
MONGOLIAN STATE ADMINISTRATION
OF GEODESY AND CARTOGRAPHY
(MSAGC)

MR. S. SAITO
LEADER
JICA STUDY TEAM
(JST)

MR. H. KOSUGA
DEPUTY DIRECTOR FOR ENVIRONMENTAL
GEOGRAPHIC INFORMATION,
PLANNING & COORDINATION DIVISION,
PLANNING DEPARTMENT
GEOGRAPHICAL SURVEY INSTITUTE

I. DATE AND TIME: May 17 14:45 - 17:50
18 10:05 - 12:10 14:30 - 16:00
19 14:30 - 17:30

II. PLACE: Director General's office

III. ATTENDANTS:

1) Mongolian side

Dr. J. Sanjaajamts	Director General, MSAGC
Mr. Z. Bataa	Referent, MSAGC
Mr. M. Enkhbayar	Director, Aerial & Mapping Enterprise of Mongolia (AMEM)
Mr. Y. Serevjaa	Deputy Director, AMEM
Mr. D. Tsedendorj	Chief, Research Div., AMEM
Mr. Kh. Jorgal	Chief, Photogrammetry Lab, AMEM

2)Japanese side

Mr. H. Kosuga	Deputy Director for Environmental Geographic Information, Planning & Coordination Div., Planning Department, Geographical Survey Institute
Mr. Y. Sugano	First Development Study Division, Social Development Study Department, Japan International Cooperation Agency (JICA)
Mr. S. Saito	Leader, JST

Dr. K. Muraoka	Deputy Leader, JST
Mr. K. Okumura	Mapping Planner, JST
Mr. H. Yoshida	Chief Engineer, JST
Mr. H. Hosoda	Inspector of Aerial Photography, JST
Mr. M. Tsujimoto	Member, JST
Mr. S. Ishiwata	Mechanician, JST
Mr. T. Horiuchi	Interpreter, JST
Mr. Y. Kokufu	Coordinator, JST

IV. Mr. Saito, leader of the JST, briefed the plan of operations (hereinafter referred to as the "P/O") for the Study of the Topographic Mapping of Ulaan-Tsav Area (hereinafter referred to as the "Study") prepared by JICA as attached (Attachment). After discussions, the P/O was accepted by the Mongolian side.

V. Mr. Saito stressed on the undertaking of both sides and requested the Mongolian contribution to the Study for its smooth implementation. The items agreed upon by both sides are as follows:

a. Concerning the security of the team members, the instructor shall offer necessary information prior to enter into the field.

b. MSAGC can authorize bringing the necessary documents, such as originals of aerial photographs, maps, etc., out to Japan.

c. MSAGC shall appoint following personnel as counterparts to work with the Team:

1) Field surveys	5 persons
2) Photo processing	2 persons
3) Aerial photography	2 persons

d. Instruments and/or materials to be used next year (Refer to Fig. 10 of the attached P/O) shall be kept in MSAGC.

M.C.

S.S.

VI. MSAGC requested to establish permanent monuments for the new control points. The metal markers for monuments shall be handed over to the Team before their departure to the field.

VII. The geodetic control points without their results (co-ordinates) shall not be shown on the map.

M.C.

A.A.

MINUTES OF MEETINGS ON THE PROGRESS OF THE FIELD OPERATIONS

MINUTES OF MEETINGS
AT
THE COMPLETION
OF
THE FIRST YEARS'S FIELD WORK
FOR
TOPOGRAPHIC MAPPING
OF
ULAAN-TSAV AREA
IN
MONGOLIA
BETWEEN
MONGOLIAN STATE
ADMINISTRATION OF
GEODESY AND CARTOGRAPHY
(MSAGC)
AND
JICA STUDY TEAM

ULAANBAATAR, 9TH JUNE (LY), 1993

DR. J. SANJAAJAMTS
DIRECTOR GENERAL
MSAGC

MR. S. SAITO
LEADER
JICA STUDY TEAM
(JST)

I. DATE AND TIME: 7th June, 1993 10:15 ~ 13:40
8th June, 1993 10:05 ~ 13:00

II. PLACE: Director General's office

III. ATTENDANTS:

1) Mongolian side

Dr. J. Sanjaajamts	Director General, MSAGC
Mr. H. Jargal	Head, Shop of Photogrammetria, Aerial Surveying and Mapping Enterprise of Mongolia

2) Japanese side

Mr. S. Saito	Leader, JST
Dr. K. Muraoka	Deputy Leader, JST
Mr. K. Okumura	Mapping Planner, JST
Mr. H. Yoshida	Chief engineer, JST
Mr. T. Horiuchi	Interpreter, JST

IV. The JST submitted a report "Progress Report of the First Year's Field Work for the Topographic Mapping of Ulaan-Tsav Area in Mongolia" (Annex-1), along which the progress of the field work is briefed. The MSAGC was satisfied with the progress of the work and the meeting accepted the report.

V. The conventional signs and their application to be used for the study of Topographic Mapping of Ulaan-Tsav Area in Mongolia (hereinafter referred to as the "Study") was discussed by a small group composing of MSAGC members and JST members. Mr. Jargal reported the

results of the discussions presenting a report "Technical Discussion on Conventional Signs and their Application Rule for the 1/25,000 Topographic Map" (Annex-2). After discussions the Meeting accepted the report with some modifications.

VI. The JST proposed a form of annotation and numbering on each frame of the aerial photograph agreed by engineers in charge of both sides as shown on the separate sheet. The Meeting accepted the proposal.

VII. The JST requested to keep the equipment and materials to be used for the field work scheduled next year until the JST visits Mongolia. MSAGC accepted the request and asked to submit the list of equipment and materials to keep.

VIII. The JST requested to hand over a set of 1/100,000 topographic maps of the Study area and several sheets of 1/25,000 topographic maps shoving the characteristics of the area as sample for further study. MSAGC accepted the request.

IX. The JST request to get authorization to take maps and surveyed materials such as processed negative films, contact prints and survey results out of Mongolia to Japan. MSAGC accepted the request.

X. The JST explained the tentative schedule of the Study after going back to Japan. In connection with the field work (field identification) scheduled in May, 1994, the JST requested the participation of MSAGC counterparts (at least five persons including a chief counterpart) and five drivers. MSAGC accepted the request.

XI. The JST remarked that the transfer of new technology to the counterparts was realized during the work:

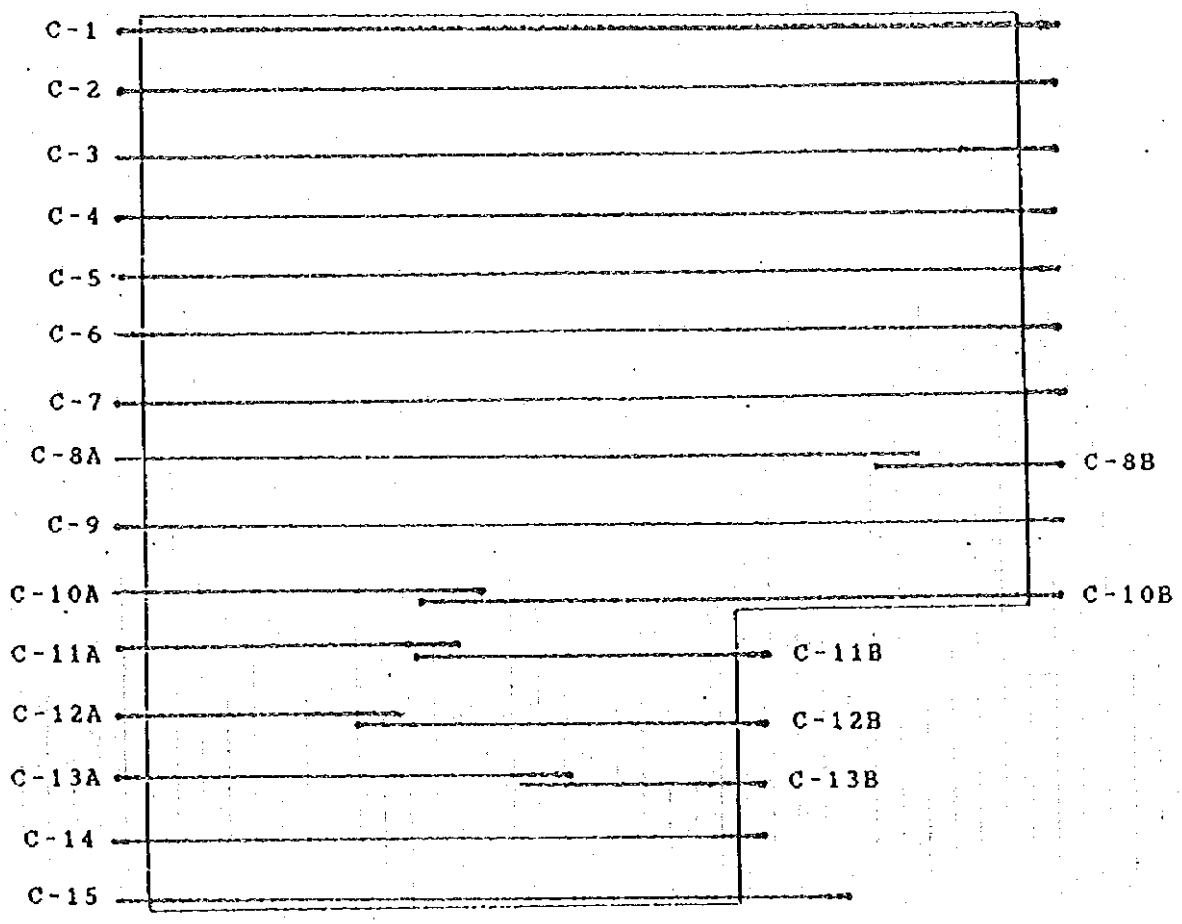
1. In the ground control survey, the use of GPS instruments was practiced.
2. In the aerial photography, navigation of the airplane by GPS navigation instruments and handling of Wild RC-10 aerial camera were practiced.

XII. Mr. Saito, leader of the JST appreciated the collaboration of MSAGC to the Study, especially to counterparts who joined the field work and the aerial photography, for the successful completion of this year's field work.

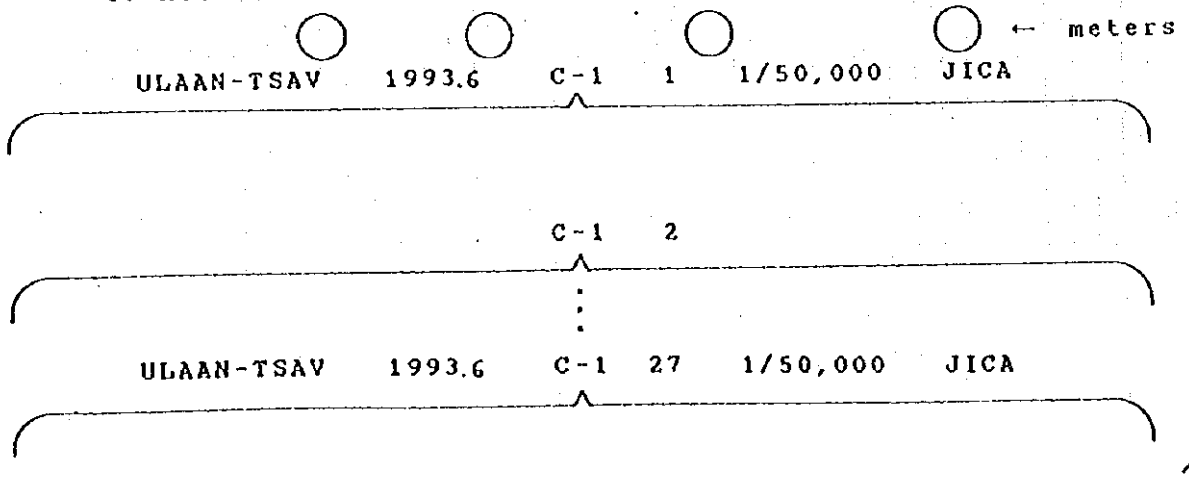
Dr. Sanjaajamts, Director General of MSAGC, remarked that the successful progress of the first year's work, which is usually hard to proceed, assures the successful completion of the whole study. We, the Mongolian side, will do our best for the completion of the Study.

ANNOTATION ON AERIAL FILM

1. Course name: from the north C-1, C-2, C-3, · ·
2. Photo number: from the west 1, 2, 3, · ·
3. Divided courses: from the west C-8A, C-8B, · · ·



4. Location of annotation on each frame



MINUTES OF MEETINGS
ON
TOPOGRAPHIC MAPPING
OF
ULAAN-TSAV AREA
IN
MONGOLIA
BETWEEN
MONGOLIAN STATE
ADMINISTRATION OF GEODESY
AND CARTOGRAPHY (MSAGC)
AND
JICA STUDY TEAM (JST)

ULAANBAATAR, JUNE 3, 1994

MR. M. ENKHBAYAR
FOR
DIRECTOR GENERAL
MSAGC

MR. S. SAITO
LEADER, JST

MR. H. KOSUGA
DEPUTY DIRECTOR FOR ENVIRONMENTAL
GEOGRAPHIC INFORMATION
PLANNING & COORDINATION DIVISION
PLANNING DEPARTMENT
GEOGRAPHICAL SURVEY INSTITUTE

I. DATE AND TIME: May 30 14:00 - 16:00
May 31 09:30 - 11:30
June 1 11:00 - 12:30

II. PLACE: Director General's office

III. ATTENDANTS:

1) Mongolian side

Dr. J. Sanjaajamts	Director General, MSAGC
Mr. M. Enkhbayar	Director, Aerial & Mapping Enterprise of Mongolia (AMEM)

2) Japanese side

Mr. H. Kosuga	Deputy Director for Environmental Information, Planning & Coordination Div. Planning Department, Geographical Survey Institute
Mr. H. Kumagai	First Development Study Div. Social Development Study Dept. Japan International Cooperation Agency (JICA)
Mr. S. Saito	Leader, JST
Dr. K. Muraoka	Deputy Leader, JST
Mr. K. Okumura	Mapping Planner, JST
Mr. H. Yoshida	Chief engineer, JST
Mr. T. Horiuchi	Interpreter, JST

IV. a. Dr. Sanjaajamts welcomed JST and hoped success in this year's field survey.

b. Mr. Saito appreciated the help to clear smoothly the customs procedures at the airport by the personnel of MSAGC and pre-arrangements including the assignment of counterpart engineers and drivers to work with JST in the field.

S.S.

V. JST briefed the following items in line with the Plan of Operations (P/O) for the Study of the Topographic Mapping of Ulaan-Tsav Area prepared by JICA at attached (Attachment).

a. The study so far executed,

b. The study items and schedule for the present phase,

c. The assignment which shall be imposed on both sides,

d. The request of documents to be applied on the map.

After discussions, the P/O was accepted by the Mongolian side.

S.S.

APPENDIX– 5

MINUTES OF MEETINGS
AT
THE COMPLETION
OF
THE THIRD YEAR'S FIELD WORK
FOR
TOPOGRAPHIC MAPPING
OF
ULAAN-TSAV AREA
IN
MONGOLIA
BETWEEN
MONGOLIAN STATE
ADMINISTRATION OF
GEODESY AND CARTOGRAPHY
(MSAGC)
AND
JICA STUDY TEAM
(JST)

ULAANBAATAR, 22ND JULY, 1994

DR. J. SANJAAJAMTS
DIRECTOR GENERAL
MSAGC

MR. S. SAITO
LEADER, JST

I. DATE AND TIME: 18th July, 1994 10:05 ~ 12:10
15:05 ~ 17:40
19th July, 1994 10:00 ~ 12:05

II. PLACE: Director General's office

III. ATTENDANTS:

1) Mongolian side

Dr. J. Sanjaajamts	Director General, MSAGC
Mr. H. Jargal	Engineer of Technical Control, Aerial Surveying and Mapping Enterprise of Mongolia (ASMEM)

2) Japanese side

Mr. S. Saito	Leader, JST
Dr. K. Muraoka	Deputy Leader, JST
Mr. K. Okumura	Mapping Planner, JST
Mr. H. Yoshida	Chief engineer, JST
Mr. T. Horiuchi	Interpreter, JST

IV. The JST submitted a report "Progress Report of the Third Year's Field Work for the Topographic Mapping of Ulaan-Tsav Area in Mongolia" (Annex-1), along which the progress of the field work is briefed. The JST reported the field work was completed as planned. The MSAGC was satisfied with the progress of the work and the meeting accepted the report.

V. The JST explained the succeeding study of this Phase after going back to Japan: the preparation of the manuscript of compilation. They also touched upon the study of the next phase.

VI. The MSAGC proposed that the colour of ink shall be black, brown, blue and yellow and that other colours shall be represented by the combination of the above fours colours. The JST accepted the proposal.

VII. The JST recommended the prompt submission of A2 and A3 form of the candidate for the counterpart training of this year through the diplomatic channel like last year. The MSAGC appreciated the recommendation.

VIII. The conventional signs and their application rule to be used for the Study was discussed by a small group composing of MSAGC members and JST members in the last Phase. The discussions were also held in this Phase by the same group from time to time in Ulaanbaatar and in Choibarsan. The report of the discussions was submitted to the meeting as "Technical Discussions on Conventional Signs and their Application Rule for the 1/25,000 Topographic Map" (Annex-2). After discussions the Meeting accepted the report adding the following modifications:

Code No.	Name	Treatment	Remarks
a. Geodetic point			
---	Decimal point	Change	When the numeral stands for the distance between two points the decimal point shall be (,).
b. Contour line			

215	Contour value	Change	According to the situation of contour lines, contour values can be written down upside down.

d. Hydrography

179 180 182	Well	Change	The abbreviated annotation shall not be applied to the well out of use.
175	Pipeline	Addition	The conventional sign of the pipeline crossing over a road shall be added. The height of the pipeline above the road surface shall be shown.

g. Constructions

---	Buildings isolated from an urban area	Change	Classified abbreviated annotation shall not be applied, but only the abbreviated annotation (б а й ш) representing a building.

IX. The JST expressed their indebtedness to the MSAGC for their contribution to the Study in administration and execution of the field work, as well as to the Dornod Aymag in providing us necessary documents.

MINUTES OF MEETINGS
ON
TOPOGRAPHIC MAPPING
OF
ULAAN-TSAV AREA
IN
MONGOLIA
BETWEEN
MONGOLIAN STATE
ADMINISTRATION OF GEODESY
AND CARTOGRAPHY (MSAGC)
AND
JICA STUDY TEAM (JST)

ULAANBAATAR, 12 JUNE, 1995

DR. J. SANJAAJAMTS
DIRECTOR GENERAL
MSAGC

MR. S. SAITO
LEADER, JST

MR. K. HAYASHI
CHIEF, FIRST PLANNING SEC.,
PLANNING DIV., CARTOGRAPHIC DEPT.,
GEOGRAPHICAL SURVEY INSTITUTE

I. DATE AND TIME: June 6 11:00 - 12:10
15:30 - 17:50
June 7 10:20 - 12:20

II. PLACE: Director General's office

III. ATTENDANTS:

1) Mongolian side

Dr. J. Sanjaajamts	Director General, MSAGC
Mr. Z. Bataa	Referent, MSAGC

2) Japanese side

Mr. K. Hayashi	Chief, First Planning Sec., Planing Div., Cartographic Dept., Geographical Survey Institute (GSI)
Mr. S. Goto	Legal Affairs Div., General Affairs Dept. Japan International Cooperation Agency (JICA)
Mr. S. Saito	Leader, JST
Dr. K. Muraoka	Deputy Leader, JST
Mr. K. Okumura	Mapping Planner, JST
Mr. H. Yoshida	Chief Engineer, JST
Mr. M. Onaka	Member, JST
Mr. T. Horiuchi	Interpreter, JST

IV. a. Dr. Sanjaajamts, Director General, MSAGC, welcomed JST and hoped success in this year's field survey and proposed to give JST every facility they need.

b. Mr. Saito, Leader, JST, appreciated the assistance in clearing smoothly the formalities in entering the country at the airport by the persons of MSAGC and pre-arrangements including the assignment of counterpart engineers and drivers to work with JST in the field.

V. JST briefed the following items in line with the Plan of Operations (P/O) for the Study of the Topographic Mapping of Ulaan-Tsav Area prepared by JICA as attached (Attachment).

a. The whole scope of the Study

b. The study so far executed

c. The study items and schedule for the present phase

d. The assignment which shall be imposed on both sides

After discussions, the P/O was accepted by the Mongolian side.

VI. Concerning the description related to the present mapping in the marginal information, both sides agreed as follows. The sentences shall be entered outside the outer left neat line in parallel with it.

Энэхүү газрын зургийг Монгол, Японы Засгийн газар хоорондын хэлэлцээрийн дагуу техникийн хамтын ажиллагааны хөтөлберийн хүрээнд Японы олон улсын хамтын ажиллагааны агентлаг (ЖАЙКА), Улсын геодези, зураг зүйн газар (УГЗЗГ) хамтран гүйцэтгэв.

This map was prepared jointly by Japan International Cooperation Agency (JICA) and Mongolian State Administration of Geodesy and Cartography (MSAGC) under the Technical Cooperation between the Government of Japan and the Government of Mongolia.

MINUTES OF MEETINGS
AT
THE COMPLETION
OF
THE FOURTH YEAR'S FIELD WORK
FOR
TOPOGRAPHIC MAPPING
OF
ULAAN-TSAV AREA
IN
MONGOLIA
BETWEEN
MONGOLIAN STATE
ADMINISTRATION OF
GEODESY AND CARTOGRAPHY
(MSAGC)
AND
JICA STUDY TEAM
(JST)

ULAANBAATAR, 28TH JULY, 1995

DR. J. SANJAAJANTS
DIRECTOR GENERAL
MSAGC

MR. SHO SAITO
LEADER, JST

I. DATE AND TIME: 24th July, 1995 11:15 ~ 12:45
14:55 ~ 17:20
25th July, 1995 14:40 ~ 15:50

II. PLACE: Director General's office

III. ATTENDANTS:

1) Mongolian side

Dr. J. Sanjaajamts	Director General, MSAGC
Mr. H. Jargal	Engineer of Technical Control, Aerial Surveying and Mapping Enterprise, MSAGC
Mrs. B. OYUNCHIMEG	Inspetor, MSAGC

2) Japanese side

Mr. S. Saito	Leader, JST
Dr. K. Muraoka	Deputy Leader, JST
Mr. K. Okumura	Mapping Planner, JST
Mr. H. Yoshida	Chief Engineer, JST
Mr. A. Onaka	Member, JST
Mr. T. Horiuchi	Interpreter, JST

IV. At the last meeting in June, the specifications for map printing were discussed. The results were confirmed and agreed by both parties as given in Annex-1.

V. The JST submitted a report titled "Progress Report of the Fourth Year's Field Work of the Topographic Mapping of Ulaan-Tsav Area in Mongolia" (Annex-2) and, referring to the report, the progress of the field work was briefed. The JST reported the field work was completed as planned. The MSAGC was satisfied with the progress of the work. After discussion the Mongolian side accepted the report.

VI. As a result of the field work, addition of conventional signs and/or change of their application were introduced. The result is tabulated on pages 7-10 of the Progress Report. After discussion, the result is modified as follows:

1) Wells without data shall be shown by only conventional sign on the map. The effect shall be entered in the report.
2) Water velocity and direction of a river shall be entered near the annotation of a river.
3) For rivers represented with single line, only the conventional sign indicating water direction shall be entered.
4) The annotation of destination of two roads close to each other shall be entered in their center.
5) The conventional sign of No. 101, "traces of railway site", shall be the same as that of Nos 90-1 and -2, "railway".
6) Only triangulation points with their coordinates shall be shown. For triangulation points without height shall be shown only with their conventional sign. When the spot height and newly plotted triangulation point are superimposed on each other, the spot height shall be deleted.

VII. On account of the change of the circumstances of areas the JST proposed the necessity of changing sheet name of 8 sheets. After discussion the proposal was accepted by the Meeting.

VIII. The final product (printed map) shall be distributed among other agencies and local governments. To facilitate their understanding on the map, MSAGC requested to provide them with a report written in Russian. The Team took note of the request.

IX. The JST explained the succeeding study of this Phase after going back to Japan: drafting and printing. They also touched upon the study of the next phase: the rest part of printing.

X. The JST expressed their indebtedness to the MSAGC for their contribution to the Study in administration and execution of the field work, as well as to the Dornod Aymag and Som concerned in providing them necessary documents.

DISCUSSION OF PRINTING ON THE BASIS OF A TRIAL MAP

Tovards the end of meetings, HSAGC and the Team discussed the specifications of printing on the basis of trial maps Nos 1, 2 and three proposed by the Team. The points vere as follovs:

1. Colour tone
   *The colour tone of objects represented on the map shall be as close as possible to that specified in the Russian specifications.
   *The colour tone of No. 1 is best as a vhole.

2. The tone of the colour represented by the superposition of different colour (representation of 5 colours vith the combination of 4 colours)
   *The colour shoving a quarter vith many non-firepoof buildings shall be produced vith the superposition of yellov and brovn.
   *The percentage of a half-tone screen of each colour shall be determined by the Team.

3. Representation of surface colour
   *The surface colour shall be represented by a half-tone screen in place of a linear zip-a-tone. The percentage of a half-tone screen shall be determined by the Team.

4. The size of a printed map sheet
   *The size of a printed map sheet shall be proposed by a counterpart for printing.

5. Marginal information

*The index map of the whole Study area shall be entered.

*The map history shall be entered on the right side as shown in the following figure both in Mongolian and English.