Document for Operation

Work Specifications for National Base Mapping

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Infrastructure Management Department
Japan International Cooperation Agency

Work Specifications for National Base Mapping
Revision history

Outline	Release date	Creation organization
Creation	December, 2006	Japan International Cooperation Agency
Enactment	February 28, 2022	Japan International Cooperation Agency

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Work Specifications for National Base Mapping

Part 1 General

Article 1 (Purpose)

These specifications (hereinafter referred to as “the Specifications”) define the standard methods for the "Base Mapping Survey" to be implemented by the Japan International Cooperation Agency (hereinafter referred as JICA) outside of Japan, whose scope is to contribute in the preparation of adequate specification in accordance with the conditions of the target country and ensure the required accuracy.

Article 1-2（Definition of terms）

The definitions of terms in this specification are as set forth in the following items.

1. "Rules" means the "Rules for operating specification stipulated in Article 34 of the Surveying Law" and the manual on the surveying method using the new surveying technology developed by the Geospatial Information Authority of Japan stipulated in Article 17 of the Rules for operating specification.

2. "2006 Specifications" means Work Specifications for National Base Mapping (December 2006, JICA).

3. The Survey Results, etc. (hereinafter referred to as "Results") include "Survey Results," "Survey Records," and "Operational Materials", can be described as follows:

(1) Survey Results: Results obtained as a final target of each process of operation.
(2) Survey Records: Operation records completed in the process of obtaining survey results.
(3) Operation Materials : Various materials used in the process of obtaining survey records.

Article 2 (Scope of Survey)

The Specifications apply to Control Point Survey, Topographic Mapping, Photogrammetry and 3D Point Cloud Survey.

Article 3 (Survey Reference)

The survey defined in the article 2 (Scope of Survey) shall be conducted in compliance with accordance with the geodetic reference system (name, ellipsoid, and the locations and values of horizontal origin and height origin) established by the target country, or as instructed by JICA.

Article 3-2 (Units of Measurement)

The unit of measurement to be used for the survey is in accordance with the Measurement Act of Japan unless otherwise stated by the target country.

Article 4 (Compliance with related laws and regulations)

In carrying out the work, JICA, executing organization for the survey (hereinafter referred to as " executing organization ") and persons engaged in the work (hereinafter referred to as "workers") must comply with the laws and regulations related to surveying, property rights, intellectual property rights, labor, safety, transportation, land use, environmental protection, protection of personal information, etc. of the country concerned, and must respect the social practices regarding these.

Article 5 (Operational Plan)

1. JICA must specify specifications showing the type, content, structure, quality, etc. of the Survey Results that are intended to be obtained (hereinafter referred to as “Product Specifications”).
The Product Specifications shall be in accordance with ISO 19131:2007/Amd.1:2011 “Geographic Information - Data product specifications” (JIS X 7131 2014).

2. The executing organization shall prepare a work plan and update the Product Specifications in accordance with the instructions (including instruction based on the Product Specifications) given and materials collected by JICA.

3. The documents prescribed in the preceding paragraphs must be submitted to JICA for approval. The

same procedure will be followed for any amendments.

Article 6 (Process Control)
1. The executing organization must follow adequate process control mentioned in article 5 (Operational Plan).
2. The executing organization must report the progress status of operation to the JICA as required.

Article 7 (Accuracy Control)
1. The executing organization must perform adequate accuracy control to ensure the accuracy of survey. Based on the result of accuracy control, create and submit a quality control record to JICA.
2. The executing organization must conduct the inspections at the end of each process of operation appropriately.
3. The executing organization must promptly check survey the items specified by JICA at the end of each work and during the work.
4. Forms used for quality control reports must generally be those specified in the Rules.
5. The check survey ratio must be as follows:
Control Point Survey: 3%
Leveling: 3%
Topographic Mapping and Photogrammetry: 2%
3D Point Cloud Survey: 5%

Article 8 (Certification of Equipment)
1. The executing organization shall normally use instruments specified by JICA and certified by an organization specified by JICA.
2. The main equipment used for observations must be properly inspected and necessary adjustments must be made by workers before and during work.

Article 9 (Certification of Survey Results)
A request shall be made generally by the executing organization to an organization specified by JICA in order to inspect the survey results which are specified by JICA before their submission.

Article 9-2 (Format of Results)
In principle, the format of Results shall be presented in the format defined by the target country. When there is no format proffered by the target country, the format specified in the Rules will be the standard.

Article 10 (Special Exceptions)
1. The instruments and the survey methods other than those specified in the Specifications may only be used in parts of the works subject to the approval of JICA and provided that their use will not cause any problems to ensure the required accuracy and maintain the work efficiency.
2. The survey methods, references, items, processes, etc. specified in the Specifications may only change with the approval of JICA.

Article 11 (Submission of Results)
1. The executing organization shall submit the Survey Results immediately on completion of work with the accuracy control results specified in article 7 (Accuracy control).
2. The executing organization is required to submit the Survey Records and Operation Materials at the request of JICA.
3. When JICA receives the submission of the results, etc. pursuant to the provisions of the preceding 2 paragraphs, it must promptly inspect the accuracy, contents, etc. of the results, etc.

Part 1-2 Survey Planning and Implementation

Article 12 (Outline)
1. The planning and implementation of the survey must be in accordance with part 2 and later of the

Specifications and Rules.
2. The “planning organization” in the article of Rules shall be replaced as “JICA”.
3. Part 2 and later of the Specifications is based on "Appendix 1 contradiction summary table" and "Appendix 2 contradiction and response policy" that summarize the inconsistencies and response policies between Rules and 2006 Specifications, and necessary items are added to the "Operation criteria" of Part 2 and later of the 2006 Specifications.

Article 13 (Review of Appendix Tables 1 and 2)
Appendix 1(Contradiction Summary Table) and Appendix 2(Contradiction and Response Policy) shall be reviewed in accordance with the update of Rules.

Appendix 1 - Contradiction Summary Table

Item (Extracted items related to Article 2 (Scope of Survey) of the Specifications from "Rules for operating specification".)	Rules	2006 Specifications	Work processes to which Part 2 and later of the Specifications should be applied	Appendix 2 Reference No.
Part 1 General	×	×	Priority is given to Part 1 of this specification	01
Part 2 Control Point Survey				
Chapter 1 General	○	—	—	
Chapter 2 Control Point Survey	○	△	Partial Priority	02
Chapter 3 Leveling with Leveling Instrument	○	△	Partial Priority	03
Chapter 4 Leveling with GNSS Survey	○	—		
Chapter 5 Restoration Survey	○	—		
Part 3 Topographic Mapping and Photogrammetry				
Chapter 1 General	○	△	Partial Priority	04
Chapter 2 Field Survey	○	—		
Chapter 3 Terrestrial LiDAR Survey	○	—		
Chapter 4 Mobile Mapping System (MMS) Survey	○	—		
Chapter 5 UAV Aerial Photogrammetry	○	—		
Chapter 6 Aerial Photogrammetry	○			
Section 1 Summary	○			04
Section 2 Work Plan	○			
Section 3 Installation of Ground Control Points	○			
Section 4 Air Photo Signalization	○			
Section 5 Aerial Photography	○	△	Use Sections 1 and 2 of Chapter 4 together	05

See Appendix 2 for details of Appendix 1 above.

○： Priority is given to specifications with ○ in each item.

△： For work processes not specified in the Rules for operating specification, priority is given to Part2 and later of the Specifications.

×： Items not used.

－： Items not specified in the Rules for operating specifications and 2006 Specifications.

Item (Extracted items related to Article 2 (Scope of Survey) of the Specifications from "Rules for operating specification".)	Rules	2006 Specifications	Work processes to which Part 2 and later of the Specifications should be applied	Appendix 2 Reference No.
Section 6 Simultaneous Adjustment	○	△	Use Sections 2 and 3 of Chapter 6 together	06
Section 7 Field Identification	○			
Section 8 Digital Plotting	○	△	Use Section 1 of Chapter 7 together	07
Section 9 Digital Editing	○			
Section 10 Complementary Field Survey and Digital Editing	○			
Section 11 Data files creation for Digital Topographic Maps	○			09
Section 12 Quality evaluation	○			
Section 13 Compilation of Results	○			
No provision in the Rules for operating specification	—	○	Chapter 10 Data structurization	08
Chapter 7 Digitizing of Existing Maps	○	—		10
Chapter 8 Digital Map Revision	○	△	Partial Priority	10
Chapter 9 Photo Map Creation	○	—		
Chapter 10 Airborne LiDAR Survey	○	—		
Chapter 11 Map Editing	○	—		
Chapter 12 Fundamental Geospatial Data Creation	○	—		
No provision in the Rules for operating specification	—	○	Part 4 Analog Topographic Mapping Process	11

See Appendix 2 for details of Appendix 1 above.

○： Priority is given to specifications with ○ in each item.

△： For work processes not specified in the Rules for operating specification, priority is given to Part2 and later of the Specifications.

×： Items not used.

－： Items not specified in the Rules for operating specifications and 2006 Specifications.

Item (Extracted items related to Article 2 (Scope of Survey) of the Specifications from "Rules for operating specification".)	Rules	2006 Specifications	Work processes to which Part 2 and later of the Specifications should be applied	Appendix 2 Reference No.
No provision in the Rules for operating specification	—	○	Part 5 Original Map Production Process Through the Scribe Method	11
No provision in the Rules for operating specification	—	○	Part 6 Production of Topographic Map Reproduction Film and Printing Processes	11
Part 4 3D Point Cloud Survey	○	—		

Item (The manual on the surveying method using the new surveying technology developed by Geospatial Information Authority of Japan)	Rules	2006 Specifications		
3D Point Cloud Survey Manual using Mobile Mapping System [MMS] (Draft)	○	—		
Cross-Section Drawing Creation Manual using 3D point cloud data (Draft)	○	—		
Public Survey Manual using UAV LiDAR (Draft)	○	—		
Multi-GNSS Survey Manual (Draft)	○	—		

See Appendix 2 for details of Appendix 1 above.

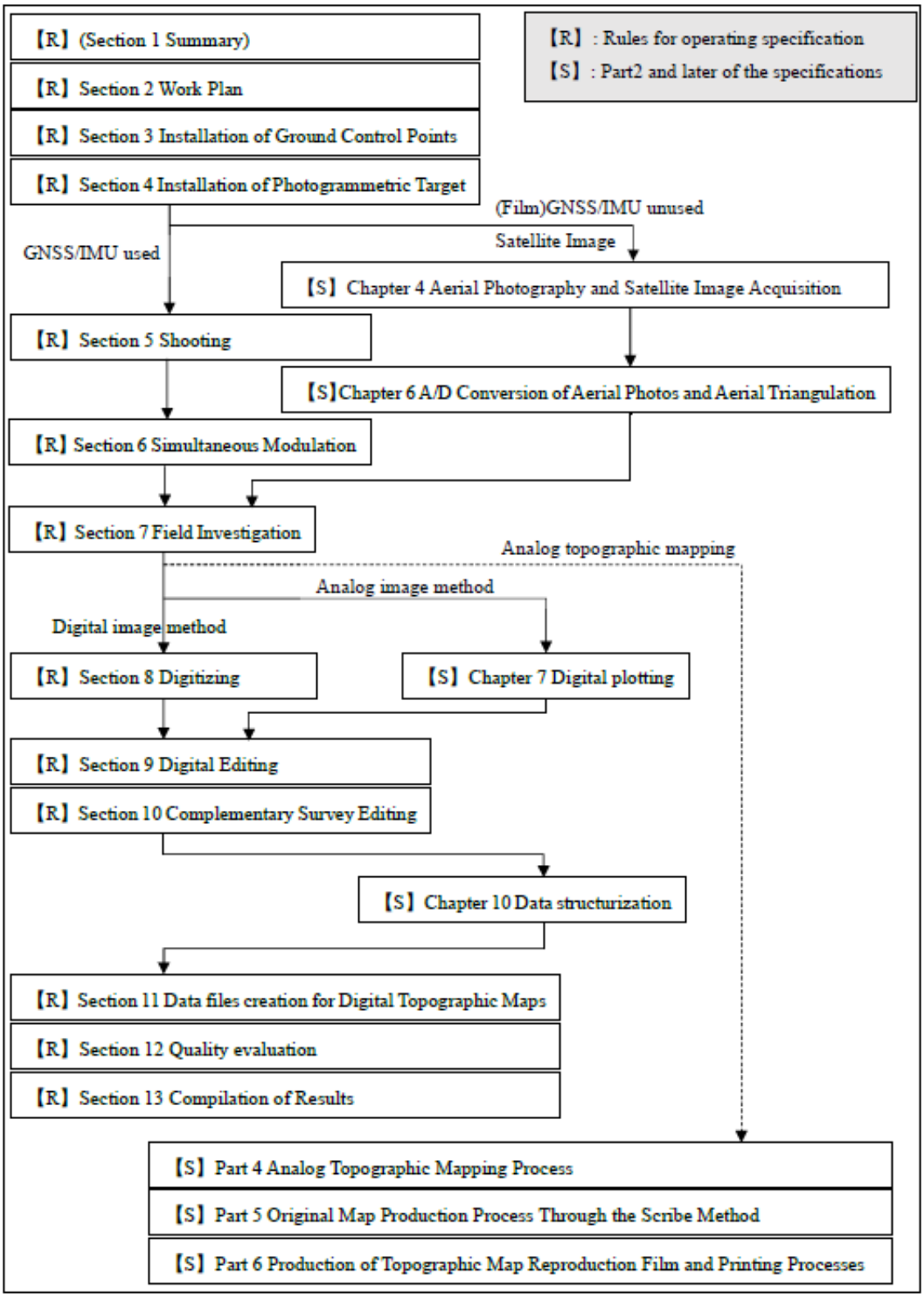
○： Priority is given to specifications with ○ in each item.

△： For work processes not specified in the Rules for operating specification, priority is given to Part2 and later of the Specifications.

×： Items not used.

－： Items not specified in the Rules for operating specifications and 2006 Specifications.

The following figure is a flowchart showing whether rules or Part2 and later of the specifications should be applied for Aerial Photogrammetry work.



Chapter 6 Aerial Photogrammetry Flow chart

Appendix 2 - Contradiction and Response Policy

In the table, 【R】refers to the Rules for operating specification and【S】refers to Part2 and later of the Specifications.

No.	(Part, Chapter, Section)	Contradiction		Response policy	Grounds for response
		2016 Specifications	Rules for operating specification		
01	Common to all （【S】Part 1 General） （【R】Part 1 General）			Part 1 of the Specification shall be applied.	

<table>
<tr>
<td>02</td>
<td>【S】Part 2 Control Point Survey
Chapter 2 Control Point Survey

【R】Part 2 Control Point Survey
Chapter 2 Control Point Survey</td>
<td>The order of the Control Point Survey is different.
<table>
<tr><td>【S】</td><td>1st</td><td>2nd</td><td>3rd</td><td colspan="3">－</td></tr>
<tr><td>【R】</td><td colspan="2">－</td><td>1st</td><td>2nd</td><td>3rd</td><td>4th</td></tr>
<tr><td>Distance between survey points
(Distance between known points)</td><td>30,000 (m)</td><td>10,000 (m)</td><td>4,000 (m)</td><td>2,000 (m)</td><td>1,500 (m)</td><td>500 (m)</td></tr>
</table>
</td>
<td>If the distance between survey points is 4,000 m or less, 【R】is applied.

If it exceeds 4,000m, the standard is 【S】1st order and 2nd order.</td>
<td>In order to make the best use of the latest technology, 【R】is standardized for inconsistent items.
For items not specified in 【R】, the standard is 【S】.</td>
</tr>
<tr>
<td rowspan="2">No.</td>
<td rowspan="2">(Part, Chapter, Section)</td>
<td colspan="2">Contradiction</td>
<td rowspan="2">Response policy</td>
<td rowspan="2">Grounds for response</td>
</tr>
<tr>
<td>2016 Specifications</td>
<td>Rules for operating specification</td>
</tr>
</table>

<table>
<tr>
<td>03</td>
<td>【S】Part 2 Control Point Survey
Chapter 3 Leveling

【R】Part 2 Control Point Survey
Chapter 3 Leveling with Leveling equipment</td>
<td>The order of the leveling survey is different.

<table>
<tr><td>【S】</td><td>1st</td><td colspan="2">2nd</td><td colspan="3">3rd</td></tr>
<tr><td>【R】</td><td colspan="2">—</td><td>1st</td><td>2nd</td><td>3rd</td><td>4th</td><td>Simplified</td></tr>
<tr><td>Route length</td><td>400 km or less</td><td>200 km or less</td><td colspan="2">150 km or less</td><td colspan="3">50 km or less</td></tr>
</table>
</td>
<td>If the route length is 150km or less, 【R】 is applied.

If it exceeds 150km, the standard is 【S】 1st order and 2nd order.</td>
<td>In order to make the best use of the latest technology, 【R】 is standardized for inconsistent items.
For items not specified in 【R】, the standard is 【S】.</td>
</tr>
<tr>
<td>No.</td>
<td>(Part, Chapter, Section)</td>
<td>Contradiction</td>
<td>Response policy</td>
<td>Grounds for</td>
</tr>
</table>

		2016 Specifications	Rules for operating specification		response
04	【S】Part 3 Digital Topographic Map Production Process Chapter 1 General 【 R 】 Part 3 Topographic mapping and Photogrammetry Chapter 1 General and Chapter 6 Aerial Photogrammetry Section 1 Summary			【R】 is the standard. However, the "accuracy of topographic maps" "map symbols" and "data of a digital topographic map" are as follows.	In order to make the best use of the latest technology, 【 R 】 is standardized for inconsistent items. However, for items not appropriate to apply in the target country, the standard is 【S】.

<table>
<tr>
<td></td>
<td></td>
<td>・Map information level specified from 2500 (1 / 2,500) to 100000 (1 / 100,000)
・The accuracy of Topographic Maps should generally be shown in the following table. The accuracy of the horizontal location of a Digital Topographic Map is represented by that of the map whose scale corresponds to the level of map information.
<table>
<tr><th colspan="2">Classification</th><th>Accuracy (standard deviation)</th></tr>
<tr><td colspan="2">Horizontal location of a planimetric feature</td><td>0.7 mm or less on the map</td></tr>
<tr><td rowspan="2">Elevation</td><td>Elevation point</td><td>One-third or less of contour line intervals</td></tr>
<tr><td>Contour line</td><td>One-half or less of contour line intervals</td></tr>
</table>
</td>
<td>・Map information level specified from 250 (1 / 250) to 10000 (1 / 10,000)
・ The Positional Accuracy and Map Information Level of the Digital Topographic Map Data in the following table should be standard.
<table>
<tr><th>Map Information Level</th><th>Standard deviation of horizontal positions</th><th>Standard deviation of elevation points</th><th>Standard deviation of contours</th></tr>
<tr><td>250</td><td>Within 0.12 m</td><td>Within 0.25 m</td><td>Within 0.5 m</td></tr>
<tr><td>500</td><td>Within 0.25 m</td><td>Within 0.25 m</td><td>Within 0.5 m</td></tr>
<tr><td>1000</td><td>Within 0.70 m</td><td>Within 0.33 m</td><td>Within 0.5 m</td></tr>
<tr><td>2500</td><td>Within 1.75 m</td><td>Within 0.66 m</td><td>Within 1.0 m</td></tr>
<tr><td>5000</td><td>Within 3.50 m</td><td>Within 1.66 m</td><td>Within 2.5 m</td></tr>
<tr><td>10000</td><td>Within 7.00 m</td><td>Within 3.33 m</td><td>Within 5.0 m</td></tr>
</table>
</td>
<td>【R】 is the standard for "accuracy of topographic maps".
Use 【S】 for the map whose map information level is more than 10000.

However, "Map Information Level" and "Position Accuracy" are not always match due to the purpose of the topographic map and the regulations of the target country, so they are used as a guide.</td>
<td>For items not specified in 【R】, the standard is 【S】.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>・The map symbols, map projection, size of a map extent, contour interval, data file specifications, etc. of digital topographic maps should, in principle, comply with the specifications of the target country.</td>
<td>・ The Map symbols should properly be defined according to the purpose and Map Information Level.
・It is standard to use the map symbols of the 【R】appendix and the basic survey according to the map information level.</td>
<td>If there are no regulations in the target country, refer 【R】.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>・The data of a digital topographic map should be classified as structured data and topographic</td>
<td>No description</td>
<td>For "data of a digital topographic map ", 【S】 is</td>
<td></td>
</tr>
</table>

		map data.		the standard.	
No.	(Part, Chapter, Section)	Contradiction		Response policy	Grounds for response
		2016 Specifications	Rules for operating specification		

05	【S】Part 3 Digital Topographic Map Production Process Chapter 4 Aerial Photography and Satellite Image Acquisition 【R】Part 3 Topographic mapping and Photogrammetry Chapter 6 Aerial Photogrammetry Section 5 Shooting	・Regulations for Aerial Photography with film camera that does not use GNSS / IMU and preparation of satellite image data.	・Regulations for Aerial Photography with a film camera using GNSS / IMU and a digital camera using GNSS / IMU.	【R】is the standard. 【S】is standard for Aerial Photography with a film camera that does not use GNSS / IMU. 【S】is the standard for the preparation of satellite image data.	In order to make the best use of the latest technology, 【R】is standardized for inconsistent items. For items not specified in 【R】, the standard is 【S】.
No.	(Part, Chapter, Section)	Contradiction		Response policy	Grounds for

		2016 Specifications	Rules for operating specification		response
06	【S】Part 3 Digital Topographic Map Production Process Chapter 6 A/D Conversion of Aerial Photos and Aerial Triangulation 【 R 】 Part 3 Topographic mapping and Photogrammetry Chapter 6 Aerial Photogrammetry Section 6 Simultaneous adjustment	・ Regulations for Aerial Triangulation (simultaneous adjustment) of data taken by GNSS / IMU unused film cameras and satellite image data	・ Simultaneous adjustment (Aerial Triangulation) by a film camera using GNSS / IMU and a digital camera using GNSS / IMU is specified.	【R】 is the standard. 【S】 is the standard for Aerial Triangulation of data taken by "GNSS / IMU unused film camera" and "satellite image data".	In order to make the best use of the latest technology, 【R】 is standardized for inconsistent items. For items not specified in 【R】, the standard is 【S】.

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">(Part, Chapter, Section)</th><th colspan="2">Contradiction</th><th rowspan="2">Response policy</th><th rowspan="2">Grounds for response</th></tr>
<tr><th>2016 Specifications</th><th>Rules for operating specification</th></tr>
<tr><td rowspan="3">07</td><td rowspan="3">【S】Part 3 Digital Topographic Map Production Process

<u>Chapter 7 Digital plotting</u>

【R】Part 3 Topographic mapping and Photogrammetry
Chapter 6 Aerial Photogrammetry
<u>Section 8 Digital Plotting</u></td><td>・Regulations for Digital Plotting of the Analog Image method and the Digital Image method.</td><td>・Regulations for Digital Plotting of the Digital Image method.</td><td>【R】 is the standard.

【S】 is the standard for the Digital Plotting of the Analog Image method.

However, the "unit of coordinates to be acquired", "classification code", and "measurement of elevation points" are as follows.</td><td rowspan="3">In order to make the best use of the latest technology, 【R】 is standardized for inconsistent items. However, for items for which 【R】 is not suitable for overseas circumstances, 【S】 is standardized

For items not</td></tr>
<tr><td colspan="2">・The unit of coordinates to be acquired is different

<table><tr><td>Map Information Level</td><td></td><td>250</td><td>500</td><td>1000</td><td>2500</td><td>5000</td><td>10000</td><td>25000 or higher</td></tr><tr><td rowspan="2">The unit of coordinate data (m)</td><td>【S】</td><td colspan="3">－</td><td colspan="2">0.01</td><td>0.1</td><td>1</td></tr><tr><td>【R】</td><td colspan="3">0.01</td><td colspan="2">0.01</td><td>0.01</td><td>－</td></tr></table></td><td>For "unit of coordinates to be acquired", 【R】 is the standard.
For level 25000 and above, 【S】 is the standard.</td></tr>
<tr><td>The digital plotting data to be obtained must be assigned a classification code that represents its type established in the map symbolling system, etc. (comply with the specifications of the target country.).</td><td>The classification code is based on the Digital Topographic Map acquisition classification criteria in the appendix.</td><td>If there are no regulations in the target country regarding the "classification code", refer 【R】.</td></tr>
</table>

					specified in 【R】, the standard is 【S】.
		・ Specified the allowable range of two measurements of elevation points from level 2500 to 100000. ・ If the difference between the two measurements exceeds the tolerance, should be reselect the elevation point and re-measured.	・ Specified the allowable range of two measurements of elevation points from level 500 to 10000. ・If the difference exceeds the allowable range, one more measurement is performed and the average value of the three measured values must be adopted.	【R】 is the standard for "unit of coordinates to be acquired". 【S】 is the standard for exceed level 10000. However, if the difference exceeds the allowable range, the work method of 【R】 will be the standard.	

08	【S】Part 3 Digital Topographic Map Production Process Chapter 10 Data structurization	・Describes the rules of data structurization.	・No description	【S】 is the standard.	For items not specified in 【R】, the standard is 【S】.

No.	(Part, Chapter, Section)	Contradiction		Response policy	Grounds for response
		2016 Specifications	Rules for operating specification		

09	【S】Part 3 Digital Topographic Map Production Process Chapter 11 Data File Production 【 R 】 Part 3 Topographic mapping and Photogrammetry Chapter 6 Aerial Photogrammetry Section 11 Data file creation for digital topographic maps Section 12 Quality evaluation and Section 13 Compilation of results	・ Describes the data files for Digital Topographic Maps and for data structurization.	・ There is no description of the data structurization file.	When creating "structured data files", 【S】 is the standard.	For items not specified in 【R】, the standard is 【S】.
No.	(Part, Chapter, Section)	Contradiction		Response policy	Grounds for

		2016 Specifications	Rules for operating specification		response
10	【S】Part 3 Digital Topographic Map Production Process Chapter 12 Digitization and Revision of Existing Map 【R】Part 3 Topographic mapping and Photogrammetry Chapter 7 Digitization of Existing Maps and Chapter 8 Digital Map Revision	・Describes the digitization and revision of existing map for analog photogrammetry.	・No description about the revision of an existing map for Analog Photogrammetry.	【R】 is the standard. However、for revision of existing map for analog photogrammetry, use【S】.	In order to make the best use of the latest technology, 【R】 is standardized for inconsistent items. For items not specified in 【R】, the standard is 【S】.

No.	(Part, Chapter, Section)	Contradiction		Response policy	Grounds for response
		2016 Specifications	Rules for operating specification		
11	【S】Part 4 Analog Topographic Mapping Process Part 5 Original Map Production Process Through the Scribe Method and Part 6 Production of Topographic Map Reproduction Film and Printing Processes	Described "Analog Topographic Mapping Process", "Original Map Production Process Through the Scribe Method" and "Production of Topographic Map Reproduction Film and Printing Processes"	No description	【S】 is the standard.	For items not specified in 【R】, the standard is 【S】.

Part 2 Control Point Survey

Chapter 1 General

Article 14 (Outline)
The control point survey refers to the determination of the location of a new point based on known points.
2. A control point refers to a marker established for use as a reference point in survey and having numerical results about its location.
3. A known point refers to an existing control point whose result is used as an existing point in the implementation of control point survey.
4. A new point refers to a control point to be established in control point survey.

Article 15 (Classification of control point survey)
The control point survey shall be classified into two categories, namely control point survey in a narrow sense (hereinafter referred to as "control point survey") and leveling.
2. A marker to be established in control point survey shall be called a control point in a narrow sense (hereinafter referred to as a "control point").
3. A marker to be established in leveling shall be called a bench mark.

Chapter 2 Control Point Survey

Section 1 Outline

Article 16 (Outline)
The control point survey refers to the determination of the horizontal location and elevation of new points based on the existing points and production of a result table.
2. The control point survey is classified into 1st, 2nd, and 3rd order control point survey depending on the types of known points, distances between survey points, and relative accuracy of observation.

<Article 16 Operation criteria>
Normally, the types of known points, distances between survey points, and relative accuracy of observation shall be as listed in the following table:
If the distance between the survey points is 4 km or less, the “Rules for operating specification” shall be applied.

Classification	Types of known points	Distance between survey points	Relative accuracy of observation
1st order control point survey	1st order control points or higher	30 km	$3 * 10^{-6}$
2nd order control point survey	1st and 2nd order control points	10 km	$1 * 10^{-5}$
3rd order control point survey	1st to 3rd order control points	4 km	$2.5 * 10^{-5}$

Article 17 (Control point survey methods)
Control point survey shall be performed using the GPS survey method or the traversing method.
2. The GPS survey method refers to a survey method using GPS.
3. The traversing method refers to a survey method based on traverse nets using an electro-optical distance meter, theodolite, etc.

Article 18 (Work processes and their order)
Work processes and their order shall be as follows:
(1) Plan
(2) Site Selection
(3) Establishment of survey markers
(4) Observation

(5) Computation
(6) Summary of results, etc.

Section 2 Plan

Article 19 (Outline)
A plan shall be made in accordance with the specification in Article 5 (Operation plan) and in view of the characteristics of different survey methods.
2. The approximate locations of new points shall be examined on a map, etc. to make a net adjustment plan.
3. In principle, the 1st and 2nd order control point survey shall be performed using the GPS survey method.
4. The 3rd order control point survey shall be performed using the traversing method or the GPS survey method.

<Article 19 Operation criteria>
1. A plan shall be made in view of survey methods, equipment to be used, personnel, work processes, topographic features, traffic routes, distribution of known points, etc.
2. In the GPS survey method a survey network is formed by the base lines which are the connections of a known point with a new point or two new points with each other.
3. The GPS survey method shall be used in view of the Health Status and Visibility of GPS satellites.
4. In the traversing method, a joined traverse net is formed. If the known points of the target country are used, the known points shall be subject to the inspection measurement to verify the accuracy of the known points. In this case, the GPS survey method may be used for the inspection measurement even though the traversing method would be used for the control point survey itself.

Article 20 (Forming a control point network)
A survey network and a joined traverse net (hereinafter referred to as a "control point network") shall be formed in view of strengths of figures.
2. When a control point network is to be formed, the elevation from a bench mark to a control point shall be determined as required.

<Article 20 Operation criteria>
1. An elevation shall be determined using the following survey methods:
1) Direct leveling
2) Indirect leveling using a distance and a vertical angle
3) Combination of indirect and direct leveling
4) GPS survey
2. Either of the survey methods listed in the previous item shall be implemented using the nearest bench mark.

Section 3 Site Selection

Article 21 (Outline)
The site selection refers to the survey of the current status of known points in the field based on a net adjustment plan, the selection of locations in view of conditions required for establishing of new points and point allocation densities, and the determination of the means of survey that conforms to the topographic features, vegetations, and other field status.

Article 22 (Implementation of site selection)
New points shall be selected at adequate locations in view of subsequent works, maintenance of markers, etc.

<Article 22 Operation criteria>
1. GPS survey shall be implemented as follows:
1) In principle, new points shall be selected at locations free of artificial influences from radio

interferences, planimetric features, vegetations, etc.
2) Normally, skyward angular range of view must have an elevation angle of 15 degrees or more in all the directions.
3) If a known or new point shows a poor reception of radio waves from GPS satellites, an eccentric point shall be established or obstructing objects shall be removed.
2. Traversing method shall be implemented as follows:
1) A control point network shall be any figure consisting of two or more known points and, at each known point, the direction angles for establishing shall be observed. Depending on the field status, etc. however, the direction angles for establishment may be omitted.
2) One route (between two known points, a known point and an intersection, or two intersections) shall have six sides at the maximum.
3) An eccentric point shall be set at a location that meets the condition, $e < 0.10 \times S$, where S is the distance between the original point and neighboring point and e is the eccentric distance.
4) If a new point would be selected on the outside from a line that connects between adjacent known points in the circumference of a control point network, new points shall be selected normally within 40 degrees from this line.

Article 23 (Production of a net adjustment diagram, etc.)
A site selection map shall be created by marking the locations of new points and known points on a map, etc.
2. A net adjustment diagram shall be created based on a site selection map in view of the strengths of figures.
3. An observation diagram shall be created based on a net adjustment diagram by specifying an observation implementation plan.

<Article 23 Operation criteria>
1. A site selection map shall be created by marking the locations of new points and known points as well as eccentric points if there is any eccentricity in observation points.
2. All the visibility lines and observation points shall be marked on a site selection map if the traversing method is applied.
3. If the GPS survey method is applied, an observation diagram shall show a combination status for an observation repetitiously performed at fixed data acquisition intervals (hereinafter called a "session") using more than one GPS survey instrument, eccentric points, etc.
4. The GPS observations shall be performed by forming polygons with closed traverse routes that connect known and new points and shall be checked by either of the followings.
1) Polygons shall be formed through a combination of different sessions and used for inspection.
2) Overlapping observation on more than one side shall be implemented for inspection using different sessions.

Section 4 Establishment of survey markers

Article 24 (Outline)
The establishment of survey markers refers to the establishment of permanent monuments or temporary markers at the locations of new points, etc.

Article 25 (Permanent monuments and temporary markers)
In principle, new point shall be marked by establishing a permanent monument and establishing a protective facility, if required.
2. A known or new point shall be marked by establishing a temporary marker if required.

<Article 25 Operation criteria>
1. A permanent monument to be established shall comply with the specifications and forms established by the target country.
2. Specifications or forms shall be established through a consultation between the target country and JICA, if none of them is established by the target country.

Article 26 (Control point description)
Control point description shall be created for established permanent monuments and used control points and bench marks.

<Article 26 Operation criteria>
1. Control point description shall be created in formats established by the target country.
2. The formats shall be established through a consultation between the target country and JICA, if none of them is established by the target country.

Section 5 Observation and Computation based on the GPS survey method

Article 27 (Outline)
Observation based on the GPS survey method refers to the reception of radio waves from GPS satellites and recording of phase data, etc. (hereinafter called the "GPS observation").
2. Computation refers to the computation of horizontal locations, elevations, and other related elements of new points and creating a table of results, etc.

Article 28 (Performances of survey instrument, etc.)
Major instrument used for observation shall be those listed in the following table or equivalent.

GPS receiver (dual-frequency)	±(5mm+1mm・D)	1st and 2nd order control point survey
GPS receiver (single-frequency)	±(10mm+2mm・D)	3rd order control point survey

D: Measuring distance (km)

Article 29 (Inspection and adjustment of instrument)
The instrument to be used shall be subject to a functional inspection according to the prescribed method before work and they shall be adjusted, if required.
2. During the work period, the instrument shall be subject to the functional inspections and other ones, if required.

<Article 29 Operation criteria>
A GPS survey instrument shall be subject to a functional inspection to comply with the following conditions:
a. The optical centering device is normal.
b. The digital display is normal.
c. The antenna cable is normal.
d. The connectors are normal.
e. The power voltage is within the specified values.

Article 30 (GPS observation)
The GPS observation shall be performed through the static relative positioning method (hereinafter referred to as the "static method"), etc.
2. The GPS observation shall be performed based on the observation diagram for each session.

<Article 30 Operation criteria>
1. If the distance is 500 m or less in the connecting observation for determining the elevation, a difference between the ellipsoidal heights may be used as a difference of elevation.
2. One session of observation shall be performed once.
3. The antenna height shall be measured in units of cm.
4. The observation time shall be indicated in the following table:

Classification	Observation time		Data acquisition interval
1st order control point survey	60 minutes or more		30 seconds or less
2nd order control point survey	20 minutes or more		15 seconds or less
3rd order control point survey	10 minutes or more		15 seconds or less

5. GPS observation shall be performed in view of the health status, visibility, etc. of GPS satellites and shall not be performed when the GPS satellites are in an unbalanced arrangement.
6. Normally, the reception elevation angle of a GPS satellite shall be 15 degrees or more. However, the reception elevation angle may be 30 degrees or more, if it is difficult to acquire the field of vision overhead.
7. The minimum number of common GPS satellites to be used at one time shall be four.

Article 31 (Measurement of element of eccentricity)
If an observation point is eccentric, the element of eccentricity shall be measured according to a prescribed method.

<Article 31 Operation criteria>
1. For the measurement of eccentricity element, the operation criteria specified in the previous article (GPS observation) or Article 42 (Measurement of eccentricity element) shall be applied.
2. If the visibility cannot be obtained in the zero direction, at an eccentric point for determine element of eccentricity an azimuth mark shall be established.
1) The distance to the azimuth mark shall be four times longer than the eccentric distance and 100 m at the minimum.
2) The azimuth mark may be established using the static method of GPS observation and the observation time, etc. shall be as follows:

Classification	Observation time	Data acquisition interval	Number of GPS satellites to be used
Static	30 minutes or more	30 seconds or less	4 satellites or more simultaneously
Shortened static	10 minutes or more	15 seconds or less	5 satellites or more simultaneously
Kinematic	1 minute or more	1 second	5 satellites or more simultaneously

Article 32 (Base line analysis computation)
Base line analysis computations refers to the computation of the relative three-dimensional location relationships between observation points and other related elements using phase data, etc. acquired from GPS satellites and displaying the result to a decimal place specified in the following table:

Item	Unit	Decimal place
Base line vector component	m	0.001

<Article 32 Operation criteria>
1. The base line analysis computation shall be performed as follows:
1) In principle, the orbital element of a GPS satellite shall be broadcast ephemeris.
2) An observation point to be used as a fixed point in the base line analysis shall have a longitude, latitude, and ellipsoidal height that are initially set to values on an approximately precise WGS84 ellipsoid. In the subsequent base line analysis, the values on the WGS84 ellipsoid obtained through

calculation shall be used for input in turn.
3) The analysis method shall be the single base line analysis for each session to compute base line vectors between observation points.
4) The elevation angle to be used for base line analysis shall be the reception elevation angle specified for the GPS survey instrument at the time of observation.
5) Weather elements shall be corrected using the standard atmosphere of the base line analysis software.
6) In principle, the cycle slip shall be automatically compiled through the base line analysis software.

Article 33 (Check computation and resurvey)
The check calculation shall be performed at the end of the base line analysis computation. If the tolerance is exceeded, either resurvey shall be performed or an appropriate measure shall be taken according to an instruction from JICA.

<Article 33 Operation criteria>
1. The observed values shall be checked through one of the following methods:
1) For a check route, select a polygon with a minimum number of sides in a combination of different sessions and compute the circuit closure errors for the elements (ΔX, ΔY, and ΔZ) of a base line vector.
2) Compare the components of overlapping base line vectors.

2. The tolerances of check computation shall be indicated in the following table:

Circuit closure error of each component of a base line vector	45mm √N (N: Number of sides)
Difference of each component of overlapping base line vectors	45mm

Article 34 (Adjustment computation, etc.)
The adjustment computation refers to the execution of the three-dimensional network adjustment computation at the end of the check calculation to find the horizontal position and elevation of new points.
2. A program used for the adjustment computation must be approved by JICA before use.

<Article 34 Operation criteria>
1. The values shall be calculated down to the decimal places listed in the following table:

Item	Unit	Decimal place
Longitude and latitude	Degrees, minutes, and seconds	0.0001
Ellipsoid height	m	0.001
Value of angle	Degrees, minutes, and seconds	1
Length of side	m	0.001

2. The three-dimensional network adjustment computation that sets one known point (hereinafter referred to as "three-dimensional virtual network adjustment computation ") shall be performed as follows:
1) In the three-dimensional virtual network adjustment computation, the weight (P) shall be the inverse matrix of a variance-covariance matrix obtained through the base line analysis.
2) The tolerances of three-dimensional virtual network adjustment computation shall be indicated in the following table:

a. The tolerances of each component of a base line vector shall be indicated in the following table:

Classification / 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	45mm		
Closure error of horizontal position	$\Delta S = 10cm + 4cm \sqrt{N}$ ΔS: Distance obtained from the result value of a known point and the result of three-dimensional virtual network adjustment computation 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 in terms of the azimuth, slope distance, and ellipsoidal relative height

Classification / 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	$\Delta S = 10cm + 4cm \sqrt{N}$ ΔS: Distance obtained from the result value of a known point and the result of three-dimensional virtual network adjustment computation 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 network adjustment computation that sets three or more known points shall be performed as follows. However, any abnormal known point shall be excluded from the set points.

1) The elevation of a new point shall be determined using either of the following methods:

a. Assume the vertical deflection as an unknown quantity and obtain the elevation through three-dimensional network adjustment computation.

b. Using GPS survey and leveling, obtain a local geoid model and correct the geoid height.

2) In the three-dimensional network adjustment computation, the weight (P) shall be the inverse matrix of a variance-covariance matrix obtained through the base line analysis.

3) The tolerances of three-dimensional network adjustment computation shall be indicated in the following table. If a tolerance is exceeded, examine the observed value and the computation process and inquire with JICA for instructions.

Classification / Item	1st order control point survey	2nd order control point survey	3rd order control point survey
Standard deviation of the horizontal position of a new point	10cm		
Standard deviation of the elevation of a new point	20cm		

Section 6 Observation and computation based on the traversing method

Article 35 (Outline)
The observation and computation based on the traversing method refers to the measurement of the horizontal and vertical angles and distances of observation points using a theodolite, the electro-optical distance meter, etc. and, based on known points, the determination of the horizontal position and elevations of new points, and the production of a table of results.

Article 36 (Performances of survey instruments)
The major instrument to be used for observation shall be those listed in the following table or equivalent.

Survey instrument & device	Performance
electro-optical distance meter	±(5mm＋2ppm・D)　D: distance Measurable distance: 6 km
Theodolite	Minimum readable value 1″
Thermometer	Air psychrometer with a minimum scale value of 1”
Barometer	Minimum scale value of 2hPa
Level and staff	Level: Main bubble tube sensitivity of 40"/ 2mm Staff: Wooden graduated scale (except telescopic staff)

Article 37 (Inspection and adjustment of instruments)
The instruments to be used shall be subject to a functional inspection according to a prescribed method before work and shall be adjusted, if required.
2. During the work period, the instruments shall be subject to the functional inspection, if required.

<Article 37 Operation criteria>
1. A distance meter shall be subject to the functional inspection regarding the following requirements:
a. The optical centering device shall be normal.
b. The digital display shall be normal.
c. The values indicating the light reception sensitivity, power voltage, etc. shall be within the range of normal values specified in the instruction manual for the concerned distance meter.
2. A theodolite shall be subject to inspection regarding the following requirements:
1) Functional inspection
a. The optical centering device shall be normal.
b. Each shaft shall rotate smoothly.
c. The bubble tube adjustment feature shall be normal and the bubble shall move smoothly.
d. The telescope diopter adjustment function shall be normal and the diopter shall not change during observation.
e. The horizontal and vertical angle reading device shall be normal and the angle can be correctly read.
f. The functions of the automatic adjustment device shall operate normally.
2) Inspection through horizontal angle observation
a. Three directions with almost same height as the theodolite and a fixed included angle shall be observed.
b. Observation consisting of one sight setting and one reading shall be performed twice.
c. The number of sets for observation shall be two, performing three observation pairs per set.
d. The tolerances of observation shall be indicated in the following table. However, the difference between sets shall be the difference of average values of these sets.

Double angle difference	Observed difference	Difference between sets	Scale graduation that should match indexes
11”	7”	4”	(0°, 60°, 120°) (30°, 90°, 150°)

3) Inspection through vertical angle observation
a. Observation consisting of one sight setting and one reading shall be performed twice.

b. The observation shall be performed in the directed to three different targets.
c. For each target, one pair of observation shall be performed.
d. The difference of the height constant shall be 10 seconds or less.

Article 38 (Measurement of distances and weather elements)
A distance shall be measured for the prescribed number of sets.
2. The weather elements shall be the temperature and atmospheric pressure, and the measurement of elements shall be made at a point of instrument.

<Article 38 Operation criteria>
1. A distance shall be measured as follows:
1) The guideline for measurement shall be as listed in the following table. However, the sight shall be repetitiously collimated for every set.

Measurement method	Direct reading method
Number of measurements per set	3 measurements
Time of measurement per set	5 minutes or less
Number of sets	2 sets
Measurement intervals of sets	5 minutes or more

2) The tolerances of measured values shall be as follows:
a. Normally, the difference in a set using a direct-reading electro-optical distance meter shall be 30 mm or less.
b. The difference between sets for measured values after weather correction shall be 50 mm or less.
2. A weather element shall be measured as follows:
1) Measure a weather element at the start and end of each set.
2) A temperature shall be measured as follows:
a. Set a thermometer where it is distant from planimetric features, vegetations or the ground, is not influenced by a radiation heat, and is at a suitable position for measuring a distance.
b. Check a thermometer to ensure that the mercury thread is not broken.
3) The air pressure shall be measured as follows:
a. If the barometer is subject to a strong shock, check whether there is an instrumental error.
b. If the barometer is exposed to a direct sunlight for a long time or removed from a location with a significant temperature difference from the outside air, wait for it to rise or drop to the air temperature before measuring the air pressure.
c. Compare the measured air pressure with an air pressure obtained from the elevation of the point of instrument to ensure that there is no significant difference between them.
4) The air temperature and pressure of a point of reflection shall be obtained using a prescribed calculation formula, if required.

Article 39 (Observation of a horizontal angle)
A horizontal angle shall be observed for the prescribed number of observation pairs using the direction method.

<Article 39 Operation criteria>
1. A horizontal angle shall be observed as follows:
1) The observation consisting of one collimation one reading in and one direction shall be performed twice.
2) For one group of observation, the maximum number of observation directions shall be five.
3) The zero direction shall be one of a group of observation directions for a point that facilitates collimation and is closer to the average distance and the elevation of the observation point.
4) The number of observation pairs shall be two and the graduated scale shall match indexes at 0 and 90 degrees.
5) In principle, the sight line target shall be signal or heliotrope.
2. The tolerances of observed values shall be indicated in the following table:

Double angle difference	Observed difference
15”	8”

Article 40 (Vertical angle observation)
The vertical angle observation shall be performed for the prescribed number of observation pairs.
2. In principle, the vertical angle observation shall be performed both in the forward and backward directions consecutively.

<Article 40 Operation criteria>
1. The vertical angle observation shall be performed as follows:
1) For one direction, the observation consisting of one collimation and one reading shall be performed four times.
2) One observation pair shall constitute one set and two sets shall be performed.
3) In principle, the sight line target shall be signal or heliotrope.
2. The tolerances of observed values shall be as follows:
1) The difference of elevation constants shall be 10 seconds or less.
2) A set-to-set difference between one set of average values in the forward and backward directions and another set of average values in the forward and backward directions shall be five seconds or less.

Article 41 (Observation of elevation determination)
The elevation determination shall be performed by direct or indirect leveling.

<Article 41 Operation criteria>
1. The direct leveling shall be performed as follows:
1) The go and back observation shall be performed.
2) A bench mark to be used as a known point shall be measured direct leveling up to an adjacent bench mark in one-way-observation.
3) Normally, the maximum distance of sight shall be 70 m.
2. Indirect leveling shall be performed as follows:
1) For the distance measurement and vertical angle observation, the operation criteria specified in Article 38 (Measurement of distances and weather elements) and the previous article 40 (Vertical angle observation) shall apply.
2) Two sets of vertical angle observation between a bench mark and a control point shall be performed twice. For the second time, the observation shall be performed with the instrument height or target height changed by 20 mm or more.
3. The tolerances of the elevation or difference of elevation obtained through direct or indirect leveling shall be as follows:
1) The tolerances regarding direct leveling are shown in the following table:

Tolerance	
Difference between the go and back observation values	20mm√S
Difference between a measured value and a result value	20mm√S

2) The difference of elevation obtained from indirect leveling shall be calculated separately for the forward and backward directions and the difference between them shall be less than a value calculated using the following equation:
5 cm x D
Where D is the slope distance between survey points (in km).

Article 42 (Measurement of element of eccentricity)
If there is an eccentricity when a distance is measured or a horizontal angle is observed, element of

eccentricity shall be measured according to a prescribed method.

<Article 42 Operation criteria>
1. The guideline for measurement of element of eccentricity and the tolerances of measured values shall normally be indicated in the following table:

<table>
<tr><td rowspan="3">Eccentric distance</td><td colspan="3">Measurement of eccentric distance</td><td colspan="3">Measurement of angle of eccentricity</td></tr>
<tr><td rowspan="2">Instruments and measurement method</td><td rowspan="2">Measurement unit</td><td rowspan="2">Tolerance</td><td rowspan="2">Instruments and measurement method</td><td rowspan="2">Measurement unit</td><td colspan="2">Tolerance</td></tr>
<tr><td>Double angle difference</td><td>Observed difference</td></tr>
<tr><td>Less than 30cm</td><td>Straight measure</td><td>mm</td><td>-</td><td rowspan="3">Draw a direction line on a measurement sheet using an alidade, etc. and obtain the angle using a protractor or through calculation (measurement to be made twice).</td><td>1°</td><td></td><td></td></tr>
<tr><td>More than 30cm, less than 2m</td><td rowspan="3">Steel tape</td><td rowspan="3">mm</td><td rowspan="3">Difference between the forward and backward directions 5 mm.</td><td>10’</td><td></td><td></td></tr>
<tr><td>More than 2m, less than 10m</td><td rowspan="3">Perform the measurement using a theodolite (measurement to be made for two pairs).</td><td>10”</td><td>120”</td><td>90”</td></tr>
<tr><td>More than 10m, less than 50m</td><td rowspan="2">1”</td><td rowspan="2">60”</td><td rowspan="2">40”</td></tr>
<tr><td>More than 50m</td><td>Electro-optical distance meter</td><td>mm</td><td></td><td>30”</td><td>20”</td></tr>
</table>

2. An eccentric distance shall be measured as follows if a distance meter is used:
1) For the guideline for measurement, the operation criteria specified in Article 38 (Measurement of distances and weather elements) shall be applied. However, the measurement intervals between the sets may be arbitrary.
2) For the tolerances of measured values, the operation criteria specified in Article 38 (Measurement of distances and weather elements) shall be applied. However, the set-to-set difference of measured values after the weather correction shall be 15 mm or less.
3. An eccentric distance shall be measured as follows if a steel tape is used:
1) Two rounds of measurement shall constitute one set and two sets shall be performed. In the second set of measurement, the measurers on the front and rear ends shall change places with each other. The

temperature shall be measured for each set.
2) The set-to-set difference shall have a tolerance of one-10,000th of the measuring distance. However, the difference for a measuring distance of 25 m or less shall have a tolerance of 2 mm or less.
4. The guideline for measurement of a difference of elevation between an original point and an eccentric point and the tolerances of measured values shall be indicated in the following table. For the vertical angle measurement using indirect leveling, the operation criteria specified in Article 40 (Vertical angle observation) shall apply.

Eccentric distance	Measuring instrument and measuring method	Tolerance of observed value
Less than 30cm	Set an eccentric point at the same elevation as an original point using an independent level.	----------
More than 30cm less than 100m	Perform observation the go and back observation using a level. The number of survey points in one-way observation may be one using the same staff for the backsight and foresight. (Case of direct leveling)	Difference between the go and back measurements: 20 ㎜√S S: Observed distance (in km)
	Perform the vertical angle observation in the forward and backward directions using a theodolite. The vertical angle observation in the forward and backward directions may be substituted with two pairs of vertical angle observation in one direction with two different instrument heights. (Case of indirect leveling)	Difference of height constants Eccentric distance of less than 10 m: 60" Eccentric distance of 10 m or more: 30" Difference between a difference of elevations obtained in the forward and backward direction or in two rounds of observation: 10 cm
More than 100m	Perform the go and back observation using a level. (Case of direct leveling)	Difference between go and back measurements: 20 ㎜√S S: Observed distance (in km)
	Perform the vertical angle observation in the forward and backward directions using a theodolite. (Case of indirect leveling)	Difference between height constants: 30" Difference a difference of elevations obtained in the forward and backward direction or in two rounds of observation: 15 cm

5. If all the directions related to a control point are measured with one eccentric point, element of eccentricity shall be measured as follows:
1) An eccentric angle shall be observed twice with different zero directions. One of the results shall be adopted and the other shall be subject to the inspection measurement.
2) If an eccentric distance is measured using an electro-optical distance meter or steel tape, the result shall be subject to inspection measurement by changing the instrument height, etc.

Article 43 (Resurvey)
If, during horizontal or vertical angle observation or distance measurement, an observed value exceeds the prescribed tolerance, resurvey must be performed.

<Article 43 Operation criteria>
Horizontal angle resurvey must be performed for all the directions of a scale and must not be performed only for one specific direction.

Article 44 (Calculation methods and decimal places)
The plane rectangular coordinate (hereinafter referred to as the "coordinate"), longitude/latitude, and elevation of a new point shall be computed and related correction computation shall be performed using prescribed formulas down to decimal places shown in the following table:

Plane rectangular coordinate	Longitude/latitude	Angle	Distance	Elevation
0.001m	0.0001”	Horizontal angle 0.1" Vertical angle 1"	0.001m	0.01m Direct leveling 0.001m

2. The calculation process shall include the production of a table of results.

Article 45 (Check computation and resurvey)
At the end of observation, the prescribed check computation shall be promptly performed to check the conformity of an observed value.
2. Check computation shall be performed on a direction angle and its closure error, a coordinate and its closure error, and an elevation and its closure error.
3. If the result of check computation exceeds the prescribed tolerance, a necessary resurvey shall be performed or an appropriate measure shall be taken.

<Article 45 Operation criteria>
1. A program used for the check computation shall be tested with the trial computation to ensure its accuracy.
2. A closure error shall be computed as follows:
1) A direction angle or a closure error of a coordinate shall be computed for all the check routes selected according to the following conditions:
a. A check route shall be the shortest possible route that connects two known points.
b. All the known points shall be connected with each other by at least one check route.
2) The tolerances of closure errors shall be indicated in the following table:

Closure error	Tolerance	Remarks
Closure error of a direction angle Closure error of a coordinate Closure error of an elevation	5” + 8” $\sqrt{n}$ 10cm+2cm $\Sigma S \sqrt{N}$ 20cm + 5cm$\Sigma S / \sqrt{N}$	n: Number of measured angles N: Number of sides ΣS: Route length (in km) A closure error of a coordinate shall be $\sqrt{(\Delta x^2 + \Delta y^2)}$, where Δx and Δy are the closure errors of X and Y coordinates, respectively.

Article 46 (Adjustment computation, etc.)
At the end of check computation, the adjustment computation, etc. shall be performed to determine the coordinates, longitude/latitude, and elevation of new points.
2. The adjustment computation shall be performed, in principle, using a network adjustment computation program approved by JICA.
3. The adjustment computation of a coordinate shall be performed as follows:
(1) Input data shall be indicated in the following table:

Given parameters	1. Weight element 2. Coordinates of a known point
Approximate value	Coordinate of a new point, etc. obtained through check calculation
Observed value	1. Horizontal angle 2. Spherical distance

(2) A weight to be used for horizontal network adjustment computation shall be obtained using the prescribed formula. The parameters m_t, γ, and m_s in the formula shall be indicated in the following table:

m_t	1.8”
γ	$3*10^{-6}$
m_s	1.0cm

In this table, m_t is a standard deviation of an angle in one direction, m_s is a standard deviation that does not relate to the length, and γ is a proportional constant of an error that is proportional to the length.

(3) Tolerance of an error
The standard deviation of an observed value per unit of weight shall normally be 10 seconds or less.

4. The adjustment computation of an elevation shall be performed as follows:
(1) Input data shall be indicated in the following table:

Given parameters	1. Elevation of a known point 2. Determined elevation through connecting to an existing bench mark
Approximate value	Elevation of a new point, etc. obtained through check calculation
Observed value	1. Angle of elevation, instrument height, and target height 2. Spherical distance

(2) In the elevation network adjustment computation, the weight shall be 1 for a set of forward and backward directions.
(3) Tolerance of an error
The standard deviation of an observed value per unit of weight shall be 15 seconds or less.

Section 7 Summary of results, etc.

Article 47 (Results, etc.)
The results, etc. shall be as follows:
(1) Table of results
(2) Index map of control points
(3) Observation field book
(4) Observation record
(5) Computation book
(6) Control Point description
(7) Quality control record
(8) Observation field book for check survey
(9) Net adjustment diagram
(10) Terrestrial photos of survey markers
<Article 47 Operation criteria>
All or part of the results, etc. may be output from a printer, automatic drafter, etc. of the data processing system.

Chapter 3 Leveling

Section 1 Outline

Article 48 (Outline)
Leveling refers to determining the elevation of new points based on known points and creating a table of results.

Article 49 (Classification of leveling)
Leveling is classified into 1st, 2nd, and 3rd order leveling depending on the type of known points, leveling routes, and accuracy and method of observation.

Article 50 (Work process and their order)
Work process and their order shall be as follows:
(1) Plan
(2) Site selection
(3) Establishment of permanent monuments
(4) Observation
(5) Computation
(6) Summary of results, etc.

Section 2 Plan

Article 51 (Outline)
A plan shall be made in accordance with the specifications in Article 5 (Operation plan) and a net adjustment plan shall be made by determining the approximate locations of leveling routes and new points on a map, etc.

Article 52 (Leveling route)
A leveling route is a connection of bench marks in succession and comes in types listed below. If the target country has existing bench marks, some shall be connected and others shall not be connected depending on their accuracy.

(1) 1st order leveling route
A 1st order leveling route shall start and end at national datum of leveling or existing 1st order bench marks and, in principle, form a circuit that connects routes.
(2) 2nd order leveling route
A 2nd order leveling route shall be formed by being connected to 1st order bench marks or existing 2nd order bench marks. However, it may be closed at the starting point (hereinafter referred to as a "closed type") if it is unavoidable due to the circumstances of the concerned region or other reason.
(3) 3rd order leveling route
A 3rd order leveling route shall be formed by being connected to 1st order bench marks, 2nd order bench marks, or existing 3rd order bench marks. However, it may be a closed type or a non-connected or non-closed open type if it is unavoidable due to the circumstances of the concerned region or other reason.

<Article 52 Operation criteria>
The route length shall normally be indicated in the following table:
If the route length is 150km or less, the "Rules for operating specification" shall be applied.

Classification	1st order leveling	2nd order leveling	3rd order leveling
Route length	400 km or less	200 km or less	50 km or less

Article 53 (Bench mark density)
In principle, the point allocation density for bench marks shall comply with the specifications of the target country.

<Article 53 Operation criteria>
Unless otherwise specified, the point allocation density shall meet the following requirements:
1) In principle, the 1st and 2nd order bench marks shall be established, every 2 km.
2) In principle, the 3rd order bench marks shall be established, every 4 km.

Section 3 Site Selection

Article 54 (Outline)
The site selection refers to the verification of routes in the field as well as the check and the selection of new points out of those planned on a map, whether their locations are adequate in view of establishment, maintenance, use, etc. of survey markers.

Article 55 (Implementation of site selection)
The new points shall be selected at locations where the ground is stable and suited to preservation of a survey marker.

<Article 55 Operation criteria>
1. The new points shall be selected out of those planned on a map, etc. by selecting the locations in view of future alteration, improvement, or construction of roads so that they are not lost or need to be relocated at the end of survey.
2. During the establishment and resurvey processes, the existing bench marks shall be verified as for their status quo to determine whether they need to be restored.

Article 56 (Production of a net adjustment diagram, etc.)
A site selection map shall be created by marking the locations of selected new and known points on a map, etc.
2. A net adjustment diagram shall be created based on a site selection map.

Section 4 Installation of survey markers

Article 57 (Outline)
Installation of survey markers refers to establishing permanent monuments at the locations of new points.

Article 58 (Establishment of permanent monuments)
In principle, the new points shall be marked by establishing permanent monuments and installing protective facilities, if required.

<Article 58 Operation criteria>
1. Permanent monument shall be established in accordance with the specifications and forms stipulated by the target country.
2. Specifications or forms, if none are stipulated by the target country, shall be established through consultation between the target country and JICA.

Article 59 (Control Point description)
Control Point description shall be created if permanent monuments are established.

<Article 59 Operation criteria>
1. Control Point description shall be created regarding all the bench marks used.
2. Control Point description shall be created in a format established by the target country.
3. The format, if not established by the target country, shall be established by consultation between the target country and JICA.

Section 5 Observation

Article 60 (Outline)
The observation refers to the use of levels and staffs to obtain a difference of elevation between the staffs based on a net adjustment diagram and repeating this process to obtain a difference of elevation between bench marks.

Article 61 (Performances, etc. of survey instruments)
Major instruments to be used for observation shall be those listed in the following table or equivalent.

Classification	Performance	Leveling classification
1st order level	Bubble sensitivity 10" / 2 mm (Equipped with a precision reading feature using a plane mirror, etc. or a precision reading feature through image processing, etc.)	1st order leveling
2nd order level	Bubble sensitivity 20" / 2 mm (Including those equipped with a precision reading feature through image processing, etc.)	2nd order leveling
3rd order level	Bubble sensitivity 40" / 2 mm (Including those equipped with a precision reading feature through image processing, etc.)	3rd order leveling
1st order staff	Graduated scale 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/ m	1st order leveling 2nd order leveling
2nd order staff	Graduated scale made of invar tape or precision wood having a graduated scale with 10 mm or 5 mm intervals or a bar-code scale. A folding staff, if used, shall have a precise joint and a stable structure.	3rd order leveling
Calculate for leveling work	It shall have performance specified by JICA.	A calculate specified by JICA shall be subject to certification.

However, automatic and electronic levels may be used if the compensator has an approximately equivalent performance to those specified in the above.

Article 62 (Inspection and adjustment of instruments)
Instruments to be used shall be subject to the functional inspection according to a prescribed method before work and shall be adjusted if required.
2. During the work period, the instruments shall be subject to functional and other inspections if required.

<Article 62 Operation criteria>
1. A level shall be subject to the following inspections:
1) Functional inspection
a. The vertical axis shall rotate smoothly.
b. The bubble tube adjustment feature shall be normal and the bubble shall move smoothly.

c. The telescope diopter adjustment function shall be normal.
d. The line of sight adjustment feature shall be normal.
e. The setting screw shall rotate smoothly.
f. The micrometer shall rotate smoothly.
g. The digital display of an electronic level shall be normal.
2) Inspection adjustment
a. For the adjustment of the round bubble tube of the level, first set up the level properly so that the bubble comes to the center. Next, rotate the main unit 180 degrees and make sure that the bubble is in the center. If the bubble is off the center, adjust the bubble tube using the leveling-up screw, bubble tube adjustment screw, etc. so that the bubble comes to the center. After adjustment, rotate the main unit further 90 degrees and make sure that the bubble is in the center.
b. Correctly stand two staffs 30 m apart from each other, set up the level properly in the center, and measure the difference of elevation between the staffs. Move the level for 18 m onto a straight line that connects the staffs as much as possible, then measure the difference of elevation between the staffs to check that the difference between the two measured values remains within the tolerances.
c. In the case of an automatic or electronic level, perform the adjustment described in Step-b and make a measurement while keeping the level horizontal in the midpoint between the two staffs 30 m apart from each other and keeping it inclined with the bubble in the round bubble tube inscribed in the concentric circles and check that the difference between the two measured values remains within the tolerances.
d. The units of reading and the tolerances are indicated in the following table:

Classification	1st order level	2nd order level	3rd order level
Unit of reading	0.01mm	0.1mm	1mm
Tolerance	0.3mm	0.3mm	3mm

2. A leveling staff shall be subject to the following inspections:
1) The leveling staff shall be normal, free of abnormalities, peeling, and dents, etc. of the graduated scale.
2) The attached bubble tube adjustment screw shall be normal.
3) The fold of the staff shall be normal.
3. The effective period of the 1st order leveling staff approved by an organization specified by JICA shall be 3 years.

Article 63 (Implementation of observation)
The observation shall be performed as follows:
(1) The go and back observation shall be performed.
(2) Two staffs shall be paired and numbered as I and II and Staffs I and II must be exchanged between the go and back observation.
(3) An even number of survey points shall be measured in the go and back observation between the bench marks.
(4) The distances shall be equal between the level and the backsight and foresight staffs and the level and the two staffs shall be set up properly on the same straight line as much as possible.
(5) The sight length and the units of the staff scale shall be indicated in the following table:

Classification	1st order leveling	2nd order leveling	3rd order leveling
Sight length	40m max	60m max	70m max
Unit of reading	0.1mm	1mm	1mm

For levels other than the electronic levels, the maximum sight length in the 1st order leveling may be set to 50 m.

(6) A level shall be set up while keeping its two specific legs and the line of sight parallel at all times and shall be set up properly on the left and right in turn toward the direction of movement at each survey point. A level shall be leveled with the telescope pointed to a specific staff.

<Article 63 Operation criteria>
1. The distance to the foresight or backsight staff shall be measured and recorded. If the distances are not equal, the foresight staff or level shall be moved back and forth to make the distances equal.
2. The observation shall be performed by one reading after collimation and the order of staffs to be read shall be indicated in the following table:

Order / Classification	1	2	3	4
1st order leveling	Backsight	Foresight	Foresight	Backsight
2nd order leveling	Backsight	Backsight	Foresight	Foresight
3rd order leveling	Backsight	Foresight	-	-

3. In the 1st order leveling, the reading shall not be performed on the part 20 mm or lower than the bottom of a staff whenever possible.
4. The tolerance of difference in the go and back observation shall be indicated in the following table:

Classification	1st order leveling	2nd order leveling	3rd order leveling
Difference between go and back observation	2.5mm√S	5mm√√S	10mm√S
	S: Observed distance (one way, in km)		

However, the tolerances shall conform to the specifications established by the target country, if any.

5. If the observation using an electronic level is performed at a location where vibrations are frequently encountered, the measurement shall be performed after checking that the staff in the field of vision of the telescope is not vibrating.

Article 64 (Resurvey)
If the discrepancy of the go and back observation values in each of various order leveling works exceeds the prescribed tolerances, a resurvey must be performed.

<Article 64 Operation criteria>
During the resurvey, observed values in the same direction must not be adopted in 1st and 2nd order leveling.

Section 6 Calculation

Article 65 (Outline)
The calculation refers to the calculation of the elevation of a new point, the execution of related correction calculations using prescribed formulas, and the production of a result table.
2. The elevation of a bench mark shall be obtained through adjustment computation of leveling net after performing rod correction and orthometric correction, if required.

<Article 65 Operation criteria>
1. The rod and orthometric corrections shall be performed in 1st order and 2nd order leveling.
2. The calculation shall be performed down to the same decimal place at the unit of reading.

Article 66 (Check computation and resurvey)
At the end of observation, the prescribed check calculation shall be promptly performed to check the

conformity of an observed value. If the result of check calculation exceeds the tolerance, the required resurvey shall be performed.

<Article 66 Operation criteria>
1. Regarding all the unit leveling circuits and check routes selected according to the following conditions, a circuit closure error and a closure error from one known point to another known point shall be calculated to check the conformity of observed values.
1) A check route shall connect a known point with another known point.
2) A check route shall be the shortest possible route.
3) All the known points shall be connected with each other by at least one check route.
4) All the unit leveling circuits, at least partly, shall overlap with check routes.
2. The tolerances of closure errors shall be indicated in the following table:

Classification	1st order leveling	2nd order leveling	3rd order leveling
Circuit closure error	2mm√S	5mm√S	10mm√S
Closure error from a known point to another known point	15mm√S	15mm√S	15mm√S

S is an observed distance (one way, in km) as mentioned in this table.

Article 67 (Adjustment computation, etc.)
At the end of check calculation, adjustment computation, etc. shall be performed to determine the elevations of new points.
2. Adjustment computation shall be performed, in principle, using a net adjustment computation program for leveling network approved by JICA.

<Article 67 Operation criteria>
1. A weight to be used for adjustment computation shall be the inverse of an observed distance.
2. The tolerances to be used in adjustment computation shall be as follows:

Classification	1st order leveling	2nd order leveling	3rd order leveling
Standard deviation of observation per unit of weight	2mm	5mm	10mm

Section 7 Summary of results, etc.

Article 68 (Results, etc.)
The results shall be as follows:
(1) Observation result table and adjustment result table
(2) Leveling route map
(3) Observation field book
(4) Adjustment computation book
(5) Control point description
(6) Accuracy control sheet

Part 3 Digital Topographic Map Production Process

Chapter 1 General

Section 1 Outline

Article 69 (Outline)
The digital topographic map production process refers to the execution of a new survey and the production of topographic maps as well as digitizing the existing maps.
2. The topographic maps as shown in this manual refer to the medium scale general maps with scales

from 1:2,500 to 1:100,000.

Article 70 (Classification of topographic map production process)
The topographic map production process is classified into the digital topographic map production process and the analog topographic map production process depending on the form of a topographic map to be created.
2. The analog topographic map production process is described in Part 4.

Article 71 (Accuracy of topographic maps)
The accuracy of topographic maps shall normally be indicated in the following table. However, in a digital topographic map, a horizontal location shall have an accuracy equivalent to a scale corresponding to the map information level.

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 71 Operation criteria>
Rules for operating specification shall be the standard for "accuracy of topographic maps". The Specifications shall be applied for maps whose map level is more than10000.
However, "Map Information Level" and "Position Accuracy" are not always match due to the purpose of the topographic map and the regulations of the target country, so they shall be used as a guide.

Article 72 (Definitions of terms)
The terms used in this part shall conform to the following definitions:
(1) Digital topographic map: Refers to a map in which map information about topographic and planimetric features, etc. are shown as coordinate data that represents locations and forms and attribute data that represents their content in a format enabling computer processing.
(2) Digital mapping: Refers to conducting a photogrammetry, etc. to collect map information about topographic and planimetric features, etc. in a digital format and systematically summarizing the information using computer technology to structure a digital topographic map.
(3) Map information level: Indicates a representation accuracy of a digital topographic map about topographic and planimetric features, etc. created in the digital topographic map production process and would be used as the index for an averaged general accuracy of data enclosed by neat lines on a digital topographic map.
(4) Acquisition classification: The map information classifies systematically and is indicated as a code.
(5) Digital Photogrammetry: Refers to performing 3D measurement on a digital image or an A/D converted digital image using a digital stereo plotter.
(6) Digital stereo plotter: A computer system provided with automatic orientation, stereo matching, and image processing functions for stereo images and, based on these functions, allows a user to create digital terrain models and ortho image data.

<Article 72 Operation criteria>
The relationship between map information levels and map scales shall be indicated in the following table:

Map information level	Corresponding map scale
2500	1 / 2,500
5000	1 / 5,000
10000	1 / 10,000
25000	1 / 25,000
50000	1 / 50,000
100000	1 / 100,000

Section 2 Digital topographic map production process

Article 73 (Outline)
The digital topographic map production process refers to the production of a topographic map in the format of a digital map.

Article 74 (Classification of digital topographic map production process)
The digital topographic map production process shall be classified into digital mapping and digitizing of existing maps.

Article 75 (Map specifications, etc.)
The map symbols, projection drawing method, size of surrounding frame, contour line interval, data file specifications, etc. (hereinafter referred to as "map specifications, etc.") of digital topographic maps shall, in principle, comply with the specifications of the target country.

<Article 75 Operation criteria>
If there are no regulations in the target country, shall be used “Rules for operating specification” as a reference.

Article 76 (Development of a digital topographic map)
A data file of digital topographic map (hereinafter referred to as a "Data file") shall be developed according to the specifications on coordinate systems, classification codes, accuracy, etc.

Article 77 (Representation of topographic features and heights)
The topographic features shall be represented by contour lines or digital elevation models (DEM) in a digital topographic map.

Article 78 (Unit of data files)
The unit of data files refers to a basic unit of digital topographic maps for data management and, in principle, shall comply with the specifications of the target country.

<Article 78 Operation criteria>
The basic unit, if not stipulated by the target country, shall be the area surrounded by sheet line of a topographic map.

Article 79 (Data of a digital topographic map)
The data of a digital topographic map shall be classified into structured data and topographic map data.
(1) Structured data refers to the compiled data in a geometric structure that have not been subject to such processing as horizontal location displacement, interruption, etc.
(2) Topographic map data refers to data that has been subject to such processing as horizontal location displacement, interruption, generalization, etc. in the same way as the representations of paper topographic maps.

Article 80 (Instruments)
The instruments to be used to edit and output a digital topographic map shall have the following functions and performances:
(1) A data compilation (including editing) system shall consist of a computer, graphic display, and tablet or digitizer, etc. or equivalent functions and allows the user to add, delete, and modify map data.
(2) An output device shall be an ink-jet plotter or a similar device that assures a positional accuracy of 0.2 mm or less and allows the user to select a drawing line according to a purpose, and supports the combined use of paper made of a material with tolerated explanation and shrinkage.

Article 81 (Digital mapping method)
The digital mapping method shall be those listed in the following:
(1) Method using analog images
Refers to a digital mapping method based on photogrammetry for obtaining map information on

topographic and planimetric features, etc. from analog aerial photos.

(2) Method using digital images
Refers to a digital mapping method based on photogrammetry for obtaining map information on topographic and planimetric features, etc. from digital aerial photos or satellite image data.

2. Digital mapping may be performed, depending on the circumstances of the survey region, etc., using the work methods described in the previous items and, partly, the work described in Chapter 12 (Digitization and revision of existing maps).

Article 82 (Work processes and their order)
Digital mapping shall be performed, normally, pursuant to the work processes and their order as follows:
(1) Method using analog images
a. Control point survey
b. Signalization for aerial photos
c. Aerial Photography
d. Pricking
e. Field identification
f. Aerial triangulation
g. Digital plotting
h. Digital compilation
i. Field completion and digital compilation for field completion
j. Topographic map data structurization
k. Data file production
(2) Method using digital images
a. Method using digitalized aerial photos
1) Control point survey
2) Signalization for aerial photos
3) Aerial Photography
4) Pricking
5) Field identification
6) A/D conversion of aerial photos
7) Aerial triangulation
8) Digital plotting
9) Digital compilation
10) Field completion and digital compilation for field completion
11) Topographic map data structurization
12) Data file production
b. Method using satellite image data
1) Preparation of image data
2) Control point survey
3) Signalization for aerial photos and pricking (consistency with the manual)
4) Field identification
5) Aerial triangulation
6) Digital plotting
7) Digital compilation
8) Field completion and digital compilation for field completion
9) Topographic map data structurization
10) Data file production

Chapter 2 Control Point Survey

Article 83 (Outline)
Control point survey refers to the establishment of control points and bench marks (hereinafter referred to "control points") required for aerial triangulation and digital plotting processes based on the existing control points.

Article 84 (Accuracy of control points)
The accuracy of control points shall be classified as follows:

Map information level	Horizontal location (standard deviation)	Elevation (standard deviation)
2500	Less than 0.2m	0.2m or less
5000	Less than 0.2m	0.2m or less
10000	Less than 0.5m	0.5m or less
25000	Less than 1.0m	0.5m or less
50000	Less than 1.0m	1.0m or less
100000	Less than 1.5m	2.0m or less

Article 85 (Control point survey methods)
The establishment of control points shall be performed as follows: The control points shall be established using the GPS survey method or the traversing method; Bench marks shall be established according to 3rd order leveling (hereinafter referred to "Simple leveling") or the GPS leveling method.

Article 86 (Control point survey planning)
The control point survey shall be planned as described in Article 5 (Work plan) as well as the current statuses of known points, the scale of a topographic map to be created, etc.
2. The locations of control point shall be selected in view of aerial photography plan, arrangements of existing control points, aerial triangulation, etc.

<Article 86 Operation criteria>
1. The control point survey using a closed traverse network or a connecting traverse network shall be performed according to 3rd order control point survey.
2. The control point survey using the GPS survey method shall meet the following requirements:
1) If the distance between a known point and a control point is 10 km or more, the specifications for 2nd order control point survey shall be applied.
2) If the distance between a known point and a control point is less than 10 km, the specifications for 3rd order control point survey shall be applied.
3) The elevation may be obtained using indirect leveling.
3. The control point survey using the traversing method shall meet the following requirements:
1) In principle, the route shall start from a control point and connect another control point. If it is extremely difficult to comply with this requirement, a route may be closed at the control point from which it starts and the azimuth observation shall be performed at two or more points as far apart from each other as possible.
2) The open traverse survey may be performed if there are four sides or less and the distance measurements are made using electro-optical distance meter. In this case, the azimuth observation must be performed on both ends. If there are two sides or less, the azimuth observation on one end may be omitted.
3) An azimuth may be determined using other method with which a prescribed accuracy may be maintained.
4. The simple leveling shall meet the following requirements:
1) In principle, the leveling route shall start from a control point or bench mark and connect to another control point or bench mark.
2) A closed-type leveling route that is closed at a starting point may be used if it is unavoidable due to topographic conditions, etc. An open-type leveling route may be used if the route is short.
3) Normally, the length of one route shall be 50 km or less.
5. The indirect leveling shall be performed according to the specifications for the 3rd order control point survey.
6. The GPS leveling shall be performed according to the specifications for the 3rd order control point survey using the GPS survey method.

Article 87 (Implementation timing)
The control point survey may be performed simultaneously with signalization for aerial photos or pricking.

Article 88 (Implementation)
The order of control point survey shall be as follows:
(1) Site selection
(2) Establishment of survey markers
(3) Observation
(4) Computation
2. The control point survey shall be performed according to the specifications for control point survey described in Part 2, unless otherwise specified in this chapter.

<Article 88 Operation criteria>
1. The site selection shall be performed in the field according to a plan described in Article 86 (Control point survey planning).
2. The temporary markers required for observation shall conform to the specifications described in Article 25 (Permanent monuments and temporary markers).
3. The observation and computation shall be performed as follows:
1) Using the GPS survey method
a. The number of observation sessions, etc. used in the rapid static method shall be as follows:

Number of observation sessions:	1 session
Observation time:	20 minutes or more
Data acquisition interval:	15 seconds or less
Common GPS satellites to be used:	5 or more
Survey method:	Matching method using 3 known points

If a control point is nearer than 0.1 x S (S is a distance between known points; in km) from a straight line that connects known points, the number of known points may be 2 (two).
b. If, between known points, the difference between ellipsoidal heights difference and an elevations difference are worse than the accuracy classification specified in Article 84 (Accuracy of control points), the correction using the declination of Geoid shall be applied to determine the elevation of the control point. Otherwise, the correction using the declination of Geoid may be omitted.
2) Using the traversing method
a. The observation of horizontal and vertical angles shall be as follows:
(1) Observation instrument
Theodolite, ten second reading or better
(2) Number of observation pairs, etc.

Horizontal angle				Vertical angle	
Number of observation pairs	Observation difference	Double angle difference	Horizontal scale	Number of observation pairs	Constant difference
2	24”	36”	0° 90°	1	36”

b. The distance measurement shall be performed according to the specifications in Article 38 (Measurement of distances and weather elements).
c. The tolerance of a closure error of a direction angle shall be 30 seconds √N (where N is a number of included angle).
d. The tolerance of a closure error of a coordinate shall conform to the accuracy classification specified in Article 84 (Accuracy of control points).
e. Azimuth specified in Article 86 (Control points survey planning) operation criteria, paragraph 3, Item 3, shall be determined as shown in the following table:

Classification	Solar observation	Gyro
Observation instrument	10-second reading theodolite or better	Gyro theodolite
Number of observation pairs	4 effective observation pairs or more	7 observation pairs
Discrepancy among pairs	40"	40"
Observation time	Avoid 2 hours before and after culmination.	
Unit of reading for time	1"	
Time correction	Before and after observation, record how much the clock is ahead of or behind the time using the time signal.	

3) Simple leveling

a. The observation shall be one-way observation according to 3rd order leveling except for an open-type route, which shall be subject to go and back observation.

b. The tolerances of closure errors, etc. in observation shall be indicated in the following table:

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

In this table, S is an observed distance (one-way, in km).

c. The locations of pricking performed in tandem with observation shall be executed at intervals of 2 to 4 km and at the location of a staff set up properly at distinct locations on aerial photos and satellite images.

4) GPS leveling

a. The observation shall be made using traverse routes from one known point to another known point of elevations.

b. In principle, the locations of pricking performed in tandem with observation shall be executed at intervals of 2 to 4 km and at precise locations on aerial photos and satellite images.

Article 89 (Results, etc.)

The results, etc. shall be as follows:

(1) Control point result table
(2) Control point layout map and leveling route map
(3) Control point survey register and control point details register
(4) Aerial photo with control points
(5) Quality control record

Chapter 3 Air photo Signalization and Pricking

Article 90 (Outline)

The air photo signalization and pricking refers to establishing markers or performing pricking at control points, and bench marks (hereinafter referred to as "control points, etc.") required for aerial triangulation and digital plotting and marking the locations on photogrammetric aerial photos and satellite images (hereinafter referred to as "aerial photos and satellite images").

Article 91 (Planning)

The air photo signalization and pricking shall be planned in view of aerial triangulation and digital plotting.

Article 92 (Setting of air photo signals)
The location of air photo signals to be set shall be approved by the target country before establishment.
2. The materials of air photo signals shall be preserved until the completion of photographing and they shall be firmly set.
3. The air photo signals shall have colors, specifications, and forms that allow users to check where they are set, the center of signals can be measured on aerial photos and satellite images used in subsequent works.

<Article 92 Operation criteria>
1. The field of vision overhead shall be sufficiently secured.
2. A location with good background conditions shall be selected.
3. An air photo signal may be set off the center of a location if it is difficult to set it directly on the location. An element of eccentricity shall be measured while ensuring the accuracy of the eccentric control point, etc.
4. After the setting, a rough sketch shall be prepared and a terrestrial photo shall be attached on the air photo signal details register (Form No.3).

Article 93 (Identification of air photo signals)
At the completion of photographing, the air photo signals shall be identified on aerial photos and satellite images.
2. The air photo signals shall be substituted with pricking if they cannot be distinctly identified.

Article 94 (Pricking)
Pricking refers to pricking the locations of control points, etc. directly on aerial photos and satellite images.

<Article 94 Operation criteria>
If pricking cannot be performed directly on an aerial photo or if it is advantageous to set an eccentric point at a distinct location on an aerial photo, pricking shall be performed at the location of the eccentric point.

Article 95 (Results, etc.)
The results shall be as follows:
(1) Air photo signal or pricking point details register and element of eccentricity survey register
(2) Eccentricity computation book
(3) Aerial photos and satellite images displaying air photo signals or pricking points
(4) Air photo signal or pricking point plan
(5) Quality control record

Chapter 4 Aerial Photography and Satellite Image Acquisition

Section 1 Aerial photography

Article 96 (Outline)
Aerial photography refers to taking aerial photos from an aircraft, etc. and includes photo processing required for subsequent works.
2. Kinematic GPS photography refers to taking aerial photos from an aircraft equipped with a GPS mobile station for kinematic positioning and recording the location data of photographed points.

<Article 96 Operation criteria>
Except when shooting with a film camera that does not use GNSS / IMU, the "Rules for operating specification" shall be applied to the shooting of aerial photography.

Article 97 (Aircraft, aerial camera, etc.)
An aircraft, aerial camera, GPS receiver, etc. with a prescribed performance shall be used.

<Article 97 Operation criteria>
1. The aircraft shall have the following performance:
1) When it is loaded with necessary photography equipment, the aircraft shall be able to maintain a stable flight suitable for photography at prescribed altitudes.
2) Regardless of the flight attitude at the time of photography and the leveling correction and drift angle of the aerial camera, the angle of view shall be secured at all times.
3) The aerial camera shall be installed where the lens or filter is not affected by extraordinary refraction due to exhaust gas, etc. and droplets of oil.
4) When kinematic GPS photography is performed, the GPS antenna shall be installed where no multipath interference is generated and the offset value between the antenna center and the center of projection of the installed camera shall be distinct.
2. The aerial camera shall have the following performance:
1) The aerial camera shall be a wide-angle aerial camera whose principal distance and aberration in combination with a filter used for photographing are distinct up to the level of 0.01 mm. However, a normal-angle or super-wide-angle camera may be used depending on the topography in the photographing area and other conditions.
2) The aerial camera shall have a performance certificate including the following information:
a. Camera number and lens serial number
b. Principal point location relative to fiducial marks (in units of 0.01 mm)
c. Adjusted principal point location (in units of 0.01 mm)
d. Radial distortion corresponding to the above principal point location
e. Certifier and location of certification
3) When kinematic GPS photography is performed, the GPS data record system shall be equipped,
3. A GPS receiver to be used for the base and mobile stations shall be equipped with large-capacity memory for data storage.
4. The film shall have the following performance:
1) The anisotropy of the expansion and contraction rate due to photographic processing shall be 0.01% or less.
2) The anisotropy of the expansion and contraction rate and the irregular shrinkage rate shall be 0.001% or less per relative humidity of 1%.
3) The color sensitivity of the film shall be panchromatic, unless otherwise specified.

Article 98 (Aerial photography plan)
An aerial photography plan shall be made for each photography area in view of the following conditions:
(1) The photography scale or altitude shall be the prespecified scale or altitude.
(2) The photography course, unless otherwise specified, shall be a straight line maintaining an equal altitude from the datum plane for flight and shall be selected in view of subsequent aerial triangulation and plotting.
(3) Normally, the overlap between adjacent aerial photos in one course shall be 60% and the overlap between different courses, 30%.
(4) When kinematic GPS photography is performed, the existing control points suitable for GPS base stations shall be selected in the photography area.

Article 99 (Implementation of photographing)
In principle, photography shall be performed under favorable weather conditions in a period suitable for photography.
2. Photography shall be performed while maintaining the photography altitude, photography course, and overlap between aerial photos based on an aerial photography plan.
3. The exposure time shall be determined to meet exposure conditions under which the sharpness of images can be sufficiently maintained.
4. The kinematic GPS photography shall use simultaneously five or more common satellites for the base and mobile stations.

<Article 99 Operation criteria>
1. Normally, the timing of photography shall meet the following conditions:
1) The atmosphere remains in stable conditions and is less influenced by fog, mist, etc.
2) No presence of cloud or cloud shadow in the photographed area.
3) The ground is not in abnormal conditions such as being covered with snow or flooded.
4) There are less shadows or halation, etc.
2. Normally, the aerial camera shall be inclined 3 degrees or less for φ and ω and 10 degrees or less for κ.
3. The difference of actual altitude for a planned photography altitude shall be 5% or less of a planned flight height above the ground.
4. The deviation from a planned photography course shall be 15% or less of a planned flight height above the ground.
5. The overlap between aerial photos above the standard shall meet the following limits:
1) The overlap between adjacent aerial photos in one course shall be 80% at maximum and 53% at minimum.
2) A model with the photo base length of 68% to 77% shall be one-fourth or less of the number of photos in a course.
3) The overlap between courses shall be 10% at minimum.
4) If it is unavoidable to divide one course into two or three parts, the divided parts shall have an overlap of two models or more.
6. The following inspections shall be performed before performing the kinematic GPS photography.
1) Functional inspection of the GPS receiver according to the specifications in Article 29
2) Inspection of interlock between the aerial camera and the GPS receiver.

Article 100 (Use of an aerial camera)
Photography of one area shall be performed using one aerial camera.

<Article 100 Operation criteria>
If it is unavoidable to use more than one aerial camera, one course should be photographed using only one aerial camera.

Article 101 (Use of film)
The two ends of a roll film, each one meter long, must not be used for photography.

Article 102 (Photography record)
When photography is performed, the following items shall be recorded.
(1) Contract name
(2) Photographer
(3) Film number
(4) Photography start and end time
(5) Date of photography
(6) Camera number, lens number, and magazine number
(7) Principal distance
(8) Aperture, filter, exposure time
(9) Film
(10) Aircraft
(11) Photography altitude
(12) Existence or non-existence of GPS data

Article 103 (Photo processing of film)
At the end of photographing, film shall be promptly subject to photo processing in an appropriate way.

<Article 103 Operation criteria>
1. The developer specified for the concerned film or other developer with equivalent quality or better shall be used.
2. The film shall be developed evenly to attain a uniform tone with sufficient gradation for the entire roll

film and the image details and instrument gauge records shall be visible.
3. A fixer of an acid formula shall be used and fixing shall be sufficiently performed so that no unexposed silver halide remains.
4. Rinsing shall be sufficiently performed so that no fixer remains.
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 to be used for contact prints shall be sufficiently large to include frame borders, indexes, instrument gauge record, etc. around the image.
7. Contact prints shall be created according to the specifications for photo processing of films.

Article 104 (Inspection and rephotography)
The exposed film shall be promptly developed to create contact prints for inspection and the contact prints shall be inspected.
2. Rephotography, if found to be necessary as a result of inspection, shall be performed promptly.

<Article 104 Operation criteria>
1. The inspection shall be performed on the following items:
1) Adequacy of photography altitude
2) Adequacy of photography course
3) Existence of area when stereoscopy cannot be attained
4) Distinctness of fiducial mark and instrument gauge
5) Adequacy of inclination and rotation of photos
6) Adequacy of photo processing
7) Adequacy of image color tones
8) Lack of GPS data that should have been obtained
2. The following inspection materials shall be produced:
1) Quality control record for each photography course
2) Aerial photo inspection sheet for each photography roll
3) Index map with principal points of photos
3. An index map shall be made from an existing map of an appropriate scale.

Article 105 (Compiling of film)
The film for which photo processing is completed shall be compiled in an appropriate way.

<Article 105 Operation criteria>
Compiling of film, unless otherwise specified, shall meet the following requirements:
1) The film shall be compiled while leaving one-meter blank on both ends of the reel so that images are not contaminated.
2) The information items to be written to film shall be the region name, date of photography, photography altitude, course number, photo number, and name of JICA. All of these items shall be indicated on the photos of both ends of a course and only the course number and photo number for all the other photos.

Article 106 (Storage of films and contact prints)
Each roll of film that has been compiled shall be stored separately in a can on which the film record is affixed.
2. Contact prints for each course shall be stored separately.

Article 107 (Results, etc.)
The results and other data shall be as follows:
(1) Film
(2) Contact print
(3) GPS observation data and ground base point results
(4) Index map for aerial photography
(5) Photography record
(6) Enlarged aerial photos that are particularly specified

(7) Quality control record

Section 2 Preparation of image data

Article 108 (Outline)
Preparation of image data refers to preparing satellite image data required to create a digital topographic map, including acquisition of data via JICA.

<Article 108 Operation criteria>
The stereo satellite image data to be used shall have a B/H ratio of 0.4 or higher.

Article 109 (Selection of a sensor on artificial satellite)
A sensor on artificial satellite to be used shall have a spatial resolution and be used in an observation method suitable for obtaining map information of digital map to be created (digital plotting).

<Article 109 Operation criteria>
1. A sensor on artificial satellite shall have a spatial resolution suitable for obtaining map information.
2. Map information levels and spatial resolution shall have a relationship shown in the following table. However, this requirement may be omitted if the processes such as control point survey are reinforced to maintain the accuracy of a digital topographic map and these processes are approved by JICA.

Map information level	Spatial resolution power
5000	Less than 0.8m
10000	Less than 1.0m
25000	Less than 2.5m
50000	Less than 5m
100000	Less than 10m

Chapter 5 Field identification

Article 110 (Outline)
Field identification refers to the identification of items, names, etc. shown on a topographic map to be created, writing the results on aerial photos or reference materials, and the production of materials required for plotting and data compilation on site.
2. The field identification shall be performed using appropriate enlarged aerial photos, digital orthophotos, or satellite images (hereinafter referred to as "aerial photos, etc.").

Article 111 (Planning)
The field identification shall be planned according to the conditions of various materials such as aerial photos obtained from the target country, the relationship with plotting, etc.

Article 112 (Preliminary photo-interpretation)
The Preliminary photo-interpretation shall be performed using aerial photos and reference materials before starting the field identification.

<Article 112 Operation criteria>
1. When map specifications, etc. established by the target country, are used, their application shall be examined.
2. Questions raised in the examination specified in the previous item shall be organized.
3. In principle, the aerial photos, etc. to be organized shall be every other aerial photos in one course or satellite photos cut out for each neat line area so that they are consistent with mapping ranges.
4. The preliminary photo-interpretation shall be performed for the following items:
1) Determining the usage methods and conformity of various materials to be collected
2) Checking aerial photos, etc. for items not easily discernible and their ranges
3) Selecting indiscernible areas

4) Checking various materials for inconsistencies of names, administrative boundaries, etc.

5. The various items, among those which can be written and shown on a topographic map, shall be written on aerial photos, etc. or reference maps according to map specifications, etc.
6. Regarding the verification items, etc. specified in Item 4, the reference items about the region and its circumstances shall be written on aerial photos, etc. or reference maps.

Article 113 (Field identification targets and display criteria)
The field identification targets and display criteria shall be the representation items defined in the map symbols to be used.

<Article 113 Operation criteria>
1. The following criteria shall apply, unless otherwise specified.
1) The roads shall be shown after their classification according to the map specifications system related to the road grades, numbers of lanes or road widths, road conditions such as the pavement condition, etc. and their sections.
2) The railroads shall be shown after their classification according to the map specifications system related to the distinction of single-track, double-track, and side-track lines and the track width.
3) The artificial structures that accompany roads and railroads such as cutting, embankments, tunnels, bridges, elevated lines, stations, and ferries or other means of transportation shall be shown selectively according to the map specifications.
4) The buildings shall be classified and shown as individual or generalized ones according to the map specifications. Those buildings for which specific purposes or functions must be indicated shall be shown using regular or short annotations, or symbols.
5) In principle, pricking for control points not used for control point survey shall be performed after verifying their locations, if required.
6) Specific areas such as parks, nature preserves, graveyards, and ports that need to be distinguished and have definite boundaries shall be shown with specific area boundaries, annotations, or symbols.
7) Rivers including natural and artificial rivers that have constant flow, rivers that run dry or intermittently in some seasons shall be shown with specified symbols so that the flow pass conditions, flow directions, etc. shall be distinct. The representation items that accompany rivers such as waterfalls, dams, and revetments shall be surveyed and shown if required.
8) Coastlines with large tidal variations shall be shown on aerial photos, etc. based on the results of field identification.
9) Vegetations and vegetation boundaries that are not distinctly discernible in aerial photos, etc. shall be verified and shown.
10) Topographic features whose representations can be easily mistaken such as depressions, cliffs, and rocks not easily discernible shall be verified in detail and shown so that they can be used as reference for the plotting process.
11) Names that need to be shown on topographic maps shall be verified in the field using various materials as references.
2. Terrestrial photos shall be taken if required as reference materials for plotting and data compilation.

Article 114 (Summary of field identification results)
The field identification results shall be summarized using aerial photos, etc. for field identification.

<Article 114 Operation criteria>
1. The verification items shall be written in ink, etc. without omissions or errors on survey-use aerial photos, etc. or duplicates of mapping manuscripts using map symbols or field identification symbols specified separately.
2. The verification items shall be expressed distinctly regarding the real form and location data.
3. The locations and diverging points at which road and railroad types and widths change shall be shown distinctly.
4. Places and other names and their ranges may be summarized using different maps than aerial photos, etc. or blueprints of plotting manuscripts.
5. If the summary of results specified in the previous paragraph is extremely difficult, overlay may be

used in combination as described in the following guidelines:
1) Boundary lines, course numbers, photo numbers, locations of fiducial mark, etc. that indicate the scope of verification of the target aerial photos, etc. shall be shown.
2) Representation on the overlay shall be performed according to the specifications for the summary of results on aerial photos, etc.
3) Roads, if crowded with different classifications, shall be shown in different colors for distinction.

Article 115 (Edge matching)
The verification items shall be harmonized with adjoin aerial photos when the field identification is performed or its results are summarized.

Article 116 (Results)
The results shall be as follows:
(1) Aerial photos, etc. or duplicates, etc. of plotting manuscripts used in field classification
(2) Overlay that is accompanied by the above-mentioned aerial photos, etc. or duplicates, etc. of plotting manuscripts
(3) Reference terrestrial photos for plotting
(4) Quality control record

Chapter 6 A/D Conversion of Aerial Photos and Aerial Triangulation

Section 1 A/D Conversion of aerial photos

Article 117 (Outline)
A/D Conversion of aerial photos refers to the conversion of aerial photo images to digital representations in pixel and gradation, acquiring thus the digital aerial photos.

Article 118 (Instrument)
The performance of scanners to be used for A/D conversion of aerial photos shall be as prescribed.

<Article 118 Operation criteria>
A scanner shall have the following performance:
1) Capability for reading an aerial photo 230 mm x 230 mm in size
2) Resolution of 0.01 mm or more
3) Reading accuracy of 0.02% or more (between two arbitrary points)

Article 119 (Scanning)
The aerial photo images shall be scanned with parameters set through prescribed calibration.

<Article 119 Operation criteria>
1. The calibration shall be performed on the correlation between the coordinate system of photo mounts and the pixel coordinate system of sensors, pixel size, and input color tone.
2. The pixel size shall normally be 0.025 mm.

Article 120 (Results)
The results shall be as follows:
(1) Digital aerial photo data
(2) Quality control record

Section 2 Aerial triangulation (analog image method)

Article 121 (Outline)
Aerial triangulation (analog image method) (hereinafter referred to as "aerial triangulation") refers to the determination of the horizontal locations and elevations of pass points and tie points required for digital plotting using the photogrammetry.
2. The aerial triangulation shall be performed using aerial photos through adjustment computation for

each block using the analysis method.

Article 122 (Instruments to be used)
The major instruments to be used for aerial triangulation shall be an analytical stereo plotter or stereo comparator.

Article 123 (Adjustment computation method)
The adjustment computation in aerial triangulation shall be performed using the bundle method or the independent model method.
2. The aerial triangulation using location data of projection centers of aerial photos as the initial value (hereinafter referred to as "GPS aerial triangulation") shall be made adjustment computation using the bundle method.
3. A program used for adjustment computation shall be approved previously by JICA.

Article 124 (Arrangement of control points, etc.)
The arrangement and number of control points, etc. in aerial triangulation shall be determined properly according to the adjustment computation method and block forms.
2. Distinct points on existing topographic maps (hereinafter referred to as "map GCPs") may be used as control points, etc. only if they are approved by JICA.

<Article 124 Operation criteria>
1. The control points shall be arranged as follows:
1) Not using the location data of projection centers of aerial photos as the initial value
a. The points used for determination of horizontal locations shall be placed on the four corners of a block. Normally, in a course on both ends, one point shall be placed every six models and, in a model on both ends of a course, one point shall be placed every three courses. For other parts, one point shall be placed uniformly every 30 models for the accuracy in a block.
b. Normally, the points used to determine the elevations shall be placed as follows: One point on models on both ends of every two courses and one point on every 12 models so that they are placed uniformly among the courses.
c. The number of points used to determine horizontal locations (Nh) and elevations (Nv) shall be obtained using the following formulas:

$$Nh=4+2[(n-6)/6]+2[(c-3)/3]+[(n-6)(c-3)/30]$$
$$Nv=[n/12]c+[c/2]$$

Where n is the average number of models per course
and c is the number of courses.
The decimal part of the result of calculation in square brackets [ ] shall be rounded up. If the number of models or courses is too small with the outcome that the part of computation in square bracket [ ] produces a negative result, this result shall be assumed as 0, or if Nv is smaller than Nh, being equal to Nh.

Article 125 (Pass points and tie points)
The pass and tie points shall be selected for the orientation of aerial photos where the coordinates on photos can be measured correctly.
2. The pass and tie points, as well as other points shall be stippled on a contact positive film as required. In this case, stipplers, etc. shall be used in stereoscopic viewing.

<Article 125 Operation criteria>
1. The pass points shall be selected as follows:
1) The pass points shall be placed near the principal point of an aerial photo and both sides of the principal point on a straight line that passes near the principal points and runs approximately orthoganal to the principal point base line. If required, the supplementary points may be set for these points.
2) The pass points shall be selected at locations where the vicinity is as flat as possible and stereoscopy can be performed on three consecutive aerial photos.
3) The points at both sides of principal point shall be selected at a distance approximately equal to the points near the principal points. For an aerial photo with a image size of 23 x 23 cm, the distances of

point from principal point to the points at both sides shall be approximately 7 cm or more and less than 10 cm.
2. In principle, the pass points shall be named as follows:
1) The names of pass points shall be classified into a, b, and c. In the target aerial photo, a point near the principal point shall be named b-point, a point above it a-point, and a point below it c-point.
2) The supplementary points near b-point shall be named b', b", ... in this order starting from the one near b-point. The same naming convention shall apply to a-point and c-point.
3. Tie points shall be selected as follows:
1) Normally, there shall be one tie point in one model. Tie points shall be placed at intervals that are approximately equal on the upper and lower sides of the overlapping portion of neighboring courses, in order to avoid forming a straight line.
2) Tie points shall be selected at locations where they can be identified distinctly using related aerial photos of both the courses.
3) The tie points can be act as the pass points.
4. In principle, the tie points shall be named as follows:
1) A tie point shall be named by adding letter "T" to the end of the photo number of an aerial photo that shows the concerned tie point of one course the closest to the b-point.
2) A pass point that also acts as a tie point shall be named by adding letter "T" to the end of the name of the pass point.
5. Pricking of pass points and tie points shall be performed as follows:
1) The location of a pass point or tie point shall be accurately shown by pricking on an aerial photo contact print and the name of the point shall be written on it.
2) Pricking specified in the previous item shall be performed only on a photo that shows a pass point or tie point the closest to a principal point in one course.
6. In principle, the selected pass points shall be shown on contact positive films.

Article 126 (Measurement of machine coordinates)
The machine coordinates shall be measured twice separately, regarding each of fiducial marks, control points, etc., pass points, and tie points included on aerial photos.

<Article 126 Operation criteria>
1. The variance of two measurements shall be 0.02 mm or less, and their average value shall be adopted.
2. If the variance exceeds tolerances, measurement shall be performed once again and the average value of three measurements shall be adopted.

Article 127 (Inner orientation)
The aerial photo coordinates shall be determined using four fiducial marks or more. The residual errors of fiducial marks in the result of adjustment computation shall not exceed the prescribed tolerances.
2. In principle, the aberration of an aerial camera, deviation of a principal point location, and atmosphere refraction shall be corrected.

<Article 127 Operation criteria>
1. The residual errors of fiducial marks shall be within the tolerances of 0.02 mm for the standard deviation and 0.03 mm for the maximum value.
2. The coordinate values of fiducial marks shall be the calibrated values of an aerial camera that has been used.

Article 128 (Relative orientation)
If the adjustment through the independent model method is performed, the relative orientation shall be executed as follows:
(1) The relative orientation shall be performed using all the pass points, tie points, and control points, etc. included in a target model.
(2) Residual vertical parallax after relative orientation shall not exceed the prescribed tolerances.

Article 129 (Block adjustment using the independent model method)
Block adjustment using the independent model method refers to performing the adjustment calculation

in a block after performing the inner orientation and relative orientation.
2. The adjustment calculation shall be performed using all the control points, etc., pass points, centers of projection, and tie points included in a target block.
3. The coefficients of transformation formulas for each model shall be determined as concurrent average for each block. However, the adjustment calculations for a horizontal location and an elevation may be performed separately.
4. The influence from the earth curvature shall be corrected.
5. The residual error of control points and the discrepancy of tie points in a block shall not exceed the prescribed tolerances.

<Article 129 Operation criteria>
1. The adjustment calculation formulas to be used shall be as follows:
To adjust the horizontal location and elevation at once, use the 3D orthogonal transformation formula in view of scales. To adjust the horizontal location and elevation separately, use the Helmer's transformation formula for a horizontal location and a linear polynomial expression for an elevation.
2. In case of some control points, etc. not used for calculation, their names and the reasons for not using them shall be written in the calculation book.
3. As for the tolerances of the residual errors of control points in one block and the residual errors of adjusted values of pass points and tie points, both the horizontal location and elevation shall comply with the standard deviation of 0.02% or less of the flight height above ground and the maximum value of 0.04% or less. For a super-wide-angle camera, however, the former shall be 0.04% or less and the latter shall be 0.07% or less.

Article 130 (Block adjustment using the bundle method)
Block adjustment using the bundle method refers to performing adjustment computation for a block after performing inner orientation.
2. The adjustment computation shall be performed using all the control points, etc., pass points, and tie points included in a target block.
3. The coefficients of transformation formulas shall be determined as concurrent average for each block.
4. The influence from the earth curvature shall be corrected.
5. The residual errors of control points, etc. in a block and the residual of intersection of pass points and tie points shall not exceed the prescribed tolerances.

<Article 130 Operation criteria>
1. The adjustment computation formulas to be used shall be the projective transformation formula with unknowns being the inclination of each photo and location of its projection center, to which self-calibration terms corresponding to various systematic errors may be added.
2. In case of some control points, etc. not used for computation, their names and reasons for not being used shall be written in the calculation book.
3. As for the tolerances of the residual errors of control points in one block, both the horizontal location and elevation shall comply with the standard deviation of 0.02% or less of the flight height above ground and the maximum value of 0.04% or less. For a super-wide-angle camera, however, the former shall be 0.04% or less and the latter shall be 0.07% or less.
4. The residuals of intersection of pass points and tie points in one block shall comply with the standard deviation of 0.015 mm or less, and the maximum value of 0.03 mm or less.
5. The correction of the influences from aberration of the aerial camera, atmospheric refraction, and earth curvature may be substituted with self-calibration.

Article 131 (Matching of neighboring blocks)
The discrepancy of tie points between neighboring blocks shall not exceed the prescribed tolerances.

<Article 131 Operation criteria>
As for the tolerance of tie point discrepancies between neighboring blocks, both the horizontal location and elevation shall be 0.09% or less of the flight height above ground.

Article 132 (Results)
The results shall be as follows:
(1) Aerial triangulation result table and index map
(2) Diapositives with pass points and tie points
(3) Contact prints with pass points and tie points
(4) Control point residual error table and tie point discrepancy table
(5) Measurement register and computation book
(6) Quality control record

<Article 132 Operation criteria>
If the coordinate measurement using the non-stipple method is performed, Items (2) and (3) are not required.

Section 3 Aerial triangulation (digital image method)

Article 133 (Outline)
Aerial triangulation (digital image method) refers to the determination of the horizontal locations and elevations of tie points required for digital plotting using the digital photogrammetry.
2. The aerial triangulation (digital image method) shall be performed using digital aerial photos or satellite image data and performing the adjustment computation for each block through the analytical method.

<Article 133 Operation criteria>
Except when shooting with a film camera not using GNSS / IMU, aerial triangulation shall be carried out following the provisions of "simultaneous adjustment" in the "Rules for operating specification".

Article 134 (Instruments to be used)
The major instrument used for aerial triangulation (digital image method) shall be digital stereo plotter.

Article 135 (Adjustment computation method)
The adjustment computation using digital aerial photos shall be performed according to the specifications in Article 123.
2. The bundle method shall be used for the adjustment computation using the satellite image data.
3. A program used for adjustment computation shall be approved previously by JICA.

Article 136 (Arrangement of control points, etc.)
The arrangement of control points, etc. in aerial triangulation (digital image method) shall be performed according to the specifications in Article 124.

<Article 136 Operation criteria>
If satellite image data are used, the points provided for determining the horizontal locations and elevations shall be set properly using a method specified by a program for adjustment computation.

Article 137 (Tie points)
As many tie points as required for orientation of digital aerial photos and satellite images shall be selected automatically through stereo matching.

Article 138 (Measurement of machine coordinates)
The machine coordinates shall be measured, regarding fiducial marks, control points, etc., and tie points included on aerial photos or satellite image data.
2. The fiducial marks and control points, etc. shall be subject to multiple measurements.
3. As many tie points as required shall be selected and measured once through stereo matching at an appropriate location for orientation of digital aerial photos or satellite images.

<Article 138 Operation criteria>
1. The discrepancy of multiple measurements shall be 0.02 mm or less, and the average value of them

shall be adopted.
2. The concerned point shall be deleted if the discrepancy exceeds the tolerances.

Article 139 (Relative orientation)
If the adjustment using the independent model method is performed, the relative orientation shall be performed according to the specifications in Article 128.

Article 140 (Block adjustment using the independent model method)
The block adjustment using the independent model method shall be performed according to the specifications in Article 129.

Article 141 (Block adjustment using the bundle method)
The block adjustment using the bundle method shall be performed according to the specifications in Article 130 (Block adjustment using the bundle method).
2. The coefficients of transformation formulas for satellite image data shall be determined for each strip.

<Article 141 Operation criteria>
When the satellite image data are be used, adjustment shall be performed as follows:
1) The adjustment computation formulas to be used shall be the projective transformation formula with known inner orientation elements, to which self-calibration terms corresponding to various systematic errors may be added.
2) As for the tolerances of the residual errors of control points, etc. in one block, the horizontal location shall comply with the standard deviation of 1/5,000 (m) or less of the map information level, and the maximum value of 1/2500 (m) or less, and the elevation shall comply with the standard deviation of 1/4 of the contour line intervals and the maximum value of 1/2 or less.
3) The residuals of intersection tie points in one block shall comply with the standard deviation of one pixel or less, and the maximum value of two pixels or less.

Article 142 (Matching of neighboring blocks)
The discrepancy of tie points between neighboring blocks shall conform to the specifications in Article 131 (Matching of neighboring blocks).

Article 143 (Results)
The results shall be as follows:
(1) Aerial triangulation result digital data and index map
(2) Residual error table for control points and tie points
(3) Measurement register and computation book
(4) Quality control record

Chapter 7 Digital plotting

Section 1 Digital plotting (analog image method)

Article 144 (Outline)
Digital plotting (analog image method) (hereinafter referred to as "digital plotting") refers to the acquisition of map information in digital format and the production of digital plotting data using an analytical stereo plotter or analog plotter with encoder (hereinafter referred to as "analytical stereo plotter").

Article 145 (Analytical stereo plotter)
An analytical stereo plotter used for digital plotting shall have a performance that ensures a prescribed accuracy.
2. For the verification of its performance, a digital stereo plotter shall be subject to the inspection adjustment before the work is started and whenever inspection adjustment is required during the work period.

<Article 145 Operation criteria>
1. An analytical stereo plotter to be used shall have a function for entering and recording X, Y, and Z coordinate values and the prescribed codes.
2. An analytical stereo plotter shall have a measuring accuracy of 0.02 mm or less (standard deviation) when converted to a value on a contact positive film, and its encoder shall have a resolution power of 0.01 mm or more, when converted to a value on a contact print.

Article 146 (Unit of coordinates to be obtained)
The coordinate (ground coordinate) data to be obtained in digital mapping shall be in the following units with the following decimal places:
(1) The map information levels 2500 and 5000 shall be in 0.01 meter.
(2) The map information level 10000 shall be in 0.1 meter.
(3) The map information levels 25000 or higher shall be in 1 (one) meter.

<Article 146 Operation criteria>
For the unit of coordinates obtained by digital mapping of level 10000 or lower, "Rules for operating specification" shall be the standard.

Article 147 (Monitoring)
Monitoring refers to the output and verification of the location, format, etc. of data to a graphic display or drafting table, etc. during digital plotting.

Article 148 (Input and development of control point coordinates, etc.)
The control point coordinates, etc. shall be entered and developed in the prescribed coordinate system and unit.
2. When monitoring is performed on a drafting table, the development shall be executed according to the specifications in Article 223 (Development of neat lines, pass points, etc.).

<Article 148 Operation criteria>
Control point coordinates, etc. refers to the coordinates of neat lines, grid lines, control points, pass points, and tie points.

Article 149 (Orientation)
The relative orientation shall be performed near six pass points.
2. The absolute orientation shall be performed using six pass points obtained through aerial triangulation.
3. If there are control points, etc. in a model, these points shall be used for checking and correction.
4. The residual errors, etc. in orientation shall not exceed the prescribed tolerances.

<Article 149 Operation criteria>
1. After the relative orientation is performed, residual vertical parallax on six pass points shall be 0.02 mm or less on a contact positive film.
2. At the end of the absolute orientation, the error of a point on a model shall be 3/10,000 (m) or less of the map information level.
3. The error of elevation in the previous item shall be 1/4 or less of contour line intervals.
4. The result of orientation shall be recorded in the orientation register.
5. The orientation register shall be in a form (Form No.4) defined separately.

Article 150 (Scope of digital plotting)
In principle, the scope of digital plotting shall be the area surrounded by pass points of a target model.

Article 151 (Detail digital plotting)
Detail digital plotting refers to drawing linear objects, buildings, vegetations, and contour lines in this order.

<Article 151 Operation criteria>
The aerial photos, overlays, and other materials on which field identification results have been recorded

shall be used to obtain all the necessary data.

Article 152 (Classification code)
The digital plotting data to be obtained shall be assigned a classification code that represents its type established in the map symbol system, etc.

<Article 152 Operation criteria>
If there are no regulations in the target country, “Rules for operating specification” shall be referred.

Article 153 (Acquisition of topographic data)
The data used for topographic representation shall be obtained through the contour method, digital terrain model method, map digitization method, or a combination of these methods.

<Article 153 Operation criteria>
1. Using the contour method, the data shall be obtained at distance intervals (distances converted to those on the map) of 1 millimeter or time intervals of 0.3 seconds, both of which may be changed according to the conditions of the topographic features.
2. Using the digital terrain model method, the data shall be obtained by directly measuring the elevation values of prescribed grid points with a digital stereo plotter.
1) The prescribed intervals of grid points shall be selected according to the specifications.
2) When the arbitrary points are measured, the specifications in Article 154 (Selection of elevation points) are applied.
3. Either the method of generating a digital terrain model from read data of contour lines (including those in existing maps) or the method for generating contour lines using the triangulated irregular network model (TIN) may be used.
4. The map digitization method shall conform to the specifications in Chapter 12 (Digitizing of existing maps).
5. The data for digital terrain models shall be checked using a check program and output maps, etc.
6. As a result of checking, elevation values that do not conform to topographic features, including surrounding areas, shall be measured again.

Article 154 (Selection of elevation point)
The elevation points shall be selected through the geographic feature interpretation so that they are distributed at as uniform a density as possible.

<Article 154 Operation criteria>
1. The elevation points shall be selected at the following locations:
1) Major summits of mountains
2) Major diverging points of roads and cols to which roads lead
3) Mouth of valley, confluences of rivers, and wide valley floors or river beds
4) Major changes of slopes
5) Locations that represent general planes in the vicinity
6) Readable deepest parts of depressions

Article 155 (Measurement of elevation point)
If the discrepancy exceeds the allowable range, Measurement shall be conducted once more, and the mean value of measured values three times shall be adopted.

<Article 155 Operation criteria>
If the difference of two measurements exceeds the following tolerances, the elevation points shall be reselected and measured again, and the average of three measurements shall be the elevation value.

Map information level	Tolerance for variance of measurements of elevation point
2500	0.4m or less
5000	0.6m or less
10000	0.8m or less
25000	1.0m or less
50000	1.8m or less
100000	2.4m or less

Article 156 (Addition of data using other surveying method)
Addition of data obtained using other measurement method to digital plotting data requires approval from JICA.

Article 157 (Production of outputs)
In principle, the output of digital mapping data shall be created by a scale corresponding to the map information level.

Article 158 (Checking of digital plotting data)
The digital plotting data shall be checked using a data compilation system or output created as specified in the previous article related to aerial photos, field identification materials, etc.

<Article 158 Operation criteria>
The digital plotting data shall be checked for the following items:
1) Lack of data that should have been obtained and presence of errors in horizontal locations and elevations
2) Presence of errors in classification codes
3) Conformity of data matching
4) Conformity of locations, densities, and measurements of spot height
5) Consistency of topographic representation data

Article 159 (Results)
The results shall be as follows:
(1) Digital plotting data
(2) Orientation register
(3) Quality control record

Section 2 Digital plotting (digital image method)

Article 160 (Outline)
Digital plotting (digital image method) refers to the acquisition of map information in digital format and the production of digital plotting data using a digital stereo plotter.

Article 161 (Digital stereo plotter)
A digital stereo plotter to be used shall have a performance that ensures a prescribed accuracy.

<Article 161 Operation criteria>
1. A digital stereo plotter shall have a measuring accuracy and its digitizer shall have a resolution equal to or higher than those of an analytical stereo plotter specified in the operation criteria for Article 145 (Analytical stereo plotter).

Article 162 (Unit of coordinates to be obtained)
The coordinate (ground coordinate) data to be obtained in digital plotting (digital image method) shall be in units with decimal places according to the specifications in Article 146 (Unit of coordinates to be

obtained).

Article 163 (Digital plotting methods)
The digital plotting (digital image method) shall be performed using one of the following methods:
(1) Method based on stereo images
(2) Method based on orthographic images or their outputs, i.e., orthographic image maps (hereinafter referred to as "single-image plotting").

Article 164 (Classification code)
Digital plotting data to be obtained shall be assigned a classification code according to Article 152 (Classification code).

Article 165 (Acquisition of topographic data)
The data to be used for terrain representation shall be obtained according to the specification in Article 153 (Acquisition of topographic data).

<Article 165 Operation criteria>
1. The data shall be obtained automatically through stereo matching, using the digital terrain model.

Article 166 (Selection of elevation point)
The elevation points shall be selected according to the specifications in Article 154 (Selection of elevation points).

Article 167 (Measurement of elevation point)
The elevation points shall be measured through stereomatching according to the specifications in Article 155.

Article 168 (Acquisition of detail digital plotting data)
The detail digital plotting data shall be obtained according to the specifications in Article 151 (Detail digital plotting).

<Article 168 Operation criteria>
The single-image plotting using orthographic image maps shall be performed as follows:
1) The orthographic image maps to be used for single-image plotting shall have an accuracy corresponding to the scale of a map to be generated.
2) The orthographic image maps shall be created by cutting out each of the surrounding frame of digital-mosaicked orthographic image maps and, if required, outputting them to film with less expansion and shrinkage on an ink jet printer, etc.
3) The detail digital plotting data shall be obtained through digitizing or scanning.

Article 169 (Production of output)
The output of digital plotting data shall be created according to the specifications in Article 157 (Production of outputs).

Article 170 (Checking of digital plotting data)
The digital plotting data shall be checked according to the specifications in Article 158 (Checking of digital plotting data).

Article 171 (Results)
The results shall be as follows:
(1) Digital plotting data
(2) Orientation register
(3) Quality control record

Chapter 8 Digital compilation

Article 172 (Outline)
Based on the result of field identification, the digital compilation refers to the compilation of digital plotting data and production of compiled data and topographic map data.

Article 173 (Input of digital plotting data, field identification data, etc.)
The digital plotting and field identification data shall be entered in the data compilation system.
2. Materials such as maps collected in field identification, etc. shall be digitized through a digitizer or scanner and entered in a data compilation system.

Article 174 (Digital compilation)
The data entered as described in the previous article shall be added, deleted, corrected, etc. in the data compilation system to create compiled data.
2. The topographic map data shall be created by further compiling compiled data according to the map specifications.

<Article 174 Operation criteria>
The contour line data shall be checked using graphic display or output, then corrected in case of inconsistencies.

Article 175 (Data matching)
Data matching shall be executed between models or adjacent neat lines, and the coordinates shall be matched.

<Article 175 Operation criteria>
1. If the gaps of topographic and planimetric features are 0.7 mm or less on the map, the related figures shall be corrected to complete the matching process.
2. If the gaps of topographic and planimetric features exceeds 0.7 mm on the map, the digital plotting shall be executed again.

Article 176 (Production of output)
The output shall be created from compiled and topographic map data for the purposes of checking and field completion etc. using an ink jet printer, etc.

Article 177 (Checking)
Checking shall be executed using output created as described in the previous article, graphic display, and check program.
2. The check program shall check compiled data for logical inconsistencies.

Article 178 (Results)
The results shall be as follows:
(1) Digital mapping data
(2) Topographic map data
(3) Quality control record

Chapter 9 Field Completion and Digital compilation after Field Completion

Article 179 (Outline)
Field completion refers to the verification of the boundary, place, and other names in the field using materials created or provided with the approval by the target country as well as the verification of important items represented in output for compiled data or topographic map data and performing supplementary field survey where it is required in the field.
2. Digital compilation after field completion refers to the execution of the completion processing such as adding the results of field completion to compiled data and correcting them in order to create compiled and topographic map data that include the results of field completion.

Article 180 (Implementation)
The field completion shall be executed for the following items:
(1) Checking the boundary, place, and other names against those in the field using materials provided by the target country
(2) Checking the questions arising in digital compilation
(3) Checking the important representation items, if required
(4) Performing supplementary field survey on areas where digital mapping is impossible or where it is necessary
2. The supplementary field survey shall be executed based on reliable and distinct points on compiled data output by using Total Station or directly obtaining data through GPS survey, etc.
3. The results of field completion shall be summarized in the electronic storage media, compiled data, or topographic map data output, etc. so as to avoid any problem in subsequent works.

<Article 180 Operation criteria>
1. If the results of field identification show names different from those in the materials provided by the target country, the field inspection shall be executed.
2. In case of approval of all the boundaries, places, and other names on compiled data or topographic map data output, by the target country, these outputs shall be signed by a person in charge of the government of the target country.
3. As for the results of field completion, the measurement results shall be recorded on electronic storage media and the annotations, symbols, attributes, etc. shall be summarized in compiled data or topographic map data output.

Article 181 (Digital compilation after field completion)
The summarized results of field completion as described in the previous article shall be added to and be used to correct the compiled data, using a data compilation system in order to create compiled and topographic map data that include the results of field completion.
2. Digital compilation after field completion shall conform to the specifications in Chapter 8. Digital compilation

Article 182 (Production of output)
The output shall be created from compiled data and topographic map data that include the results of field completion according to the specifications in Article 176 (Production of output).

Article 183 (Checking)
The compiled and topographic map data that include the results of field completion shall be checked according to the specifications in Article 177 (Checking).

Article 184 (Results)
The results shall be as follows:
(1) Compiled data that include the results of field completion
(2) Topographic map data that include the results of field completion
(3) Output of topographic map data that include the results of field completion
(4) Quality control record

Chapter 10 Data structurization

Article 185 (Outline)
Data structuring refers to the production of the structured data in which compiled data that include the results of field completion are provided with topological relations in points, lines, and polygons so that the data can be used on a geographic information system, etc.

Article 186 (Data structurization)
Data structuring refers to the production of the structured data by entering compiled data that include the results of field completion in a data compilation system and using interactive processing, automatic processing, and a combination of these processing.

Article 187 (Checking)
The data shall be checked using the structured data output and check programs to ensure that the content of a file conforms to the specifications.
2. The check program checks the data for logical inconsistencies, etc.

<Article 187 Operation criteria>
The structured data output shall be created in prescribed formats.

Article 188 (Results)
The results shall be as follows:
(1) Structured data
(2) Quality control record

Chapter 11 Data File Production

Article 189 (Outline)
Data file production refers to recording topographic map data subject to field completion and structured compiled data, each according to their respective specifications, in electronic storage media.
2. The data files shall be classified into topographic map and structured data files.

Article 190 (Implementation)
The topographic map data files shall be provided with topographic map data that include the results of field completion, recorded in the electronic storage media, according to their specifications.
2. The structured data files shall include structured compiled data recorded in electronic storage media, according to their specifications.

Article 191 (Checking)
The data files shall be checked for contents by using a check program or displaying them on graphic display, etc.
2. The check program shall check the data files for logical discrepancies, etc.

Article 192 (Production of instruction manuals)
An instruction manual for data files shall be created for items whose instructions are required to manage and use data files.

Article 193 (Results)
The results shall be as follows:
(1) Topographic map data files
(2) Structured data files
(3) Instruction manual for data files
(4) Quality control record

Chapter 12 Digitization and Revision of Existing Map

Section 1 Outline

Article 194 (Outline)
Existing map digitization refers to digitizing existing topographic maps, etc. (hereinafter referred to as "existing maps") and the production of digital topographic maps. The existing maps shall be revision, if required.

< Article 194 Operation criteria>
For existing map digitization and revision of Existing Map with a map information level of 10000 or less, the standard shall be "Rules for operating specification".
2. The Specification shall be used when revising an existing map by analog photogrammetry.

Article 195 (Definitions of terms)
The terms used in this chapter shall conform to the following definitions:
(1) Vector data: Refers to graphic data represented by a sequence of points with coordinate values.
(2) Raster data: Refers to image data consisting of an array of pixels arranged in rows and columns.

Article 196 (Scale of existing maps used)
Normally, the existing maps to be digitized shall have scales from 1/10,000 to 1/100,000.

Article 197 (Formats of results)
The results of existing map digitization shall be in vector data format. However, they may be in raster data format if specified by JICA.

Article 198 (Unit of coordinate values)
The vector data shall have coordinate values (ground coordinates) in units with decimal places according to the specifications in Article 146 (Unit of coordinates to be obtained).
2. The raster data shall have one pixel of an image coordinate that is max. 0.1 mm on a map.

Article 199 (Work processes and their order)
The existing map digitization shall be executed according to the following work processes and order:
(1) Map manuscript production
(2) Measurement
(3) Data compilation
(4) Existing map revision
(5) Data structurization
(6) Data file production

2. (4) The existing map revision shall be executed if specified by JICA.
3. (5) The data structurization shall be executed according to the specifications in Chapter 10 in this section.

Section 2 Map Manuscript production

Article 200 (Outline)
Map manuscript production refers to the use of original existing maps or original reproduction positives, and production of map manuscript used for measurement.

< Article 200 Operation criteria>
In original existing maps or original reproduction positives, neat and diagonal lines shall comply with the corresponding tolerance as follows, and a consultation shall be held with JICA if the tolerance is exceeded.
1) Neat line: 0.5 mm
2) Diagonal line: 0.7 mm

Article 201 (Map manuscript production)
Map manuscript shall be created by duplicating the original existing maps or original reproduction positives through photo processing, etc.
2. The existing maps used for the map manuscript production shall be complemented by collecting materials, if required.

<Article 201 Operation criteria>
1. In principle, one map manuscript shall be created for each color-separation plate of original existing maps.
2. Map manuscript shall be made of such materials as polyester film with limited elasticity.

Section 3 Measurement

Article 202 (Outline)
Measurement refers to digitizing the map manuscript with measuring instrument and the acquisition of digital data.

Article 203 (Measuring instrument)
The measuring instrument shall have performances indicated in the following table and be selected for accuracies, etc. of digital topographic maps to be created.

Classification	Performance	Reading range
Digitizer	Resolution power of 0.1 mm or less Reading accuracy of 0.3 mm or less	Should allow reading the area within neat lines of a map manuscript.
Scanner	Resolution power of 0.1 mm or less Reading accuracy of 0.25% or less (between two arbitrary points)	Should allow reading the area within neat lines of a map manuscript.

Article 204 (Digitizer measurement)
The measurement using a digitizer shall be executed for each map manuscript and the measurement data shall be obtained for each map sheet.
2. The measurement shall be executed at the specified accuracy and measurement data shall be assigned a classification code, etc.

<Article 204 Operation criteria>
1. The measurement shall be executed as follows:
1) At the start and end of measurement for each item, each of the four corners of neat lines shall be measured twice separately and, if the variance of coordinate values at each corner exceeds 0.3 mm on the map, the measurement shall be executed again.
2) The planimetric features, etc. shall comply with the measurement accuracy of 0.3 mm on the map (standard deviation).
2. The coordinate transformation shall be executed as follows:
1) Normally, affine transformation shall be used to transform machine coordinates to coordinates that comply with the specifications of the target country.
2) The transformation coefficient shall be determined using the least-squares method based on measurements of the four corners of neat lines and their ground coordinates.
3) The residual error of coordinates of the four corners of neat lines shall not exceed 0.2 mm on the map.

Article 205 (Scanner measurement)
The measurement using a scanner shall be executed on an area that includes the sheet frame, at uniform specifications and accuracy for each measurement item. The measurement data shall be obtained for each map sheet.
2. If digital topographic map data must conform to the specifications in Article 197 (Formats of results), the raster-vector transformation shall be executed on measurement data.

<Article 205 Operation criteria>
1. The measurement shall be executed as follows:
1) During the measurement, data of each map sheet shall be corrected both in longitudinal and horizontal directions so that they comply with the specified pixel number.
2) The reading accuracy shall be one-half (standard deviation) or less of the minimum drawing line width of a figure.
2. The coordinate transformation shall be executed as follows:

1) The image coordinates of the four corners of neat lines or a nearby point, whose coordinates can be verified, shall be shown and measured on graphic display.
2) The machine coordinates shall be transformed to coordinates that comply with the specifications of the target country according to Item 2 of the operation criteria of the previous article.
3) The residual error of coordinates of the four corners of neat lines shall be a maximum of two pixels.
3. The rearrangement of pixels shall be executed using the nearest neighbor interpolation, bi-linear interpolation, or cubic convolution method.

Section 4 Compilation

Article 206 (Outline)
Compilation refers to the correction or processing measurement data on a data compilation system for creating compiled data.

Article 207 (Compilation)
Compilation refers to the compilation of measurement data on graphic display of a data compilation system.
2. If an omission in measurement, error, etc. is found at the check process, the compiled data shall be corrected.

<Article 207 Operation criteria>
The map data shall have consistent coordinates on the neat lines through edge matching process.

Article 208 (Checking)
Checking shall be executed using output for checking, graphic display, and check program.
2. The check program shall be executed to verify the logical inconsistencies, etc. of compiled data.

<Article 208 Operation criteria>
1. The output for checking shall be created from compiled data using a plotter, etc.
2. Checking shall be executed on omission, etc. of digital mapping items, accuracies of locations, connections of drawing lines, and matching of adjacent map sheets.

Section 5 Existing map revision

Article 209 (Outline)
Existing map revision refers to the revision of the contents for digitization shown on existing maps being changed through secular variations to make them consistent with the current conditions.

Article 210 (Revision methods)
The existing map revision shall be executed using one of the following methods:
(1) Through analog photogrammetry
(2) Through digital photogrammetry
2. A revision method shall be determined by identifying the type and volume of revision based on changes extracted in advance on aerial photos, etc.
3. Methods (1) and (2) listed in Item 1 shall be those that can be used after measurement or data compilation processes.

Article 211 (Implementation)
The existing map revision shall be executed as follows:
(1) The existing map revision through digital photogrammetry shall be executed according to the specifications in Chapters 7 (Digital plotting) and 9 (Field Completion and Digital compilation after Field Completion) of this part.
(2) The existing map revision through analog photogrammetry shall be executed according to the specifications in Chapters 2 (Mapping) and 4 (Field Completion), Part 4.

<Article 211 Operation criteria>
1. Plotting shall be executed by measuring and drawing changes on manuscript maps.
2. The absolute orientation in plotting shall be as follows:
1) The absolute orientation shall be executed using planimetric features, etc. on manuscript maps. Six planimetric features or more shall be used for absolute orientation.
2) The discrepancy of horizontal locations shall be 0.7 mm or less on the map.
3) The discrepancy of elevations shall be one-third or less of contour line intervals.
3. The digital plotting shall be executed by obtaining revision data and revising measurement data.
4. The absolute orientation in digital plotting shall be executed according to the specifications in Item 2.

Section 6 Data file production

Article 212 (Outline)
Data file production refers to recording compiled data on electronic storage media.

Article 213 (Implementation)
A data file shall be created by recording compiled data on electronic storage media according to the specifications.

Article 214 (Production of instruction manuals)
An instruction manual for data files shall be prepared for items whose instructions are required to manage and use the data files.

Article 215 (Production of output)
The output shall be created by outputting digitized items using a plotter, etc.

<Article 215 Operation criteria>
An output shall be created by including digitized items on one sheet. If the items are complicated, they can be included on more than one sheet to create an output map.

Article 216 (Results)
The results shall be as follows:
(1) Data file
(2) Instruction manual for data files
(3) Quality control record

Part 4 Analog Topographic Mapping Process

Chapter 1 General

Article 217 (Outline)
This section describes the analog process for creating topographic maps.

Article 218 (Map specifications, etc.)
In principle, the map specifications, map projection, size of sheet frame, contour line interval, data file specifications, etc. (hereinafter referred to as "map specifications, etc.") shall comply with the specifications of the target country.

<Article 218 Operation criteria>
The map specifications, etc., if not established by the target country, shall comply with the instructions given by JICA and a map specifications, etc. established separately. (The map specifications shall comply with the "Standard Map specifications Samples for Base Map" and the projection drawing method shall follow Specifications No.2).

Article 219 (Production of topographic maps)
The topographic maps shall be created through the aerial photogrammetry.

Article 220 (Work processes and their order)
The topographic map production shall be executed according to the following work processes and order:
(1) Control points survey
(2) Signalization for aerial photos
(3) Aerial Photography
(4) Pricking
(5) Field identification
(6) Aerial triangulation
(7) Plotting
(8) Compilation
(9) Field completion
2. Processes (1) Control points survey, (2) Signalization for aerial photos, (3) Aerial photography, (4) Pricking, (5) Field identification, and (6) Aerial triangulation shall be executed according to the specifications in Chapters 2 through 6, Part 3.

Chapter 2 Plotting

Article 221 (Outline)
Based on the results of aerial triangulation, field identification, etc., plotting refers to the measurement, and drawing on a stereo plotter of various items required for topographic maps and creating plotting manuscripts, etc.

<Article 221 Operation criteria>
1. The plotting manuscripts shall have scales equal to those of original maps.
2. The plotting manuscripts shall be made of polyester sheets or equivalent with a contraction ratio of 0.05% or less, at room temperature and atmospheric pressure, with a thickness of 0.12 mm or more.
3. The mapping may be executed separately for planimetric features and contour lines.

Article 222 (Stereo plotter)
The stereo plotters used shall ensure the prescribed accuracy.
2. The stereo plotters used shall be checked for performance, etc. according to a prescribed method before work, and they shall be adjusted, if required.
3. During the work period, the stereo plotters shall be subject to functional inspections, if required.

Article 223 (Development of neat lines, pass points, etc.)
The neat lines, pass points, etc. shall be developed using automatic drafting machines, etc. and the maximum error shall be 0.2 mm or less on the map.
2. The error of two diagonal lines of quadrangle consisting of developed neat lines for a specified length shall be 0.3 mm or less on the map.

Article 224 (Orientation)
The orientation shall be executed according to the specifications in Article 149 (Orientation).

Article 225 (Scope of plotting)
The target of plotting shall be the area surrounded by pass points of a target model.

Article 226 (Detail plotting)
In principle, detail plotting refers to drawing linear objects, buildings, vegetations, and contour lines in this order.
2. At the end of drawing of a target model, the prescribed items on plotting manuscripts shall be checked and summarized based on materials, etc. that have been used.

<Article 226 Operation criteria>
1. All the necessary items shall be drawn without omissions using aerial photos, overlays, and other materials on which field identification results have been recorded.
2. The deformed areas shall be drawn with contour lines wherever possible and, depending on

circumstances, the deformed area symbols shall be drawn over the areas.
3. The contour lines shall be measured and drawn one by one for each contour line established in the map specifications and no auxiliary contour lines shall be omitted at locations where they are required.
4. The elevations shall be measured for peaks of mountains, depressions, passes, etc. in order to avoid omitting contour lines from maps, and the elevation values shall be written on plotting manuscripts, if required.
5. At the end of plotting of a target model, the following items shall be checked and summarized:
1) Conformity of development of control points, etc.
2) Conformity of horizontal locations and elevations of pass points, etc.
3) Presence of mistakenly omitted items, errors in horizontal locations of planimetric features, etc. that have been drawn, and those in elevations.
4) Redraw the faded lines, etc. in order to avoid impairing the conditions of topographic and planimetric features of plotting manuscripts.
5) Write the values for contour lines to improve reading the contour elevations on plotting manuscripts.
6) Conformity of relationships between elevation points and contour lines.

Article 227 (Matching)
The adjacent mapping manuscripts shall be strictly matched using a prescribed method.
2. If the plotting of matching parts cannot be executed smoothly according to the specifications in Article 225 (Scope of mapping), the target may be changed.

<Article 227 Operation criteria>
Matching shall be executed as follows:
1) If there is no adjacent map, a polyester-sheet tie strip covering up to one cm outside the neat lines shall be created.
2) If an adjacent map is provided, the tie-strip shall be referenced for plotting of matching parts.
3) If figures are misaligned by 1.0 mm or less, the concerned figures shall be corrected in order to fully process the matching.

Article 228 (Selection of elevation points)
The elevation points shall be selected according to the specifications in Article 155 (Selection of elevation points).

Article 229 (Measurement of elevation points)
The elevation points shall be measured twice separately and the average value of the measurements shall be adopted.

<Article 229 Operation criteria>
1. The tolerance of discrepancy of two measurements shall be as follows:

Map information level	Tolerance for discrepancy of measurements of elevation points
2500	0.4m or less
5000	0.6m or less
10000	0.8m or less
25000	1.0m or less
50000	1.8m or less
100000	2.4m or less

2. If the discrepancy exceeds the tolerance, the elevation shall be measured again, and the average value of three measurements shall be adopted.

Article 230 (Production of chart of control points)
A chart of control points shall be created by entering the locations, height, etc. of control points, etc. on a drawing paper as large as a plotting manuscript.

<Article 230 Operation criteria>
1. The control points, etc. shall be shown using a map symbol, and the name, number, and elevation shall be written on it.
2. An elevation point shall consist of a single-point overlay and two measurements, and a mean value shall be written on it.

Article 231 (Results)
The results shall be as follows:
(1) Plotting manuscript
(2) Chart of control points
(3) Orientation register
(4) Tie-strip diagram
(5) Quality control record

Chapter 3 Compilation

Article 232 (Outline)
Compilation refers to the production of the manuscripts compiled according to a mapping symbol system, etc. (hereinafter referred to "compilation manuscripts") and materials required for subsequent works using plotting manuscripts and materials from field identification, etc.
2. The areas which cannot allow plotting shall be compiled using the results of field completion.

Article 233 (Production of compilation manuscripts)
The compilation manuscripts shall be created by tracing items shown on plotting manuscripts, based on various materials complying with the map specifications.

<Article 233 Operation criteria>
1. The drawing paper used for compilation manuscripts shall comply with the same specifications as plotting manuscripts.
2. The compilation manuscripts shall show the developed neat lines, control points, etc.
3. The error of a neat line on compilation manuscripts compared with a prescribed length shall be 0.2 mm or less.
4. The error of two diagonal lines on compilation manuscripts compared with a prescribed length shall be 0.3 mm or less.
5. The compilation manuscripts shall be compiled based on plotting manuscripts and various materials according to the map specifications, and the vegetation boundaries in unplowed land, wetland, etc. not shown on completed maps, shall also be drawn on compilation manuscripts.
6. If they must be dislocated for representation as symbols, the targets represented in compilation shall be dislocated within the range mentioned by the map specifications, etc.

Article 234 (Production of lettering guide)
The lettering guide shall be produced by determining the placement, sizes, spacing, fonts, and typefaces of characters to be shown on topographic maps (hereinafter referred to as "annotation characters") based on the results of field identification, according to the prescribed formats.

<Article 234 Operation criteria>
1. The lettering guide shall be made using polyester base or equivalent, or using a better material of 0.075 mm to 0.1 mm in thickness.

2. The lettering guide shall show items as follows:
1) The annotation characters shall be shown according to the map specifications, etc.
2) The location of the annotation characters shall be shown by the symbol “ 「”. The location of the first character comes in the corner of the symbol. The line of the symbol shall be approximately as long as the character string.
3) A linear target or annotation characters representing a region with wide spacing, or whose location

cannot be easily determined, shall be substituted with a number of the symbol "□".
4) In principle, each set of annotation characters shall be put outside symbols “□”and “「”.
5) If the annotation characters are too crowded, the annotation may be put at another appropriate location indicated by an arrow and required items such as character size may be shown using abbreviations.
6) If executed in field completion, the survey of names shall comply with the operation criteria in this article.

Article 235 (Matching)
All the representation items in joining parts with adjacent compiling manuscripts shall match with each other in order to avoid inconsistency on neat lines.

<Article 235 Operation criteria>
1. Among the representation items that must match each other on neat lines, those being different for distinct reasons, such as secular changes caused by a difference in years of production or changes in map specifications, may remain different from each other.
2. When matching is not performed for some reason, it shall be discussed with the surveying and mapping organization of the target country.

Article 236 (Handling of chart of control points)
Among the control and elevation points shown on chart of control points, those which are not adopted in compilation shall be indicated with a deletion mark.

Article 237 (Handling of marginal information materials)
The marginal information items shall be classified into those directly written on compilation manuscripts and those written on marginal information material sheets.

<Article 237 Operation criteria>
1. The marginal information items shown on compilation manuscripts shall be as follows:
1) Map sheet name
2) Map sheet number
3) Longitude and latitude and coordinate values
4) Elevation values outside neat lines
5) Direction label
2. The items to be put on marginal information material sheets shall be topographic map numbers, projection, revision history, and other items required.

Article 238 (Results)
The results shall be as follows:
(1) Compilation manuscript
(2) Annotation material map
(3) Chart of control points
(4) Marginal information material sheet
(5) Accuracy control record

Chapter 4 Field Completion

Article 239 (Outline)
Field completion refers to the verification of the boundaries, places, and other names in the field using materials created or provided with the approval by the target country as well as the verification of important items represented in compilation manuscripts and the execution of supplementary field survey if required in the field.

<Article 239 Operation criteria>
1. The field completion shall be executed at the end of compilation using mainly the following materials:
1) Polyester-base duplicate or blueprint thereof, etc.

2) Blueprint on which a compilation manuscript and an annotation material map are superimposed
3) Aerial photo that shows the results of field identification and reference materials provided by the target country
2. A polyester-based duplicate shall be produced by copying a compilation manuscript on a polyester base.

Article 240 (Implementation)
The field completion shall be executed for the following items:
(1) Checking the boundary, place, and other names against those in the field using materials provided by the target country
(2) Checking the questions arising in compilation
(3) Checking the important representation items, if required
(4) Performing supplementary field survey on areas where plotting is impossible or where it is necessary
2. The field completion shall be executed using the plane table survey method.

<Article 240 Operation criteria>
1. If the results of field identification show names different from those in the materials provided by the target country, the field inspection shall be executed.
2. If the field completion is executed through the plane table survey method, a polyester-base duplicate shall be used.
3. When the questions have been investigated and checked, and all the boundary, place, and other names on blueprints of compilation manuscripts are approved by the target country, these maps shall be signed by a person in charge of the government of the target country.

Article 241 (Summary)
The results of field completion shall be summarized on polyester-base duplicates, etc. according to the prescribed method.
2. The correction and summary of information on compilation manuscripts shall be executed using the results of field completion.

<Article 241 Operation criteria>
1. The results of verification on boundary, place, and other names checked against the field shall be summarized on blueprints on which compiling manuscripts and lettering guide are superimposed.
2. The results of verification of questions and important representation items shall be summarized on blueprints of polyester-base duplicates.
3. Among the items subject to field completion or verification, those concerning vegetations shall be added or corrected with a green pencil while others shall be added or corrected with a red pencil, etc.
4. The results of the plane table survey on areas where mapping is impossible or where supplementary field survey is necessary shall be summarized on polyester-base duplicates.
5. The lettering guide shall be corrected using blueprints of approved compilation manuscripts.
6. At the field completion, the following items shall be checked.
1) Presence of inconsistencies between items being subject to field completion and verification with each other or with other materials, and conformity of deletion processing
2) Conformity of matching of map sheets of field completion results
3) Conformity of methods and results of field completion
4) Presence of omission of items on compilation manuscripts or omission, etc. of correction of lettering guide
5) Conformity of drawing density of compilation manuscripts, and presence of fading or smear of drawing lines

Article 242 (Original topographic map manuscript)
The original topographic map manuscript shall be created by summarizing the results of field completion on compilation manuscripts.
2. The compilation manuscripts used as original topographic map manuscript must undergo checking as specified in Section 2, Article 7 (Accuracy control).

<Article 242 Operation criteria>
At the end of compilation, the original topographic maps shall be checked for the following items:
1) Conformity of dimensions of compilation manuscripts
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) Presence of inconsistencies between compilation manuscripts and materials
7) Conformity of unification of methods for application of the map specifications
8) Conformity of process of selection, etc.
9) Conformity of checking process
10) Conformity of correction results

Article 243 (Results)
The results shall be as follows:
(1) Original topographic map manuscript
(2) Blueprints of compilation manuscripts approved by the target country for the boundary or place names, etc.
(3) Polyester-base duplicates, etc. of compilation manuscripts used for field work
(4) Various reference data corrected according to the results of field completion
(5) Check survey register for accuracies of compilation manuscripts and a list of check results
(6) Quality control record

Part 5 Original Map Production Process Through the Scribe Method

Chapter 1 General

Article 244 (Outline)
The separated original topographic map production process refers to the use of original topographic maps, and the production of separated original topographic map corresponding to the number of colors according to the prescribed map specifications, etc.
2. The work method shall be the scribe drawing method (hereinafter referred to as "scribe drawing").

Article 245 (Accuracy of scribing)
The accuracy of scribing shall be 0.1 mm or less, starting from the center line of topographic map transcription drawing lines.

Chapter 2 Separated Original Topographic Map

Article 246 (Outline)
A separated original topographic map refers to a color-separation scribe plate created through scribe drawing from the original topographic maps as the base map.

<Article 246 Operation criteria>
1. Scribe drawing sheets shall be made of polyester sheets or equivalent with expansion and shrinkage ratio of 0.05% or less, at room temperature and atmospheric pressure, with a thickness of 0.12 mm or more.
2. The scribe sheets shall be lightproof for photos and have a coating well bonded to the base film.
3. The color-separation scribe plates shall include masking plates, annotation plates, etc.

Article 247 (Work processes and their order)
The work processes and their order shall be as follows:
(1) Preparation

(2) Scribing
(3) Matching
(4) Summary
(5) Checking
(6) Result, etc.

Article 248 (Preparation)
Preparation refers to the following processes required to perform the drawing process properly and efficiently.
(1) Planning
(2) Preparation of materials
(3) Preparation of devices

<Article 248 Operation criteria>
The preparation shall be executed as follows:
1) Planning refers to the production of a scribing process schedule in view of contents and completion timing of topographic maps to be created for the target country.
2) Preparation of materials refers to the control of quantities, specifications, materials, etc.
3) Preparation of devices refers to the maintenance and control of devices required for drawing.

Article 249 (Scribing)
The scribing to be executed shall consist of the following process classifications:
(1) Scribe plate production
(2) Masking plate production
(3) Annotation plate production
(4) Integrated surprint production

<Article 249 Operation criteria>
1. The scribing plate production shall comply with the following requirements:
1) The scribing process shall be executed using a register punch system.
2) The copying on scribing sheets shall be executed for the density of drawing lines of original topographic maps to accomplish a distinct transcription of original topographic map images with adequate exposure and development.
3) The neat lines of black plate and two cross-hair register marks in the middle of and outside the vertical neat lines, which shall be shown on the original topographic maps in advance, shall be scribed correctly.
2. Masking plate production using the strip coat method refers to the production of the masking plates by superimposing strip bases of different colors over scribed bases and cutting them according to the required drawing lines.
3. Annotation plate production refers to superimposing single-sided matt polyester films over multicolor-printed surprints, which is made from a scribing plate created as described previously in Item 1, and affixing annotations, or building symbols, etc. that have been created as filmset composing at the locations specified in lettering guide and original topographic maps.
4. The symbol section of marginal information items in annotation plates shall be created by preparing positive films about marginal information items common to maps and affixing filmset composing for marginal information annotation required for target topographic maps.
5. The annotation negative plates shall be created using annotation plates prepared as described in Items 3 and 4.
6. The integrated surprints shall be created by superimposing scribing plates, masking plates, and annotation negative plates for each color on the matt side of single-sided matt polyester films.

Article 250 (Matching)
Matching with the adjacent maps shall be performed by the direct matching process using separated original topographic maps.

<Article 250 Operation criteria>

1. If direct matching is difficult, a tie-strip shall be created.
2. A tie-strip shall be created by duplicating on a polyester base the figures within neat lines in a range one cm from the integrated surprint of a corresponding adjacent map.

Article 251 (Summary)
The summary shall be executed on scribe plates, etc. created as described in Article 249 (Scribing) (hereinafter referred to as "separated originals, etc.").

<Article 251 Operation criteria>
1. The scale, map sheet name, and color-separation plate name (color name) shall be written in black oil-based ink, on separated originals.
2. The separated originals shall be placed in storage envelops, etc. with thin slip sheets inserted between them for a protection of the film surface of plates.
3. The area name, scale, map sheet name, map number, number of sheets, etc. shall be written on storage envelops, etc.

Article 252 (Checking)
All the results shall be checked according to the map specifications, etc. in order to maintain the uniformity and accuracy of the results.
2. All the results of correction for items selected for correction in checking shall be verified.

<Article 252 Operation criteria>
Checking shall comply with the following requirements:
1) The final results and integrated surprints shall be checked.
2) Checking of final results refers to comparing each of color-separation sheets against original topographic maps, etc. to strictly check for presence of errors and omissions, conditions of drawing lines, relationships with the map specifications, etc.
3) Checking of integrated surprints refers to comparing each of them against original topographic maps, etc. to check for presence of errors and omissions, appropriateness of relationships, locations, etc. of drawing lines between different color-separation plates in scribing.

Article 253 (Results)
The results shall be as follows:
(1) Scribe plate, negative
(2) Masking plate, negative
(3) Annotation plate, positive and negative
(4) Integrated surprint
(5) Tie-strip
(6) Quality control record

Part 6 Prodction of Topographic Map Reproduction Film and Printing Processes

Chapter 1 General

Article 254 (Outline)
The topographic map reproduction process refers to the use of separated original topographic map or topographic map data, creating reproduction films and printing plates and printing topographic maps, etc. through the offset printing method.

Article 255 (Work processes and their order)
The work processes and their order shall be as follows:
(1) Plate-making
a. Production of proof print
b. Proofreading and proof correction
c. Production of reproduction films
d. Production of printing plates

(2) Printing of topographic maps
a. Printing of topographic maps
b. Checking
c. Summary

Article 256 (Accuracy)
The accuracy of reproduction films and printing plates shall be 0.3 mm or less compared with the neat line dimensions of each original plate.

Chapter 2 Plate-Making

Article 257 (Outline)
Plate-making refers to the production of the reproduction films and printing plates required to print topographic maps as well as the production of proof maps and the execution of proofreading and correction

Article 258 (Production of proof maps)
The proof maps shall be created through one of the following methods:
(1) The separated originals shall be printed for each color separation to create proof PS plates. Using the proof PS plate, the proof maps shall be printed on an offset proof printer.
(2) The proof prints shall be produced by outputting topographic map data on a color plotter, etc.

<Article 258 Operation criteria>
1. Producing proof prints from separated originals, etc.
1) The proof prints shall reproduce faithfully the separated originals, etc. to be used, have accurate alignment between color-separation plates, and have color tones that conform to the specified color samples.
2) The offset proof printer used shall maintain a printing accuracy equal to or higher than that of an offset printer.
3) The paper used for proof prints shall be the one used for topographic maps, and the proof maps shall be printed at a specified location.
2. Creating proof maps from topographic map data
1) A color plotter, etc. to be used shall maintain the positional accuracy and color tones of original data.
2) The proof prints shall be output at a specified position.

Article 259 (Proofreading and proof correction)
Proofreading shall be executed by selecting errors, omissions, smears, etc. from the content of topographic maps and record them in proof prints.
2. The proof correction shall be executed by correcting directly the separated originals, etc. or topographic map data for the proofreading items recorded in proof prints.

Article 260 (Production of reproduction films)
The reproduction films shall consist of negative films (original plates) for different colors used for printing of printing plates.
2. The reproduction films to be used shall conform to the prescribed criteria.

<Article 260 Operation criteria>
1. The reproduction films shall be created through the following methods:
1) The scribe plate, masking plate, annotation plate, etc. of separated originals shall be synthesized for each color to create positive films. These synthesized positive films shall be subject to contact printing to create reproduction films.
2) The topographic map data shall be output on an image setter.
2. The reproduction films shall be made of polyester films with specifications to be established separately (Specifications No.3).
3. The images shall be clear and have a sufficient density adequate for plate-making printing.

Article 261 (Production of printing plates)
The printing plates shall be produced by printing reproduction films on PS plates.

<Article 261 Operation criteria>
The printing plates shall comply with the specifications established separately (Specifications No.5) and have a sufficient plate life.

Article 262 (Results)
The results shall be as follows:
(1) Reproduction films (negative and positive films)
(2) Proof prints
(3) Quality control record

Chapter 3 Topographic Map Printing

Article 263 (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 263 Operation criteria>
1. The printing paper shall comply with the specifications established separately (Specifications No.4) 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 264 (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 that may cause reading errors, and shall be no smear and breakage of paper.
(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 maps, and the number of acceptable maps shall be the specified quantity or more.

Article 265 (Organizing)
The separated originals etc. after this printing procedure shall be put in storage envelops for an exclusive use of original drawings, attached with a content list, and stored until delivery.

<Article 265 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 JICA at the end of topographic map production process.
2. The rejected printed maps shall be destroyed by cutting and disposed of after their quantity is verified.

Article 266 (Results)
The results shall be as follows:
(1) Printed map
(2) Quality control record

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