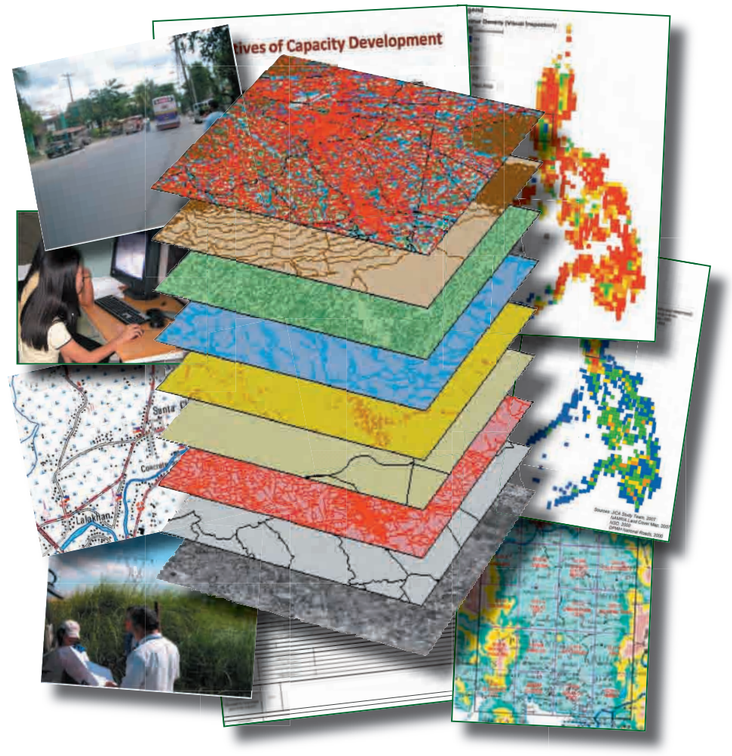
Japan International Cooperation Agency (JICA)

National Mapping and Resources Information Authority (NAMRIA)

No.

# The Study for Mapping Policy and Topographic Mapping for Integrated National Development Plan in the Republic of the Philippines

## Final Report
## Volume 3
## Specifications




## March 2008

Pasco Corporation

Nomura Research Institute, Ltd.

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# for
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## Final Report

## Volume III

## Specifications

**March 2008**

**Pasco Corporation**

**Nomura Research Institute, Ltd.**

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# Specifications for Topographic Mapping at Scale of 1:50,000

EDITION 1

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# Part 1 General

## Chapter 1 General

### Article 1 Purpose

The purpose of the specifications is to define the methods of topographic mapping executed by NAMRIA or by contracted entities and accuracies regarding topographic mapping.

### Article 2 Scope of specifications

The scope of the specifications covers: control survey; topographic-mapping work by the digital method; reproduction-film preparation for topographic maps; and printing work.

### Article 3 Mapping criteria

The execution of the survey and topographic mapping work specified in Article (Scope of Specification), shall follow the items of the reference ellipsoid, the horizontal control datum and the original BM, and system of coordinate defined by NAMRIA.

1. Elements of the geodetic survey

To secure exchangeability of outputs, the following geodetic and mapping elements shall be used for topographic mapping.

| Item | Element | Description |
|---|---|---|
| Reference Ellipsoid | Clarke1866 | Semi major radius: 6378,206.400m<br>Flattening: 1/294.9786982 |
| Horizontal Datum | PRS92 | |
| Vertical datum | Mean sea level | Refer to existing BM |
| Geoid Model | EGM96 | OSU |
| Transformation parameters<br>WGS84 to PRS92 | 127.62195 m<br>67.24478 m<br>47.04305 m<br>–3.06762 sec<br>4.90291 sec<br>1.57790 sec<br>$1.06002 \times 10^{-6}$ | Delta X<br>Delta Y<br>Delta Z<br>Rotation around X axis<br>Rotation around Y axis<br>Rotation around Z axis<br>Delta Scale |

2. Mapping elements

The accuracies of plane and elevation of the topographic maps shall be defined as follows:

| Item | Element | Description |
|---|---|---|
| Map projection | UTM | Zone 50, 51, 52 |
| Size of map | 15 min x 15 min | Refer to Map index |
| Map symbols | PMS50K<br>(Philippine Map Symbols for 50K) | Should be prepared by this project |
| Representation of terrain | Contour | 20 m interval |
| Accuracy of Plane | Less than 0.5 mm on map | In USGS |
| Accuracy of Elevation | $\sigma$ 0=10 m | 1/2 of contour interval for contour |

| | | |
|---|---|---|
| | σ 0=7 m | line<br>1/3 of contour interval for spot height |
| Numbering System of Map sheet | | Index of Topographic maps at a scale of 1:50,000 in 701 series |

Notes : <definitions of terms>

The definitions of terms used in the specifications are as follows:

1) PRS92: Philippines Reference System 92

The new Geodetic System of the Philippines based on the ministerial ordinance in 1992.

2) UTM: Universal Transverse Mercator Projection

A set of Transverse Mercator Projections for the globe which divided into 60 Zones, each covering a 6 degree longitude.

3) Geoid

The shape of the earth as defined by the mean sea level and imagined continuation under the continents at the same level of gravitational potential.

4) PMS50K

The map symbols defined in topographic map at a scale of 1:50,000 in the Philippines.

<Abbreviations to be used>

Abbreviations used in the specifications are as follows:

1) WGS-84: World Geodetic System

2) PTM: Philippine Transverse Mercator

3) DEM (DTM): Digital Elevation Model, (Digital Terrain Model)

4) GPS: Global Positioning System

5) BM: BM

**Article 4 Units of measurements**

The metric system used for survey and topographic mapping shall be based on the measurement method defined by NAMRIA.

**Article 5 Operation plan**

An entity of conducting the survey and mapping (henceforth "executing organization") shall prepare an operation plan based on instructions from NAMRIA and collected source materials, and shall prepare an operation plan document.

2 The operation plan shall be submitted to and approved by NAMRIA. When the operation plan needs to be amended, the amendment shall follow the same procedure.

**Article 6 Process control**

The executing organization shall conduct appropriate process control based on the operation plan specified in Article 5.

2 The executing organization shall report the progress of work to NAMRIA in a timely manner.

**Article 7 Quality control**

The executing organization shall conduct appropriate quality control based on results from the accuracy control tables to be prepared. The accuracy control tables that are the results of the quality control shall be submitted to NAMRIA.

2 The executing organization shall perform necessary inspection at the end of each work process and when it is necessary.

3 The executing organization shall conduct a check survey on subjects specified by NAMRIA promptly after completion of each work process.

**Article 7 <Operation Criteria>**

1. The forms to be used for the accuracy control tables are Accuracy Control Table 1 to 13 in the "appendices-forms."

2. Check survey ratios shall be as follows:

| | |
|---|---|
| Control point survey: | 3% |
| Photo Control point survey: | 3% |
| Topographic mapping: | 2% |

**Article 8 Inspection of instruments**

The executing organization shall submit the official approval document of equipments (software and hardware) used for survey and topographic mapping to NAMRIA for checking and approval.

**Article 9 Inspection of mapping results**

The executing organization shall submit the final topographic-mapping outputs to NAMRIA for checking and approval.

**Article 10 Results**

The survey results and related outputs (henceforth the "results"), shall mean "survey and topographic mapping results", "survey and topographic mapping records", and "source materials"; the contents are as follows:

(1) Survey topographic-mapping results: Results obtained as the final outputs in each work process.

(2) Survey and topographic mapping records: Records obtained in each work process for the purpose of acquiring the final survey results.

(3) Source materials: Various source materials obtained in each process for the purpose of keeping records on survey and topographic mapping.

**Article 10 <Operation Criteria>**

The forms to be used shall be defined by NAMRIA in principle.

**Article 11 Special Exceptions to Instruments and Operation Methods**

A method or equipment that is not included in the specification shall be allowed only to a portion specified by the method; the method and the use of equipment shall maintain required accuracy and

operational efficiency and shall be approved by NAMRIA.

2 The method, standards, and work process may be allowed only after approval by NAMRIA.

**Article 12 Submission of results**

An executing organization shall submit survey results to NAMRIA promptly after the end of work with the accuracy control tables specified in Article 7 "Accuracy Control."

2 An executing organization shall submit the survey records and source materials, when it is instructed by NAMRIA.

# Part 2 Control Survey

## Chapter 1 General

### Article 13 Outline

Control survey is work which defines locations of new points based on known points.

2 A control point is a sign installed to be a standard of survey; it has numerical values.

3 A known point is an established control point. It is to be used as given value during a control survey.

4 A new point is a control point newly established by a control survey.

### Article 14 Classification of control survey

A control survey is classified into control point survey (GPS survey) and leveling.

2 A thing that is installed by a control point survey is called control point.

3 A thing that is installed by a leveling is called a BM.

## Chapter 2 Control Point Survey

## Section 1 Outline

### Article 15 Outline

A control point survey is work to define a horizontal position and elevation of a new point based on known points and to prepare the result tables.

2 A control point survey is classified into the first order control point, the second order control point survey and the third order control point survey based on distances between points and relative precision of observation.

### Article 15 <Operation Criteria>

The type of known points, the distance between survey points, and the relative observation accuracy shall be standardized as in the following table:

| Classification | Type of known points | Distance between survey points | Relative precision of observation |
|---|---|---|---|
| The first order control point survey | More than the first order control point | 30 km | 3x10-6 |
| The second order control point survey | The 1-second class control point | 20 km | 1x10-5 |
| The third order control point survey | The 1-third class control point | 10 km | 2.5x10-5 |

### Article 16 Survey method

A GPS survey method shall used in for control point survey.

### Article 17 Work schedule and items

A work flow and work items are as follows:

(1) Plan

(2) Point selection

(3) Installation of a survey marker

(4) Observation

(5) Calculation

(6) Arrangement of results

## Section 2 Plan

### Article 18 Outline

A plan shall be prepared based on Article 5 (Operation Plan) as each survey method is being considered.

2 New points shall be planed by examining approximate positions using maps or others and the network adjustment plan shall be prepared.

3 A control point survey shall be based on a GPS survey method in principle.

### Article 18 <Operation Criteria>

1. A method of survey, equipment used, necessary personnel, work flow, topography, transportation route, and known points etc. shall be considered in planning.

2. A GPS survey shall be conduced in a way to structure a survey network using base-line vectors by connecting known points and new points or new points to new points.

3. When a GPS survey is conducted, the health status and visibility of satellites shall be taken into consideration.

### Article 19 Formation of control point network

A survey network and a joint traverse network (henceforth the "control point network") shall form in consideration of strength of shapes of figures.

2 When the control point network is formed, an elevation shall be determined using a BM as needed.

### Article 19 <Operation Criteria>

1. The following survey method shall be used to determine elevations.

    1) Direct leveling

    2) Indirect leveling by distance and vertical angles

    3) Combination of direct and indirect leveling

    4) GPS survey

2. The survey work described above shall be conducted using nearby BMs.

## Section 3 Point Selection

### Article 20 Outline

The point selection is: to study current conditions of known points on the field using the network adjustment plan; to plan positioning points according to required conditions and density of points; and to determine survey method which is appropriate to reflect topography, vegetation and other local conditions.

### Article 21 Execution of point selection

A new point shall be selected in an appropriate location in consideration of preservation.

### Article 21 <Operation Criteria>

1. The GPS survey method is as follows:

    1) A new point shall be selected in locations which are not influenced by artificial electric wave hindrance or planimetric features and vegetation in principle.

    2) An angle of sky exposure shall be 15 degrees or large to all directions.

    3) When obstacles of receiving electric waver from GPS satellites are recognized at new or known point, an eccentric point shall be installed, or obstacles shall be removed.

### Article 22 Preparation of network adjustment map

A point-selection map shall be prepared including the selected new and known points recorded onto a map.

2 The network adjustment map shall be prepared based on the point selection map as the strengths of shapes are considered.

3 The observation map shall be prepared based on the network adjustment map reflecting the implementation plan of observation.

### Article 22 <Operation Criteria>

1. When there is an eccentric point of known or new point, the location of the eccentric point shall be recorded onto the point selection map.

2. The observation map of a GPS survey method shall show a condition of combination of continuous observation at defined data acquisition intervals using two or more GPS receivers, eccentric points and others.

3. GPS observation shall form a polygon which has known and new points forming a closed traverse routes. The method to be followed is one of the followings.

    1) A polygon is formed for checking by a combination of different sessions.

    2) For checking by different sessions, one or more sides shall be observed twice or more.

## Section 4 Establishment of Monument

### Article 23 Outline

Installing survey markers is to install permanent monuments at locations of new points.

**Article 24 Establishment of permanent monument**

A permanent monument shall be installed for a new point in principle, and protection device shall be established if needed.

**Article 24 <Operation Criteria>**

1. A permanent monument shall be installed in accordance with the specifications and shapes defined by NAMRIA.

2. When there is no implementation rules, the matter is discussed and resolved with NAMRIA.

**Article 25 Survey mark description**

A survey marker description shall be prepared for installed monuments of control points and BMs.

**Article 25 <Operation Criteria>**

1. The survey marker description shall be prepared using a form specified by NAMRIA.

2. When the form is not available, the form shall be discussed and resolved with NAMRIA.

## Section 5 GPS Survey

**Article 26 Outline**

Observation in the GPS survey method (henceforth "GPS observation") means to receives the electric wave from GPS satellites and to record phase data and others.

2 Calculation in GPS survey means to calculate horizontal position of new points, elevations, and other relevant data, and to prepare final result tables.

**Article 27 Performance of GPS receiver**

The major instruments used for observation shall be equivalent to the following GPS receivers:

| | | |
|---|---|---|
| GPS Receiver (dual frequency) | ± (5 mm+1 ppm-D) | The first or second order control point survey |
| GPS Receiver (single frequency) | ± (10 mm+2 ppm-D) | The third order control point survey |

D: Measured distance (km)

**Article 28 Inspection of GPS receiver**

A performance inspection shall be conducted prior to the survey. When necessary, adjustment shall be performed.

2 During the work, proper functional checking shall be conducted when it is necessary.

**Article 28 <Operation Criteria>**

Functions of a GPS receiver is checked on the following items:

1. Optical centering equipment

2. Digital display

3. Antenna cable

4. Connector

5. The range of voltage of a power unit

**Article 29 GPS observation**

A static differential positioning method (henceforth the "static method") shall be used for GPS observation.

2 The GPS observation shall be conducted according to an observation plan per session.

**Article 29 <Operation Criteria>**

1. The vertical difference of ellipsoid can be used in observation which determines an elevation when the distances are less than 500 meters.

2. The observation is performed once in one session.

3. The height of antenna shall be measured to centimeters.

4. The duration of observation shall be as follows:

| Classification | Observation time | Data-acquisition interval |
|---|---|---|
| The first order control point survey | 180 minutes or longer | Less than 30 seconds |
| The second order control point survey | 120 minutes or longer | Less than 15 seconds |
| The third order control point survey | 60 minutes or longer | Less than 15 seconds |

5. Information on conditions and visibility of satellites shall be considered, and uneven use of GPS shall be avoided.

6. The receiving altitude angle of a GPS satellite shall be 15 degrees or higher as standard. However, when securing the sky exposure angles is difficult, the angle is allowed to have 30 degrees or less.

7. Four or more common GPS satellites shall be observed simultaneously.

**Article 30 Measurement of eccentric elements**

When there is eccentricity in an observation point, elements of eccentricity shall be measured by a specified method.

**Article 30 <Operation Criteria>**

1. Measurement of elements of eccentricity applies correspondingly regulation of operation mentioned in the preceding article (GPS observation).

2. When visibility of the zero direction for elements of the eccentric points cannot be secured, the azimuth marker shall be installed.

1) The distance to an azimuth marker shall be four time of the distance of an eccentric point or longer. The minimum distance shall be 100 meters.

2) An azimuth marker can be installed with the static method of GPS observation. The observation time shall be as follows:

| Classification | Observation time | Data-acquisition interval | GPS Satellite to be used |
|---|---|---|---|
| Static | 30 minutes or longer | Less than 30 seconds | four or more simultaneously |
| Shortening Static | 10 minutes or longer | Less than 15 seconds | five or more simultaneously |
| Kinematic | 1 minutes or longer | 1 second | five or more simultaneously |

**Article 31 Base-line analysis computation**

The base-line analysis calculation calculates the three-dimensional relative position relation between observation points, and many components relevant to these using the phase data acquired from the GPS satellite. The results shall be calculated to the following decimals.

| Item | Unit | Grade |
|---|---|---|
| Base-line vector component | meter | 0.001 |

**Article 31 <Operation Criteria>**

1. The calculation of base-line analysis calculation shall be conducted as follows:

    1) The broadcast calendar is used for the orbit element of a GPS satellite in principle.

    2) The latitude, longitude and the ellipsoid elevation used for fixed points of the base-line analysis shall be the values almost exact to the initial values of the WGS84 ellipsoid. The base-line analysis after `setting the initial values shall be conducted by inputting values one by one on the ellipsoid of WGS84 obtained by calculation.

    3) The method of analysis computes the base-line vectors between observation points from the single base-line analysis by session.

    4) The altitude used for the base-line analysis is taken as the receiving altitude set as the GPS survey instrument at the time of observation.

    5) Compensation of a meteorological element is based on the standard atmosphere of the base-line analysis software.

    6) Editing the cycle slip shall be conducted automatically using the base-line analysis software.

**Article 32 Check computation and resurvey**

Checking calculation shall be performed after completion of the base-line analysis calculation. When the set tolerance is exceeded, the survey work shall be conducted again or other appropriate measure shall be taken under the instructions of NAMRIA.

**Article 32 <Operation Criteria>**

1. The observed values shall be checked by one of the following methods.

    1) The checking route shall select a polygon with the least number of sides by combining different sessions. The errors of closure on the components ($\triangle$X, $\triangle$Y, $\triangle$Z) of the base-line vector shall be calculated after selecting the polygon.

    2) The major components of the base-lines overlapping shall be compared and checked.

2. The tolerance levels of check calculation is as in the following table:

| | |
|---|---|
| Closure errors of each element of a base-line vector | 45 mm root N (N: the number of sides) |
| Discrepancy of each component of overlapping base-line vectors | 45 mm |

**Article 33 Adjustment computation**

The adjustment computation shall calculate the horizontal values and elevations of new points by conducting the three-dimensional network adjustment calculation after the check calculation.

2 The program used for the adjustment computation shall be approved by NAMRIA in advance.

**Article 33 <Operation Criteria>**

1. The significance of the values is specified in the following table.

| Item | Unit | Grade |
|---|---|---|
| Longitude and latitude | degree, minutes and second | 0.0001 |
| Ellipsoid elevation | meter | 0.001 |
| Value of angle | degree, minutes and second | 1 |
| Lengths of sides | meter | 0.001 |

2. The three-dimensional network adjustment calculation which fixes one known point (henceforth "tentative three-dimensional network adjustment calculation") is conducted as in the following manner.

   1) The inverse matrix of the variance-covariance matrix called for in base-line analysis is used for the weight (P) of assumed three-dimensional adjustment calculation.

   2) The tolerance by assumed three-dimensional adjustment calculation is based on either of the following.

   a. The tolerance by each component of a base-line vector is summarized in the following table.

| Classification<br><br>Item | 1st order control point survey | 2nd order control point survey | 3rd order control point survey |
|---|---|---|---|
| Deviation of each component of a base line vector | 45 mm | | |
| Closure error of horizontal location | $\Delta S = 10\ cm + 4\ cm\ \sqrt{N}$<br>$\Delta S$: Distance obtained from the result value of a known point and the result of three-dimensional net adjustment computation of false net<br>N: The minimum number of sides to a known point | | |
| Declination of Geoid | The standard value shall be 20 cm + 10 cm·S where S is a spherical distance (km). | | |

b. Tolerances based on the azimuth, slope distance, and ellipsoid relative height

| Classification<br><br>Item | 1st order control point survey | 2nd order control point survey | 3rd order control point survey |
|---|---|---|---|
| Deviation of azimuth | 1 second | 3 seconds | 7 seconds |
| Deviation of slope distance | 20 mm + 4 ppm·D D: Measuring distance (km) | | |
| Deviation of ellipsoid relative height | 30 mm + 4 ppm·D D: Measuring distance (km) | | |
| Closure error of horizontal location | $\Delta S = 10cm + 4cm \sqrt{N}$<br>ΔS: Distance obtained from the result value of a known point and the result of three-dimensional net adjustment computation of false net<br>N: The minimum number of sides to a known point | | |
| Declination of Geoid | The standard value shall be 20 cm + 10 cm·S. | | |

3. The three-dimensional adjustment calculation which fixes three or more known points is conducted as follows. However, when there is an unusual known point, it shall be removed from fixed points.

   1) The elevation determination of a new point is based on one method of the following:

   a. A vertical deviation is assumed to be the unknown value and the elevation of a new point is calculated by the three-dimensional adjustment calculation.

   b. A local geoid model is calculated by GPS observation and leveling; the geoid elevation is rectified.

   2) The inverse matrix of the variance-covariance matrix required in a base-line analysis is used for the weight (P) of three-dimensional adjustment calculation.

   3) The tolerance by three-dimensional adjustment calculation carries out as in the following table. However, values beyond the tolerance shall be examined against the observation values and calculation processes, and be treated according to NAMRIA's instruction.

| Classification<br><br>Item | The first order control point survey | The second order control point survey | The third order control point survey |
|---|---|---|---|
| Standard deviation of a new point horizontal position | 10 cm | | |
| Standard deviation of new point Elevation | 20 cm | | |

**Article 34 Results**

The results are as follows:

(1) Final result table

(2) Index map of control points

(3) Field note

(4) Original draft result tables

(5) Computation book

(6) Description of station

(7) Accuracy control table

(8) Checking survey field note

(9) Network adjustment plan

(10) The terrestrial photograph of a survey marker

**Article 34 <Operation Criteria>**

All or a part can be outputted using a printer of a data processing system or an automatic drafting machine.

## Chapter 3 Leveling

## Section 1 Outline

**Article 35 Outline**

Based on a known point, leveling defines elevations of new points and means the work which creates a final result table.

**Article 36 Classification of leveling**

Leveling is classified into the first order leveling, the second order leveling, and the third order leveling according to the accuracy and the observation method of the type of known point, a leveling route, and observation.

**Article 37 Work schedule and items**

A work flow and work items are as follows:

(1) Plan

(2) Point selection

(3) Installation of permanent monuments

(4) Observation

(5) Calculation

(6) Arrangement of outputs

## Section 2 Plan

**Article 38 Outline**

A plan shall be prepared in accordance with Article 5 (Operation Plan). New leveling routes are planned using maps; locations of new points are determined; and the net adjustment plan shall be prepared.

**Article 39 Leveling route**

A leveling route is a line connecting BMs and has classes as follows. When there are existing BMs

in NAMRIA, the points shall be connected according to the levels of accuracies.

(1) The first order leveling route

The first order leveling route forms a network with a national original BM or NAMRIA BM (first grade BM) as a starting point and a terminal point.

(2) The second order leveling route

The second order leveling route is a route connecting a NAMRIA BM (first grade BM) or the first class BM. However, when local conditions do not allow such connection, the route can be a circuit type closing at the starting point.

(3) The third order leveling route

The third order leveling route is connected and formed at NAMRIA BM (1, 2 grade BM) or the first class BM, and the second class BM. However, when a local condition does not allow such connection, the route can be a closure-type or open type.

**Article 39 <Operation Criteria>**

The route lengths by class are as in the following table:

| Classification | The first order leveling | The second order leveling | The third order leveling |
|---|---|---|---|
| Route length | 400 km or less | 200 km or less | 50 km or less |

**Article 40 Interval of BM**

The distribution density of BMs shall be determined by NAMRIA in principle.

**Article 40 <Operation Criteria>**

Unless otherwise indicated, the distribution density shall be as follows:

1) The first class BM and the second class BM are installed every 2 km in principle.

2) The third class BM is installed every 4 km in principle.

## Section 3 Point Selection

**Article 41 Outline**

Point selection is work, which involves an on-site route study; to plan location of new points on maps; and to verify the validity of selection from the view points of installation of BMs, maintenance and uses.

**Article 42 Execution of point selection**

New points shall be selected at stable ground and suited for preserving survey markers.

**Article 42 <Operation Criteria>**

1. The locations of new points shall be planned with a map as road routing alteration; improvement and development are being considered not to cause losses or relocation of points.

2. New installment or improvement shall be determined after conditions of existing BM are studied.

### Article 43 Preparation of leveling route map

A point-selection plan shall be prepared by recording existing and new points onto maps or other sheets.

2 The adjustment plan shall be prepared based on the point selection plan.

## Section 4 Installation of Survey Marker

### Article 44 Outline

Installation of survey marker is work of installing permanent monuments at locations of new points.

### Article 45 Establishment of permanent monument

A permanent monument shall be installed at new points in principle, and protective facilities shall be placed when necessary.

### Article 45 <Operation Criteria>

1. A permanent monument shall be placed in accordance with specifications and forms specified by NAMRIA.
2. When there is no regulation in NAMRIA, the specifications shall be discussed with NAMRIA and determined.

### Article 46 Survey mark description

When a permanent monument is installed, a description of station shall be prepared.

### Article 46 <Operation Criteria>

1. A survey mark description shall be prepared for all BMs.
2. The survey mark description shall be prepared using a format of NAMRIA.
3. When there is no such regulation in NAMRIA, the format shall be discussed with NAMRIA and determined.

## Section 5 Observation

### Article 47 Outline

Observation is work of determining height differences between BMs using a level and staff in accordance with a leveling route plan.

### Article 48 Performance level

The major instruments to be used for observation shall satisfy the following functional specifications.

| Classification | Performance | Leveling classification |
|---|---|---|
| first order level | Bubble sensitivity 10" / 2 mm<br>(Equipped with a precision reading feature using a plane mirror, etc. or a precision reading feature through image processing, etc.) | first order leveling |
| second order level | Bubble sensitivity 20" / 2 mm<br>(Including those equipped with a precision reading feature through image processing, etc.) | second order leveling |
| third order level | Bubble sensitivity 40" / 2 mm<br>(Including those equipped with a precision reading feature through image processing, etc.) | third order leveling |
| first order staff | Graduated circle made of invar tape having a both-side graduated scale with 10 mm or 5 mm intervals or a bar-code scale with a scale accuracy of 100 μm/mm/m | first order leveling<br>second order leveling |
| second order staff | Graduated circle made of invar tape or precision wood having a graduated scale with 10 mm or 5 mm intervals or a bar-code scale.<br>A folding staff, if used, shall have a precise joint and a stable structure. | third order leveling |
| Calculator for leveling work | It shall have performance specified by JICA. | A calculator specified by JICA shall be subject to certification. |

An auto level or electronic level which has equivalent computer functionality shall be allowed for use.

**Article 49 Inspection of level**

Equipment used shall be inspected on its functional performance before work. It is to be adjusted when necessary.

2 During the work, when necessary, functions of equipment shall be checked.

**Article 49 <Operation Criteria>**

1. A level shall satisfy the following functions to be inspected.

    1) Functional check

    a. Rotation of vertical axis

    b. Bubble tube adjustment feature and movement of the bubble

    c. The telescope diopter adjustment function

    d. The line of sight adjustment feature

    e. Rotation of setting screws

    f. Rotation of the micrometer

    g. The digital display of an electronic level

    2) Adjustment

a. The adjustment of the circular bubble tube of a level shall start with placing the level and leading the bubble to the center. Next, the main body shall be turned 180 degrees, and the central location of the bubble shall be confirmed. When the air bubble has shifted from the center, a bubble tube is adjusted so that air bubbles may come to the center using a leveling screw, a bubble-tube adjustable screw, etc. After the adjustment, the main body shall be turned 90 degrees to confirm the location of the bubble in the center.

b Two staffs are to be placed 30 m apart correctly. A level is placed in the middle, and the difference of elevation between the staffs is measured. Then, the location of a level is moved 18m along the straight line connecting the two staffs. The difference of elevation between both staffs is measured again. The values of difference shall be checked if they are within the range of tolerance.

c. For an auto-level and electronic level, the checking item b shall be conducted. Further, checking will be conducted in two states: keeping the level horizontal in the midpoint between the two staffs that are 30 meter apart; and keeping it inclined while the outer edge of the air bubble of the circular bubble tube is touching inside of the circle.

d. The units of reading and the tolerances are indicated in the following table:

| Classification | first order level | second order level | third order level |
|---|---|---|---|
| Unit of reading | 0.01 mm | 0.1 mm | 1 mm |
| Tolerance | 0.3 mm | 0.3 mm | 3 mm |

2. The leveling staff shall be subject to the following inspections:

   1) The leveling staff shall be normal, free of abnormalities, peeling, and dents.

   2) The attached bubble tube adjustment screw shall function normally.

   3) The crease part of the staff shall be normal.

3. The approval by an official inspection agency specified by NAMRIA on the first order leveling staff shall be valid for three years.

**Article 50 Execution of observation**

The observation shall be performed as follows:

(1) A both-way observation shall be conducted.

(2) Two staffs shall make one set, and the staffs shall be numbered (I and II). A staff used for one direction needs to be exchanged to the number II staff during the return process.

(3) The number of survey points shall be an even number between BMs during the both-way observation.

(4) The distances from the level to the fore-sight staff and from the level to the back-sight staff shall be equal, and the two staffs and the level shall be placed along a straight line as much as possible.

(5) The sight lengths and significant figure of reading are summarized in the following table by the classification of leveling.

| Classification | first order leveling | second order leveling | third order leveling |
|---|---|---|---|
| Length of sight | 40 m max. | 60 m max. | 70 m max. |
| Unit of reading | 0.1 mm | 1 mm | 1 mm |

The sight length can be 50 meters for the first order leveling when a level other than an electric level is used.

(6) Two specific legs of a level shall be parallel to the line of sight. The setting of the legs shall be reversed at each observation point. The telescope shall be aimed to a specific staff.

**Article 50 <Operation Criteria>**

1. Distances from the staffs to the level shall be measured and recorded. When the distances are not equal, the fore-sight staff or the level needs to be moved to secure equal distances.

2. The observation shall be made once per view. The reading order is as in the following table:

| Order<br>Classification | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| first order leveling | Back sight | Foresight | Foresight | Back sight |
| second order leveling | Back sight | Back sight | Foresight | Foresight |
| third order leveling | Back sight | Foresight | - | - |

3. In the first order leveling, the part lower than 20 cm of a staff is discouraged to be used for reading.

5. The tolerance of discrepancy of the both-way observation is as in the following table:

| Classification | first order leveling | second order leveling | third order leveling |
|---|---|---|---|
| Discrepancy between forward and backward observation | 2.5 mm √S | 5 mm √S | 10 mm √S |
| | S: Observed distance (one way, km) | | |

If the rules and regulations are available in NAMRIA, the tolerance of NAMRIA shall be used.

5. When an electronic level is used, the observation shall be made after confirming that there is no vibration effect in the view of the telescope in an area where such vibration is expected.

**Article 51 Resurvey**

If discrepancies of the both-way observation exceed the tolerance levels specified according to the classification, a resurvey shall be conducted.

Article 51 <Operation Criteria>

When a resurvey is conducted, the observation values of the same direction shall be used for the first and second order leveling.

## Section 6 Computation

### Article 52 Outline

Computation is work of preparing a result table by conducting an adjustment calculation on elevation of new points by specific computation methods.

2 The elevation of BMs shall be calculated by the leveling network adjustment computation with the staff adjustment and the ellipsoid adjustment if such adjustments are required.

### Article 52 <Operation Criteria>

1. The adjustment computation for the staffs and the ellipsoid shall be conducted for the first and second order leveling.

2. The significant values to be read shall be the same as in the reading units.

### Article 53 Article 53 Check computation and resurvey

When observation is completed, specified checking calculation is performed promptly to ensure validity of observation. When the values exceed the tolerance, necessary resurvey sessions need to be conducted.

### Article 53 <Operation Criteria>

1. All the circuits and leveling routes selected according to a condition specified, circuit closure errors and closure errors from known points to other known points are calculated, and the validity of observation is determined.

    1) A check route connects a known point and another known point.

    2) The check route shall be as short as possible.

    3) All known points shall be connected to at least one check route.

    4) As for all circuits, at least one part shall overlaps to a check route.

2. The tolerance of the check calculation is as in the following table.

| Classification | first order leveling | second order leveling | third order leveling |
|---|---|---|---|
| Circuit closure error | 2 mm √S | 5 mm √S | 10 mm √S |
| Closure error from a known point to another known point | 15 mm √S | 15 mm √S | 15 mm √S |

note: S is an observed distance (one way, unit: km)

### Article 54 Adjustment computation

After the completion of checking calculation, the elevation of new points shall be determined by the adjustment computation.

2 Adjustment computation shall be performed using the leveling-network adjustment computation

program approved by NAMRIA in principle.

**Article 54 <Operation Criteria>**

1. The weight used for adjustment computation shall be the inverse of observation distances.
2. The tolerance of adjustment computation is as follows:

| Classification | first order leveling | second order leveling | third order leveling |
|---|---|---|---|
| Standard deviation of observation per unit of weight | 2 mm | 5 mm | 10 mm |

**Article 55 Results**

The results shall include the followings:

(1) An observation result table and adjustment computation table

(2) Leveling-route map

(3) Field note

(4) Adjustment computation book

(5) Description of station

(6) Accuracy control table

# Part 3 Digital Topographic Mapping at Scale of 1:50,000

## Chapter 1 General

### Section 1 Outline

#### Article 56 Outline

Topographic mapping (digital topographic mapping) work means to prepare new topographic maps (digital topographic maps) from the results of new survey works; it includes digitizing existing topographic maps.

Digital ortho-photograph preparation is specified in Appendix 2 a "Manual for Digital Ortho Photograph Preparation."

#### Article 57 Accuracy of topographic maps

The standard accuracy of topographic maps is shown in the following table. The horizontal accuracy of digital topographic maps shall be the accuracy of topographic map information level equivalent to scales.

| Classification | | Accuracy (standard deviation) |
|---|---|---|
| Horizontal location of a planimetric feature | | 0.7 mm or less on the map |
| Elevation | Elevation point | One-third or less of contour line intervals |
| | Contour line | One-half or less of contour line intervals |

#### Article 58 Definition of terms

The terms used shall conform to the following definitions:

(1) Digital topographic map: It refers to a map which can be digital processed. The data may include geographic data such as topography and planimetric features with coordinate values which show locations and shapes as attribute data.

(2) Digital mapping: The work involves data acquisition of topographic and planimetric features by a method of photogrammetry. The data are systematically arranged using computation technology to structure a digital topographic map.

(3) Map information level: It shows expression accuracy of digital topographic maps, such as topography and planimetric features, created by the digital-topographic-map preparation work. It serves as indices which show average comprehensive accuracy of data in the neat lines of a digital topographic map.

(4) Acquisition classification: It arranges the map information systematically, and is expressed with codes.

(5) Digital photogrammetry: It is work which performs three-dimensional measurement for digital imaging or the digital imaging by which A/D conversion was carried out using a digital stereo plotter.

(6) Digital stereo plotter: It has automatic orientation, stereo matching and image -processing functions. It is a computer system which is capable of producing a digital terrain model and ortho-image data.

**Article 58 <Operation Criteria>**

The relationship between map information levels and map scales is shown in the following table:

| Map information level | Corresponding map scale |
|---|---|
| 25000 | 1 / 25,000 |
| 50000 | 1 / 50,000 |
| 100000 | 1 / 100,000 |

## Section 2 Digital-Topographic-Mapping

**Article 59 Outline**

Digital-topographic mapping is a work of preparing topographic maps in a digital form.

**Article 60 Classification of digital topographic mapping**

Digital-topographic-mapping is classified into digital mapping and digitizing existing maps.

**Article 61 Map Symbols**

The map symbols for digital mapping shall be specified in Appendix 1 "PMS50 K Specifications for Map Symbol for Topographic Map at Scale 1:50,000 of Republic of the Philippines."

**Article 62 Digital map data structures**

The composition of the data file for digital topographic mapping (henceforth a "data file") is structured with specifications of coordinate system, classification code and accuracy.

**Article 63 Representation of topographic features**

Expression of topography in a digital topographic map shall be based on contour lines or digital elevation model (DEM).

**Article 64 Unit of data files**

The unit of a data file shall be a fundamental unit for data management of a digital topographic map. The area surrounded by neat lines is the fundamental unit of data in principle.

**Article 65 Data of a digital topographic map**

The data of a digital topographic map shall be classified into structure data and topographic-map data.

(1) Structured data are the data with geometric structure given to edited data of which transposition of horizontal positioning or intermission has not been conducted.

(2) Topographic data are the data equivalent to the original of topographic maps with horizontal transposition; intermission and comprehensive drawing processing have been conducted.

**Article 66 Mapping equipment**

The instrument used for edit and the output of a digital topographic map shall have the following functions and capabilities"

(1) Editing equipment shall consist of a computer with a display, and perform addition, deletion, correction of mapping data.

(2) An output equipment shall have a position accuracy of 0.2 mm or less. It shall be an ink-jet plotter or equivalent which enables printing of various types of lines onto less elastic paper.

**Article 67 Mapping method**

The digital mapping has the following system:

(1) A method of using digital images

It is a method of photogrammetry which utilizes aerial photographs in a digital format or satellite images to acquire topographic and planimetric data.

2 Depending on conditions of a survey area, the method of using digital images can be supplemented by the method of digitization of existing topographic maps which is specified in Chapter 12 (Existing Map Digitization and Revision).

**Article 68 Work schedule and items**

A standard digital mapping process and work items are as follows:

(1) Use of digital images

a. Use of aerial photographs in a digital format

1) Control point survey

2) Air-photo-signal installation

3) Photography

4) Pricking

5) Field verification

6) Raster-data acquisition of aerial photographs

7) Aerial triangulation

8) Digital plotting

9) Digital editing

10) Field compilation and supplementary digital editing

11) Data structurization

12) Preparation of data files and storage

b. Use of satellite images

1) Preparation of image data

2) Photo control point survey

3) Air-photo-signal installation and pricking

4) Field verification

5) Aerial triangulation

6) Digital plotting

7) Digital editing

8) Field compilation and supplementary digital editing

9) Data structurization

10) Preparation of data files and storage

## Chapter 2 Photo Control Point Surveying

### Article 69 Outline

A photo control point survey is work which newly installs control points and BMs (henceforth a "photo control point") required for aerial triangulation and digital-plotting work based on established control points.

### Article 70 Accuracy of photo control points

The accuracy of a control point shall be based on the following classification:

| Map information level | Horizontal location (standard deviation) | Elevation (standard deviation) |
|---|---|---|
| 25000 | 2.0 m or less | 1.0 m or less |
| 50000 | 2.0 m or less | 2.0 m or less |
| 100000 | 3.0 m or less | 4.0 m or less |

### Article 71 Survey method

The GPS survey method is used for the control points and the third order leveling (henceforth "lower order leveling") shall be used for BMs. Leveling work may employ the GPS leveling method.

### Article 72 Plan

Planning of the photo control point survey shall be conducted in accordance with Article 5 (Operation Plan). The plan shall be based on the conditions of existing points and the scale of topographic maps.

2 The locations of photo control points shall be selected in consideration of existing condition of control points, flight plan and aerial triangulation.

### Article 73 <Operation Criteria>

1. The GPS survey method shall be conducted as follows:

   1) When the distance between a known point and a control point exceeds 10 km, the rules and regulations regarding the second order control point survey shall be applied.

   2) When the distance between a known point and a control point is less than 10 km, the rule and regulations regarding the third order control point survey shall be applied.

   3) Indirect leveling may be used to determine elevations.

2. A low order leveling shall be conducted as in the following manner.

   1) A leveling route shall start from a BM or a control point and be connected to other BM or a

control point.

2) The route may become a closed type when connecting to other BM is not possible because of topographic condition. When a route is short, the route can be an open type.

3) The length of one route shall be 50 km or less.

3. The indirect leveling shall apply the standards of the third order control point survey.

4. The GPS leveling shall apply the third order control point survey by the GPS survey method.

**Article 73 Execution**

The process of the photo control point surveying shall be as follows:

(1) Point selection

(2) Installation of survey markers

(3) Observation

(4) Calculation

2 Implementation of the photo control point survey shall follow the rules of Part 2 Control Survey except for the rules stipulated in this Chapter.

**Article 74 <Operation Criteria>**

1. The work of point selection shall be conducted in the field in accordance with Article 73 (Photo Control Point Planning).

2. The observation and calculation shall be conducted as follows:

1) GPS survey method

a. The number of observation sessions and other standards, in the case of the short static method, shall as follows:

- The number of observation sessions: One session

- Observed time: 60 minutes or longer

- Data-acquisition interval: Less than 15 seconds

- Common GPS Satellite to be used: Five or more

- Survey method: The linking method of three known points.

However, when a control point is within 0.1x S (S is a distance between known points) km from a straight line connecting two known points, the known points can be reduced to two points.

b. When the discrepancy of differences in ellipsoid heights and elevations exceed the tolerance between known points, the elevation of a photo control point shall be determined by adjusting geoid inclination. When the discrepancy does not exceed, the adjustment of geoid inclination is omitted.

c. Tolerance of an error of closure in observation is indicated in the following table:

| | |
|---|---|
| Circuit error of closure of the elements of the base-line vector | 5 ppm (closure errors/total lengths) |
| Discrepancies of elements of overlapping base-line vectors | 50 mm |

d. The range of accuracy for portable GPS is as follows:

| | |
|---|---|
| RMS | 5 m or less |

3) Low order leveling

a. The observation shall be one-way observation in accordance with the standards of the third order leveling. As for the open type of route, a both-way observation shall be conducted.

b. The closure error shall be within the following tolerance range:

| Classification | Closure error from one known point to another known point | Circuit closure error | Discrepancy of go and back observation values |
|---|---|---|---|
| Discrepancy | 50 mm √S | 40 mm √S | 40 mm √S |

S is an observation distance (one way, unit: km).

c. The location of pricking performed in parallel to observation shall be 2-4 km spacing. And it is the location of the staff which is placed to points clearly visible onto aerial photographs or satellite images.

4) GPS leveling

a. The method of observation shall be the traverse route method which connects from a known point of elevation to another known point.

b. The locations of pricking points, the work conducted along with the observation, shall have two to four kilometers apart in principle. The points shall be clearly visible on an aerial photograph or a satellite image.

**Article 74 Results**

The results are as follows:

(1) Photo control point result table

(2) Photo control point distribution map and leveling-route map

(3) Control points survey register and control points details register

(4) Aerial photo (enlarged copy) with photo control points

(5) Accuracy control table

## Chapter 3 Premarking and Pricking

**Article 75 Outline**

Premarking and pricking are to install marks at control points, BMs and photo control points (henceforth a "control point") required for aerial triangulation and digital plotting. Pricking is a work of showing locations onto aerial photographs or satellite images for survey.

**Article 76 Plan**

A plan for aerial photo signal installation and pricking shall be prepared in consideration of the aerial triangulation and digital plotting processes.

**Article 77 Premarking**

The locations of installing air-photo signals shall be approved by NAMRIA in advance.

2 The air-photo signals shall be installed securely by using materials which can be preserved until the completion of aerial photography.

3 The air photo signal shall have a color and shape of which locations can be recognized on aerial photographs or satellite images. The center point of the air-photo signals shall be correctly identifiable, also.

**Article 78 <Operation Criteria>**

1. Secure sufficient sky exposure

2. Select a location which has a good background condition

3. When a direct installation is difficult, an eccentric survey shall be conducted to install a signal. The elements of the eccentric survey method shall have adequate accuracy for the control points.

4. After the installation, a form of air-photo signal description (Form ) shall be filled out with a photograph attached to the form.

**Article 78 Identification of aerial photo signals**

Immediately after aerial photography, the air-photo signals shall be confirmed on the aerial photographs or satellite images.

2 When air photo signals are not clearly confirmed, pricking may replace the marking.

**Article 79 Pricking**

Pricking is work to prick locations of controls points directly onto aerial photographs and satellite images.

**Article 79 <Operation Criteria>**

When pricking of control points are not possible onto aerial photographs, or when it is found that an eccentricity has an advantage, pricking shall be conducted at eccentric points.

**Article 80 Results**

The results are as follows:

(1) A book of control-point details or a book of pricking point details, and an elements-of-eccentric-reduction measurement book

(2) Eccentricity computation book

(3) An index aerial photographs or satellite images showing air-photo-signal points or pricking points

(4) An index map of air-photo signals or pricking points

(5) Accuracy control table

# Chapter 4 Aerial Photography and Satellite Image Acquisition

## Section 1 Aerial Photography

### Article 81 Outline

Aerial photography is a work of taking aerial photographs from an aircraft. It includes processing of photographs required for successive work.

2 Kinematic GPS photography utilizes an on-board GPS mobile station with a kinematic positioning system to acquire positions of photographs taken.

### Article 82 Equipment and materials to be used

An aircraft, aerial camera and GPS equipment used of aerial photography shall satisfy a certain level of performance.

### Article 82 <Operation Criteria>

1. The performance level of an aircraft is as follows:

    1) When required photography equipment is placed on-board, the aircraft shall perform stable flights at a specified altitude.

    2) Regardless of the flight attitude at the time of photography, the leveling correction of an aerial camera nor the degree of drift angle, a view angle should always be secured at all times.

    3) An aerial camera can be installed in a way that neither a lens nor a filter may be affected by unusual refraction due to exhaust gas or splash of oil.

    4) When kinematic GPS photography is performed, a GPS antenna shall be installed at place where it does not cause multipass. The offset value from the center of projection of the camera to the center of an antenna shall be clearly identifiable.

2. An aerial camera shall satisfy the following requirement:

    1) An aerial camera shall be a wide-angle camera that has the principal distance with a filter and distortion up to 0.01 mm.

        A normal angle or a super-wide angle aerial camera can be used according to the situation of the topography.

    2) The aerial camera shall have the following functional proof documents:

    a. Camera number and lens serial number

    b. Principal point location relative to an index (in units of 0.01 mm)

    c. Adjusted principal point location (in units of 0.01 mm)

    d. Diameter-direction distortion corresponding to the above principal point location

    e. Certifier and location of certification

    3) When kinematic GPS photography is conducted, the GPS data recording system is equipped.

3. The large data storage devises shall be equipped to the fixed station and the GPS survey system used as mobile station.

4. The quality of film shall satisfy the following requirements:

1) The anisotropy of the degree of shrinkage by photography processing should be 0.01% or less.

2) The anisotropy and irregular contraction percentage of a degree of shrinkage should be 0.001% or less by 1% of relative humidity.

3) The color sensitivity of a film should be panchromatic except when others are specified.

**Article 83 Flight plan**

A flight plan shall be formulated for each photographic area in consideration of the following conditions.

(1) The photographic scale and flight altitude shall be a specified scale and a specified altitude.

(2) The flight courses shall have, unless otherwise specified, an equal altitude from the basic photograph plane and straight lines. The course shall be planned with consideration of aerial triangulation and plotting.

(3) The standard forward overlap within the same flight course shall be 60%, and the standard side overlap between adjacent courses shall be 30%.

(4) When kinematic GPS photographing is performed, the existing control points suitable for GPS base stations shall be selected in the photographing area.

**Article 84 Execution of aerial photography**

In principle, the aerial photography shall be taken under favorable weather conditions in a period year.

2 Photography shall be conducted in accordance with a flight plan which specifies altitude, flight courses and overlaps.

3 The exposure time shall be determined according to the exposure conditions in a way to maintain sufficient clarity of images.

4 The kinematic GPS photography shall uses five or more common satellites simultaneously at the fixed and mobile stations.

**Article 85 <Operation Criteria>**

1. The conditions of photography shall be as follows in principle:

1) Atmospheric condition is stable; influence of haze or fog is minimal;

2) Clouds or shadows of clouds do not cover the ground.

3) Influence of snow cover or flood water is not considered to affect the quality.

4) Effects from shades or halation are minimal.

2. As for the inclination of an aerial camera: φ and ω shall be three degrees or less; κ shall be 10 degrees or less in principle.

3. The difference of flight altitudes shall be 5% of less than the planned flight altitude.

4. The deviation from a planned photographing course shall be 15% or less than the planned flight altitude.

5. The discrepancies of overlaps between aerial photographs shall be within the following ranges:

1) The forward overlap in a same course shall be within a range from 80% to 53%.

2) The number of model with the photo-base length of 68% to 77% shall be one fourth of the total number of photographs in one course.

3) The minimum side-lap between courses shall be 10%.

6. If one course needs to be divided into two or three, the divided part shall have two or more models of overlaps.

6. When kinematic GPS photography is conducted, following items shall be checked in advance.

1) Functional check of the GPS survey equipment which satisfies the requirement specified in Article 28.

2) Simultaneous functioning of the aerial camera and the GPS survey equipment

**Article 85 Requirements of aerial photography**

In principle, the same camera shall be used in one photography area.

2. The last one meter of a roll film shall not be used for photography.

**Article 86 <Operation Criteria>**

Even when a use of different camera cannot be avoided, the same course shall be photographed with the same aerial camera.

**Article 86 Flight record**

Following items shall be recorded as the records of aerial photography.

(1) Contractor's name

(2) Implementing persons

(3) Film number

(4) Commencement and completion time

(5) Date

(6) Camera number, lens number, magazine number

(7) Focal length

(8) F value, filter, exposure time

(9) Film

(10) Aircraft

(11) Flight altitude

(12) Existence of GPS data acquisition

**Article 87 Photographic processing**

The film shall be processed promptly after the completion of photography with an appropriate method.

**Article 87 <Operation Criteria>**

1. The specification of developing solution shall satisfy the requirement of a film or equivalent.

2. The roll of film developed shall have an even gradation; details and instrument records are clearly recognized.

3. The fixing solution shall have acid prescription; the fixation process shall be adequate enough not to leave non-exposed silver.

4. The fixing solution shall be rinsed so that no fixing agent may remain.

5. Photo processing shall be performed carefully so as to avoid various inconsistencies and not to impair the photo quality with bends, scratches, dents, surface peeling, etc.

6. The photographic paper used for contact prints shall have a size to cover frame borders, indexes, and instruments.

7. Contact prints shall be prepared in accordance with the processing procedure specified by the film.

**Article 88 Checking and re-flight**

The film shall be developed, and contract prints for checking shall be printed for checking.

2 When re-flight is required as a result of checking, the re-flight shall be implemented promptly.

**Article 89 <Operation Criteria>**

1. Checking items are as follows:

    1) Appropriateness of a flight altitude

    2) Appropriateness of courses

    3) Existence of non-stereo pair

    4) Articulation of index and instrument

    5) Range of inclination and rotation of photography

    6) Quality of photography processing

    7) Appropriateness of tones

    8) GPS data omission

2. Following checking materials shall be prepared:

    1) The accuracy control table by course

    2) The aerial-photograph inspection table by photography rolls

    3) The index map with principal points

3. The index map shall be prepared using an existing map with an appropriate scale.

**Article 89 Film labeling (editing of negative film)**

The film after completion of processing shall be edited with an appropriate method.

**Article 89 <Operation Criteria>**

Editing film, unless otherwise specified, shall meet the following requirements:

    1) The film shall be edited while leaving one-meter blank space at the both ends of the roll so that images are not disturbed.

2) The pieces of information written on a film are: regional name, date, flight altitude, course number, frame number, and NAMRIA. All pieces of information shall be displayed on the both ends of each course, and for other photographs, only course number and frame number shall be recorded.

**Article 90 Storage of films and contact prints**

The film after editing shall be stored in a bin with a film record attached by roll.

2 Contact prints shall be stored by course.

**Article 91 Results**

The results are as follows:

(1) Film

(2) Contact prints

(3) GPS observational data and results of the fixed ground point

(4) Index map

(5) Photography record

(6) Enlargement aerial photograph specified

(7) Accuracy control table

## Section 2 Preparation of Image Data

**Article 92 Outline**

Preparation of image data is to acquire satellite images required for digital topographic mapping.

**Article 92 <Operation Criteria>**

The B/H ratio shall be 0.4 or higher in the case of the stereo satellite imagery data.

**Article 93 Selection of satellite sensor**

An appropriate spatial resolution of a satellite sensor and an appropriate observation method shall be required for acquiring geographic information of digital maps.

**Article 93 <Operation Criteria>**

1. A satellite sensor shall have a spatial resolution suitable for acquiring geographic information.

2. The relationship between the map information level and spatial resolution are as in the following table in principle. However, when accuracy of digital topographic mapping is secured by photo control point surveys with NAMRIA's approval, the spatial resolution may be changed.

| Map information level | Spatial resolution |
|---|---|
| 25000 | 2.5 m or less |
| 50000 | 5 m or less |
| 100000 | 10 m or less |

## Chapter 5 Field Identification

### Article 94 Outline

Field verification is a work process to prepare data and information required for plotting and editing as recording field information to be expressed onto aerial photographs or other reference materials.

2 The field verification utilizes enlarged aerial photographs, digital ortho-photographs, or satellite images.

### Article 95 Plan

A plan of field verification shall be prepared in consideration of the situation of various source materials that are provided by NAMRIA and of the relation to plotting.

### Article 96 Preliminary photo interpretation

A preliminary photo interpretation is conducted before a commencement of filed verification using aerial photographs and other source materials.

### Article 95 <Operation Criteria>

1. The symbol used shall be determined by NAMRIA.

2. Uncertain matters shall be organized.

3. The aerial photographs to be used are every other photograph in each course. Satellite images extracted to map sheet sizes can also be used. The areas shall match plotting areas.

4. A preliminary photo interpretation shall involve the following work items:

    1) Methods and appropriateness of collected sources materials to be used.

    2) Confirmation of areas and items of difficulties in aerial photograph interpretation.

    3) Extraction of areas where interpretation is not possible

    4) Confirmation of inconsistencies on names and administrative boundaries

5. Among the items to be included in topographic maps, possible items shall be recorded according to the map symbols onto aerial photographs or other reference maps.

6. Items that require studies, as specified in Item 4, shall be recorded onto aerial photographs or other reference maps with areas and related reference information.

### Article 97 Field data acquisition and criteria

The items and criteria of field verification shall be expressions specified in the symbols to be used.

### Article 98 <Operation Criteria>

1. Unless otherwise specified, the following matters shall be applied:

    1) A road is classified into the number of lanes, widths, surface types and expressed using the symbols and expressed.

    2) A railroad is classified into single track, double track, and temporary track, and widths.

    3) Cut and fill, tunnel, raised track, railway station, ferryboat or other transportation related facilities shall be selectively expressed in accordance with map symbols.

4) Structures are classified into independent structures and collectively expressed clustered structures. When special uses are to be expressed annotation or abbreviated annotation shall be used.

5) The control points that are not used as photo-control points shall be pricked as confirming the locations when necessary.

6) When boundaries are clear in classifying special districts such as parks, preservation areas, cemetery, port, they are expressed as boundaries of special districts, and annotation or symbols.

7) A river is classified into: natural or artificial river, seasonal dry river, interrupted river, and expressed accordingly. Directions of flow and conditions of channel are also expressed. Waterfalls, dams, revetment are also studied and expressed if necessary.

8) Coast lines that are changed because of tide shall be expressed onto aerial photographs based on the results of the field verification.

9) Vegetation and vegetation boundaries that cannot be interpreted using aerial photographs shall be studied.

10) Topographic items such as depression, cliff, rock, that often become items of error during the plotting process shall be studied in details.

11) Names to be expressed onto topographic maps shall be confirmed during the filed identification using various source materials.

2. When required as references for plotting and editing, photographs shall be taking on the ground.

**Article 98 Editing of survey data**

The study results are to be edited using aerial photographs for field verification.

**Article 99 <Operation Criteria>**

1. The studied items shall be edited not to cause errors or omission in accordance with the map symbols or symbols for field verification by using ink onto aerial photographs for field verification or copies of plotting originals.

2. The studied items shall be recorded as exact shapes at true locations.

3. Classification of roads and railways and locations of widths change or junctions shall be displayed clearly.

4. Aerial photographs or printed plotting originals shall be used to organized place names and boundaries.

5. When arrangement becomes difficult, overlaying technique can be used.

   1) Display the borderlines which show coverage, course number, frame number, and index location.

   2) Drawing on the overlay shall be the same as in the organization using aerial photographs.

   3) When a road classification is complicated, the classification shall be used in different colors.

**Article 99 Adjoining**

The studied elements shall join at the time of field verification and at the time of arrangement.

**Article 100 Results**

The results are as follows:

(1) Aerial photographs or copies plotting originals used for field verification

(2) Overlay used to supplement the aerial photographs or copies of plotting originals

(3) Ground photographs as reference during the plotting work

(4) Accuracy control table

## Chapter 6 Acquisition of Aerial Photos Raster Data and Aerial Triangulation

## Section 1 Acquisition of Aerial Photos Raster Data

**Article 101 Outline**

Raster-data acquisition of aerial photography is a work process to acquire data by converting aerial photographs to changes aerial-photograph images into the digital representation by pixels and gradients. The digital aerial photographs are created.

**Article 102 Performance of scanner**

A scanner used for raster-data acquisition of aerial photography shall satisfy functional standards.

**Article 103 <Operation Criteria>**

The performance of the scanner shall be as follows:

1) It must be capable of scanning aerial photographs with a 230 mm x230 mm format.

2) Resolution 0.01 mm or less

3) Reading accuracy 0.02% of less (between two arbitrary points)

**Article 103 Scanning**

Scanning of aerial-photographs shall be performed after setting parameters by specified calibration.

**Article 104 <Operation Criteria>**

1. The calibration is conducted on correlation between the coordinate system of a sensor and the photography frame, pixel size, and input color tone.
2. The pixel size shall be 0.025 mm in principle.

**Article 104 Results**

The results are as follows:

(1) Digital aerial-photograph data

## Section 2 Aerial Triangulation

**Article 105 Outline**

Aerial triangulation is a work process which determines the horizontal position and elevation of a tie point required for a digital plotting by the method of digital photogrammetry.

2 An aerial triangulation shall perform adjustment calculation for every block with an analytical method using digital aerial photographs or satellite images.

**Article 106 Instrument to be used**

The instrument to be used for aerial triangulation shall be the digital stereo plotter.

**Article 107 Adjustment computation**

The adjustment computation of aerial triangulation shall be based on a bundle adjustment.

2 The adjustment calculation in the case of using satellite imagery data shall be the bundle adjustment method.

3 The program used for adjustment computation shall be approved by NAMRIA beforehand.

**Article 108 Distribution of control points**

Placement of the control points in aerial triangulation.

1. The arrangement of control points are as follows in principle:

    1) Case 1: The location data of a camera station are not used as an initial value.

    a. The points which determine the horizontal positions shall be placed at the four corners of a block. To the models at the both ends of courses, one point is placed in every six models. To the models at the both ends of each course, one point in every three courses shall be place. In other areas, one point in every thirty models shall be placed in consideration of accuracy of a block.

    b. The points that determine the elevation shall be placed in every two courses at both ends of a model. In addition, one point is placed in every twelve models evenly.

    c. The number of horizontal position determining points (Nv) and vertical position determining points (Nh) shall be defined by the following formula.

    Nh=4+2[(n-6)/6]+2[(c-3)/3]+[(n-6)(c-3)/30]

    Nv=[n/12]c+[c/2]

    n is an average number of models in one course.

    c is the number of courses.

    The decimals within the brackets [] are rounded up to the integer. When numerals within parentheses () become negative because of small number of models or courses, the values with the parentheses () shall be treated as zero. When Nv is smaller than Nh, Nv shall be equal to Nh.

    2) Case 2: GPS aerial triangulation

    a. horizontal position and elevation determining points shall be determined at four corners of a block.

    b. A point to verify horizontal position and elevation shall be placed one in every 100 to 200 models.

2. One point may be used as both horizontal position and elevation determining points.

3. GCPs (Ground Control Points) can be used only when they are selected from maps, with a precise scale, that have larger scale than the ones to be prepared.

**Article 109 <Operation Criteria>**

When satellite imagery data are used, the points defining horizontal position and elevation shall be arranged properly using a program used for adjustment calculation.

**Article 109 Tie points**

Tie points shall be placed in appropriate locations for orientation of digital aerial photographs or satellite images. The required number of points shall be identified by the stereo-matching and the points are digitized at the same time.

**Article 110 Measurement of image coordinates**

The image coordinates are digitized on an index that includes digital aerial photographs or satellite images, control points, and tie points.

2 Multiple measurements shall be performed to indices and control points.

3 A tie point shall perform selection and measurement for a required number in the appropriate location for the standardization of a digital aerial photograph or satellite images at the same time by stereo matching.

**Article 111 <Operation Criteria>**

1. The discrepancy of multiple measurements shall be 0.02 mm or less. A mean value shall be used.

2. When a discrepancy exceeds tolerance, the points shall be deleted.

**Article 111 Block adjustment using the bundle method**

The block adjustment of aerial triangulation using the bundle adjustment.

1. The adjustment calculation formula shall be a projection conversion equation which sets the inclination of each photograph and the location of a center of projection with the unknown values. A self calibration item can be added corresponding to various systematic errors.

2. When there is a control point not used for calculation, the reason shall be recorded in a computation book.

3. The standard deviation of the residual errors of control points within a single block shall have a tolerance range of the minimum 0.02 % or less of the flight height for both horizontal position and elevation and the maximum of 0.04% or less. When a super wide angle camera is used, the standard deviation shall be 0.04% or less; the maximum value shall be 0.07% or less.

4. The tolerance of the intersection residuals of pass points and tie points within a single block shall have a standard deviation of 0.015 mm or less and the maximum value of 0.03 mm or less.

5. The distortion of an aerial camera and adjustment of influence by earth curvature and atmospheric refraction can be replaced by a self calibration.

2 The coefficient of the conversion equation of satellite imagery data shall be determined by every strip.

**Article 112 <Operation Criteria>**

The case of using satellite imagery data is specified as follows:

1) The adjustment calculation formula shall be a projection conversion equation which sets the

inner orientation component as known. A self calibration item can be added corresponding to various systematic errors.

2) The ranges of tolerance on the residual errors of control points are: 1/5,000 meter or less of the geographic information level for the standard deviation of horizontal positions; the maximum is 1/2,000 meter or less; the standard deviation of elevations is 1/4 or less of the contour line intervals; the maximum is 1/2 or less.

3) The tolerance of intersection residuals of tie points on the images are: the standard deviation is one pixel or less; the maximum is two pixels or less.

**Article 112 Adjoining of neighboring blocks**

The tolerance of the tie-point discrepancy between contiguity blocks on both horizontal position and the elevation shall be than 0.1% of the flight height above ground.

**Article 113 Results**

The results are as follows:

(1) Aerial-triangulation digital data and index map

(2) Residual tables for control points and tie-points

(3) A measurement book and a computation book

(4) Accuracy control table

## Chapter 7 Digital Plotting

**Article 114 Outline**

Digital plotting is a work process which utilizes a digital stereo plotter to acquire geographic information in a digital format and to create digital plotting data.

**Article 115 Digital stereo plotter**

A digital stereo plotter shall have the capability to satisfy specified accuracy.

**Article 115 <Operation Criteria>**

1. The digital stereo plotter shall have functions of inputting and recording X, Y and Z coordinates and specified codes.

2. The measurement accuracy of an analytical plotter is less than (standard deviation) 0.02 mm in the value converted on the contact positive film. The resolution of a coordinate's reader shall be 0.01 mm or higher in the value converted on the contact print.

**Article 116 Unit of coordinate values**

The unit and the decimal place of coordinate (ground coordinates) data acquired in digital plotting are as follows:

(1) The map information level 25000 or higher shall be one meter.

**Article 117 Digital plotting methods**

Digital plotting shall be performed by the following methods:

(1) A method based on stereo images

(2) A method based on ortho-images (henceforth a "single image plotting")

**Article 118 Classification code**

To the digital plotting data to be acquired, the classification codes, to show categories defined in the map symbols, shall be attached.

**Article 119 Acquisition of topographic data**

The data for topographic-representation are acquired by contour method, digital elevation model, map digitization method, and combination of these methods.

**Article 119 <Operation Criteria>**

1. When the contour method is used, the distance spacing shall be 1 mm (on a map sheet) or 0.3 seconds in principle. It can be changed according to the condition of topography.
2. When the digital-elevation-model method is used, the data are acquired automatically in the stereo matching process.
    1) The grid interval shall be determined as required.
    2) When arbitrary points are measured, Article 120 (Distribution of spot points) shall be used.
3. The methods of generating contour lines are: DEM generation from topographic data acquired (including contour lines from existing topographic maps) and contour line generation from the method of irregular triangulation-network topographic model (TIN).
4. The map digitization method shall follow the rules of in Chapter 12 (Existing Map Digitization and Revision).
5. The data of digital elevation mode shall be checked using checking software and hardcopy of the data.
6. When elevation data that are not suited to topography are found after checking, the area shall be re-surveyed.

**Article 120 Distribution of spot heights**

The spot heights shall be distributed as dense as possible in consideration of readability of topography in principle.

**Article 120 <Operation Criteria>**

1. The spot elevation shall be placed at locations as follows:
    1) Major summit of mountain
    2) Major diverging points of roads and cols with road passage
    3) Mouth of a valley, juncture of a river, a large bottom of a valley or riverbed
    4) The critical points of major inclinations
    5) Representing point of surround general plane
    6) The deepest spot of depression that can be identifiable

**Article 121 Acquisition of digital mapping data**

A detailed digital plotting shall follow the plotting order of linear objects, buildings, vegetation, and

contour line in principle.

**Article 121 <Operation Criteria>**

The single image plotting using ortho-images shall be conducted as follows:

1) The ortho-images used for single image plotting shall have the accuracy corresponding to the scale of topographic maps to create.

2) The ortho-images shall be used after the images are separated into the unit covering each map sheet from the digital mosaic of the ortho-images.

**Article 122 Ortho-image to be used**

The ortho-images used for acquisition of detailed digital-plotting data shall be created according to the equivalent scale of the map information level in principle.

**Article 123 Checking digital plotting data**

Digital-plotting data are checked using the plotted maps that are created using the editing equipment or in a work process of the previous Article as aerial photographs, and field verification source materials are used as references.

**Article 124 <Operation Criteria>**

Checking of digital-plotting data shall be conducted to the following items:

1) Omission, errors in horizontal position and elevation

2) Error in classification code

3) Quality of adjoining

4) Location of spot elevations, density quality of measurements

5) Consistency of topographic-representation data

**Article 124 Results**

The results are as follows:

(1) Digital-plotting data

(2) Accuracy control table

## Chapter 8 Digital Editing

**Article 125 Outline**

Digital editing is work which edits digital-plotting data using edit equipment, and creates edited data and topographic-map data based on the result of field verification.

**Article 126 Input of digital mapping data and field verification data**

Digital-plotting data and field verification data shall be inputted into the edit equipment.

2 Source materials, such as maps and drawings collected in the field verification shall be digitized using a scanner, and shall be inputted into edit equipment.

**Article 127 Digital data compilation**

Editing equipment processes the data inputted in the preceding article; some data are added, deleted and corrected. Then edited data are prepared.

2 The topographic-map data shall be prepared from the edited data as the maps by editing the data according to the map symbols specified.

**Article 128 <Operation Criteria>**

The contour line data are checked to correct inconsistencies by viewing a graphic display or plotted maps.

**Article 128 Adjoining**

Adjoining is work which is conducted between models and adjacent map sheets to make coordinate same among different sheets.

**Article 129 <Operation Criteria>**

1. When a gap of topography and planimetric features is less than 0.7 mm, related shapes are to be edited to match the adjoining work completely.

2. When a gap of the topography and a planimetric feature exceeds 0.7 mm of conversion/ on a figure, carry out digital-plotting work again.

**Article 129 Output maps**

A plotting map shall be created using an ink jet plotter etc. from edited data and topographic-map data for checking and field verification.

**Article 130 Checking**

Checking shall be performed using the plotting map, graphic display, and checking program which were created in the preceding article.

2 The checking program is used to the compiled data on logical contradiction and others.

**Article 131 Results**

The results are as follows:

(1) Compiled data

(2) Topographic-map data

(3) Accuracy control table

## Chapter 9 Field compilation

**Article 132 Outline**

In field compilation, boundaries, names of places, and other names are confirmed using source materials provided or approved by NAMRIA. The work includes field compilation in the filed and confirmation of important items expressed on the edited data or plotted topographic map data.

2 Supplemental digital editing is work which creates supplemental editing completion data and topographic data to which the supplemental editing is completed by conducted supplemental processing such as adding and correcting from the supplemental field survey to the edited data.

**Article 133 Execution**

Field compilation shall be conducted to the following items:

(1) Confirmation and collation of boundaries, names of places and other names from the source materials provided or approved by NAMRIA.

(2) Confirmation of the interrogative matters arose during the digital editing

(3) Confirmation of important expression matters if necessary

(4) Field compilation in areas necessary and where digital-plotting is not possible.

2 Field compilation shall be conducted to acquire data directly based on the secure and clear point shown on the edited data or the plotted maps using total station or by means of GPS survey if necessary.

3 The result of field compilation shall be recorded to electronic storage media or onto the edited data or plotted topographic maps for the subsequent work processes.

**Article 133 <Operation Criteria>**

1. When there are differences between the result of field survey and source materials of NAMRIA, the matter shall be resolved on the field if needed.

2. When all the boundaries, names of places and other names are approved by NAMRIA on the edited data or the plotted topographic maps, the person-in-charge in NAMRIA shall sign on the plotted maps.

3. The result of field compilation shall be recorded to electronic storage media. In addition, annotation symbols and attributes shall be recorded to the edited data or plotted topographic maps.

**Article 134 Digital data compilation**

The results of field compilation shall create the edited data with the field compilation results and topographic data with the results of field compilation after the edited data go through the process of editing such as adding and correcting data using editing equipment.

2 Digital data compilation shall be conducted in accordance with the rules stipulated in Chapter 8.

**Article 135 Output maps**

Output maps shall be produced in accordance with the rules stipulated in Article 129 Output maps. The maps are created from the edited data with the field compilation results and topographic maps with the results of the field compilation.

**Article 136 Checking**

Checking of data the edited data with the field compilation results and topographic map data with the field compilation results shall be checked in accordance with the rules stipulated in Article 130 (Checking).

**Article 137 Results**

The results are as follows:

(1) Edited data with the field compilation results

(2) Topographic-map data with the field compilation results

(3) Output maps of topographic maps data with the field compilation results

(4) Accuracy control table

## Chapter 10 Structured Compilation

### Article 138 Outline

Structured compilation is work which creates structured compilation data that include point, line and polygon data with topology for the purpose of being used in a geographic information system.

### Article 139 Structured compilation

Structured compilation is work to edit the compilation data with the field compilation results interactively and automatically.

### Article 140 Checking

Checking is work to verify validity of contents of files against specifications using a plotting maps from the structured compilation data and using a checking program.

2 Checking inspects logical contradiction of data.

### Article 140 <Operation Criteria>

The plotting maps of the structured compilation shall be prepared according specifications.

### Article 141 Results

The results carry out as follows:

(1) Structured compilation data

(2) Accuracy control table

## Chapter 11 Data File Storage

### Article 142 Outline

Data file storage is work to store the topographic data with the results of field compilation and the structured compilation data in an electronic medium in accordance with specifications.

2 The data files shall be classified into topographic-map data files and structured data files.

### Article 143 Execution

The topographic-map data with the results of the filed compilation shall be stored in an electronic medium according to specifications.

2 The structured data files with the results of the field compilation shall be stored in an electronic medium according to specifications.

### Article 144 Checking

Contents of the data files shall be checked using a checking program or by viewing the graphic display.

2 The checking program shall be used to correct logical contradictions.

**Article 145 Preparation of metadata**

The metadata of a data file shall create about the matter which is needed in management and use of a file.

**Article 146 Results**

The results are as follows:

(1) Topographic-map data file

(2) Structure data file

(3) Metadata

(4) Accuracy control table

## Chapter 12 Existing Map Digitization and Revision

## Section 1 General

**Article 147 Outline**

Existing map digitization and revision is work which creates digital topographic maps from existing topographic maps. When it is necessary, the existing topographic maps are revised.

**Article 148 Definition of terms**

The definition of terms in this chapter are as follows:

(1) Vector data: The graphic data expressed by sequence of points with coordinate values.

(2) Raster data: The image data constituted by arrangement of pixels organized in rows and columns.

**Article 149 Scale of an existing maps to be used**

The scale of the existing topographic maps shall be 1/10,000 to 1/100,000 in principle.

**Article 150 Formats of results**

The format of the results in existing topographic maps digitization shall be vector data in principle. When NAMRIA specifies, the format may be raster data.

**Article 151 Unit of coordinate value**

The unit and decimal place of coordinate values (ground coordinates) in vector data shall be in accordance with the rules in Article 116 (Unit of coordinate values).

2 One pixel of image coordinates in raster data shall have a maximum value of 0.1 mm on a map in principle.

**Article 152 Work schedule and items**

The work flow and work items of existing map digitization shall be as follows:

(1) Base map preparation for digitizing

(2) Digitizing

(3) Compilation

(4) Revision of existing maps

(5) Structured compilation

(6) Preparation of data files and recording

2 Revision of existing maps shall be conducted when it is instructed by NAMRIA.

3 As for structured compilation, the rules in Chapter 10 apply.

## Section 2 Digitizing

### Article 153 Outline

Digitizing is to acquire digital data from base maps for digitization using a digitizer.

### Article 154 Performance of scanner

The capability of a scanner shall be as in the following table. It shall be selected according to accuracy of digital topographic maps to be created.

| Division | Capacity | | Scanning area |
|---|---|---|---|
| Scanner | Resolution | 0.1 mm or less | The area bounded the neat lines shall scanned. |
| | Reading accuracy | 0.25% or less | |
| | (between two arbitrary points) | | |

### Article 155 Digitizing and Scanning

Digitizing using a scanner is work to acquire digitized data by map sheet for the area bounded by the neat lines at specified accuracy and specification by digitization items.

2 When the digital topographic maps data are to be prepared in accordance with Article 151 (Formats of results), the raster data shall be converted to vector data.

### Article 155 <Operation Criteria>

1. Scanning shall be conducted as follows:

   1) The scanned data shall be adjusted to have specified pixel sizes for vertical and horizontal directions.

   2) The reading accuracy shall be 1/2 of the finest line width of a symbol or less.

2. The coordinate conversion shall be conducted as follows:

   1) Pixel coordinates at four corners neat lines or pixels near the four corners that can be recognized shall be displayed on-screen and digitized.

   2) The machine coordinates to the coordinates according to the specifications of NAMRIA shall be conducted in accordance with the rules in the previous article item 2.

   3) The residual errors of the coordinates at the four corners of the neat lines shall not exceed two pixels.

3. Resampling of the images shall be conducted using methods of nearest neighbor, bi-linear interpolation, cubic convolution or others.

## Section 3 Compilation

### Article 156 Outline

Compilation is work which edit digitized data and creates the edited data using edit equipment.

### Article 157 Compilation

Compilation shall be performed on-screen using the digitized data.

2 When omission in digitization or errors are recognized after checking, the compiled data shall be corrected.

### Article 157 <Operation Criteria>

The map data whose map sheets are adjacent to each other shall be joined so that the corresponding coordinates shall be consistent among map sheets.

### Article 158 Checking

Checking shall be conducted using plotting maps, images displayed on-screen, and checking program.

2 The checking program shall be used to the parts with logical contradiction in the compiled data.

### Article 159 <Operation Criteria>

1. Create the plotting map for Checking using a plotter etc. from edited data.

2. The checking items are: omission of digitization, positional precision, linage of lines and connection between adjacent maps.

## Section 4 Existing map revision

### Article 159 Outline

Existing map revision is work which revises contents expressed in a digital format to the present conditions when secular changes are recognized in the contents of existing topographic maps.

### Article 160 Revision method

Existing map revision shall be conducted by the method of digital photogrammetry.

1 The method of correction shall be decided after grasping contents and quantity of revision by extracting areas of secular changes by studying aerial photographs and other reference materials.

### Article 161 Execution

Existing map revision shall be conducted as follows:

(1) When the revision is conducted by the digital photogrammetry method, the rules stipulated in Chapter 7 (Digital plotting) and Chapter 9 (Field compilation) shall apply.

### Article 161 <Operation Criteria>

1. Plotting shall be conducted onto the digital base map to encode secular changes.

2. The absolute orientation in plotting shall be conducted as follows:

1) Absolute orientation shall be performed using planimetric features on the digital base maps. The number of planimetric features for the absolute orientation shall be six or more.

2) The discrepancy of horizontal positions shall be 0.7 mm or less in principle.

3) The discrepancy of elevation shall be 1/3 or less of the contour line interval in principle.

3. Digital plotting acquires correction data and corrects digital data.

4. The absolute orientation in digital plotting shall be conducted in accordance with the rules in Item 2.

## Section 5 Data file storage

### Article 162 Outline

Data file storage is work which records compiled data on an electronic storage medium.

### Article 163 Execution

Compiled data are stored as data files in an electronic storage medium in accordance with the specifications.

### Article 164 Preparation of metadata

The metadata of data files shall be created on items that are needed for use and are useful in management.

### Article 165 Output maps

A plotting map shall be printed using a plotter or similar device from the items digitized.

### Article 165 <Operation Criteria>

In principle, digitized items shall be organized and printed to one plotted map. However, when some complication is expected, the data can be organized into two or more sheets.

### Article 166 Results

The results are as follows:

(1) Data file

(2) Metadata

(3) Accuracy control table

## Chapter 13 Topographic Map Data for Platemaking

### Article 167 Outline

The preparation of topographic map data for platemaking means to create vector data files that can be color-separated with symbols and border information specified using the topographic map data files.

### Article 168 Topographic Map Data for Platemaking

The topographic map data for platemaking should be symbolized based on the topographic data with data which has been arranged from the result of a field compilation.

2 The topographic data with the field compilation results which become the topographic map data for platemaking shall be the data inspected in accordance with the rules stipulated in Article 7, Item 2.

**Article 168 <Operation Criteria>**

1. Symbolization work shall be conducted in accordance with the specifications of map symbols by every sheet.
2. If they must be dislocated for representation as symbols, the targets represented in compilation shall be dislocated within the range mentioned by the specifications of map symbols, etc.
3. The annotation characters shall be entered according to the map specifications, etc.
4. The marginal information items shown on compilation manuscripts shall be as follows:
    1) Manuscript name
    2) Topographic map number
    3) Longitude and latitude and coordinate values
    4) Legend
    5) Adjoining map index
    6) A scale and scale bar
    7) Direction label
5. The items to be entered on marginal information material sheets shall be topographic map numbers, drawing methods, revision history, and other items required.
6. It must be edited using colors defined.
7. Inspection items of topographic map data for platemaking shall be as follows:
    1) Conformity of dimensions of compilation manuscripts (accuracy as specified Article 222 in this specifications)
    2) Conformity of application of map specifications, etc.
    3) Conformity of representation methods of various representation items
    4) Conformity of drawing lines
    5) Conformity of summary of various materials
    6) Conformity of presence of inconsistencies between compilation manuscripts and materials
    7) Conformity of unification of methods for application of the specifications of map symbols
    8) Conformity of process of selection, etc.
    9) Conformity of border information, sheet name, and adjacent map indication
    10) Conformity of color adoption according to the rule
    11) Conformity of inspection quality
    12) Conformity of correction results

**Article 169 Adjoining**

All expressions of adjoining topographic map data for platemaking shall match so that there may be no unreasonable expression along the neat line.

**Article 169 <Operation Criteria>**

1. When there are clear reasons such as secular changes or changes in symbols, discrepancies of the joining of expressions is allowed.

2. When the joining of adjacent maps is not consistent with reasonable causes, NAMRIA shall decide the joining of adjacent maps.

**Article 170 Results**

The results are as follows:

(1) Topographic map data for platemaking

(2) Outputs of topographic map data for platemaking

(3) Reference maps with boundary, place names and other data agreed with NAMRIA.

(4) The topographic data with the field compilation results and outputs;

(5) Inspected outputs;

(6) Quality control table

# Part 4 Reproduction Film for Topographic Map and Printing

## Chapter 1 General

### Article 171 Outline

The topographic map reproduction process refers to the use of topographic map data, creating reproduction films and printing plates and printing topographic maps, etc. through the offset printing method.

### Article 172 Work schedule and items

The classification and order of processes of operation shall be as follows:

(1) Platemaking

a. Creation of proof maps

b. Proofreading and proof correction

c. Creation of reproduction films

d. Creation of printing plates

(2) Topographic map printing

a. Topographic map printing

b. Inspection

c. Organizing

### Article 173 Accuracy

The accuracy of the film for platemaking and a printing plate shall be 0.3 mm or less compared with the neat line dimensions of each original plate.

## Chapter 2 Platemaking

### Article 174 Outline

Platemaking refers to the creation of the reproduction films and printing plates required to print topographic maps as well as the creation of proof maps and the execution of proofreading and correction

### Article 175 Preparation of a proof maps

The proof maps shall be created through one of the following method:

(1) The proof maps for platemaking data shall be created according to the color version by a color plotter etc.

### Article 175 <Operation Criteria>

2. Creating proof maps from topographic map data

1) The performance capability of a color plotter used shall satisfy the quality of positions and the tones of the original colors.

2) The output position of a proof maps must be the specified position.

**Article 176 Proofreading and proof revision**

Proofreading shall be extracted errors, omission, smir, etc. of topographic maps and record onto proof maps.

2 The error correction work shall be conducted directly onto a topographic map data for platemaking based on the error-recording items recorded on the proof maps.

**Article 177 Preparation of the reproduction film for platemaking**

The reproduction film for platemaking work shall be prepared using negative film used for printing plates for every color.

2 The reproduction film for platemaking to be used shall satisfy the standards prescribed by NAMRIA.

**Article 178 <Operation Criteria>**

The reproduction films for platemaking shall follow the following method.

1. The film shall be produced using an image setter with the data of the topographic map data for platemaking.

2. The film of prescribed standards by NAMRIA shall be used for the film for platemaking.

3. The image shall be clear and satisfy the consistency suitable for platemaking.

**Article 178 Preparation of a printing plate**

The printing plates shall be created by printing reproduction films on PS plates.

**Article 179 <Operation Criteria>**

The printing plate shall satisfy the set standards by NAMRIA and have the sufficient printing pressure resistance.

**Article 179 Results**

The items of results are as follows:

(1) Reproduction films for platemaking (negative and positive films)

(2) Proof maps

(3) Quality control table

## Chapter 3 Printing

**Article 180 Outline**

Topographic map printing refers to printing topographic maps, etc. on humidity-adjusted printing paper using an offset printer.

2. The topographic map printing shall be executed following the adjustment of colors and alignment through trial printing.

**Article 180 <Operation Criteria>**

1. The printing paper shall comply with the specifications established separately by NAMRIA and have a good printability (reproducibility of fine image quality) .

2. The printing ink shall provide good color tones and superior fixability, as well as light resistance.

**Article 181 Checking**

Checking shall comply with the following requirements:

(1) In the alignment of color-separation plates, deviations on the register marks on the four corners shall be 0.1 mm or less.

(2) The content of topographic maps shall not include any inconsistency and there shall be no smear, no omission of drawling lines, or smear and breakage of paper that may cause reading errors.

(3) Generally, the printed maps shall be checked, have equal accuracy to proof maps, and be checked against color samples for proofreading.

(4) Printed maps shall be classified into accepted and rejected articles, and the number of acceptable articles shall be the specified quantity or more.

**Article 182 Film Storage**

The organizing work involves in storage of the originals using the storage bags with the content tables attached until the time of delivery of the prints.

**Article 182 <Operation Criteria>**

1. Unless otherwise specified by the target country, the printing plates used in this printing procedure shall be erased by polishing in the presence of NAMRIA at the end of topographic map creation process.

2. The rejected printed maps shall be destroyed by cutting and disposed of after their quantity is verified.

**Article 183 Results**

The results shall be the followings.

(1) Printed map

(2) Quality control table

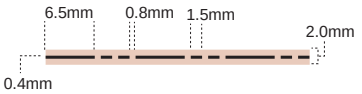
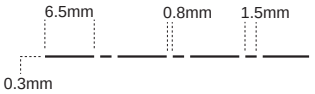
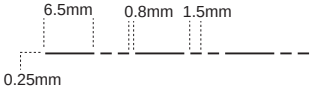
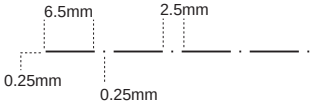
# PMS50K

# Specifications

# For

# Map Symbols for Topographic Map at Scale 1:50,000 the Republic of the Philippines

EDITION 1

| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| ADMINISTRATIVE BOUNDARIES | ADMINISTRATIVE BOUNDARIES | 010100 | Intrenational boundary | Line |  | 010100<br>010100f | K100<br>Brown20 | On<br>On | *Show to omit Boundary when practicable as following :*<br>*a) In case Boundary in road:*<br>*Show every third unit of symbol on center of road with 0.1mm lineweight.*<br>*e.g. for layer 010300*<br>*dash 6.5mm gap 0.8 dash 1.5 gap0.8 dash1.5 gap 25.4*<br><br>*b) In case Boundary along road or shoreline:*<br>*Show every third unit of symbol along road or shoreline with normal lineweight.*<br><br>*c) In case Bounday along track, trail, footpath or stream:*<br>*Show every third unit of symbol along road or stream with normal lineweight.*<br>*e.g. for layer 010400, dash6.5mm gap1.125, dash0.25, gap19.125*<br>  <br>*Province and Municipality names shown along the boundaries of layer 010300 with font Swis721 BT 8pt.*<br>*Municipality names shown along the boundaries of layer 010400 with font Swis721 BT 8pt.* |
| | | 010200 | Region boundary:<br>First-order administrative boundary | Line |  | 010200 | K100 | On | |
| | | 010300 | Province boundary:<br>Second-order administrative boundary | Line |  | 010300 | K100 | On | |
| | | 010400 | City, Municipality:<br>Third-order administrative boundary | Line |  | 010400 | K100 | On | |
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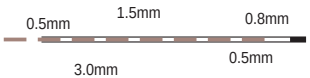
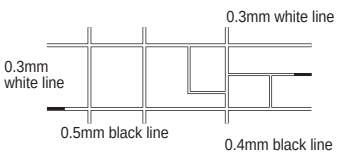
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TRANSPORTATION NETWORK | ROADS | 021000 | Toll road, expressway | Line |  | 021000c<br>021000f<br>021000 | K100<br>Brown80<br>K100 | On<br>Off<br>On | *Toll road, expressway are shown by sepia 80% color.*<br>*In case of *1 is shown toll road which is on divided way with Median Strip.* |
| | | 021100 | Divided highway; with median strip hard surface-all weather | Line |  | 021100c<br>021100f<br>021100 | K100<br>Brown40<br>K100 | On<br>Off<br>On | |
| | | 021200 | Road; two or more lanes wide hard surface-all weather | Line |  | 021200f<br>021200 | Brown40<br>K100 | Off<br>On | |
| | | 021300 | Road; two or more lanes wide loose surface-all weather | Line |  | 021300f<br>021300w<br>021300 | Brown40<br>CMYK 0<br>K100 | Off<br>Off<br>On | |
| | | 021400 | Road; one lane wide hard surface-all weather | Line |  | 021400f<br>021400 | Brown40<br>K100 | Off<br>On | |
| | | 021500 | Road; with loose surface-fair or dry weather | Line |  | 021500f<br>021500 | CMYK 0<br>K100 | Off<br>On | |
| | | 021600 | Streets in built-up areas | Line |  | 021600f<br>021600 | CMYK 0<br>K100 | Off<br>On | *Overall width 0.5mm*<br>*In case of dence concentration streets, may be reduced to overall width 0.4mm.* |
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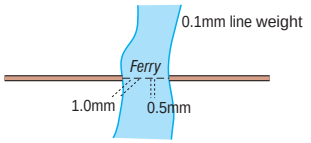
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TRANSPORTATION NETWORK | ROADS | 021700 | Track | Line |  | 021700 | K100 | On | |
| | | 021800 | Trail | Line |  | 021800 | K100 | On | |
| | | 021900 | Ferry | Line |  | 021900t<br>021900 | K100 | On | *Usage font is Swiss721 Cn BT Italic 6pt.* |
| | | 022000 | Route marker: National | Text |  | 022000t<br>022000 | K100<br>K100<br>CMYK 0 | On,text<br>On. Stroke<br>Off .fill | *Usage font is Swiss721 Cn BT Roman 5pt.* |
| | | 022100 | Route marker: Secondary | Text |  | 022100f<br>022100 | K100<br>K100<br>CMYK 0 | On,text<br>On. Stroke<br>Off .fill | *Usage font is Swiss721 Cn BT Roman 5pt.* |
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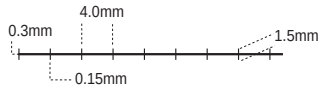
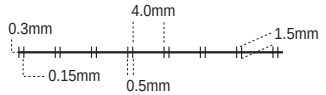
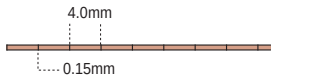
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TRANSPORTATION NETWORK | RAILROADS | 023100 | Normal or broad gauge; single track | Line |  | 023100 | K100 | On | |
| | | 023200 | Normal or broad gauge; double or multiple track | Line |  | 023200 | K100 | On | |
| | | 023300 | Siding; all gauge | Line |  | 023300 | K100 | On | |
| | | 023400 | Railroads in road or street; all gauge | Line |  | 023400 | K100 | On | *Tick length is to be as well as road width.* |
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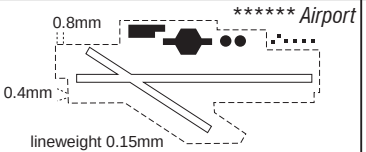
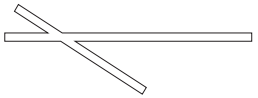
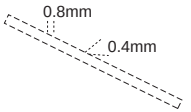
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TRANSPORTATION NETWORK | AERONAUTICAL FEATURES | 024100 | Airfield; limits known | Polygon |  | 024100t<br>024100 | K100 | On, Text<br>On | *Usage font is Swiss721 Cn BT Italic 8pt.*<br>*Plot to scale, put its annotation appropriative position.* |
| | | 024200 | Hard surface runways | Polygon |  | 024200 | K100 | On | *Plot to scale.* |
| | | 024300 | Loose surface runways | Polygon |  | 024300 | K100 | On | *Plot to scale.* |
| | | 024400 | Airfield; limits and runway information unknown | Point |  | 024400 | K100 | On | |
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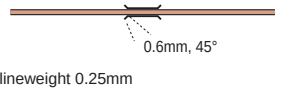
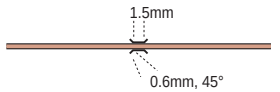
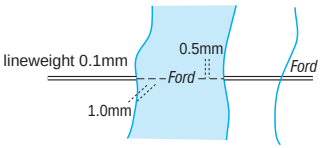
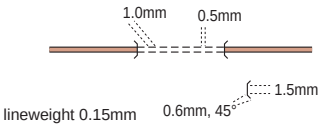
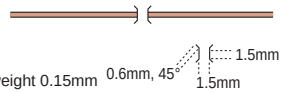
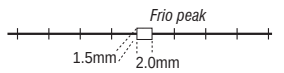
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TRANSPORTATION NETWORK | RELATED ROADS AND RAILROADS OTHER FEATURES | 025100 | Bridge; longer than 50m in length | Line |  | 025100 | K100 | On | *Show actual length.*<br>*When bridge length is shorter than 2mm on the map,*<br>*Symbol shown as layer 025200.* |
| | | 025200 | Bridge; shorter than 50m in length | Point |  | 025200 | K100 | On | |
| | | 025300 | Footbridge | Point |  | 025300 | K100 | On | |
| | | 025400 | Ford | Line |  | 025400t<br>025400 | K100<br>K100 | On<br>On | *Usage font is Swiss721 Cn BT Italic 6pt.*<br>*In case of acrossing narrow river which can not show as line, put lavel appropriate position.* |
| | | 025500 | Tunnel longer than 50m in length | Line |  | 025500 | K100 | On | *Show actual length.*<br>*When bridge length is shorter than 2mm on the map,*<br>*Symbol shown as layer 025600.* |
| | | 025600 | Tunnel shorter than 50m in length | Point |  | 025600 | K100 | On | |
| | | 025700 | Railroad station | Point |  | 025700 | K100<br>CMYK 0 | On. Stroke<br>Off .fill | *Usage font is Swiss721 Cn BT Italic 6pt.*<br>*If known station name, put annotation appropriate position.* |
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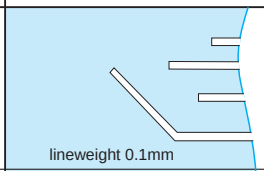
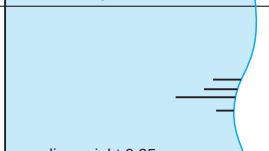
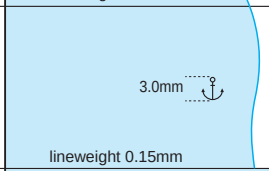
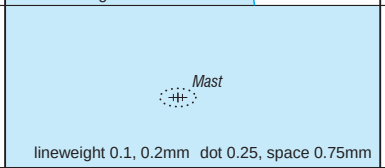
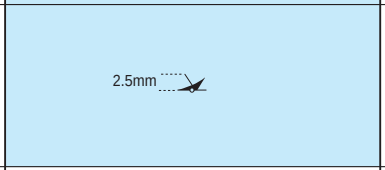
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TRANSPORTATION NETWORK | HARBOR AND COASTAL STRUCTURES | 025800 | Pier, dock, wharf; exceeding 0.4mm in width | Polygon |   | 025800 | K100<br>CMYK 0 | On. Stroke<br>Off .fill | *Plot to scale.* |
| | | 025900 | Pier, dock, wharf; not exceeding 0.4mm in width | Line |   | 025900 | K100 | On | |
| | | 026000 | Port, anchorage | Point |   | 026000 | K100 | On | |
| | | 026100 | Sunken wreck, mast exposed | Point |   | 026100t<br>026100 | K100<br>K100 | On<br>On | *Usage font is Swiss721 Cn BT Italic 6pt.*<br>*In case of mast exposed, put lavel appropriative position.* |
| | | 026200 | Exposed wreck | Point |   | 026200 | K100 | On | |
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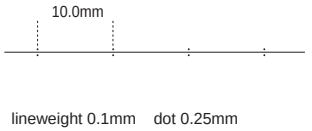
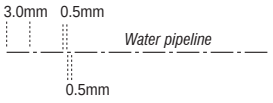
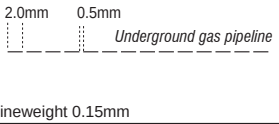
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| BASIC INFRASTRUCTURES | POWER LINES AND PIPELINES | 030100 | High-tension power transmission line | Line |  | 030100 | K100 | On | *Space between line to dot is 0.2mm.* |
| | | 030200 | Landmark pipeline, gas, oil, water above ground | Line |  | 030200t<br>030200 | K100 | On | *Usage font is Swiss721 Cn BT Italic 6pt.*<br>*In case of known the type of pipeline which are Gas, Oil, Water, is indicated.*<br>*Label is repeated at appropriate intervals to further annotate the symbol running.* |
| | | 030300 | Pipeline, gas, oil, water below ground | Line |  | 030300t<br>030300 | K100 | On | *Usage font is Swiss721 Cn BT Italic 6pt.*<br>*In case of known the type of pipeline which are Gas, Oil, Water, is indicated.*<br>*Label is repeated at appropriate intervals to further annotate the symbol running.* |
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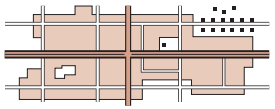
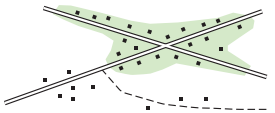
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| BUILDINGS AND POPULATED PLACES | GENERAL BUILDINGS AND BUILT-UP AREA | 041100 | Densely built-up area and moderately built-up area. | Polygon |  lineweight 0.1mm fill Brown20% | 041100L<br>041100 | K100<br>Brown20 | On<br>Off | |
| | | 041200 | Settlement | Polygon |  fill Green30% | 041200s<br>041200 | K100<br>Green30 | On | *Building symbols are placed at random along side of the road in limit of settlement. approximately 1.0 to 2.0mm apart.* |
| | | 041300 | Building; bigger than 0.7x0.7mm square | Polygon |  | 041300 | K100 | On | |
| | | 041400 | Building; smaller than 0.7x0.7mm square | Point |  0.5mm solid square | 041400 | K100 | On | |
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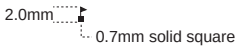
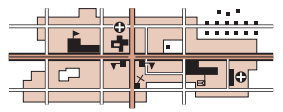
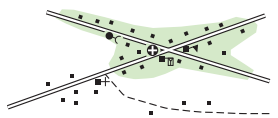
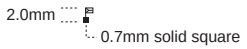
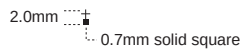
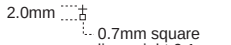
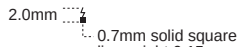
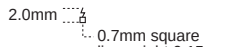
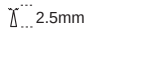
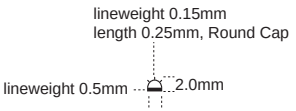
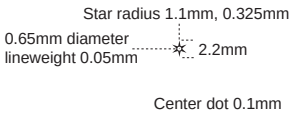
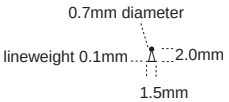
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| BUILDINGS AND POPULATED PLACES | EDUCATIONAL BUILDING | 042100 | School; bigger than 0.7x0.7mm square | Polygon |  | 042100 | K100 | On | *These symbols have the staff or characteristic attachment of the symbol at right angles to the street or road.*<br><br>*In congested areas, when the symbol overlapped road or railroad, the parts of staff and characteristic attachment can be moved from its preferred position, the length of the parts can be altered, and as in case of school and public office symbol, the direction of the pennant and flag can be changed.*<br><br>*See follwing example ** |
| | | 042200 | School; smaller than 0.7x0.7mm square | Point |  | 042200 | K100 | On | |
| | HEALTH CARE PROVIDERS | 042300 | Hospital; bigger than 0.7x0.7mm square | Polygon |  | 042300 | K100 | On | *Put symbol preferred position.* |
| | | 042400 | Hospital; smaller than 0.7x0.7mm square | Point |  | 042400 | K100 | On | |
| | PUBLIC OFFICE | 042500 | Public Office; bigger than 0.7x0.7mm square | Polygon |  | 042500 | K100 | On | *These symbols have the staff or characteristic attachment of the symbol at right angles to the street or road.*<br><br>*In congested areas, when the symbol overlapped road or railroad, the parts of staff and characteristic attachment can be moved from its preferred position, the length of the parts can be altered, and as in case of school and public office symbol, the direction of the pennant and flag can be changed.*<br><br>*Example **<br>  <br>  <br>*The street or road casing are spaded back approximate 0.15mm to 0.2mm (hold out) for clarified the symbol as required.* |
| | | 042600 | Public Office; smaller than 0.7x0.7mm square | Point |  | 042600 | K100 | On | |
| | RELIGIOUS BUILDINGS | 043100 | Church; bigger than 0.7x0.7mm square | Polygon |  | 043100 | K100 | On | |
| | | 043200 | Church; smaller than 0.7x0.7mm square | Point |  | 043200 | K100 | On | |

| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| BUILDINGS AND POPULATED PLACES | RELIGIOUS BUILDINGS | 043300 | Chapel | Point |  | 043300 | K100 | On | *These symbols have the staff or characteristic attachment of the symbol at right angles to the street or road.*<br><br>*In congested areas, when the symbol overlapped road or railroad, the parts of staff and characteristic attachment can be moved from its preferred position, the length of the parts can be altered.*<br><br>*See page 10 example ** |
| | | 043400 | Shrine | Point |  | 043400 | K100 | On | |
| | | 043500 | Mosque | Point |  | 043500 | K100 | On | |
| | OTHER BUILDINGS AND STRUCTRE | 045100 | Factory; bigger than 0.7x0.7mm square | Polygon |  | 045100 | K100 | On | *Put symbol preferred position and fill 045100 hatching pattern.* |
| | | 045200 | Power station;<br>bigger than 0.7x0.7mm square | Polgon |  | 045200 | K100 | On | *These symbols have the staff or characteristic attachment of the symbol at right angles to the street or road.*<br><br>*In congested areas, when the symbol overlapped road or railroad, the parts of staff and characteristic attachment can be moved from its preferred position, the length of the parts can be altered.* |
| | | 045300 | Power station;<br>smaller than 0.7x0.7mm square | Point |  | 045300 | K100 | On | |
| | LOCATED OBJECTS | 045400 | Transformer station | Point |  | 045400 | K100 | On | |
| | | 045500 | Radio mast or T.V. mast;<br>less than 61m avobe ground | Point |  | 045500 | K100 | On | |

| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| BUILDINGS AND POPULATED PLACES | LOCATED OBJECTS | 045600 | Tank | Point |  | 045600 | K100 | On | |
| | | 045700 | Chimney; less than 61m height above ground | Point |  | 045700 | K100 | On | |
| | | 050100 | Windmill, windpump | Point |  | 050100 | K100 | On | |
| | | 050200 | Watermill | Point |  | 050200 | K100 | On | |
| | | 050300 | Lighthouse | Point |  | 050300 | K100<br>CMYK 0 | On<br>Off | |
| | | 050400 | Monument | Point |  | 050400 | K100 | On | |
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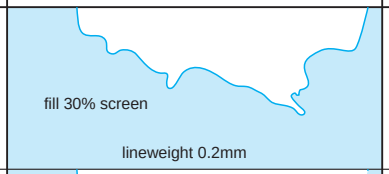
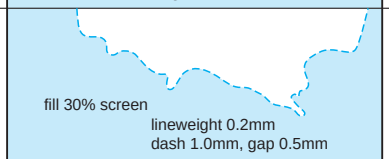
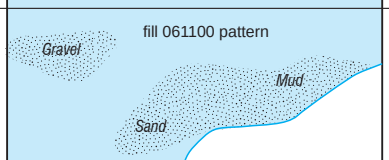
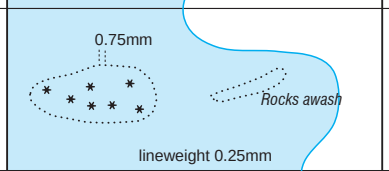
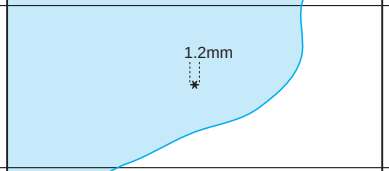
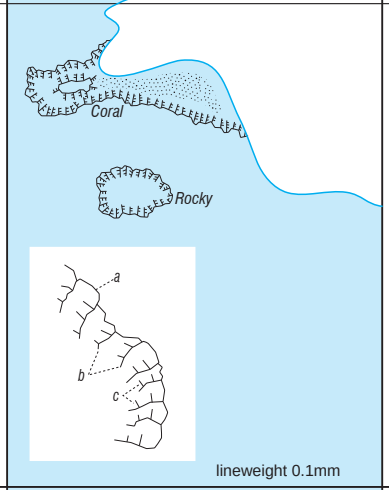
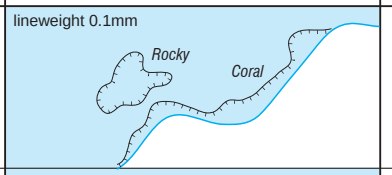
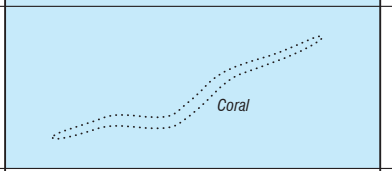
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| WATER SYSTEMS | COAST | 061000 | Coast Line, definite | Line |  | 061000<br>061000f | C100<br>C30 | On<br>Off | |
| | | 061001 | Coast Line, indefinite | Line |  | 061001<br>061001f | C100<br>C30 | On<br>Off | |
| | | 061100 | Foreshore flats<br>(sand, mud, gravel, etc) | Polygon |  | 061100t<br>061100 | K100<br>pattern | On. text | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*If known the composition of flat, label appropriately* |
| | | 061200 | Large group of rocks awash | Polygon |  | 061200t<br>061200 | K100<br>K100 | On<br>On | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*If in case of large area put random arrangement of rockawash symbols.*<br>*When area has less than 2.5mm in width on the map do not show symbols, define the limit and put label.* |
| | | 061300 | Rock awash; isolate | Point |  | 061300 | K100 | On | |
| | | 061400 | Large reef or rocky ledge with shade | Polygon |  | 061400t<br>061400 | K100<br>K100 | On<br>On | *a. Reef limits, Irregular line; avoid sharp angles and point.*<br>*b. Main ticks: length 0.75mm to 2.5mm, spacing 0.75mm to 2.0mm irregular alignment with sharp angles avoided.*<br>*c. Secondary ticks: start from right side of main ticks as viewed from reef limits. Length varies must not exceed 3/4 distance between main ticks. Smallest near end of main ticks. space between ticks approximately 0.5mm.*<br>*Usage font is Swiss721 Cn BT Italic 6pt*<br>*If known coral or rocky, label appropriately* |

| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| WATER SYSTEMS | COAST | 061500 | Small reef or rocky ledge | Polygon |  | 061500t<br>061500 | K100<br>K100 | On. text<br>On | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*If known coral or rocky, label appropriately* |
| | | 061600 | Isolated reef; less than 2.5mm | Point |  | 061600t<br>061600 | K100<br>K100 | On. text<br>On | *Usage font is Swiss721 Cn BT Italic 6pt* |
| | | 061700 | Elongated reef; less than 2.5mm in width | Polygon |  | 061700t<br>061700 | K100<br>K100 | On. text<br>On | *Usage font is Swiss721 Cn BT Italic 6pt* |
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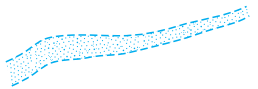
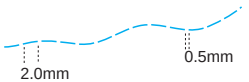
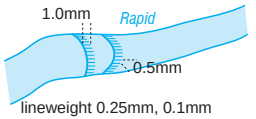
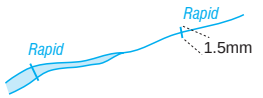
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| WATER SYSTEMS | RIVERS, STREAMS, CANALS, AND RELATED FEATURES | 062100 | Perennial river; over 50m wide | Polygon |  lineweight 0.2mm | 062100L<br>062100 | C100<br>C30 | On<br>Off | |
| | | 062200 | Perennial river; less than 50m wide | Line |  lineweight 0.2mm | 062200 | C100 | On | |
| | | 062300 | Intermittent river; over 50m wide | Polygon | Fill 062300 pattern  lineweight 0.2mm, dash 1.0mm, gap 0.5mm | 062300L<br>062300 | C100<br>pattern | On<br>Off | |
| | | 062400 | Intermittent river; less than 50m wide | Line |  lineweight 0.2mm | 062400 | C100 | On | |
| | | 062500 | Large rapids | Polygon |  lineweight 0.25mm, 0.1mm | 062500t<br>062500 | C100 | On. text<br>On | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*Delineate symbol in the rapid area with apporpriate distance.* |
| | | 062600 | Small falls | Line |  lineweight 0.25mm | 062600t<br>062600 | C100 | On. text<br>On | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*When using for double line river, extend symbol 0.2mm from river edge.* |
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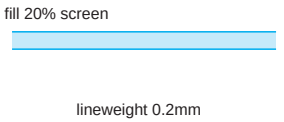
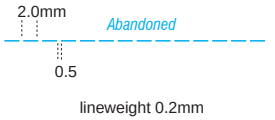
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| WATER SYSTEMS | RIVERS, STREAMS, CANALS, AND RELATED FEATURES | 062700 | Canal, ditch; over 50m wide | Polygon |  | 062700L<br>062700 | C100<br>C30 | On<br>Off | |
| | | 062800 | Canal, ditch; less than 50m wide | Line |  | 062800 | C100 | On | |
| | | 062900 | Canal, ditch; abandoned or dry, over 50m wide | Polygon |  | 062900t<br>062900L<br>062900 | C100<br>C100<br>CMYK0 | On. text<br>On<br>Off | *Usage font is Swiss721 Cn BT Italic 6pt* |
| | | 063000 | Canal, ditch; abandoned or dry, less than 50m wide | Line |  | 063000t<br>063000 | C100<br>C100 | On. text<br>On | *Usage font is Swiss721 Cn BT Italic 6pt* |
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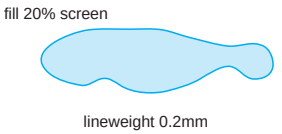
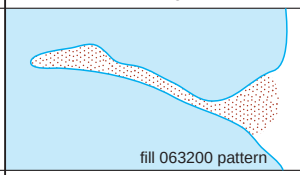
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| WATER SYSTEMS | RIVERS, STREAMS, CANALS, AND RELATED FEATURES | 063100 | Sea, Lake or Lagoon, perennial | Polygon |  | 063100L<br>063100 | C100<br>C30 | On<br>Off | |
| | | 063200 | Sandbar | Polygon |  | 063200 | pattern | Off | |
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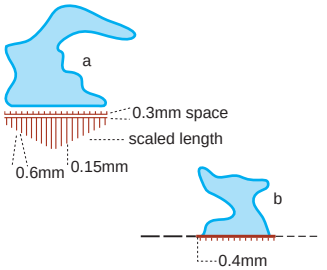
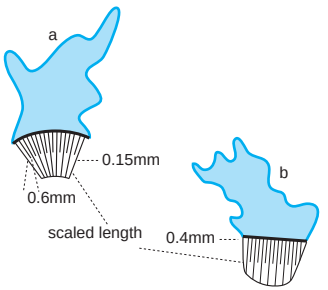
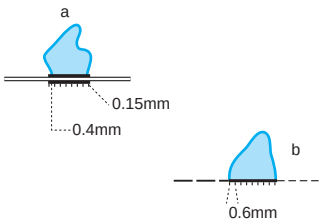
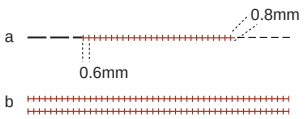
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| WATER SYSTEMS | RIVERS, STREAMS, CANALS, AND RELATED FEATURES | 063300 | Earthen dam | Line |  lineweight 0.4, 0.15mm | 063300<br><br>*the sloped base of Dam is plotted in layer 063501 | Brown100 | On | *"a" Space; between solid lines 0.3mm.*<br>*Ticks; minimun length 0.4mm, plot length of ticks (from top of Levee to base) to scale where longer than 0.4mm.*<br>*Space between ticks 0.6mm.*<br><br>*"b" Minimun width of top of Dam 0.4mm.*<br>*Base of Dam extends less than 0.8mm from top of Dam when plotted to scale.*<br>*Ticks; minimum length 0.4mm.*<br>*May be reduced if necessary to avoid conflict with other symbols.*<br>*Lineweight 0.15mm, space between ticks 0.6mm.*<br><br>**The sloped base of Dam is plotted in layer 063501 which is unnecessary to show on the map.* |
| | | 063400 | Masonry dam; with sloped sides | Line |  lineweight 0.4, 0.15mm | 063400<br><br>*the sloped base of Dam is plotted in layer 063601 | K100 | On | *Minimum width of top of Dam 0.4mm.*<br>*Ticks; lineweight 0.15mm, space between ticks 0.6mm, minimun length 0.4mm, plot to scale.*<br>*May be reduced to avoid conflict with other symbols.*<br>*Short ticks in "a" and "b" are one half the length of the long ticks.*<br><br>*"a" and "b" Sloped base of Dam extends 0.8mm or more from the top of Dam plot to scale.*<br><br>**The sloped base of Dam is plotted in layer 063601 which is unnecessary to show on the map.* |
| | | 063500 | Masonry dam; without sloped sides | Line |  lineweight 0.4, 0.15mm | 063500 | K100 | On | *Minimum width of top of Dam 0.4mm.*<br>*"a" Sloped base of Dam extends less than 0.75mm from the top of Dam carrying road.*<br><br>*"b" Sloped base of Dam extends less than 0.75mm from the top of Dam carrying track or trail or without road.* |
| | | 063600 | Levee; less than 0.3mm in width | Line |  lineweight 0.15mm | 063600 | Brown100 | On | *Ticks; minimum length 0.8mm, Plot longer of ticks to scale where longer than 0.4mm from top of Levee to base.*<br>*a. carrying track or trail.*<br>*b. along canal or ditch.* |
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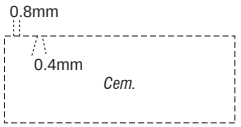
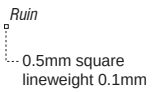
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| LAND COVER AND VEGETATION | LAND COVER | 071300 | Open space; wasteland or other lot space, holding | Polygon | | 071300 | CMYK 0 | Off | *It is unnecessary to show any symbol on map.* |
| | | 071400 | Cemetery; more than 150mx150m | Polygon |  lineweight 0.1mm | 071400t<br>071400L<br>071400 | K100<br>K100<br>CMYK 0 | On, text<br>On<br>Off | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*Plot to scale, 3 mm x 3 mm or over on the map, put annotation inside of area or apporopriate position.* |
| | | 071500 | Cemetery; less than 150mx150m | Point |  lineweight 0.1mm | 071500 | K100 | On | *Outline not shown for area less than 2.5 mm x 2.5 mm on the map.* |
| | | 071600 | Park; more than 150mx150m | Polygon |  lineweight 0.1mm | 071600t<br>071600L<br>071600 | K100<br>K100<br>Green80 | On, text<br>On<br>Off | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*Plot to scale, 3 mm x 3 mm or over on the map, put annotation inside of area or apporopriate position.* |
| | | 071700 | Park; less than 150mx150m | Point | *P* | 071700 | K100 | On | *Usage font is Swiss721 Cn BT Italic 6pt* |
| | | 071800 | Area of ruins; more than 150mx150m | Polygon |  lineweight 0.1mm | 071800t<br>071800L<br>071800 | K100<br>K100<br>CMYK 0 | On, text<br>On<br>Off | *Usage font is Swiss721 Cn BT Italic 6pt*<br>*Plot to scale, 3 mm x 3 mm or over on the map, put annotation inside of area or apporopriate position.* |
| | | 071900 | Ruin | Point |  lineweight 0.1mm | 071900 | K100 | On | *Usage font is Swiss721 Cn BT Italic 6pt* |
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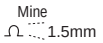
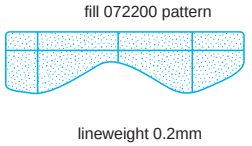
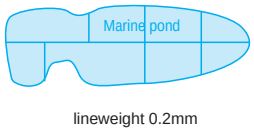
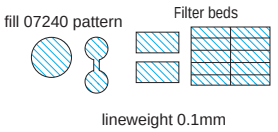
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| LAND COVER AND VEGETATION | LAND COVER | 072000 | Mining area | Polygon |  | 072000t<br>072000L<br>072000 | K100<br>K100<br>CMYK0 | On, text<br>On<br>Off | Usage font is Swiss721 Cn BT Italic 6pt<br>*Plot to scale, 3 mm x 3 mm or over on the map,*<br>*if known mining material indicated by labeling material name.*<br>*When unknown mining material, label "Mine".* |
| | | 072100 | Mine; vertical shaft, horizontal shaft | Point |  | 072100t<br>072100 | K100<br>K100 | On, text<br>On | Usage font is Swiss721 Cn BT Italic 6pt<br>*if known mining material indicated by labeling material name.*<br>When unknown mining material, label "Mine". |
| | | 072200 | Salt evaporator | Polygon |  | 072200L<br>072200 | C100<br>pattern | On<br>Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 072300 | Fish ponds or hatcheries | Polygon |  | 072300t<br>072300L<br>072300 | C100<br>C100<br>C30 | On, text<br>On<br>Off | Usage font is Swiss721 Cn BT Italic 6pt<br>*Plot to scale, 3 mm x 3 mm or over on the map,*<br>*put several annotation on divided sections*<br>*or apporopriate position.* |
| | | 072400 | Sewage disposal and filtration beds | Polygon |  | 072400t<br>072400L<br>072400 | K100<br>K100<br>pattern | On, text<br>On<br>Off | Usage font is Swiss721 Cn BT Italic 6pt<br>*Plot to scale, 3 mm x 3 mm or over on the map,*<br>*put annotation apporopriate position.* |
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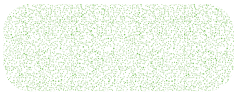
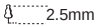
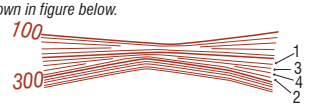
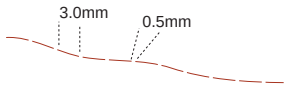
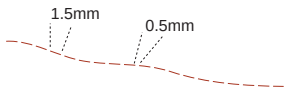
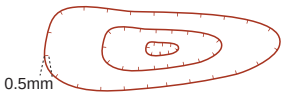
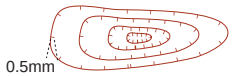
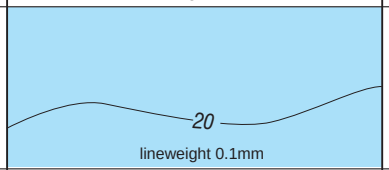
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| LAND COVER AND VEGETATION | VEGETATION | 070000 | Vegetation boundary | Line | | 070000 | CMYK0 | Off | *It is unnecessary to show on map.* |
| | | 072500 | Woodland | Polygon |  | 072500 | Green60 | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 072600 | Scrubland | Polygon | fill 072600 pattern  | 072600 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 072700 | Scattered trees | Polygon | fill 072700 pattern  | 072700 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 072800 | Clearing | Polygon |  | 072800 | CMYK0 | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 072900 | Tropical grass | Polygon | fill 072900 pattern  | 072900 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 073000 | Plantation, orchard, and nursery | Polygon | fill 073000 pattern  | 073000 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 073100 | Rice fields | Polygon | fill 073100 pattern  | 073100 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |

| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| LAND COVER AND VEGETATION | VEGETATION | 073200 | Cultivated land | Polygon | fill 073200 pattern  | 073200 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 073300 | Swamp | Polygon | fill 073300 pattern  | 073300 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 073400 | Nipa | Polygon | fill 073400 pattern  | 073400 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 073500 | Mangrove | Polygon | fill 073500 pattern  | 073500 | pattern C20 | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* *Fill background color with cyan 20%.* |
| | | 073600 | Isolated tree | Point |   | 073600 | K100 | On | |
| | | 073700 | Coconut | Polygon | fill 073700 pattern  | 073700 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* |
| | | 073800 | Trees mixed with coconut | Polygon | fill 073700 pattern and green 20%  | 073800 | pattern Green20 | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* *Fill background color with green 20%.* |
| | | 073900 | Cultivated land mixed with coconut | Polygon | fill 073700 pattern and 073200 pattern  | 073900 | pattern | Off | *Plot to scale, 3 mm x 3 mm or over on the map.* *Fill with 073700 pattern, background with 073200 pattern.* |

| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TOPOGRAPHY | CONTOUR LINE | 081100 | Intermediate contour | Line |   | 081100 | Brown100 | On | *Usage font is Swiss721 Bt italic 8pt.*<br>*Elevation value is set into layer 081900.*<br>*The labeling of contours, effort is made to position the value reading uphill towards the higher elevation and to make it legible from bottom and both side of map.*<br>*In the majority of cases, it is only necessary to label the index contours.*<br>*In case of flat areas widely spaced intermediate contours are labeled to facilitate the interpretation of terrain.*<br>*If space is permitting, contour label are added to supplementary and depression contours wherever they are shown.*<br>*As for all numerals which are contour label, control points features are shown number of 6 or maximum 10 into area of 10cm x 10cm by these are in all.*<br>*In steep areas of uniform slope, the index contours are always shown continuous. When the space between index contours dose not permit the showing of all the intermediate contours [minimum 0.2 mm (0.008in) clearance], the intermediate contours are dropped in compiance with the order of retention shown in figure below.*<br>  <br>*Contours not shown on surface of open water.*<br>*Contours not shown along the roads.*<br>*Contours shall be broken for inside of levees,cuts, fills, cliffs or columnar rock formation.* |
| | | 081200 | Index contour, contour elevation label | Line |   | 081900<br>081200 | Brown100<br>Brown00 | On, text<br>On | |
| | | 081300 | Supplementary contour; one-half interval | Line |   | 081300 | Brown100 | On | |
| | | 081400 | Supplementary contour; one-quarter interval | Line |   | 081400 | Brown100 | On | |
| | | 081500 | Depression contour; index contour | Line |   | 081500 | Brown100 | On | *Ticks: lineweight 0.1mm, length 0.5mm.*<br>*Space minimum 0.5mm, if large depression may be used appropriately (from 0.5mm to 3.0mm or much more).* |
| | | 081600 | Depression contour; intermediate contour | Line |   | 081600 | Brown100 | On | |
| | | 081700 | Depth curves | Line |   | 081700t<br>081700 | K100<br>K100 | On, text<br>On | *Usage font is Swiss721 Bt italic 8pt.*<br>*Labeling for the depth curves are always positioned as well as contour labeling manner.* |
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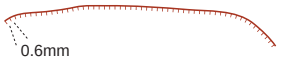
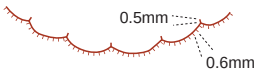
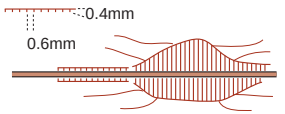
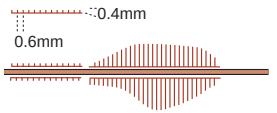
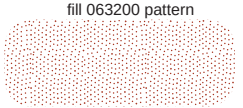
| | | CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| TOPOGRAPHY | TERRAIN | 082100 | Escarpment, cliff, or abrupt slope of greater height than contour interval | Line |  lineweight Base :0.2mm, Tick:0.1mm | 082100 | Brown00 | On | Base; lineweight 0.2mm<br>Ticks; lineweight 0.1mm, length 0.5mm, space0.6mm |
| | | 082200 | Columnar rock formation | Line |  lineweight Base :0.2mm, Tick:0.1mm | 082200 | Brown100 | On | *Base line including heavy ticks 0.2mm*<br>*Ticks; lineweight 0.1mm, length 0.5mm, space0.6mm* |
| | | 082300 | Small crater | Point |  lineweight 0.1mm | 082300 | Brown100 | On | |
| | | 082400 | Cut | Line |  lineweight 0.15mm | 082400 | Brown100 | On | Plot to scale, minimum length of ticks 0.4mm.<br>Top of slope delineate with 082400, Base of slope show with 072501 for plotting.<br>After drawing ticks, 072501 is not shown on the map. |
| | | 082500 | Fill | Line |  lineweight 0.15mm | 082500 | Brown100 | On | Plot to scale, minimum length of ticks 0.4mm.<br>Top of slope delineate with 082500, Base of slope show with 072601 for plotting.<br>After drawing ticks, 072601 is not shown on the map. |
| | | 082600 | Sand | Polygon | fill 063200 pattern  | 082600 | pattern | Off | |
| | | 082700 | Lahar | Polygon | fill 082700 pattern  | 082700t<br>082700 | K100<br>pattern | On.text<br>Off | Usage font is Swiss721 Cn BT Italic 6pt<br>*In case of large area, put appropriately several labels in the area.* |
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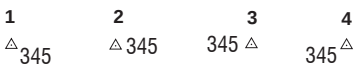
CONTROL POINT

CONTROL POINT

| CODE NUMBER | FEATURE | DATA TYPE | DRAFTING AND SPECIFICATIONS | LAYERS | COLOR | OVER PRINT | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 090100 | Geodetic control point | Point |  lineweight 0.1mm, diameter 0.2mm | 090100t<br>090100 | K100<br>K100 | On.text.<br>On. | *Usage font is Swiss721 Cn Bt 8pt.* |
| 090200 | Benchmark | Point |  diameter 0.5mm | 090200t<br>090200 | K100<br>K100 | On.text.<br>On. | *Usage font is Swiss721 Cn Bt 8pt.* |
| 090300 | Spot elevation in meters | Point |  diameter 0.5mm | 090300t<br>090300 | K100<br>K100 | On.text.<br>On. | *Usage font is Swiss721 Cn Bt 8pt.* |
| 090400 | Water surface elevation | Point | **5, Order of placement**<br>  | 090400 | C100 | On | *Usage font is Swiss721 Cn Bt 8pt.*<br>*Put elevation value nearby side or on the surface,*<br>*It is unnecessary to show point.* |

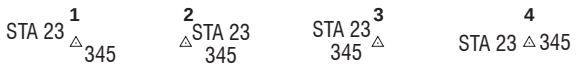
*1. The elevation value for horizontal control points are preferably positioned to the southeast side of the point, and the top of the value aligned with the horizontal center of symbol. When preferred positioning cannot be adhered to, the selection of alternative positioning is made in accordance with the following examples:*

**1, Order of placement**




*2. There are instances when control points are identified with a name or station number. When this occurs, the name or number is positioned as indicated below. Examples:*

**2, Order of placement**

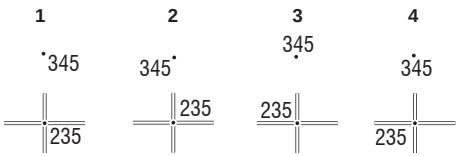



*3. When labeling benchmarks, the bottom of the type BM is aligned with the horizontal center of the point and preferably on the northwest side. Examples:*

**3, Order of placement**

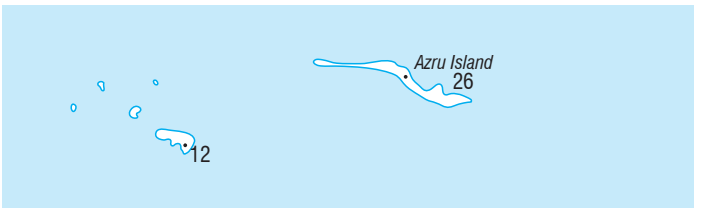

*4. Spot elevation values are positioned in close proximity to the symbol they identify. Where possible, elevation values are placed to avoid obscuring features of importance to the map user; i.e., small tops, ridges, saddles, etc. It is preferred that the values be positioned to the southeast of the defined point, with the top of the numerals aligned with the horizontal center of the symbol referenced.*
*Spot elevation values are never positioned so that the dot depicting the precise location of the elevation may be mistaken for a decimal. Examples:*

**4, Order of placement**




*5. Water-surface elevations are shown in cyan color and preferably centered within the limits of the feature. When elevations are provided for bodies of water which are not large enough to accommodate the numerals, it is permissible to position the value adjacent to the feature.*

*6. Instance will occur where spot elevations are provided for islands too small to accommodate the values. In such cases the value is positioned adjacent to the island and aligned in accordance with manner 4 (case of spot height). When the island is identified by a proper name, the value is centered below the name. Examples:*



| | | CODE NUMBER | FEATURE | LAYERS | COLOR | OVER PRINT | STYLE; SIZE | FONT EXAMPLE, DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| TYPOGRAPHY | ADMINISTRATIVE NAMES; POPULATED PLACE | 100100 | Province name | an100100 | K100 | On | Swiss721BT<br>Roman<br>Size 8pt Caps | PROV. OF ORIENTAL MINDORO<br>*The name shown along boundary |
| | | 100200 | Municipality name | an100200 | K100 | On | Swiss721BT<br>Roman<br>Size 8pt Caps | MUN. OF SANTO DOMINGO<br>*The name shown along boundary |
| | | 100300 | Municipality / City name | an100300 | K100 | On | Swiss721BT<br>Roman<br>Size 10pt Caps | SAN MIGUEL |
| | | 010400 | Barangay name | an010400 | K100 | On | Swiss721BT<br>Roman<br>Size 8pt C/L | Elias |
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| | | CODE NUMBER | FEATURE | LAYERS | COLOR | OVER PRINT | STYLE; SIZE | FONT EXAMPLE, DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| TYPOGRAPHY | GEOGRAPHIC NAME | 101100 | Large regional mountain range | an101100 | K100 | On | *Swiss721BT<br>Italic<br>Size 14-18pt Caps | S I E R R A  M A D R E<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
| | | 101200 | Large single mountain | an101200 | K100 | On | *Swiss721BT<br>Italic<br>Size 12-14pt Caps | *Mt. PULAG*<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
| | | 101300 | Small single mountain | an101300 | K100 | On | *Swiss721BT<br>Italic<br>Size 10pt C/L | *Mt. Lobi* |
| | | 101400 | Hills, peaks, gaps, tops, etc. | an101400 | K100 | On | *Swiss721BT<br>Italic<br>Size 6-8pt C/L | *Malaya Hill*<br>**Use type template when making selections.* |
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| | | CODE NUMBER | FEATURE | LAYERS | COLOR | OVER PRINT | STYLE; SIZE | FONT EXAMPLE, DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| TYPOGRAPHY | RIVER, DRAINAGE NAME | 102100 | Single line river | an102100 | C100 | On | *Times new roman Italic<br>Size 6-10pt C/L | *Agno River*<br>**Use type template when making selections.* |
| | | 102200 | Double line river | an102200 | C100 | On | *Times new roman Italic<br>Size 8-12pt Caps | *PULOG RIVER*<br>**Use type template when making selections.* |
| | | 102300 | Single line canals, drainages | an102300 | C100 | On | *Times new roman Italic<br>Size 6-10pt C/L | *Bago Canal*<br>**Use type template when making selections.* |
| | | 102400 | Double line canals, drainages. | an102400 | C100 | On | *Times new roman Italic<br>Size 8-12pt Caps | *IROIRO CANAL*<br>**Use type template when making selections.* |
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| | | CODE NUMBER | FEATURE | LAYERS | COLOR | OVER PRINT | STYLE; SIZE | FONT EXAMPLE, DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| TYPOGRAPHY | AREA IDENTIFICATIONS | 103100 | Area names | an103100 | K100 | On | *Swiss721BT<br>Roman<br>Size 8-18pt Caps | TICAO FIELD<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
| | | 103200 | Large bodies of open water | an103200 | C100 | On | *Times new roman<br>Italic<br>Size10-18pt Caps | *P H I L I P P I N E  S E A*<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
| | | 103300 | Small ponds, lakes, inlets, gulfs, bays | an103300 | C100 | On | *Times new roman<br>Italic<br>Size 6-10pt C/L | *Laguna de Bay*<br>**Use type template when making selections.* |
| | | 103400 | Large ponds, lakes, inlets, gulfs, bays | an103400 | C100 | On | *Times new roman<br>Italic<br>Size10-18pt caps | *LAGUNA DE TAAL*<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
| | | 103500 | Large marshes, swamps and similar areas | an103500 | C100 | On | *Times new roman<br>Italic<br>Size10-18pt caps | *AGUSAN SWAMP*<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
| | | 103600 | Small marshes, swamps and similar areas | an103600 | C100 | On | *Times new roman<br>Italic<br>Size6-10pt C/L | *Victoria Swamp*<br>**Use type template when making selections.* |
| | | 103700 | Woodland area | an103700 | K100 | On | *Swiss721BT<br>Roman<br>Size 6-18pt Caps | S A M A L  F O R E S T<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
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| | | CODE NUMBER | FEATURE | LAYERS | COLOR | OVER PRINT | STYLE; SIZE | FONT EXAMPLE, DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| TYPOGRAPHY | CAPES AND ISLANDS | 104100 | Large capes, islands, island chains, and peninsulas | an104100 | K100 | On | *Swiss721BT<br>Italic<br>Size 8-18pt Caps | C E B U  I S L A N D<br>*Letter space or extend as necessary.*<br>**Use type template when making selections.* |
| | | 104200 | Small capes, islands, island chains, and peninsulas | an104200 | K100 | On | *Swiss721BT<br>Italic<br>Size 6-10pt C/L | *Semirara Island*<br>**Use type template when making selections.* |
| | | 104300 | Points | an104300 | K100 | On | *Swiss721BT<br>Italic<br>Size 8pt C/L | *Siargao Point* |
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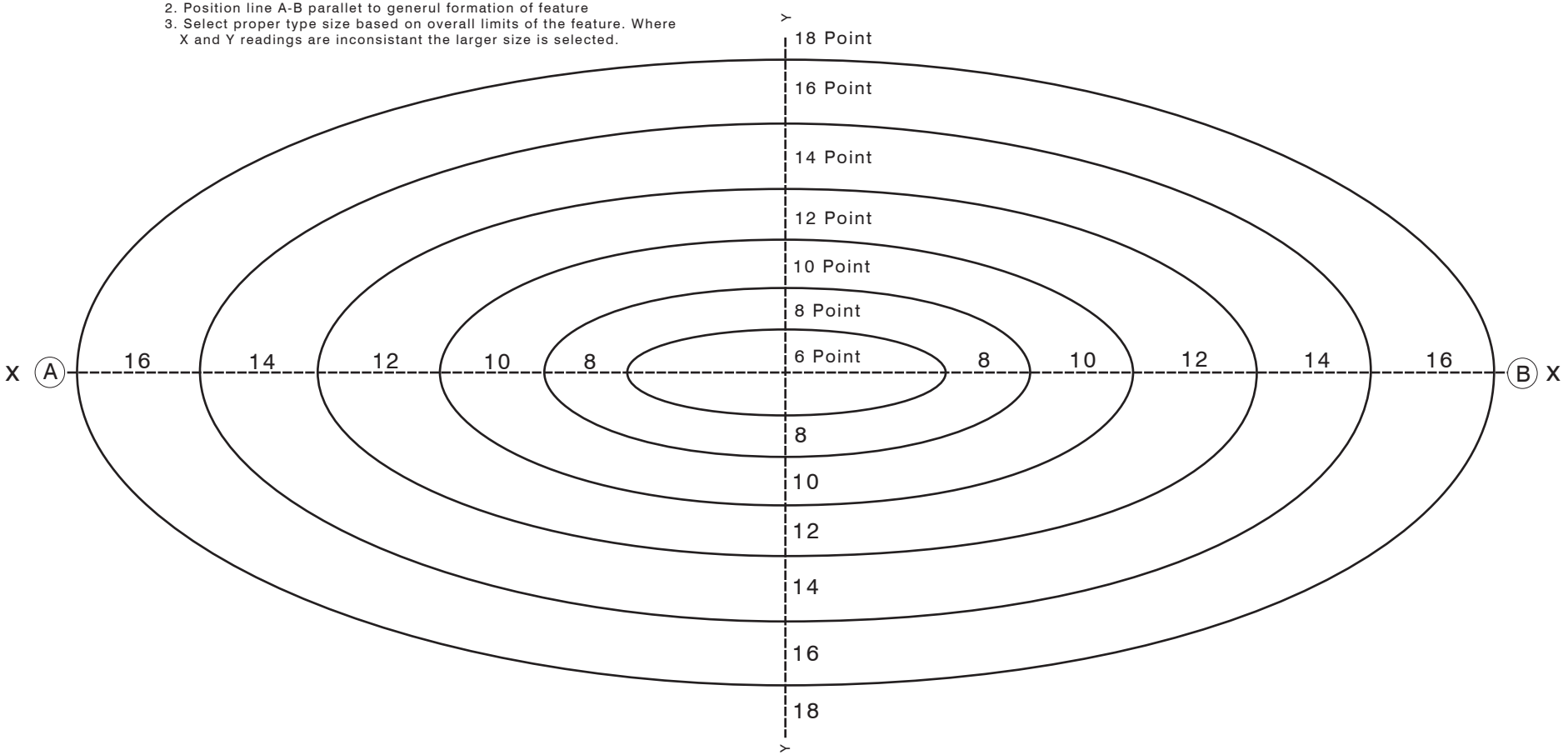
| | | CODE NUMBER | FEATURE | LAYERS | COLOR | OVER PRINT | STYLE; SIZE | FONT EXAMPLE, DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| TYPOGRAPHY | OTHER DESCRIPTION | 105100 | Roads, track, lane informations | an105100 | K100 | On | *Swiss721Cn BT<br>Italic<br>Size6pt Caps | *PHILIPPINE NATIONAL HIGHWAY* |
| | | 105200 | Railroads, related information | an105200 | K100 | On | *Swiss721BT<br>Italic<br>Size 6-10pt C/L | *PHILIPPINE NATIONAL RAILWAYS* |
| | | 105300 | Label of point feature for clarifying; black color objects | an105300 | K100 | On | *Swiss721BT<br>Italic<br>Size 6pt C/L | *Churches, cemeteries, dams, fords, hospitals, landmark buildings, landmark objects, lighthouses, towers, mines, piers, wharves, public buildings, ruins, schools, stadiums, swimming pools, tanks, reservoirs, tunnels, windmills and similar features, obstructions, etc.* |
| | | 105400 | Label of point feature for clarifying; blue color objects | an105400 | C100 | On | *Swiss721BT<br>Italic<br>Size 6pt C/L | *Concerning with water objects and similar features, obstructions, etc.* |
| | | 105500 | Annotation of Road direction | an105500 | K100 | On | *Swiss721BT<br>Italic<br>Size 5pt Caps, C/L | SAN MIGUEL Elias<br>*Annotation for Municipality or City shall be used Caps letter, for Barangay shall be used C/L letter<br>*Text direction shall be same as figure<br>  |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

# TYPE TEMPLATE

Instructions:

1. Center templet over approximate center of feature
2. Position line A-B parallet to generul formation of feature
3. Select proper type size based on overall limits of the feature. Where X and Y readings are inconsistant the larger size is selected.




SINGLE LINE DRAINAGE

*Label in 6pt C & L*

Streams 4.0cm(1.6 in)to 8.0cm(3.2 in)long

*Label in 8pt C & L*

Streams 8.0cm(3.2 in)to 16.0cm(6.4 in)long

*Label in 10pt C & L*

Streams which exceed 16.0cm(6.4 in)length 80cm(3.2 in)long

# Digital Ortho-photo Preparation Manual

EDITION 1

# Contents

# Foreword

## 1. Introduction

Preparation of ortho-photographs is work that creates ortho-photographs by orthographic conversion of aerial photographs or satellite images. The photographs are mosaicked if necessary.

Digital technologies are used in the process of orthoimage preparation as IT technologies are advance in the survey work. The equipment and process have been changed drastically.

The instrument used for digital-orthoimage preparation consists of a computer and software. The specifications and the operation methods of instrument have many varieties than the conventional analogue methods using analogue equipment; the work has been conducted without a set standard procedure. Therefore, present condition is that there are no general specification and general criteria about the quality of the created survey data.

The work manual for digital-orthoimage-photo preparation (henceforth "the Manual") is positioned and defined with the considerations discussed as digital image preparation by orthographic conversion of aerial photographs and satellite images. The method is positioned as the digital-orthoimage preparation.

The Manual shows the basic method and quality standards of survey results. It is aimed for NAMRIA to implement efficient the digital-orthoimage preparation and to promote uses of digital-orthoimages.

## 2. Digital-orthoimages

The ortho-photograph created by the conventional analog form changes an aerial photograph into an orthographic projection mechanically using the orthographic-projection machine of topocart-orthophoto, ortho projector GZ-1, Avioplan OR-1, etc., and prints it on a film or a photographic paper. On the other hand, digital-orthoimage is the digital imaging which re-arranged each evaluated pixel, such as an aerial photograph and satellite imagery, in the location of an orthographic position using the external orientation element and the digital terrain model.

The left side of Figure 1 shows a central projection of an aerial photograph, and the digital-orthoimages of which orthographic conversion was applied to the aerial photographs. The mountainous part of the area surrounding the dam-lake is shown closer to the center in the orthoimages. As a result, there are blank areas along the edges.

In the aerial photograph (left), objects near a camera are larger and objects far from a camera are shown smaller. It is a distortion by a relative-height difference and relief of earth surface. In digital-orthoimages, this distortion is rectified by orthographic

conversion using external orientation elements and heights information of the topography.

Figure 1 Aerial photograph (left) and Digital-orthoimage (right)

A digital-orthoimage is an image, which is converted from centrally projected aerial photographs, by ortho-projection--the same as in topographic maps. Therefore, the digital-orthoimage can be overlaid over topographic maps and used.

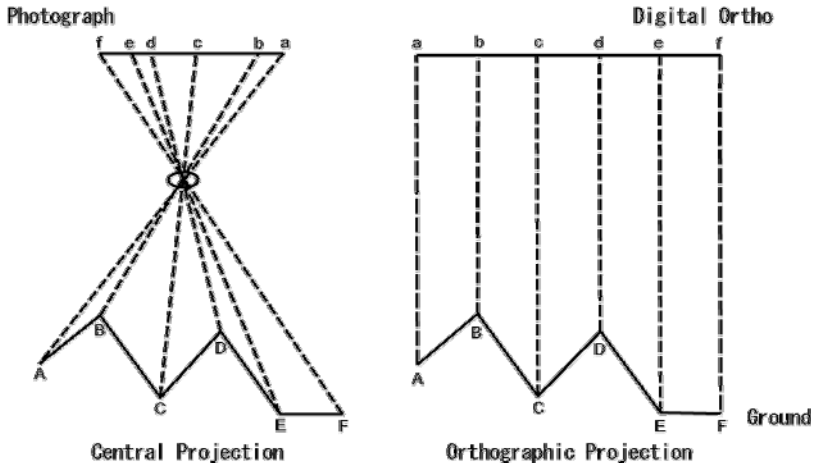



Figure 2 Central Projection (aerial photograph) and Orthographic Projection (digital-orthoimage)

The principle of an orthographic conversion is shown in Figure 3. In the figure, the point A need to be projected to the point A' in ortho-projection; however, in the aerial photograph, it is projected to the point B. Therefore, the point A is projected to a, but to project orthographically like topographic maps, the point needs to be projected to the point a'. The conversion of the point a to the point a' can be achieved, as shown in Figure 3, by calculation using the height from the point A to the A' and the angle $\theta$ as h-tan $\theta$.

h can be obtained from the measurement taken by a digital stereo plotting instrument,

and $\theta$ can be obtained from the external orientation element of an aerial photograph.

Many of satellite images are acquired by a line sensor; it is the combination of a central projection and parallel projection. Therefore, although it cannot be said that it is an orthographic projection in a strict sense, it is possible to change into an orthographic projection using an external orientation element and the height of topography as in aerial photographs.

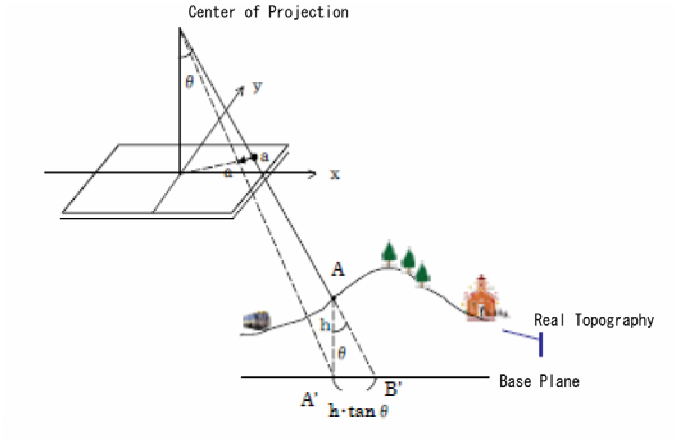



Figure 3 Orthographic conversion

There are following types of the digital terrain models used in orthographic conversion by differences in data structure.

- Grid data which have elevation data in a lattice structure;

-Irregular triangulation network (TIN) which expresses topography as an aggregation of triangle surfaces.

There are two digital terrain models depending on the types of elevation data used. (Figure 4)

- A model showing the elevation of earth surface. DTM (Digital terrain model)

- A model with the elevation of the surface including ground coverage, such as an artificial structure and vegetation. DSM (Digital Surface Model)

Although the digital terrain model used by an orthographic conversion needs DSM fundamentally, in this manual, it makes it valid to use DTM like the model created from the contour lines of topographic maps.

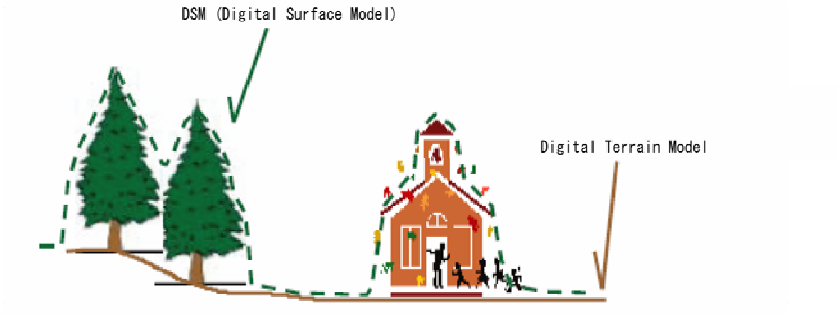



Figure 4 DSM as DTM.

3. Operation manual of digital-orthoimage preparation

1) Purpose and scope

In accordance with the Specifications for Topographic Mapping at Scale of 1:50,000 Article 11 (Special Exceptions to Equipment and Operation Methods), the standard operation method is prepared for digital-orthoimages produced in NAMRIA. It aims to unify the standards and to secure required accuracy for standardization of the results.

2) Structure of the Manual

This manual specifies the standard working methods of creating digital-orthoimages and instruments to be used.

Moreover, in order to deepen the understanding of preparation of the digital-orthoimage as a survey technology and to facilitate promotion of uses, [Note] is added to Articles and operation standards. The structure of the Manual is as follows:

(1) Part One: General Rules

Part One includes: the purpose and conditions of the digital-orthoimage data preparation.

(2) Part Two: Preparation of Digital Orthoimages

Categories of processing, standards, and methods are specified.

# Part 1 General Rules

### Article 1 Purpose

This manual aims to unify the specifications, to standardize the results, and to secure required accuracies by defining the standard preparation method of the digital-orthoimage executed based on the Specifications for Topographic Mapping at Scale of 1:50,000 Article 11, the Special Exceptions to Equipment and Operation Methods.

### Article 2 Application with Necessary Modifications of the Specifications for Topographic Mapping at Scale of 1:50,000

Except what is included in this manual, corresponding rules and regulation of the Specifications for Topographic Mapping at Scale of 1:50,000 NAMRIA is applied.

[Note]

This manual has described the item characteristic to digital-orthoimage preparation. Items other than this manual shall refer corresponding items in the Specifications for Topographic Mapping at Scale of 1:50,000 NAMRIA.

### Article 3 Overseas survey using a digital-orthoimage

The digital-orthoimage preparation within the Specifications for Topographic Mapping at Scale of 1:50,000 is work which prepares digital-orthoimage-data files by conducting orthographic conversions to digital photographs scanned from aerial photographs acquired from aerial digital photography, or satellite images using a digital stereo plotter or other device. The work includes mosaic images which combined the adjoining orthographic-projection images by digital processing.

[Note]

The standard instrument and software which are used for digital-orthoimage preparation are composed of scanner for aerial photographs, digital stereo plotter, orthographic-conversion software, and mosaic software.

1. Scanner for aerial photographs

The scanner for aerial photographs evaluates an aerial film and creates digital photographs.

2. Digital stereo plotter

A digital stereo plotting instrument creates a digital terrain model for an elevation by automatic extraction or a digital plotting from one pair of digital photographs which constitutes a solid model.

3. Orthographic-conversion software

Using the external orientation element and digital terrain model of digital photographs, orthographic-conversion software changes digital photographs into an orthographic projection, and creates orthographic-projection images.

4. Mosaic software

Mosaic software overlays a series of orthographic-projection images by digital processing, and a series of continuous mosaic images are created. Also, digital-orthoimage-data files are created from the mosaic images by dividing the mosaic images arbitrarily.

**Article 4 Instrument to be used**

The main instruments used for digital-orthoimage preparation shall be the following or equivalent.

(1) Scanner for aerial photographs

The scanner for aerial photography is a system which consists of: the scanner which scans an aerial film acquires and records a digital photograph in an image format; computer program; a computer and peripheral devices. It shall have the capability which satisfies the specific accuracy.

(2) Digital stereo plotter

A digital stereo plotter is a system which consists of: the computer program which creates and displays a stereo model, and acquires and records map information in a digital format from the digital photograph with the stereoscopic viewing function; computer hardware; and peripheral devices. It shall satisfy the specified accuracy.

**<Article 4 Operation Standards>**

1. The standard configurations of the scanner for aerial photographs are a computer, display, roll film setting device, film stabilizing device, etc.

2. The capability of the scanner for aerial photographs shall have the following accuracy.

| Item | Capability (accuracy) |
|---|---|
| Optical resolution | 21 $\mu$m or less |
| The minimum scan size | 240 mm x 240 mm or larger |
| the color of a scanning image -- gradation | 24-bit full color or higher |
| Geometric accuracy of a scanning image | 2 $\mu$m or less (mean square error) |

3. The scanner for aerial photographs shall receive a certificate of inspection, which shall be valid for six months, from an independent organization having the inspection technology. The certificate of the scanner for aerial photographs shall approved by NAMRIA in the form of a manufacturer used for a periodical inspection report.

4. The grid plate used for inspection has the grid consistency of 5x5 or more points.

And it shall be a precision lattice plate attached to each scanner for aerial photographs which can verify the geometric accuracy of 240 mm x 240 mm, and should receive an official approval by an independent organization.

5. The criterion of the composition of a digital stereo plotter and a function are as follows:

1) Digital stereo plotters are an electronic computer, stereoscopic-vision equipment, a display and a three-dimensional mouse or XY handles, and a Z board.

2) The external orientation element of inner orientation, a relative orientation, and an absolute orientation shall perform a stereo display;

3) It shall have the function which the coordinate values of X, Y and Z and a specified code can input and recorded; and

4) It shall have functions, such as an orthographic conversion.

6. Coordinate reading of a digital stereo plotter shall have the capability which can be read to subpixels.

[Note]

1. Subpixels are imaginary pixels which subdivide a pixel-- the minimum unit of digital photographs. There is no limitation of the degree of subdivision.

### Article 5 Operation plan

A survey operation agency (henceforth the "executing organization") prepares an operation plan before commencement of the work: The operation plan includes major instruments to be used, necessary personnel and a schedule. The operation plan shall be submitted to and approved by NAMRIA. When the operation plan is to be changed, the change needs to be submitted and approved by NAMRIA.

### Article 6 Process Control

The executing organization shall perform an appropriate process control based on the operation plan mentioned in Articles.

2. The executing organization shall report the progress situation of work to NAMRIA when requested.

### Article 7 Accuracy Control

In order to secure accuracy of survey, the executing organization shall perform appropriate accuracy management. An accuracy control table shall be prepared, and it shall be submitted to NAMRIA.

2. The executing organization shall perform necessary inspection at the end of each work process and other appropriate time.

**<Article 7 Operation Standards>**

1. Accuracy control shall be performed to a digital terrain model file and digital-orthoimage-data file by sheet.

2. The rules of the Specifications for Topographic Mapping at Scale of 1:50,000 Part Three Digital Topographic Map Creation Process shall be applied to the processes not specified in the manual.

3. Article 7 Accuracy Control of the Specifications for Topographic Mapping at Scale of 1:50,000 shall be applied to the amount of check survey unless otherwise specified.

[Note]

1. The general flow of the accuracy control shall be as shown in the figure. A repeated inspection shall be needed in each operation process.

1) The color tones between the images are checked on their homogeneity during the checking of the digital photograph. Since it is technically difficult to make the whole into a homogeneous color tone and a color tone is judged sensuously, it is desirable that the acceptance criteria over color tones are to be agreed between NAMRIA and the executing organization.

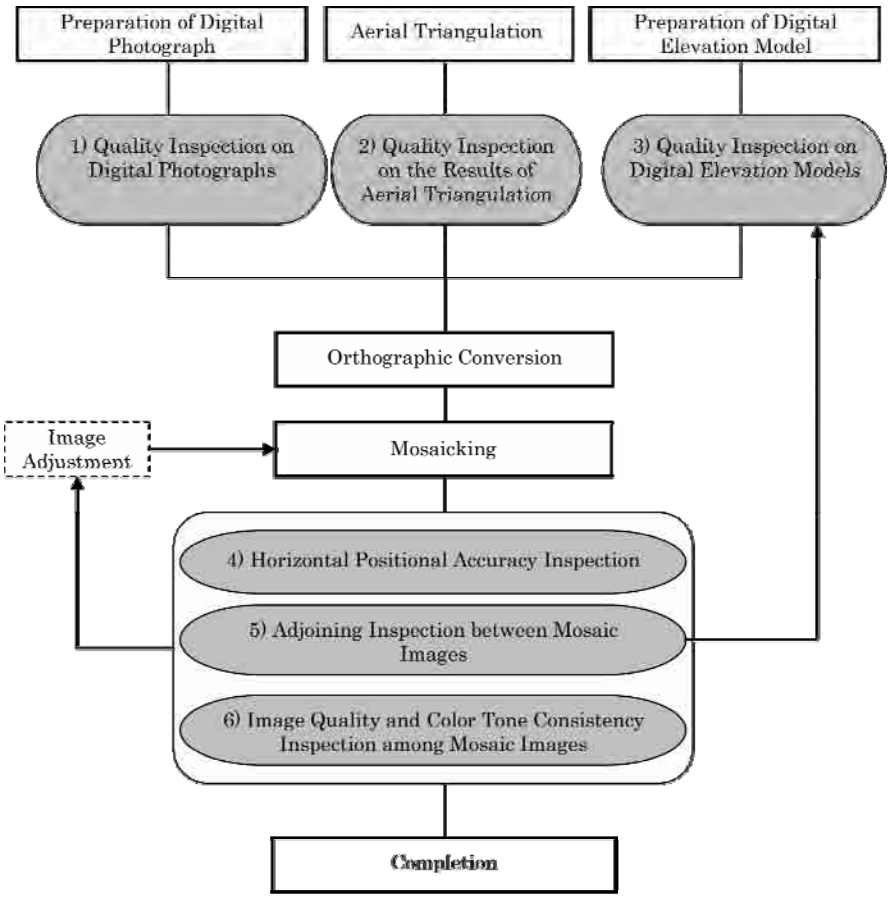
2) During the inspection, problems of aerial triangulation shall be identified, and formation of precise stereo-pair shall be confirmed. If there is a problem, the aerial triangulation shall be conducted again.

3) In accuracy control of a digital terrain model, the spot height with which they created digital terrain model is piled up and displayed on a stereo model, and regulation of the 11th article 2nd term is not filled carries out correction edit.

4) As for the items of horizontal position accuracy control, clear planimetric features shall be selected in stereoscopic models of digital photographs, and the horizontal coordinates shall be measured. Then the points of measurements shall be checked on the digital-orthoimages. The part of digital terrain model that does not satisfy the standards of Article 11 Item 2 shall be corrected.

5) A positional gap between the orthographic images after mosaicking shall be inspected visually. The location of digital terrain model that does not satisfy the standards of Article 11 Item 2 shall be corrected.

6) Accuracy control of quality between mosaicked images shall be conducted on on the difference in the quality of images between the orthographic-projection images. When the images do not match, the part of the ortho-projected images shall be corrected.




**Article 8 Source Material and Forms of Results**

The source material in preparation of a digital-orthoimage and results shall be prepared in a standard form. When NAMRIA acknowledges, approves or orders, different formats can be prepared.

**<Article 8 Operation Standards>**

A standard form is specified in this manual.

# Part 2 Preparation of Digital Orthoimages

## Chapter 1 Outline

### Section 1 Outline

#### Article 9 Outline

The digital-orthoimage preparation is to prepare digital-orthoimage-data files after the orthographic conversion from digital photographs to orthographic images. The work may include preparation of mosaic images if it is required.

#### Article 10 Method

Preparation of digital-orthoimages shall be performed by orthographic projection.

[Note]

Orthographic projection is a method of changing digital photographs into orthographic-projection images using an external orientation elements and digital terrain models.

#### Article 11 Specifications of Digital-orthoimages

A digital-orthoimage is a digital image converted orthographically from digital photographs. Annotation data, for the photo-map preparation are excluded.

2 The accuracy standards of a digital-orthoimage are as in the following table.

| Map information Level | Horizontal-position accuracy | Ground resolution | Photo scale by flight | Digital terrain model | |
|---|---|---|---|---|---|
| | | | | Grid interval | Spot-height accuracy |
| 25000 | 17.5 m or less | 2.5 m or less | 1/40,000 -1/45,000 | 250 m or less | 5.0 m or less |
| 50000 | 35.0 m or less | 5.0 m or less | 1/50,000 -1/60,000 | 500 m or less | 10.0 m or less |
| 100000 | 70.0 m or less | 10.0 m or less | 1/50,000 -1/60,000 | 1,000 m or less | 25.0 m or less |

**<Article 11 Operation Standards>**

The horizontal-position accuracy of digital-orthoimage changes with the grid interval of ground resolution, a photo scale by flight, a digital terrain model, and combination of spot-height accuracy. Since it is greatly influenced by the topography configuration, it is necessary to determine the acquisition method of an elevation in consideration of topographic characteristics.

[Note]

1. The horizontal-position accuracy of a digital-orthoimage is a standard value when the planimetric features are projected on the digital terrain model.

2. Ground resolution is a dimension of a pixel on a digital photograph projected. It is express by a length of one side.

3. The Specification for Topographic Mapping at Scale of 1/50,000, Part Three classifies the standard error by 0.7 m. The ground resolution shall be 1/5 or less than the horizontal accuracy in consideration of the horizontal accuracy and readability in the photographic interpretation work.

The grid interval of a digital terrain model shall be more or less 14 times of the horizontal accuracy. Moreover, the spot-height accuracy of a digital terrain model is one half or less than the contour line interval of the topographic mapping.

| Scale | Contour line interval |
|---|---|
| 1/25,000 | 10.0 m |
| 1/50,000 | 20.0 m |
| 1/100,000 | 50.0 m |

4. Depending the horizontal-position accuracy required, photographic scale, ground resolution or the grid interval of the digital terrain model shall be determined.

The workload of compilation of the digital topographic to remove local distortion and adjustment of color tone and mosaic are dependent on the required quality of the images. The cost and scheduling are affected by the quality of the images. As for the standards, not only the objective of the work be considered, but also the costs and schedule shall be considered thoroughly between NAMRIA and the executing organization.

5. When the density of triangles of the irregular triangulation network is inserted to the grid interval, the accuracy of the heights can be acquired as the standard to be specified.

6. The following data can be included to the digital-orthoimage-data file:

(1) Contour line

(2) Annotation

(3) Administrative boundary

(4) Others

When a contour line or an annotation is added to survey data, the following additional work is needed.

(1) The contour lines can be generated from digital terrain models. The automatic acquisition of contour lines from the digital terrain model s require following processing:

- Compilation at intersections or buildings;

- Compilation of breaks of symbols such as roads and rivers.

(2) Annotations can be created by the input from field identification or by data converted from the existing data.

(3) An administrative boundary can be created by inputting directly from the existing data or by converting the existing data.

The digital plotting work in the Volume Three, Chapter 7 Digital Plotting shall be referred for the additional work.

7. The data overlaid to a digital-orthoimage shall be created as a different file. The pixels of the digital-ortho data files shall not be changed.

**Article 12 Work Classification by Process and Order**

The classification and work items by work process are as follows:

(1) Operation plan

(2) Installation of a photo control points

(3) Installation of an air photo signals

(4) Aerial photography (or archive image search)

(5) Pricking

(6) Coordinates acquisition of a photo control point

(7) Digital imagery acquisition from aerial photographs

(8) Aerial triangulation

(9) Preparation of a digital terrain model

(10) Orthographic conversion

(11) Mosaic

(12) Preparation of a digital-orthoimage-data file

(13) Arrangement of results

When NAMRIA orders or approves, the work classification or work process can be changed or altered

[Note]

1. A digital imagery acquisition is performed from the roll film with which the taken aerial photograph was developed. And the image file of digital photography is created per photograph. (However, when a photograph is taken with a digital camera,

photography development and digital-imagery-acquisition work become unnecessary.)

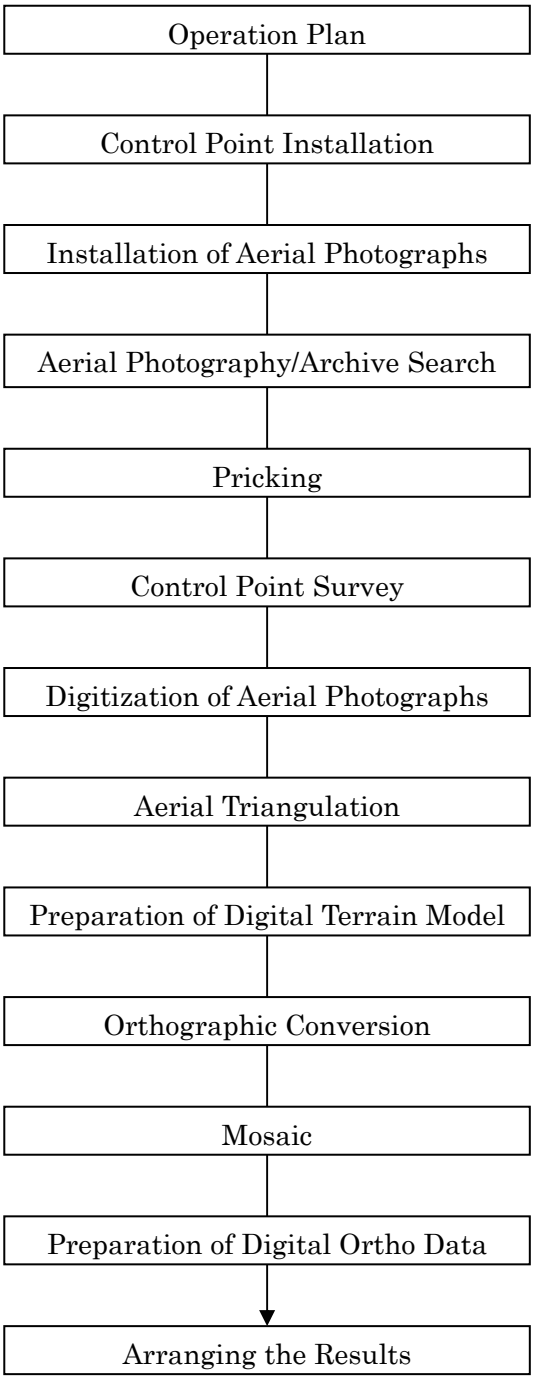
The orthographic conversion of a digital photography is carried out to the external orientation element which is the result of an aerial triangulation using the digital terrain model separately created by the digital stereo plotter etc ., and the orthographic-projection image of photography by unit is created.

The orthographic conversion of the digital photographs is carried out to the external orientation element which is the result of an aerial triangulation using the digital terrain model separately created by the digital stereo plotting instrument etc. Then the orthographic-projection image of a photography unit is created.

Orthographic-projection images are combined so that a neat line or a preparation zone may be filled, and a mosaic image is created. When creating an orthographic-projection image, only a center section which has less distortion of photography is used. Finally, a mosaic image is divided by storing unit of results and arranged as a digital-orthoimage-data file. In addition, also when using a satellite imagery, it shall apply to the work flow in the case of using an aerial photograph.

2. In overlaying a contour line, an annotation, etc. to a digital-orthoimage, the corresponding regulations of the Specifications for Topographic Mapping at Scale of 1:50,000 Part Three Chapter 7 digital plotting shall be applied. It is necessary to add field identification, digital compilation, and digital plotting to the work process of digital-ortho imaging.

[Standard work flow by process of digital-orthoimage preparation]



## Chapter 2 Preparation of Digital-Orthoimage

### Section 1 Operation Plan

#### Article 13 Outline

The operation plan shall be prepared by work process in accordance with the rules and regulation s specified in Part One, Article 5 Operation Plan in the Specifications for Topographic Mapping at Scale of 1:50,000.

#### Article 14 Usage of Digital Photographs

The digital photograph taken within one year, before start of work shall be used in principle.

**<Article 14 Operation Standards>**

The digital photograph to be used shall be adopted in consideration of change of the color tone difference and photographic subject which appear with the relation between time, weather, the course, and solar position.

[Note]

1. The rules of and regulations of the Specifications for Topographic Mapping at Scale of 1:50,000 Section 1 photography of Volume Three Chapter 4 Section 1 shall be applied correspondingly to aerial photography.

Since a color tone changes on every photograph with relation to time, weather, the course, and solar position, it is difficult to equalize the color tone of the whole preparation scope from aerial photography to mosaic. Therefore, when existing aerial photographs are used, it is desirable to adopt aerial photographs of homogeneous quality beforehand. Also when adopting a satellite imagery, the same condition applies.

2. When adjustment of a color tone is difficult because of difference of photographic conditions, NAMRIA and the executing organization shall resolve by discussion.

### Section 2 Digital Imagery Acquisition from Aerial Photographs

#### Article 15 Outline

Digital imagery acquisition from aerial photography is to create digital photographs by scanning aerial photographs using the scanner for aerial photographs.

#### Article 16 Scanning

Scanning shall be directly performed from a roll film in principle.

**<Article 16 Operation Standards>**

1. The rubbish, dirt, dust, etc. which adhered to the roll film before scanning, shall be removed. Inspection of streaks or dent shall be performed at the same time.

2. Just before loading with a roll film, dust or unwanted materials on the film frame of the scanner for aerial photographs shall be removed.

3. The pre-scan for performing color tone compensation for every course in principle shall be performed at the starting point and a terminal point. Furthermore, when there is an area with noticeable color tone change in a course, the process shall be carried out separately.

4. A sample of scanned images of aerial photographs shall be performed in consideration of the relation to the ground coverage, time, weather, the course, and solar position. And the consistency in color shall be confirmed.

[Note]

1. The equipment which stabilized the roll film during scanning has two models: the one which inspects with a sensor; and the one which depends on the internal orientation. When an error on the stabilization is present, it is shown as the result of internal orientation. Therefore, when abnormalities are recognized from the inner orientation result, the stabilizing equipment also needs to be inspected.

2. In an aerial photograph, a color tone does not become consistent because of: reduction of brightness of the perimeter part under the influence of an optical lens; and the shadow spot or halation due to directions of the sun. Moreover, a color tone changes during the processing procedures and digital imagery acquisition from the film of aerial photographs. For this reason, when the color tones are different between adjacent images, the color tone difference along the border of mosaic images becomes noticeable especially in color photographs.

In order to avoid this phenomenon, before performing a mosaic, it is necessary to: unify the color tone of overlapping images to some extent; or to adjust consistency gradually after mosaicking. However, adjustment cannot be completed to the maximum level. Therefore, it is important to perform the color adjustment at the time of digital imagery acquisition from aerial photographs.

### Article 17 Scanning Resolution

The minimum ground resolution at the time of scanning is determined based on the relation between a photo scale by flight and ground resolution in according with Article 11, Part Two.

2. The gradation of color shall be 24 bits-full color or higher in principle.

[Note]

1. The relation between a photo scale by flight, scanning resolution, and ground resolution is as in the following table.

(Unit: meter)

| Scanning resolution<br>photo scale by flight | 10 $\mu$m | 20 $\mu$m | 30 $\mu$m |
|---|---|---|---|
| 1/10,000 | 0.10 | 0.20 | 0.30 |
| 1/20,000 | 0.20 | 0.40 | 0.60 |
| 1/30,000 | 0.30 | 0.60 | 0.90 |
| 1/40,000 | 0.40 | 0.80 | 1.20 |
| 1/50,000 | 0.50 | 1.00 | 1.50 |

2. Image data compression shall be lossless compression.

## Section 3 Resolution of Satellite Imagery

### Article 18 Outline

The minimum ground resolution of satellite imagery is determined based on a map information level and the relation of ground resolution in accordance with Article 11, Item 2.

2. A map information level and ground resolution shall be as in the the following table.

| Map information level | Ground resolution |
|---|---|
| 25000 | 2.5 m or less |
| 50000 | 5.0 m or less |
| 100000 | 10.0 m or less |

3. The target satellite imagery and ground resolutions shall be as in the following table.

| Name | Ground Resolution |
|---|---|
| QuickBird | 0.61～0.72 m (Pan)<br>2.44～2.88 m (MX) |
| IKONOS | 0.82～1.0 m (Pan)<br>3.3～4.0 m (MX) |
| OrbView-3 | 1.0 m (Pan, at nadir)<br>4.0 m (MX, at nadir) |
| ALOS | 2.5 m (Pan, at nadir)<br>10 m (MX, at nadir) |
| SPOT-5 | 5 m (2.5 m after digital processing) (Pan, at nadir)<br>10 m (MX, at nadir) |
| SPOT-1/2/3/4 | 10 m (Pan, at nadir)<br>20 m (MX, at nadir) |

Notes Pan: Panchromatic, MX: Multi Spectral

## Section 4 Preparation of Digital Terrain Model

### Article 19 Outline

Preparation of a digital terrain model is to prepare a digital terrain model file using an automatic elevation extraction method.

### Article 20 Acquisition of an elevation

In acquisition of elevation, adequate grid intervals shall be secured in accordance with Article 11, Item 2 using a digital stereo plotter. When it is necessary, a basic relief line for rectifying shall be acquired.

2. The automatic elevation extraction method, the contour method, the break line method, the spot-height measuring method, or combination of these shall be used for acquisition of elevations.

**<Article 20 Operation Standards>**

1. The grid interval by the method of automatic data acquisition shall satisfy the grid interval in accordance with Article 11, Item 2.

2. The interval of contour lines created by the contour line method shall be twice as wide as the standards specified in Article 11. When the inclination is constant, the width of the interval can be widened accordingly.

3. The positions of break lines, when the break line method is used, shall be as follows:

1) The upper and the lower part of an artificial slope or ground coverage that have a large elevation difference;

2) An elevated road and the road edge of a two-level crossing;

3) A ridge, a trough, or the main shore lines;

4) Basic relief line showing a continuous change of a topography inclination; and

5) Topographic configuration required to clarify topography.

4. When a spot height is selected by the spot-height measuring method, the rules of Chapter 7 Article 121 (Placement of Spot Height) of the Specifications for Topographic Mapping at Scale of 1:50,000 shall be applied.

5. The areas where elevation data are acquired shall cover the entire area of orthoimage preparation.

6. Inland water bodies, such as rivers and small lakes shall be classified as earth surface, and the elevation values shall be given by the inner processing from

surrounding nearest values.

7. When using an established digital terrain model, the quality of data, secular change shall be checked.

[Note]

1. The automatic elevation extraction technology is a technology which computes the parallax difference of digital photographs and acquires elevation data by detecting the same point of the digital photographs used as the pair of a solid model by image correlation.

2. The contour method is a method of acquiring elevation data in a contour-line format by digital plotting.

3. The break line method is a method of acquiring elevation data as three dimensional data by digital plotting from an area where topographic conditions changes continuously.

4. The spot-height measuring method is a method of acquiring elevation data by digital plotting. It is used to add elevation data which were not acquired by other methods.

5. Although the superiority or inferiority of an acquisition method of elevation changes with topography configurations, in order to create a highly precise digital terrain model, its break line method is effective. The irregular triangulation network created considering the break line as a constraint serves as a digital terrain model which reproduced the topography most faithfully. On the other hand, in an automatic elevation extraction technology or a contour method, topography is faithfully reproducible, but there is a limitation in spacing of spot heights and contour lines. Usually, when it changes into a digital terrain model, topographic configuration is smoothed. It may become a cause of a local distortion.

### Article 21 Conversion to Digital Terrain Model

The conversion to a digital terrain model is to change the elevation data to the grid or to the irregular triangulation network data in accordance with Article 11, Item 2.

**<Article 21 Operation Standards>**

1. When a digital terrain model is created from the grid, the interval of the grid shall follow the standards specified in Article 11, Item 2.

2. When an irregular triangulation network is used, the shape configuration shall be determined in a way to represent the same topographic expressions possible.

3. The digital terrain models shall cover the entire areas of digital-orthoimage-data file.

[Note]

An example of a standard digital terrain model is shown below.

1. The acquisition classification of digital terrain models is as in the following table.

Example

| Major Classification | Classification | Category code | Name | Note |
|---|---|---|---|---|
| Topography etc. | Digital terrain model | 7501 | Grid data | An automatic elevation extraction technology generates from a preparation or contour-line, random point, and break line. |
| | | 7511 | Random point | It acquires by spot-height measurement. |
| | | 7521 | Break line | It acquires by the break line method. |
| | | 7531 | Irregular triangulation network | It generates from a grid data, random point, and break line, a contour line, etc. |

2. According to the location of an elevation is acquired; a digital terrain model is classified according to the following table.

Exemple

| Code | Content | Note |
|---|---|---|
| 00 | Earth surface | Digital terrain model |
| 51 | Surface side | |
| 52 | Sea level | |

3. A large-scale lake shall be included in a sea level.

### Article 22 Compilation of Digital Terrain Model

Compilation of a digital terrain model is work which displays the elevation data onto stereoscopic models and corrects the data that are substantially different from the surface.

**<Article 22 Operation Standards>**

A digital stereo plotter is used to correct error of a digital terrain mode.

### Article 23 Preparation of Digital Terrain Model File

Preparation of a digital terrain model file shall be prepared in a standardized form after compilation.

**<Article 23 Operation Standards>**

1. A standard format shall be used for a digital terrain model file, and the detailed specification shall be clarified.

2. The storing unit of a digital terrain model file shall be the same as the unit of a digital-orthoimage-data file.

3. When a digital terrain model file of an irregular triangulation network is to be stored a triangle over a neat line shall be split by a neat line into two or more triangles.

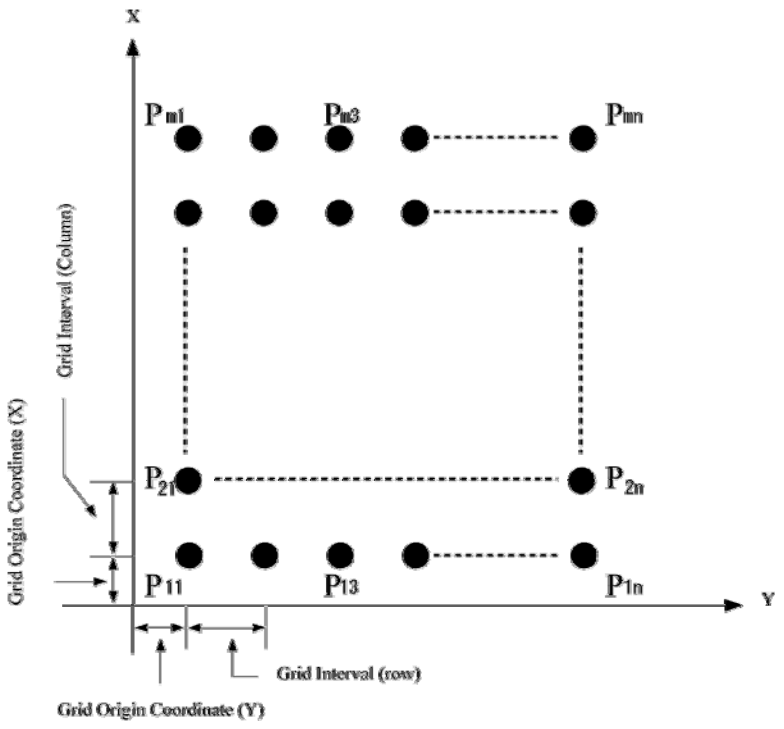
[Note]

1. Examples of a standard format of a digital terrain model file are: ASCII DTM; ASCII ARC Grid; DTED; and USGS SDTS etc.

2. A grid record shall be used for the digital terrain model (grid).

3. The origin coordinates of the digital terrain model (grid) shall have the standard position of the half of the grid interval.

4. The digital terrain model (irregular triangulation network) shall use a standardized format, and the specifications shall be clarified.



### Article 24 Inspection of Digital Terrain Model File

The inspection shall be performed using the digital terrain model created in the preceding article.

2 The spot-height accuracy of a digital terrain model shall follow the regulations specified in Article 11, Item 2.

**<Article 24 Operation Standards >**

1. The checking shall be conducted to the spot heights randomly selected from the digital terrain model file.

2. The checking shall be conducted using a digital stereo plotter or others to compare the spot elevation points measured three-dimensionally and the spot heights selected from the digital terrain model files. The results shall be organized in an accuracy control table.

[Note]

In an area such as mountainous areas or forests, where clearly identifiable planimetric features are not present, NAMRIA and the executing organization shall discuss over inspection amount and areas.

## Section 5 Orthographic Conversion

### Article 25 Outline

Orthographic conversion is work which changes digital photographs into an orthographic projection form from the central projection to generate orthographic projection images.

[Note]

1. Aerial photographs taken have the central projection that has the central point of a lens of a camera. Because of this, there are distortions which show higher places larger. The distortion becomes large in an area where height difference is large. However, since digital-orthoimages are derived from the orthographic projection which is the same as in the map projection, the same accuracy level of topographic maps can be guaranteed.

Notes 1: In the case of the satellite imagery using a line sensor, it becomes the combination of a central projection and parallel projection.

Notes 2: An orthoimage that has high-rise buildings or other high objects in consideration is sometimes called “true orthoimages”, others are called “ortho.” The latter is used in this manual.

2. A digital terrain model is used for an orthographic conversion. However, in the resulting orthographic-projection images, only the planimetric features corresponding to

the digital terrain model are positioned as the same as in a topographic map. When the data on earth surface are adopted as a digital terrain model, the planimetric feature on the surface are positioned same as in a topographic map. However, when there is a height difference from the earth surface such as roofs of buildings or crowns of trees, the locations do not become the same.

Leaning views of buildings due to relative-height differences (example of an aerial photograph).

Leaning views of buildings due to relative-height differences (example of an IKONOS satellite imagery).

3. A local distortion arises depending on the grid interval of a digital terrain model and the relation of a topographic configuration. The grid intervals of digital terrain models are internally process to have higher density to match the pixels of the digital photographs one to one. The processed elevation points used for orthographic

conversion causes the local distortion. It is due to the differences of real topographic configuration and the cases when the digital terrain models are not change linearly in the internal processing areas. Also, when the density of grid interval is higher, the local distortion occurs more frequently.

The following images are examples of the local distortions which use the digital surface model, and local distortion in which the road and right figure of the left figure are characteristic of a structure has arisen. In order to remove local distortion, it is necessary to add spot heights by the break line method. But it is difficult to remove completely.

Local distortion of a road (example of an aerial photograph)

Local distortion of a structure (example of an aerial photograph)

Local distortion of a section of a road (IKONOS Satellite Image)

Local distortion of a building (IKONOS Satellite Image)

**Article 26 Preparation of an orthographic-projection image**

Preparation of an orthographic-projection image shall be based on the digital terrain models after orientation of digital photographs.

2. The ground resolution of an orthographic-projection image shall follow the rules of Article 11 Item 2.

**<Article 26 Operation Standards>**

1. An absolute orientation shall be performed using the result obtained from the aerial triangulation etc.

[Note]

1. An absolute orientation is performed by a digital stereo plotter using: pass points acquired from aerial triangulation; geodetic coordinates of tie points; and the observation coordinates of the digital photographs; or external orientation elements.

2. The result obtained by the aerial triangulation is used for an absolute orientation. Also, the photo control points which can satisfy the accuracy standards of point distribution can be used.

## Section 6 Mosaic

### Article 27 Outline

Mosaicking means work that combine adjoining orthographic-projection images by digital processing to create mosaic images.

### Article 28 Method

Mosaicking shall be conducted to join adjacent orthographic images without causing noticeable color tone differences or planimetric inconsistencies.

2. As a standard practice, mosaicking shall use the central part of orthographic images that can be considered equivalent to the central part of aerial photographs.

**<Article 28 Operation Standards>**

1. The adjoining work shall be performed to make linear objects as consistent as possible. Other objects shall be joined without exceeding the horizontal positional limitations.

2. Digital photographs that have not been converted orthographically shall not be used for mosaicking.

3. It shall try for the difference between orthographic-projection images not to arise to a color tone.

[Note]

1. A mosaic is joining the adjoining orthographic-projection images, after performing position doubling and a color matching using the areas of overlap of the adjoining image. To the digital-orthoimage mosaic, the following procedure shall be performed to the orthographic projection images whose locations and coordinates are unified.

(1) Concentration Adjustment

Concentration adjustment matches the different shade and different color tone for every digital photograph as much as possible.

(2) Color Matching by Concentration Conversion

The color matching by concentration conversion is performed so that the difference of the shade and color tone between the images in a difference of the shade which is among two or more digital photographs using the image of areas of overlap, and a color tone which cannot be rectified systematically may be coincided as much as possible.

(3) Search for Tie Points

Tie points shall be search at locations easy to join. At the point which is easy to join, the point that the concentration difference between digital photographs is the smallest, or the point that concentration changes rapidly within each image can be considered.

There are a road, ridge, valley line where the concentration changes rapidly.

(4) Smoothing the Concentration around Tie Points

Smoothing of concentration around tie points shall be performed by a proportional distribution method at both sides of tie points by section.

2. When carrying out the mosaic of the orthographic-projection image and digital photographs with which quality differs to the orthographic-projection image created according to this manual, the scope and quality shall enable it to classify clearly.

### Article 29 Inspection of Mosaic Image

Inspection of a mosaic image shall be performed about the difference of a location gap of the junction of key features (road etc.), and the color tone between orthographic-projection images.

**<Article 29 Operation Standards >**

1. Noticeable distortion and gaps of joints of mosaic shall be inspected.

2. Noticeable color tone differences of joints shall be inspected.

[Note]

1. By a multi-story building etc., when junction is difficult, talk between NAMRIA and an executing organization.

2. Distortion and the level differences shall be checked against the following table.

| Map information level | Location gap accuracy |
|---|---|
| 25000 | 17.50 m or less |
| 50000 | 35.00 m or less |
| 100000 | 70.00 m or less |

3. Since the evaluation of color tones tends to be subjective, the color tones shall be discussed between NAMRIA and the executing organization using samples.

## Section 7 Preparation of Digital-Orthoimage-Data File

### Article 30 Outline

The preparation of the digital-orthoimage-data files is to: store the orthoimage data files from the mosaic data by map data. At the same time, a position information files is created as position information on a digital-orthoimage-data file. The file is finally stored in a medium specified in the terms of references.

**<Article 30 Operation Standards>**

1. In an adjoining neat line, it shall start from the same mosaic image to a neat-line unit.

2. When data, such as an annotation and an administrative boundary, are acquired, it shall store according to regulation of the 3rd volume Chapter 7 digital plotting of international cooperation NAMRIA overseas survey (for base maps) Operation Standards.

[Note]

In the location over a neat line, if the orthographic-projection image used by the neat line which adjoins in order to improve appearance is changed, it will become easy to produce gap of a location in junction. In order to avoid this, it starts to a neat-line unit from the mosaic image which uses the same orthographic-projection image.

**Article 31 Storing of Digital Orthoimage Data File**

Digital-digital-orthoimage-data file shall be stored as a unit of map data. The files can be divided if necessary.

2 The position information file shall be created by map data as an index file to add the positional information.

<Article 31 Operation Standards>

1. A digital-orthoimage-data file shall be stored in the TIFF format, in principle.

2. A positional information file shall be stored as the World file format, in principle.

[Note]

1. When the image is to be extracted by map data, mosaic images that cover the entire working as much as possible to avoid inconsistencies between map data.

2. Digital-orthoimage-data compression shall be lossless compression.

3. The position information file shall be the text file of the World file specification that are proposed by American ESRI for adding position information to an image file. The World File specification has six parameters of affine transformation to convert the image coordinate system to the ground coordinate system.

The affine transformation can be expressed in the equations (1).

$x' = ax + by + c$

$y' = dx + ey + f$ (1)

Where:

x’ is the x coordinate of the ground coordinate system (Cartesian coordinate-east/west, unit: meter);

y’ is the y coordinate of the ground coordinate system (Cartesian coordinate-north/south, unit: meter).

x is the x coordinate of the image coordinate system (Column, unit: pixel);

y is the y coordinate of the image coordinate system (row, unit: pixel);

a- f: Affine variables

The transformation enables movements of the origins, expansion and reduction, and rotation. In general, rotation does not exist. The scale is generally equals to both directions. An example without rotation is shown below:

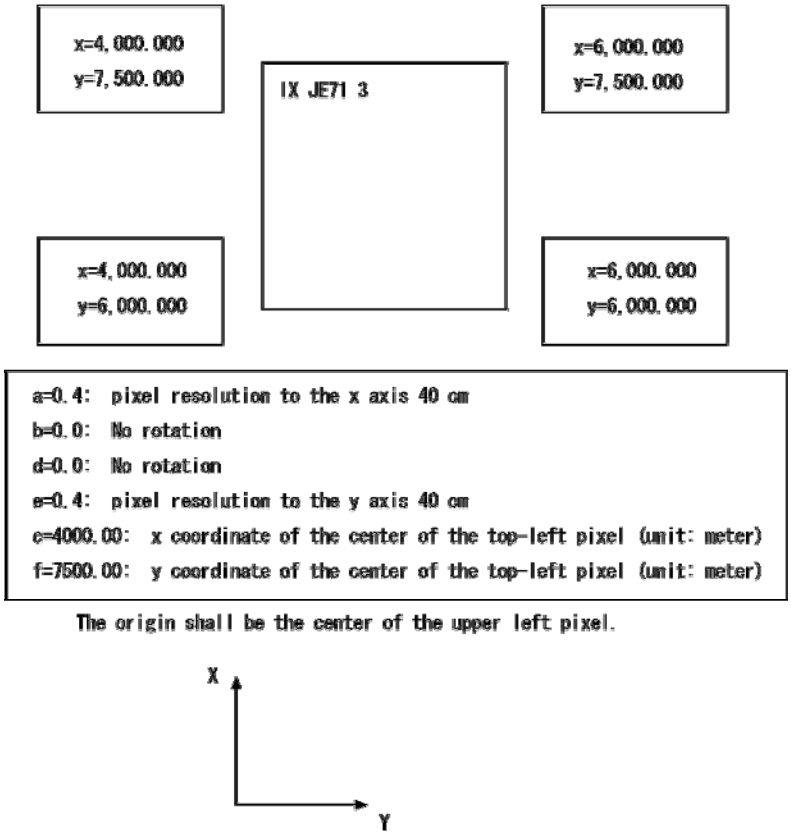
| | |
|---|---|
| 0.1 | a |
| 0.0 | b |
| 0.0 | d |
| -0.1 | e |
| -28500.00 | c |
| -330000.00 | f |

a and e express the scales of x and y directions. When the scales of x axis and y axis are the same, the absolute values become the same. Since the origins of the ground coordinate system and image coordinate system are different, the direction of y axis becomes negative. The value is the scale of the ground coordinate system to one pixel of the image. In other words, it is an area in the ground coordinate system of the one pixel in the image—equivalent to the ground resolution.

d and b express the rotation around the origin; however, since there is generally no rotation, both of the values are set to 0.0.

c and f are horizontal distances. They are the horizontal distances of the image origin moved (upper left corner). In other words, it is the location of the center of the pixel at the origin to the ground coordinate system. The unit is meter and the system is Cartesian.

An example of the position information file is shown in the next figure. The map information on level is 2500; the map data number is IX-JE71-3; the ground resolution is 0.4 meters. The coordinate values are all Cartesian.




4. The naming rule of a World File is to add "W" to the name of an image file. For example, if the name of the image file is SAMPLE.TIFF, the name of the World File becomes SAMPLE.TIFFW. However, generally, a file name has an 8.3 system. A file name generally has eight characters and the extension has three characters. In this case, therefore, the file extension takes the first two letters from the image, and the third become “w”. The name of the sample SAMPLE.TIF’s World File name becomes SAMPLE.TFW.

### Article 32 Inspection of Digital-Orthoimage-Data File

The inspection shall be conducted to horizontal positions, color tone, and local distortions and adjoining.

**<Article 32 Operation Standards >**

1. The inspection shall be conducted by map data.

2. The horizontal position inspection shall be conducted to randomly select planimetric features that are clearly recognized in the images.

3. The horizontal position inspection shall be conducted by comparing the horizontal coordinates measured using a digital stereo plotter and horizontal coordinates measured on the digital orthoimages. The results shall be organized in an accuracy control table.

4. The horizontal accuracy shall be the standards specified in Article 11, Item 2.

5. Color tones, local distortions and adjoining shall be checked if the horizontal accuracy exceeds the standards specified in Article 11, Items.

6. The position information file shall be checked using a checking program or visually on the display.

[Note]

1. In an area such as mountainous areas or forests, where clearly identifiable planimetric features are not present, NAMRIA and the executing organization shall discuss over inspection amount and areas.

2. Since the evaluation of color tones and local distortion tends to be subjective, samples shall be used to set a standard of evaluation and agreed between NAMRIA and the executing organization.

3. A digital-orthoimage-data file is a two dimensional digital image which includes spot-height accuracy of a digital terrain model as horizontal-position accuracy; it does not have height information.

## Section 8 Arrangement of Results

### Article 33 Results

The items of the outputs shall be as follows:

(1) Digital-orthoimage-data file

(2) Position information file

(3) Digital terrain model file

(4) Accuracy control table

(5) Other source materials

**<Article 33 Operation Standards>**

The survey results and related outputs shall be submitted in electronic data in principle.

## Section 9 Accuracy Control

1. Mosaic Quality Classification Map

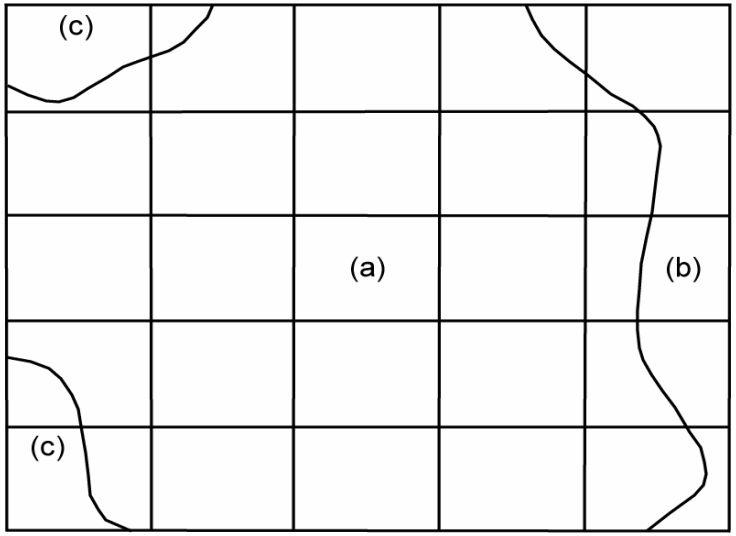
When orthographic-projection images or digital photographs of different quality are mosaicked, the area of mosaic shall be recorded onto the mosaic quality classification map.

2. Execution Management

The execution management shall be conducted based on the rules and regulations for inspection work (draft).

Mosaic Quality Classification Map

| Project Name | Planning | Executing | Period | Surveyor |
|---|---|---|---|---|
| | | | | |




| Region | Aerial Photography | | | Digital Terrain Model | | Public Survey Assistant No. | Note |
|---|---|---|---|---|---|---|---|
| | Year | Scale | Ground | Grid Interval | Elevation | | |
| (a) | | | | | | | |
| (b) | | | | | | | |
| (c) | | | | | | | |

1. This quality control table shall be used for mosaicking that used ortho projection images or digital aerial photographs of different quality.

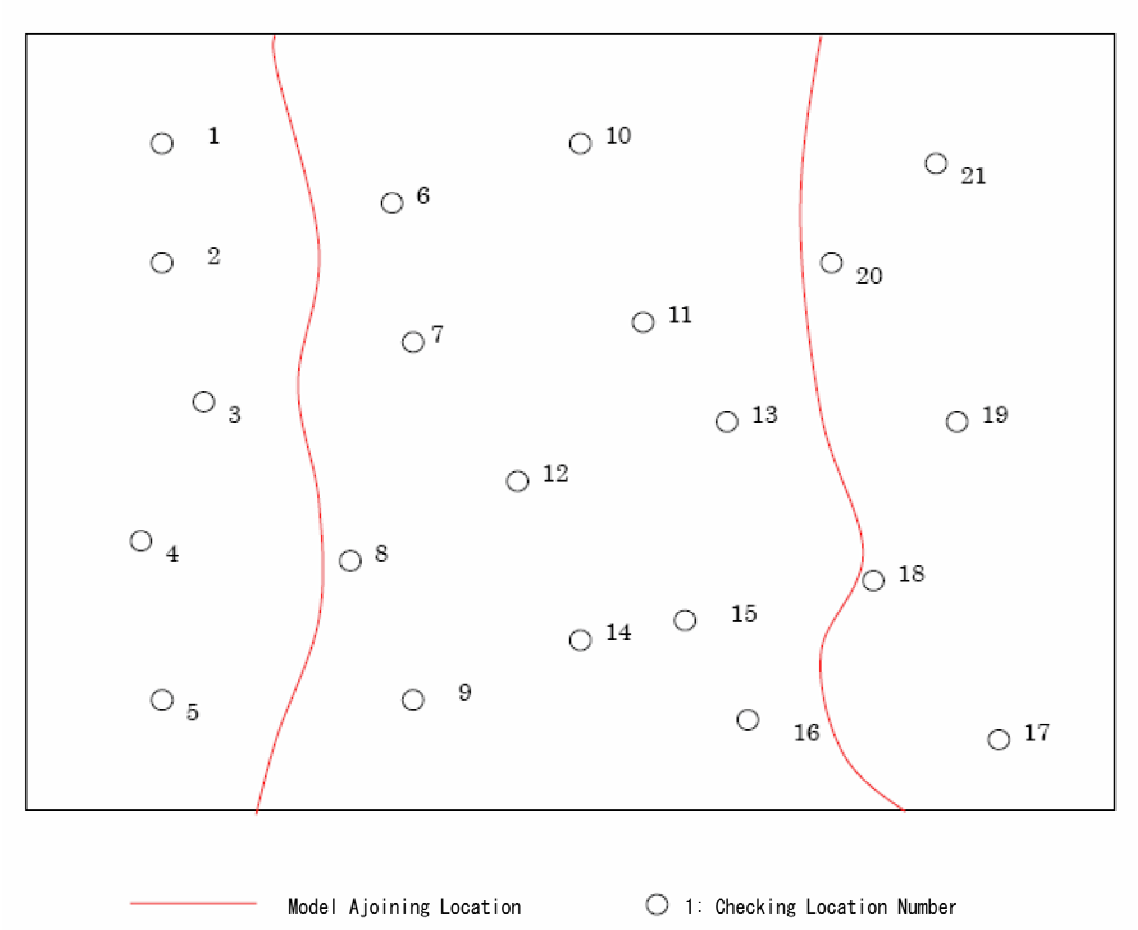
2. The quality boundary lines are indicted in thick lines.

The inspection point in the execution management (draft)

| Item | Description (Draft) | Note |
|---|---|---|
| Type of Survey | Digital-orthoimage File Preparation | |
| Checking the total work | 2% of the total survey area | |
| The amount of checking by the block unit | The amount of checking the supervisor specified.<br>The survey area is divided into blocks by a unit of district or operator depending on the condition. Then the check survey amount is determined within the block to make to the total check survey 2 % of the total survey areas. | |
| Checking items | Visual checking of planimetric features and digital plotting; topographic positions; local distortion; adjoining and color tones | |
| Checking areas | Specified by a supervisor | |
| Method of selecting checking areas | Areas where planimetric features and contour lines are included.<br>Areas over two models or adjoining area of tow mosaic images. | |
| Checking method | Major planimetric features and linear elements that clearly identifiable on the images shall be digitized. Then the horizontal positions and the coordinate values measured on the digital-orthoimage-data file are compared.<br>As for color tones, local distortions and adjoining, visual checking shall be conducted.<br>For the digital data files (format, position information, and ground resolution), a checking program or visual inspection shall be performed. | |
| Criteria | The digital-orthoimage-data files and the digital plotting data are overlaid, and it is inspected that the gaps between the two data are within the range of tolerance.<br>Presence of local distortion; the gaps on adjoining of mosaic are within the range of tolerance shall be judged.<br>Quality of color tone.<br>Check if the files satisfy the operation standards. | The quality of color tones shall be discussed with the supervisors. |
| Arrangement and submission (organization and submission formats) | Digital plotting data are overlaid on the digital-orthoimage-data file; the file is then printed. The checking areas, numbers and locations of adjoining areas of mosaic are marked in red color. The survey project name, inspector, map sheet number, checking period, photographic scale, ground resolution, scanning resolution, grid interval are noted. Then it is submitted as the execution management map.<br>As for the accuracy of positions, the results of checking are summarized in a table as the “result of positional accuracy inspection” and then submitted.<br>The qualities of local distortions, adjoining, and errors in color tones shall be checked. The results are summarized as the “Checking Results on Color Tone, Distortion, and Adjoining“. The images of major checking points are selected; a checking print is prepared; and checking map is submitted. | |

**Execution Management Map**

| | | | |
|---|---|---|---|
| Surveyor | | Inspector | |
| Map sheet name | | Checking period | yyyy/mm/dd – yyyy/mm/dd |
| Photographic scale (denominator) | | Ground resolution (m) | |
| Scanning resolution [μm] | | Grid interval [m] | |



Checking Results: Horizontal Position Accuracy

| | | | |
|---|---|---|---|
| Surveyor | | Inspector | |
| Map sheet name | | Inspection period | yyyy/mm/dd – yyyy/mm/dd |
| Photographic scale (denominator) | | Ground resolution [m] | |
| Scanning resolution [$\mu$ m] | | Grid interval [m] | |

| No | Measurement value (m) | | Inspection value (m) | | Discrepancy | | | Note |
|---|---|---|---|---|---|---|---|---|
| | x | y | x | y | Δx | Δy | Δxy | measurement point |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| 21 | | | | | | | | |
| Note: 1) The planimetric features other than on the digital topographic mode shall be excluded.<br>2) When there are not enough checking areas, the executing entity shall discuss it with the supervisor. | | | | Points | | | | |
| | | | | Average | | | | |
| | | | | Maximum | | | | |
| | | | | Std. Deviation | | | | |

Checking Results: Color tone, Distortion, Adjoining

| | | | |
|---|---|---|---|
| Surveyor | | Inspector | |
| Map sheet name | | Inspection period | yyyy/mm/dd – yyyy/mm/dd |
| Photographic scale (denominator) | | Ground resolution [m] | |
| Scanning resolution [$\mu$ m] | | Grid interval [m] | |

| | Checking Item | Checking method | Instruction | Passed | Denied |
|---|---|---|---|---|---|
| File | File format | Recorded in an appropriate format | | | |
| | Position information | Input values of position accuracy | | | |
| | Ground resolution | The pixel numbers are measured to check if it satisfied the ground resolution requirement. | | | |
| Color tone | Consistent color tone | The color tones, brightness, and quality shall be checked and compared between adjoining images | | | |
| | Gradation | The quality of darkness of the images is consistent in adjoining images. | | | |
| | Shadow | The presence of shadows and unclear areas of photographed areas by the darkness. | | | |
| | Definition | The presence of color shift or blur and the quality of the color shift or blur. | | | |
| | Unevenness, smear, or streak | Presence of streak on negatives when scanned, smear, dirt and dust. | | | |
| Distortion | Local distortion | Presence of local image distortion | | | |
| Adjoining | Adjoining point of model | Positional shifts between model s and courses; overlapping images and blur | | | |
| | Adjoining maps | Presence of gaps of planimetric features at the neat lines of adjacent maps | | | |

Auxiliary Map: Color Tone Checking

| | No. | No. | No. |
|---|---|---|---|
| Image | | | |
| Comment | | | |

Auxiliary Map: Color Tone Checking

| | No. | No. | No. |
|---|---|---|---|
| Image | | | |
| Comment | | | |

Auxiliary Map: Adjoining Checking

| | No. | No. | No. |
|---|---|---|---|
| Image | | | |
| Comment | | | |