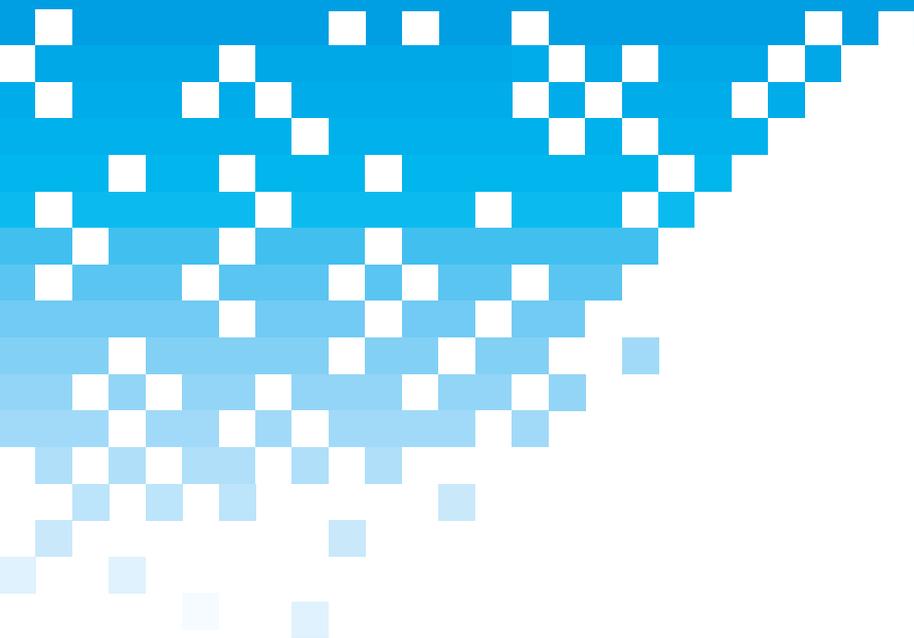# HMK

– handbok i mät- och kartfrågor

Aerial photography 2017

English summary of:
HMK – Flygfotografering 2017

Foreword

The first version of *HMK – Bilddata* (*HMK - Image data*) was published in December 2013. [HMK – Flygfotografering 2017](link) (*HMK - Aerial photography 2017*) is the fourth version of that handbook.

This constitutes an English summary of the document, with emphasis on Appendix A: *Template and examples for establishing technical specifications*, which is supplemented by a brief introduction to HMK, a short review of the corresponding Swedish handbook and some additional information in Appendix B and C.

The document has been prepared by Clas-Göran Persson, Lantmäteriet. Language examination was conducted by Sofie Adler Kleborgh, New York University, and a technical, pre-publication, expert review was carried out during September/October 2018.

The tests with English-language short versions of HMK documents will be evaluated by the end of 2019. Before that, no more documents will be translated.

Gävle 2018-11-06
/Anders Grönlund,
Uppdragsledare HMK

Table of content

1 Introduction

> **Information**
> For any ongoing adjustments of the document, see [HMK-nytt.](#)

1.1 Objectives, purposes and needs

The goal of the work with *HMK, Handbok i mät- och kartfrågor* (*Handbook in surveying and mapping*), is to contribute to an effective handling of procurements and products associated with surveying and mapping.

HMK aims at unified geodata acquisition and control of geodata, as well as high data quality. The collected data should be stored and provided in accordance with the principles applicable to Swedish data sharing and for Inspire (see Section 1.9).

The overall needs are:

- modern manuals aimed for customer/supplier relationships
- support for new employees, in new industries requiring new technology
- requirements for increased uniformity and standardization
- greater efficiency and thus lower costs.

1.2 Background

The older HMK handbook series was published in nine printed bands during the period 1993-1994. These documents have largely become out of date due to technology development and legislative changes.

The building and civil engineering works sector (Bygg- och anläggningssektorn) has developed parts of its regulations regarding procurement, specification and control of surveying services in relation to the older handbooks. This material is facing a renewal, with the wish to still have HMK as a base. Therefore, there is a need for new documents for today's technology and the customer/supplier situation.

1.3 Target group

HMK is mainly a support tool for state and municipal authorities for acquisition, quality assurance, storage and provision of basic geodata.

The content of the handbooks is primarily based on the experience and requirements that *[Lantmäteriet](#) (Swedish Mapping, Cadastral and Land Registration Authority)*, the Swedish municipalities and *[Trafikverket](#)* (*Swedish Transport Administration)* have as actors in their respective areas of activity.

However, much of the content is universal and can with minor modifications be used in other activities. HMK is supplemented, as needed, by government-specific regulations and requirements or technical specifications and formal standards of the *Swedish Standards Institute (SIS).*

1.4   Legal status of the documents

The regulation SFS 2009:946 "Lantmäteri-instruktionen" *(Instructions for Lantmäteriet)* states that (excerpt):

− Lantmäteriet has a national co-responsibility for production, co-operation, provision and development in the field of geographic information and property information.
− Lantmäteriet shall promote uniformity, coordination and quality in the field of surveying and mapping.
− Lantmäteriet shall, within the scope of its area of activity, give advice and support.
− Lantmäteriet shall ensure that the regulations and procedures available to the authority are cost-effective and simple for citizens and businesses.

The advice given in HMK is based on proven, professional work. Recommendations are not binding but can be given legal status by including them in, for example, procurement documents and employment contracts.

1.5   Introductory documents

After the 2017 update, the introduction to HMK consists of three collaborative documents:

− HMK – Introduktion 2017 (HMK – Introduction 2017).
− HMK – Geodatakvalitet 2017 (HMK – Geodata quality 2017), which is a reference work on quality issues.
− *Terminologi, principer och trender inom geodatakvalitet (Terminology, principles and trends in geodata quality)*, a complementary report in the HMK series "Technical reports", titled HMK-TR 2016:1.

The document HMK – Geodatakvalitet 2017 (HMK - Geodata quality 2017) is based primarily on the following international standards:

− SS-EN ISO 19115–1:2014, *Geografisk information – metadata; Del 1: Grunder (Geographic information - Metadata - Part 1: Fundamentals).*
− SS-EN ISO 19131:2008, *Geografisk information – specifikation av datamängder (Geographic information – Data product specifications)*; a new version is expected in 2019.

- [SS-EN ISO 19157:2013](#), *Geografisk information – datakvalitet (Geographic information - Data quality).*
- [SIS-ISO/TS 19158:2012](#), *Geografisk information – kvalitetssäkring av dataförsörjning (Geographic information – Quality assurance of data supply).*

SIS is the Swedish equivalent of the *International Standardization Organization (ISO)*, and the European body *CEN*. Information on the above and other standards in the *ISO 19100 Series on geographic information* can be found on the [SIS-TK323 website](#).

However, the terminology regarding *measurement uncertainty* and *positional uncertainty* complies with the international standard *GUM: Guide to the expression of Uncertainty in Measurement*. This standard has been developed by the *Joint Committee for Guides in Metrology (JCGM)*, which consists of ISO and six other international organizations. A complete html-version of the standard (ISO/IEC Guide 98-3:2008) is published on: www.iso.org/sites/JCGM/GUM-JCGM100.htm .

1.6   Competency and formal eligibility

In order to carry out surveying work, the person responsible and/or the performer should have sufficient competency. However, there is no formal and universally recognized competency tests or skills assessments in Sweden in this area. Therefore, the responsibility of assessing competency has fallen on the individual customer/employer.

Lantmäteriet has, however, developed a draft concept called *Grundläggande mätningsteknisk färdighet* (*Basic surveying skills*). This concept is by no means legally binding. It is only a recommendation intended to be applied in procurement and employment situations, for example in business agreements.

The basic principles of this construction are:

- Basic surveying skills mean sufficient skills to independently be responsible for most types of surveying engineering activities.
- For this skill, a degree from a two-year technical university education in surveying engineering is required, supplemented with two years of practical training, so that the total amount is at least 5 years.

  Example: Two years of education and three years of practical experience.

The assessment of surveying skills can be part of a proficiency assessment, which is also based on specific industry requirements. For more information, see *Mätningsteknisk färdighet* under *Referensbibliotek* at HMK's website, www.lantmateriet.se/HMK (in Swedish only).

1.7   Procurement authorities and legislation

Konkurrensverket (*Swedish Competition Authority*) is an authority working to safeguard and increase competition and supervise public procurement in Sweden.

General information on procurement issues and its legislation, such as *Lagen om offentlig upphandling*, SFS 2016:1145 (*Public Procurement Act*), can be downloaded from their website. Please note, though, that only the Swedish version of this act is authentic.

Upphandlingsmyndigheten (*The National Agency for Public Procurement*) has an overall responsibility for developing and supporting the procurement carried out by the contracting authorities, entities and suppliers.

1.8   Legislation regarding publicity and confidentiality

The most important laws and regulations regarding publicity and confidentiality regarding acquisition of geodata and the creation of geodatabases are:

– Offentlighets- och sekretesslagen, SFS 2009:400. (Publicity and Privacy Act).
– Lag (SFS 2016:319) och förordning (SFS 2016:320) om skydd för geografisk information. (Act and Regulation on the Protection of Geographic Information).
– Säkerhetsskyddslagen (SFS 1996:627) och säkerhetsskydds-förordningen, SFS 1996:633. (Security Act and Security Regulation).
– Skyddslagen (SFS 2010:305) och skyddsförordningen (SFS 2010:523). (Protection Act and Protective Regulation).

1.9   EU directive Inspire

The Geographical Environmental Information Act and Regulation regulate the Swedish implementation of the EU Directive *Inspire*.

The act (SFS 2010: 1767) aims to establish a coherent infrastructure, which makes it easier to access and exchange digital geodata. The infrastructure shall include geodata that are useful for activities/actions that affect health or the environment.

The regulation (SFS 2010: 1770) outlines the information responsibility of the organizations. Lantmäteriet has the task of coordinating the Swedish infrastructure for access to and exchange of geodata.

The act requires that responsible organizations make geodata and geodata services available to all.

1.10   Published documents

Current HMK documents, at the time of writing, are presented in Table 1.6.

Tabell 1.6. *Current HMK documents (November 2018) with English translation.*

Current HMK document	English translation
HMK – Introduktion 2017	HMK - Introduction 2017
HMK – Flygfotografering 2017	HMK - Aerial photography 2017
HMK – Flygburen laserskanning 2017	HMK - Airborne laser scanning 2017
HMK – Fordonsburen laserskanning 2017	HMK – Mobile laser scanning 2017
HMK – Terrester laserskanning 2017 (publiceringen försenad)	HMK - Terrestrial laser scanning 2017 (publication delayed)
HMK – Höjddata 2017	HMK - Elevation data 2017
HMK – Ortofoto 2017	HMK - Orthophoto 2017
HMK – Fotogrammetrisk detaljmätning 2017	HMK - Photogrammetric detail surveying 2017
HMK – Geodatakvalitet 2017	HMK - Geodata quality 2017
HMK – Ordlista och förkortningar, <mån> <årtal> (senaste version gäller, se hemsidan www.lantmateriet.se/hmk)	HMK - Glossary and abbreviations, <month> <year> (latest version applies, see website www.lantmateriet.se/hmk)
HMK – Geodetisk infrastruktur 2017	HMK - Geodetic infrastructure 2017
HMK – GNSS-baserad detaljmätning 2017	HMK - GNSS-based detail surveying 2017
HMK – Terrester detaljmätning 2017	HMK - Terrestrial detail surveying 2017
HMK – Stommätning 2017	HMK – Control surveying 2017
HMK – Kravställning vid geodetisk mätning 2017	HMK - Requirements for geodetic surveying 2017

The documents that are valid at any given time are continuously reported on the website www.Lantmateriet.se/HMK. For any adjustments of the documents between the major, usually annual revisions, see [HMK-Nytt](http://).

Please note that a document can be included as a basis – and therefore valid – in an ongoing procurement, even though newer versions have been published.

2 HMK – Flygfotografering 2017 (HMK – Aerial photography 2017)

2.1 General description

HMK – Flygfotografering 2017 (HMK – Aerial photography 2017) deals with the establishment of a technical specification for the procurement of aerial photos and how these are produced, checked and documented. The focus is on airborne acquisition of images with a digital aerial camera georeferenced by GNSS/INS. Common applications are photogrammetric detailed measurement in 3D (stereo mapping) as well as development of orthophotos and elevation models.

The document supports:
 – establishment of a technical specification (Chapter 2 and Appendix A), see HMK – Introduktion 2017 (HMK - Introduction 2017), Section 2.1
 – implementation of an aerial photography project (Chapter 3 and Appendix B)
 – check of delivery (Chapter 4 and Appendix C).

The following HMK standard levels are covered, see HMK – Geodata-kvalitet 2017 (HMK - Geodata quality 2017), Section 2.6.
 – HMK standard level 1: National/regional surveying and mapping for overall planning and documentation.
 – HMK standard level 2: Surveying and mapping of urban areas for municipal detailed planning and documentation.
 – HMK standard level 3: Project-oriented surveying and mapping for design and construction.

Issues of procurement, permits and confidentiality are dealt with in HMK – Introduktion 2017 (HMK – Introduction 2017), Chapter 3. Technical terms and abbreviations are explained in HMK – Ordlista (HMK – Glossary), latest version. Document structure and references are explained in HMK – Introduktion 2017 (HMK – Introduction 2017), Section 1.7.

Limitations

Satellite images, airborne image acquisition with UAV, airborne acquisition of oblique images, airborne acquisition with analogue cameras and film, vehicle-borne acquisition, and mathematical derivations and formulas are not discussed in HMK – Flygfotografering 2017 (HMK – Aerial photography 2017). Concerns regarding UAV, derivations and formulas are referred to Chapter 4: *References*. Concerns regarding analogue technology is referred to the old document HMK – Fotogrammetri (HMK – Photogrammetry) from 1994; however, in Swedish only.

2.2 Positional uncertainty and HMK standard levels

In HMK, the basic assumption is that geodata is *georeferenced*, that is, linked to an official reference system. In Sweden, this usually means that coordinates and heights are specified in the national systems SWEREF99 and RH2000 respectively.

Requirements for positional uncertainty in Table 2.2 refer to "absolute" uncertainty in these or other official reference systems.

Table 2.2. Compilation of parameters per HMK standard level for airborne acquisition of vertical images for stereo mapping and elevation models. Identical to Table 2.3.1 in HMK – Flygfotografering 2017 (HMK – Aerial photography 2017).

Parameters	HMK standard level 1	HMK standard level 2	HMK standard level 3
Geometric resolution, aerial photo (m) [I]	0.20–0.50	0.08–0.12	0.02–0.05
Positional uncertainty, ideal conditions Horiz./Vert. (m) [II]	0.20–0.50/ 0.30–0.75	0.08–0.12/ 0.12–0.18	0.02–0.05/ 0.03–0.07
Overlap, within/between strips (%) [III]	60/30		-
Image quality [IV]	≥2		≥1
Sun angle (degrees) [V]	≥30		-
Photography period [VI]	snow-free ground	leaf-free trees and snow-free ground	-

[I] For a definition of geometric resolution of aerial photos, see Section 2.3.2. The interval refers to a span within which the value of geometric resolution usually lies. The customer chooses a value for their purpose.

[II] Positional uncertainty refers to standard uncertainty for clearly identifiable objects when measured in stereo models. The interval refers to parameter values that follow the value selected for geometric resolution. Other values can be selected by the customer, see Section 2.3.3.

[III] Commonly occurring values, see recommendation in Section 2.3.4.

[IV] Commonly occurring values, see recommendation in Section 2.3.5.

[V] Commonly occurring value, see recommendation in Section 2.3.6.

[VI] Commonly occurring values, see recommendation in Section 2.3.7.

N.B. The references above refer to Chapter 2 in HMK – Flygfotografering 2017 (HMK – Aerial photography 2017).

3   Use of this document

> **Disclaimer**
>
> The information provided in this document is intended for general information purposes only. Lantmäteriet accepts no responsibility or liability regarding the information.
>
> Only Swedish editions of HMK shall be regarded as authentic.

The customer is always responsible for the information that is part of a procurement. This also applies to any errors, imperfections or other shortcomings in the HMK documents that the customer chooses to use, and Lantmäteriet accepts no responsibility or liability regarding the information in these documents.

The current document is a shortened, English translation of the Swedish original document [HMK – Flygfotografering 2017](#) (HMK - Aerial Photography 2017). It is only intended as a service for HMK users whose native language is not Swedish. In cases where differences between the Swedish and English document versions are discovered, the Swedish HMK edition shall be regarded as authentic (master document) and shall take precedence.

4   References

The numbering of the references below refers to the Swedish document [HMK – Flygfotografering 2017](#) (HMK - Aerial photography 2017).

[1]   Wingstedt, J. (2013): *Tolkningsmöjligheter vid olika geometriska upplösningar*. (*Interpretation possibilities at different geometrical image resolutions*) Lantmäteriet, HMK – Technical report No 2013:2.

[2]   Swedish Transport Administration (2013): *Laserskanning i kombination med stereofotografering* (*Laser scanning in combination with stereo photography*). Publication No 2014:099.

[3]   Persson, C-G. (2013): *Lägesosäkerhet vid fotogrammetrisk detalj-mätning i 3D*. (*Positional uncertainty for photogrammetric detail measurement in 3D*). Lantmäteriet, HMK – Technical report No 2013:3.

[4]   Jansson, A. (2013): *En noggrannhetsundersökning av fotogram-metrisk detaljmätning i stereo.* (*An accuracy investigation of photo-grammetric stereo mapping*). Degree project, Surveying and Mapping Program, Faculty of Humanities and Social Sciences, Karlstad University.

[5]   Haala, N (2014): *Dense image matching, Final report*, EuroSDR Official Publication No 64 (pp. 115-144).

[6]   Svensk geoprocess: *Geodataspecifikation "Bild" (Swedish geo-process, geodata specification "Image").* Current version with XML/GML schemas, instructions for data acquisition etc. is available on the [Swedish geoprocess website](#).

[7]   *ASPRS LAS file format*. Available, in different versions, on the [ASPRS website](#).

[8]   *Nationell metadataprofil – Specifikation och vägledning, SS-EN ISO 19115:2005-geodata.se (National metadata profile - Specification and guidance*). Current version, instructions etc. for publication on *Geodataportalen (Geodata portal)* can be found on [geodata.se](#).

The Norwegian Mapping Authority's website contains documents corresponding to those published by HMK and Swedish geoprocess:

- The website [Standarder for geografisk informasjon](#) (*Geographic information standards*) includes the latest version of *Produksjon av basis geodata* (*Production of basic geodata*).

- The website [SOSI del 3 Produktspesifikasjoner](#) (*SOSI part 3, Product specifications*) includes the latest version of *Produkt-spesifikasjon Vertikalbilde (Product specification "Vertical image"*).

Appendix A: Template and examples for establishing technical specifications

The text in Appendix A.1–A.5 is an English translation of the Swedish original. In case there are any differences between the Swedish and English text, the Swedish version shall take precedence, see Chapter 3.

Appendix A.1 Technical specification template

0   Technical specification

Planning, implementation and delivery shall be made according to this technical specification. Explanation of requirements and definitions of terms can be found in HMK – Flygfotografering 2017 (HMK – Aerial Photography 2017) and HMK-Ordlista (HMK–Glossary), latest version.

1   General description (HMK – Flygfotografering 2017, Section 2.1)

Required services: ....

Required products: ....

Planned use of products: ....

2   Specification of existing source material (HMK – Flygfotografering 2017, Section 2.2)

Mapping area, including format and reference system: ....

Other source material, including their characteristics: ....

3   Product specifications (HMK – Flygfotografering 2017, Section 2.3)

Requirements for HMK standard level: ....

Requirements for geometric resolution: ....

Requirements for horizontal and vertical standard uncertainty: ....

Requirements for overlap within/between strips (*alternatively displacement or angle of reflection*): ....

Requirements for image quality, at least: ....

Requirements for sun angle/shadow length (min/max): ....

Requirements for photography period: ....

Requirements for image type: ....

Requirements for colour depth: ....

Requirements for subsequent products: ....

Requirements for additional specification of the product: (*e.g. strip direction, check points and number of ground control points*) ....

4 Specification of delivery (HMK – Flygfotografering 2017, Section 2.4)

Reference systems

Requirements for horizontal reference system:

Requirements for vertical reference system:

Flight and ground control plan

Format requirements:

Naming requirements:

Ground control

Format requirements:

Naming requirements:

Image data

Format requirements:

Naming requirements:

Position and orientation data (GNSS/INS)

Format requirements:

Naming requirements:

Additional requirements for information content:

Position and orientation data (block triangulation)

Format requirements:

Naming requirements:

Photogrammetric point cloud

Format requirements, and version if any:

Naming requirements:

Other requirements: (*e.g. compression, geographic division, index system*)

Production documentation

Additional requirements for production documentation:

Meta data

Content requirements:

Format requirements:

Additional specifications of delivery

Requirements for additional specification of the product: (*e.g. sample and partial deliveries, delivery media and catalogue structure, handling of raw data*):

5 Specification of implementation (HMK-Flygfotografering 2017, Chapter 3)

Requirements 3 a-b in HMK-Flygfotografering 2017 applies
Recommendation 3 c in HMK-Flygfotografering 2017 applies
Requirements 3.1.1 a-c in HMK-Flygfotografering 2017 applies
Requirements 3.1.2 a-c in HMK-Flygfotografering 2017 applies
Requirements 3.1.3 a-h in HMK-Flygfotografering 2017 applies
Requirements 3.2 a-d in HMK-Flygfotografering 2017 applies
Requirements 3.2.1 a-e in HMK-Flygfotografering 2017 applies
Requirements 3.3.1 a-h in HMK-Flygfotografering 2017 applies
Requirements 3.3.2 a-e in HMK-Flygfotografering 2017 applies
Recommendation 3.3.3 a in HMK-Flygfotografering 2017 applies
Requirements 3.3.4 a-k in HMK-Flygfotografering 2017 applies
Requirement 3.4 a in HMK-Flygfotografering 2017 applies
Requirements 3.4.1 a-b in HMK-Flygfotografering 2017 applies
Requirements 3.4.2 a-g in HMK-Flygfotografering 2017 applies
Requirements 3.4.3 a-f in HMK-Flygfotografering 2017 applies
Requirements 3.5 a-c in HMK-Flygfotografering 2017 applies
Requirements 3.5.1 a-c in HMK-Flygfotografering 2017 applies

Comment on the template:

- Section 5 of the template gives references to the requirements of <u>HMK – Flygfotografering 2017</u> (HMK – Aerial Photography 2017), Chapter 3, *Genomförande (Implementation)*, which shall apply.

- The list in section 5 of the template contains all requirements and recommendations in Chapter 3. Not applicable requirements shall be removed by the customer when using the template.

- See <u>HMK – Introduktion 2017</u> (HMK – Introduction 2017), Section 1.7, for principles regarding references to requirements as well as examples of how referrals, deviations and additions can be phrased.

Appendix A.2 Example of a completed template for a municipality

0   Technical specification

Planning, implementation and delivery shall be made according to this technical specification. Explanations of requirements and definitions of terms can be found in [HMK – Flygfotografering 2017](#) (HMK – Aerial photography 2017) and [HMK-Ordlista](#) (HMK-Glossary), latest version.

1   General description (HMK – Flygfotografering 2017, Section 2.1)

Required services: The specification includes planning and implementation of aerial photography, surveying and calculation of ground control points, and block triangulation.

Required products: Digital images including orientation data.

Planned use of products: The images will be used for updating the municipality's "primärkarta" (base map) through stereo mapping and as a background map in an e-service in the form of orthophotos. The images will be archived and provided for future use, both internally and externally.

It shall be possible to interpret and measure the following object types through stereo mapping: road edge - asphalt, sidewalk, track (rail), building - roof structure and roofing details, balcony, fence, plank, pylon, lamp pillar, incl. luminaire, and manhole covers.

2   Specification of existing source material (HMK – Flygfotografering 2017, Section 2.2)

Mapping area, including format and reference system: Current mapping area as shape file, delivered in Sweref99 1800 and RH2000.

Other source material, including their characteristics: The municipality can provide the following material digitally, for the planning and implementation of aerial photography:

- Current index system
- Horizontal and vertical control points
- Elevation model, break-lines + bridge and viaduct data
- Map material containing shorelines, building areas, communications etc. (The municipality cannot guarantee the quality, including actuality, of the material provided on behalf of the supplier and which the supplier chooses to use.)

Delivered in Sweref99 1800 and RH2000.

3   Product specifications
(HMK – Flygfotografering 2017, Section 2.3)

Requirements for HMK standard level: *Standard level 2*

Requirements for geometric resolution: *0,08 m*

Requirements for horizontal and vertical standard uncertainty: *0,08/0,12 m*

Requirements for overlap within/between strips: *60/30 %*

Requirements for image quality, at least: *grade 2 (betyg 2)*

Requirements for sun angle/shadow length (min/max): *Sun angle > 30 degrees; in exceptional cases, to complete a difficult-photographed area, a 27-degree sun angle can be accepted. However, this shall be agreed with the customer for approval.*

Requirements for photography period: *Spring season (leaf-free trees and snow-free ground)*

Requirements for image type: *RGB*

Requirements for colour depth: *24 bits with 8 bits per channel*

Requirements for subsequent products: *-*

Requirements for additional specification of the product: *The strip direction shall be east-west*

4   Specification of delivery
(HMK – Flygfotografering 2017, Section 2.4)

Reference systems

Requirements for horizontal reference system: *Sweref99, projection zone 1800*

Requirements for vertical reference system: *RH2000; geoid model SWEN 08 shall be used for calculation of heights*

Flight and ground control plan

Format requirements: *ASCII file*

Naming requirements: *As agreed upon signing*

Ground control

Format requirements: *ASCII file*

Naming requirements: *As agreed upon signing*

Image data

Format requirements: *TIFF 24-bit colour resolution (8 bit/colour band)*

Naming requirements: *As agreed upon signing*

Position and orientation data (GNSS/INS)

Format requirements: *ASCII format, where the content of each column of the file is specified in the first row, with comma separation*

Naming requirements: As agreed upon signing

Additional requirements for information content: -

Position and orientation data (block triangulation)

Format requirements: Match-AT project file (version 5 or later) for loading in the ESPA system

Naming requirements: As agreed upon signing

Photogrammetric point cloud

Not included

Production documentation

Additional requirements for production documentation: -

Meta data

Not included

Additional specifications of delivery

Requirements for delivery media: USB 3.0 hard drive

Requirements for raw data handling: The supplier shall keep raw data, i.e. unprocessed image and orientation data, for four years from the photography date.

5 Specification of implementation (HMK – Flygfotografering 2017, Chapter 3)

Requirements 3 a-b in HMK-Flygfotografering 2017 applies

Recommendation 3 c in HMK-Flygfotografering 2017 applies

Requirements 3.1.1 a-c in HMK-Flygfotografering 2017 applies

Requirements 3.1.2 a-c in HMK-Flygfotografering 2017 applies

Requirements 3.1.3 a-h in HMK-Flygfotografering 2017 applies

Requirements 3.2 a-d in HMK-Flygfotografering 2017 applies

Requirements 3.2.1 a-e in HMK-Flygfotografering 2017 applies

Requirements 3.3.1 a-h in HMK-Flygfotografering 2017 applies

Requirements 3.3.2 a-e in HMK-Flygfotografering 2017 applies

Recommendation 3.3.3 a in HMK-Flygfotografering 2017 applies

Requirements 3.3.4 a-k in HMK-Flygfotografering 2017 applies

Requirement 3.4 a in HMK-Flygfotografering 2017 applies

Requirements 3.4.1 a-b in HMK-Flygfotografering 2017 applies

Requirements 3.4.2 a-g in HMK-Flygfotografering 2017 applies

Requirements 3.4.3 a-f in HMK-Flygfotografering 2017 applies

Comment on the example:
- Requirements 3.5 a-c and 3.5.1 a-c are not included because the customer does not wish for photogrammetric point clouds.

Appendix A.3 Example of a completed template for the Swedish Transport Administration

0   Technical specification

Planning, implementation and delivery shall be made according to this technical specification. Explanation of requirements and definitions of terms can be found in HMK – Flygfotografering 2017 (HMK – Aerial Photography 2017) and HMK-Ordlista (HMK-Glossary), latest version.

1   General description (HMK – Flygfotografering 2017, Section 2.1)

Required services: The specification includes planning and implementation of aerial photography, surveying and calculation of ground control points, and block triangulation. The image acquisition shall be made simultaneously with the airborne laser scanning.

Required products: Digital images, including orientation data

Planned use of products: The Swedish Transport Administration will establish a design and construction plan for this road section. The purpose of this request is to produce images for the production of orthophotos and elevation models, as the basis for design.

2   Specification of existing source material (HMK – Flygfotografering 2017, Section 2.2)

Mapping area, including format and reference system: Current mapping area as KML file, delivered in Sweref99 1800 and RH2000

Other source material, including their characteristics: The Swedish Transport Administration can provide the following material digitally, for the planning and implementation of aerial photography:

- Horizontal (planimetric) and vertical control points
- "GSD-Terrängkartan" in raster format with national road network
- "GSD-Fastighetskartan" in shape and dwg format

Delivered in Sweref99 1800 and RH2000

3   Product specifications (HMK – Flygfotografering 2017, Section 2.3)

Requirements for HMK standard level: Standard level 3

Requirements for geometric resolution: 0,02 m

Requirements for horizontal and vertical standard uncertainty: 0,02/0,02 m

Requirements for overlap within/between strips: -

Requirements for image quality, at least: grade 1 (betyg 1)

Requirements for sun angle/shadow length (min/max): -

Requirements for photography period: The road surface shall be dry and the ground shall be snow-free

Requirements for image type: RGB

Requirements for colour depth: 24 bits, 8 bits/channel

Requirements for subsequent products: Requirements for orthophoto according to special specification, developed with the use of HMK – Ortofoto 2017 (HMK – Orthophoto 2017)

Requirements for additional specification of the product:
Tests of the elevation model's vertical uncertainty shall be performed according to SIS / TS 21144: 2013. Check measurements shall be made according to "modell typ 2" (model type 2) and "prövningsutförande A" (test procedur A). Simultaneous airborne laser scanning shall be performed according to a special specification developed with the use of HMK – Flygburen laserskanning 2017 (HMK – Airborne laser scanning 2017)

4 Specification of delivery (HMK – Flygfotografering 2017, Section 2.4)

Reference systems

Requirements for horizontal reference system: Sweref99, projection zone 1800

Requirements for vertical reference system: RH2000; geoid model SWEN 08 shall be used for calculation of heights

Flight and ground control plan

Not requested

Ground control

Format requirements: ASCII file

Naming requirements: As agreed upon signing

Image data

Format requirements: TIFF 24-bit colour resolution (8 bit/colour band)

Naming requirements: As agreed upon signing

Position and orientation data (GNSS/INS)

Format requirements: trj format, according to Terrasolid

Naming requirements: As agreed upon signing

Additional requirements for information content: -

Position and orientation data (block triangulation)

Format requirements: iml file (Terraphoto imagelist), according to Terrasolid

Naming requirements: As agreed upon signing

Photogrammetric point cloud

Not included

Production documentation

Additional requirements for production documentation: -

Meta data

Not included

Additional specifications of delivery

Requirements for delivery media: USB 3.0 hard drive

Requirements for catalogue structure: According to named Chaos objects

Requirements for handling of raw data: The supplier shall keep raw data, i.e. unprocessed image and orientation data, for four years from the date of photography

Other requirements: Ortho photos, laser data and elevation model shall be delivered according to special specifications

5 Specification of implementation (HMK – Flygfotografering 2017, Chapter 3)

Requirements 3 a-b in HMK-Flygfotografering 2017 applies

Recommendation 3 c in HMK-Flygfotografering 2017 applies

Requirements 3.1.1 a-c in HMK-Flygfotografering 2017 applies

Requirements 3.1.2 a-c in HMK-Flygfotografering 2017 applies

Requirements 3.1.3 g-h in HMK-Flygfotografering 2017 applies

Requirements 3.2 a-d in HMK-Flygfotografering 2017 applies

Requirements 3.2.1 a-e in HMK-Flygfotografering 2017 applies

Requirements 3.3.1 a-h in HMK-Flygfotografering 2017 applies

Requirements 3.3.2 a-e in HMK-Flygfotografering 2017 applies

Recommendation 3.3.3 a in HMK-Flygfotografering 2017 applies

Requirements 3.3.4 a-i in HMK-Flygfotografering 2017 applies

Requirement 3.4 a in HMK-Flygfotografering 2017 applies

Requirements 3.4.1 a-b in HMK-Flygfotografering 2017 applies

Requirements 3.4.2 a-g in HMK-Flygfotografering 2017 applies

Requirements 3.4.3 a-f in HMK-Flygfotografering 2017 applies

Comment on the example:

- The requirements for airborne laser scanning, elevation model and orthophoto is not included in the example. For the formulation of requirements, see HMK – Flygburen laserskanning 2017, (HMK – Airborne laser scanning 2017), HMK – Höjddata 2017 (HMK – Elevation data 2017), HMK – Ortofoto 2017 (HMK – Orthophoto 2017), respectively.

- Requirements 3.1.3 a-f and 3.3.4 j-k are not included in the example because the customer does not wish for digital delivery of neither the flight and ground control plan nor metadata in digital form.

- Recommendations 3.5 a-c and 3.5.1 a-c are not included in the example because the customer does not wish for photo-grammetric point clouds.

Appendix A.4 List of requirements

This appendix contains all the requirements and recommendations in Chapter 3 of [HMK – Flygfotografering 2017](#) (HMK – Aerial photography 2017). The numbering refers to sections in the corresponding chapter.

3   Implementation

Requirements

a) The supplier shall be responsible for quality assurance of the production and for the material delivered to be quality controlled and complete according to the customer's technical specification.

b) All collected material shall be checked continuously during data acquisition, so that any deficiencies can be identified early and corrected.

Recommendation

c) A quality plan should be established.

3.1   Flight and ground control planning

3.1.1   Selection of flying altitude and strip planning

Requirements

When selecting flying altitude and during strip planning:

a) requirements for geometric resolution shall be met in all parts of the image

b) stereo coverage shall be obtained throughout the mapping area, with a margin of at least 15% of the image side outside the mapping area

c) consideration shall be given to hilly terrain and high-rise buildings to ensure stereo coverage.

3.1.2   Planning of ground control

Requirements

Ground control points shall be:

a) adjusted in number according to the final product's expected measurement uncertainty and the size of the mapping area

b) distributed evenly but especially in the corners, outer edge and centre of the mapping area to obtain good controllability (Figure 3.1.2.a.)

c) placed where they can be identified and surveyed in all images that include the point.

3.1.3   Delivery

Requirements

Delivery of the flight plan shall be:

a) quality controlled and complete

b) made in the form of a file of the planned strips, with their names and positions; coordinate and height values are reported in meters; image ID shall be unique within the project

c) made in the file format and with the naming specified by the customer in accordance with Section 2.4.2.

Delivery of the planned ground control points shall:

d) be quality controlled and complete

e) contain the name and position of the planned points; coordinate and height values are reported in meters

f) be made in the file format and with the naming specified by the customer.

Delivery of production documentation shall:

g) be quality controlled and complete

h) consist of the report referred to in point a) of Appendix B.1.

3.2   Signalling and surveying of ground control

Requirements

Signalling and surveying of ground control points shall:

a) take place in close connection to the aerial photography to ensure actuality.

Ground control points shall in its design:

b) be horizontal and highlighted with color to ensure good contrast with the surrounding surface as well as adapted in shape and size so that the centers of the signals can be interpreted and measured in the images.

Surveying of ground control points shall be made with:

c) a standard uncertainty, including the positional uncertainty of reference points, which does not exceed 1/3 of the standard uncertainty in the final product

d) an appropriate geodetic measurement method according to HMK – Kravställning vid geodetisk mätning 2017 (HMK – Requirements for geodetic surveying 2017), Chapter 3. Check measurements can be made using HMK – Geodatakvalitet 2017 (HMK – Geodata quality 2017), Appendix A.2.

3.2.1　Delivery

Requirements

Delivery of ground control shall:

a) be quality controlled and complete

b) be in the form of a file containing the name and position of the ground control points; coordinate and height values are reported in meters to three decimal places

c) be made in the file format and with the naming specified by the customer in accordance with Section 2.4.3.

Delivery of production documentation shall:

d) be quality controlled and complete

e) consist of a report according to paragraph a), and a list according to paragraph b), of Appendix B.2.

3.3　Acquisition of image and GNSS/INS data

3.3.1　Photography

Requirements

a) GNSS/INS systems and the digital aerial camera shall be designed for measurement and shall be calibrated and maintained according to the manufacturer's specifications.

b) Planning and acquisition of GNSS/INS data shall meet the requirements described in HMK – Geodetisk infrastruktur 2017 (HMK – Geodetic Infrastructure 2017), Appendix B.6.1 and Appendix B.6.2, respectively.

c) A photography mission shall be carried out for as short a time as possible

d) For supplementary photography, an overlap of at least two images shall be secured where new strips connect to existing ones.

e) When ordering images for stereo mapping, the entire mapping area, with a margin of at least 15% of the image side outside the mapping area, must have stereo coverage after completed aerial photography. No gaps are allowed.

For acquisition within HMK standard levels 1 and 2, a digital aerial camera:

f) of array sensor type shall be provided with image motion compensation and be mounted in a gyro foot

g) of line sensor type shall be mounted in a gyro foot

h) shall generally produce according to the guidelines for photography shown in Table 3.3.1.

3.3.2 Image processing

Requirements

a) The final product shall represent an image in central projection.

For radiometric image processing:

b) the radiometric resolution shall be chosen, and such a radiometric method shall be used, that ensure that the information content from raw data is preserved as far as possible

c) similar objects shall have similar luminance and color shade regardless of where on the image surface the objects are located

d) images shall have even shade and highlight brightness, which means that an object's shaded and non-shaded part shall have similar intensity, brightness and contrast regardless of where on the image surface the objects are located

e) images shall be well stretched so that the full colour depth is utilized.

3.3.3 Calculation of orientation data from GNSS/INS data

Recommendation

a) GNSS/INS data should be calculated according to [HMK – Geodetisk infrastruktur 2017](#) (HMK – Geodetic infrastructure 2017), Appendix B.6.3.

3.3.4 Delivery

Requirements

Delivery of image data shall:

a) be quality controlled and complete

b) contain images with a geometric resolution according to specification, or better; for HMK standard levels 1 and 2, single-image discrepancies are allowed up to 7% lower geometric resolution than specified

c) be made in the file format and with the colour resolution, image type and naming specified by the customer in Section 2.4.4

d) contain calibration documents for used cameras.

Delivery of GNSS/INS data shall:

e) be quality controlled and complete

f) for all images, be made in the form of a file containing image ID, X_o, Y_o, Z_o, ω, φ, κ and GPS time, as well as any other requirements for the content specified by the customer in Section 2.4.5; coordinate and height values (X_o, Y_o, Z_o) are reported in meters to three decimal places, image rotations (ω, φ, κ) in degrees to five decimal places and GPS time in seconds to four decimal places

g) be made in the file format and with the naming specified by the customer in Section 2.4.5.

Delivery of production documentation shall:

h) be quality controlled and complete

i) consist of a report according to paragraph a) of Appendix B.3.

Delivery of any metadata shall be:

j) quality controlled and complete

k) made in the file format and with the naming specified by the customer.

3.4 Block triangulation

Requirements

Position and orientation data shall:

a) be calculated for each individual air photo, to enable orientation of images in a digital photogrammetric workstation and used for photogrammetric detail measurement in 3D, with – at the highest – the positional uncertainty that has been specified by the customer.

3.4.1 Measurement of connection points

Requirements

a) Connection points shall be evenly distributed between images and strips and exist to such an extent that gross errors can be detected.

b) When using automatic image matching, the positions of the connection points shall be checked visually.

3.4.2 Calculation of orientation data

Requirements

a) GNSS/INS data and ground control points, as well as connection points, shall be weighted regarding their measurement uncertainty

b) Correction for refraction and the earth curvature shall be applied

c) Ground control points shall not be excluded without accounting and justification

d) The standard uncertainty of unit weight in the block triangulation shall not exceed 1/3 of the pixel size of the image.

For images collected with a matrix sensor:

e) the block triangulation shall be performed with the use of GNSS/INS-supported bundle adjustment

f) any use of self-calibration shall be made with a calibration model specifically adapted for the actual camera type and compatible with the customer's stereo mapping system – if such mapping is to be performed.

For images collected with a line sensor:

g) orientation shall be implemented according to the customer's instructions.

3.4.3 Delivery

Requirements

Delivery of exterior orientation elements and interior orientation shall:

a) be quality controlled and complete

b) be made in the form of a file containing image ID and orientation elements (Xo Yo Zo, ω, φ, κ) for all images

c) have coordinate and height values reported in meters with the number of decimal places based on the position uncertainty in the final product; image rotations (ω, φ, κ) are reported in degrees to five decimal places [1]

d) be made in the file format and with the naming specified by the customer in Section 2.4.5.

Delivery of production documentation shall:

e) be quality controlled and complete

f) consist of a report according to paragraph a) and data files according to paragraph b) of Appendix B.4.

[1] *Read more in HMK – Geodatakvalitet 2017, (HMK – Geodata quality 2017), Appendix A.8, on why you should be generous with the number of digits during the calculation process and not round off – to about one tenth of the positional uncertainty – until the final product.*

3.5 Image matching

Requirements

a) The degree of detail, in the form of point distances in the point cloud, shall be equal to the geometrical resolution of the aerial image at a minimum overlap of 80%/60%, within and between strips. In case of less overlap, the point distance shall be set to double the value of the geometrical resolution

b) The photogrammetric point cloud shall be colour-lit with colour values from the images used in the image matching.

c) Method and parameters for the image matching shall be selected so that the result can be used for the intended application.

3.5.1 Delivery

Requirements

Delivery of point cloud and any metadata shall:

a) be quality controlled and complete
b) be made in the file format and with the point density and naming specified by the customer
c) consist of a report according to paragraph a) of Appendix B.5, if the customer does not state otherwise.

Appendix B: Table of content, HMK – Flyg-fotografering 2017 (complete Swedish version)

Appendix C: Some comments regarding terminology

Here, some of the terms used in the document are commented. This is to clarify which terminological choices have been made and to avoid misunderstandings due to minor differences in the meaning of the words between the Swedish original text and the English translation.

Swedish	English	Comment
mätosäkerhet	measurement uncertainty	uncertainty in measurement, according to GUM (see Section 1.5); ISO uses the term *accuracy* instead of *uncertainty* in its 19100-standard series
lägesosäkerhet	positional uncertainty	an extension of GUM to uncertainty in positions; corresponds to the term *positional accuracy* used in the standard SS-EN ISO 19157:2013 *Geographic information – Data quality*
standardosäkerhet	standard uncertainty	the uncertainty measure applied in GUM, which corresponds to the term *standard deviation* in ISO 19157; older terms are *mean error* or *standard error* (Sw. *medelfel*)
beställare/utförare	customer/supplier	the two parties in a procurement, according to the standard SIS-ISO/TS 19158:2012 *Quality assurance of data supply;* English synonyms are e.g. *client/provider*
insamlingsområde	mapping area	the term *insamlingsområde* in the Swedish HMK is translated into *mapping area*, even if it refers to a more general data acquisition, e.g. laser scanning
stompunkter	(geodetic) control points	points in a geodetic control network
stödpunkter	ground control (points/objects)	position-determined points on the ground used for connection to a reference system in, for example, aerial photography or laser scanning *)
kontrollpunkter	check points	independent, position-determined points for checking of such connections *)

*) can be 2- or 3-dimensional objects, not just points

The compilation is by no means complete, but clearly shows that parallel bilingual texts can sometimes be difficult to handle. To avoid disputes about what has been agreed, it is often appropriate to designate one of the languages as "main language" in a procurement, see Chapter 3.