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GUIDELINES FOR EPOS-GNSS STATIONS, DATA SUPPLIERS, AND OPERATIONAL CENTRES

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Available from the M³G-Bureau at https://gnss-metadata.eu/Guidelines/
Questions and comments are welcome at C.Bruyninx@oma.be.

Updates:
January 6, 2021: Improvements based on user feedback and update of urls.
August 5, 2020: Corrections based on user feedback
March 27, 2019: Refinement
Feb. 19, 2018: Revision of "Data Supplier/OC" terminology.
Feb. 2, 2018: Revision of "Data Center/Node" and "Agency" terminology.
Jan. 23, 2018: Reflect decisions taken at WP10 meeting in Coimbra (15-16/01/2018)
- Only antenna calibration is mandatory (not antenna+radome)
- Information on 'deviation of true north' is not mandatory, but recommended for insertion in the station log
- Removed the submission of station pictures and individual antenna calibrations to the M³G-Bureau because this functionality is not active yet

July 17, 2017
- Moved more requirements to 'desired'
- Introduce M³G-bureau
- Clarify difference between OC, Station owner, and Data supplier

February 13, 2017: Creation

GNSS stations participating to EPOS-GNSS must agree to adhere to certain standards and conventions, which ensure the quality of the EPOS-GNSS services and data products.

This document lists the ***requirements*** *that* ***EPOS-GNSS Tracking Stations, Data Suppliers,*** *and* ***Operational Centres*** *(OC) should follow, as well as some additional desirable characteristics, which are not mandatory, but enhance a station's or OC's value to EPOS-GNSS.*

CONTENTS

1 Network Components

GNSS Station: Permanent GNSS tracking receivers and antennae.

Data Supplier: The EPOS Data Supplier is the agency owning the GNSS station and having the legal rights to distribute the data of the GNSS station. The Data Supplier signs the **EPOS-GNSS Data Supplier Letter** and ensures the data flow of the GNSS station to EPOS. Data Supplier and Station Owner are synonyms.

Operational Centre (OC): The Operational Centre **maintains the GNSS station metadata** (e.g. site log) within EPOS. The Data Supplier indicates the name of the agency acting as Operational Centre in Annex B of its EPOS-GNSS Data Supplier Letter. Mostly, the Data Supplier itself acts as Operational Centre.

Data Centre (DC) or Data Repository: Physical location of the GNSS station observation/navigation data.

Data Node (DN): Virtualisation layer on top of one (or more) Data Centre(s). Using the GLASS software, the Data Node makes the GNSS station data at Data Centres (or data repositories) discoverable at the EPOS-GNSS data gateway.

M3G-Bureau: Collects the EPOS-GNSS data supplier letters and helps station owners to select the most appropriate EPOS data node. It maintains the M³G portal that where GNSS station metadata must be submitted. It validates these metadata and provides them to EPOS-GNSS Data Gateway. M³G also collects information on the agencies involved in operating EPOS' GNSS stations.

Data Gateway (DGW): Provides access to the metadata and data from the EPOS-GNSS stations.

Data Monitoring Centre (DMC): Monitors EPOS-GNSS station observation data quality and metadata consistency and provides feedback to station operators (*not available yet*).

2 Requirements for Permanent Stations

EPOS-GNSS stations should fulfil the guidelines below.

2.1 Equipment

Receiver

The GNSS receiver must

2.1.1 Be known to the International GNSS Service (IGS), meaning a standard name must be included in https://files.igscb.org/pub/station/general/rcvr_ant.tab.

2.1.2 Record GPS phase and code measurements from at least two frequencies.

Antenna and Radome

2.1.3 The antenna (+radome, if any) must be known to the IGS, meaning a standard name must be available for both the antenna and radome must be included in https://files.igscb.org/pub/station/general/rcvr_ant.tab.

2.1.4 Antenna calibrations must be available for the antenna. These calibrations should be type mean calibrations available from the IGS phase centre variation file

(https://files.igscb.org/pub/station/general/igs14.atx) or individual antenna calibrations (performed by a calibration facility recognized by the IGS and available on-line).

2.1.5 The eccentricities (easting, northing, height) from the marker to the Antenna Reference Point (ARP) defined by the IGS for each antenna in the file https://files.igscb.org/pub/station/general/antenna.gra, must be surveyed and reported in the station site log and RINEX headers to ≤ 1 mm accuracy.

2.1.6 The antenna must be oriented to True North using the defined antenna reference marker (see vendor instructions).

2.1.7 The antenna must be rigidly and securely attached to the top of the station monument.

2.2 Marker and Monument

2.2.1 The station should not be moved to a different monument unless absolutely necessary. Moving to a new monument would require that a new station be established with a new station 9-char ID and a new station site log. This new station will then have to follow again the "Procedure for Including GNSS Stations in EPOS".

2.2.2 If upgrading a station from a bad monument design to a better antenna mount, involving moving the original marker, then the upgrade is essentially the commissioning of a new station.

2.3 New Stations

In addition to 2.1 - 2.2, new stations should respect the requirements below.

2.3.1 New stations can only be integrated in EPOS-GNSS after following the "Procedure for Including GNSS Stations in EPOS".

2.3.2 The station location should not

- suffer from significant changes to the surroundings (changes to buildings or trees; new construction, etc…) foreseen or likely
- have excessive radio frequency (RF) interference
- have excessive RF reflective surfaces (fences, walls, etc.) and other sources of signal multipath
- have excessive natural or man-made surface vibrations from ocean waves or heavy vehicular traffic.

2.3.3 The station monument

- should be conform with current best practices. A drilled-braced tripod structure or tapered pillar type monument are typically constructed. If possible, roof or structure mounted antennas should be avoided.
- foundation should extend to bedrock or, where bedrock is not accessible, ideally be deeply embedded into the stable subsurface to be isolated from surface effects.

2.3.4 Co-location with other geodetic techniques such as SLR, VLBI, DORIS, absolute or superconducting gravimeters, Earth tide gravimeters, seismometers, strain meters, and ocean tide gauges are encouraged and will enhance the value of the station for multi-disciplinary studies.

2.4 Recommended characteristics

Receiver

2.4.1 The receiver should track as many satellites, healthy and unhealthy (all-in-view tracking), from as many constellations as possible (within receiver limitations), always including all GPS satellites as a minimum.

2.4.2 The receiver should track satellites down to a cut off of 0°. The receiver cut off must be updated at the M³G-Bureau at each change.

2.4.3 The receivers shall be upgraded with firmware upgrades from the manufacturer within 6 months of the firmware publication. Firmware updates shall be provided to the M³G-Bureau at each change.

2.4.4 Disable pseudorange and/or phase smoothing. If activated by mistake, any changes in the receiver setting shall be reported in an updated station site log.

Antenna

2.4.5 It is recommended that calibrations are available for the antenna+radome pair. These calibrations should be type mean calibrations available from the IGS phase centre variation file (https://files.igscb.org/pub/station/general/igs14.atx) or individual antenna calibrations (performed by a calibration facility recognized by the IGS and available on-line).

2.4.6 It is recommended to document any deviations of the antenna with respect to the True North in the station log.

2.4.7 If available, new individual absolute antenna calibrations for an antenna+radome pair have to be made available on-line prior to installing the antenna+radome pair or including the station into the EPOS-GNSS network.

2.4.8 The antenna must be setup to minimize code and phase reflections (multipath), by mounting it away from close reflecting surfaces or by applying some passive protection directly below the antenna (microwave absorbing material, etc).

2.4.9 It is recommended to clean the antenna (without changing its position or removing it!) at least once a year. During wintertime, remove snow coverage as frequently as possible. Report the cleaning in the station log.

Obstructions and interferences

2.4.10 Obstruction should be minimal above 5° elevation, but satellite visibility at lower elevations is encouraged whenever possible.

2.4.11 Signal reception quality has to be verified by counting the number of observations on each frequency that is set to be tracked. A reduced number of observations can indicate interference of external signal sources like radars.

Marker documentation

2.4.12 The marker description should be fully documented in section X of the station site log file.

2.4.13 The 3-dimensional local ties between the GNSS marker, co-located instrumentation (e.g. DORIS, SLR, VLBI, gravity, tide gauge, levelling) and other monuments should be re-surveyed as frequently as practical (ideally each 2 years) to an accuracy of 1-mm and reported in ITRF:

- The marker → antenna reference point eccentricities should be re-verified during such a survey.
- Repeat the survey after known motion incidents such as earthquakes.
- All survey data, but especially ties to other IERS/IGS/EPN/EPOS-GNSS markers, should be rigorously reduced in a geocentric frame related to ITRF (preferably ITRF itself) and the results be made available in https://www.iers.org/IERS/EN/Organization/AnalysisCoordinator/SinexFormat/sinex.html, including full variance-covariance information.

- Survey notes and intermediate results of the 3D ties shall be preserved and made available publicly.

3 Responsibilities

3.1 Data Supplier

The Data Supplier must ensure responsibility for

3.1.1 Reliable data handling and transmission to the relevant EPOS-GNSS Data Node (according to the guidelines in 4)

3.1.1 Taking appropriate action if the station performance degrades, e.g. the alert/engagement of on-site staff, especially after receiving an alert from the Data Monitoring Centre (*not active yet*).

3.1.2 Taking appropriate action for correcting the metadata in the RINEX header (see 4.1.6), or updating of the station metadata (see 4.1.4) as soon as possible, if an inconsistency advisory is received.

3.1.3 Ensuring that the GNSS equipment, and its surroundings, is not disturbed or changed unless a clear benefit outweighs the potential for discontinuities in the time series. Accepted disturbances include: equipment failure, planned upgrade of obsolete equipment or vendor-recommended firmware updates

3.2 Operational Centre

The Operational Centre must

3.2.1 Document changes at the station (or its environment) by updating the station metadata within one business day at the M³G-Bureau.

3.2.2 Correct the station metadata at the M³G-bureau as soon as possible if an advisory of station metadata inconsistencies is received.

3.2.3 Maintain at the M³G-Bureau the 'My Agency' profile, and, if applicable, the 'Third-Party Agencies' information. This includes contact information, the list of operated stations.

Correctly completed and up-to-date Agency information, available at the M³G-Bureau, is a pre-requisite for uploading station metadata!

4 Requirements for Data Flow

EPOS-GNSS stations make their data routinely available to EPOS through a designated EPOS-GNSS Data Node. At this moment, EPOS only collects daily RINEX files.

4.1 Format and Distribution of Daily Data

4.1.1 The station must provide observation files to a Data Repository associated to an EPOS-GNSS Data Node. The list of EPOS-GNSS Data Nodes can be consulted from https://gnss-metadata.eu/site/datanode.

4.1.2 The minimal requirement for data submission are daily observation files with a 30-second sampling rate. These daily observation files contain the observations collected between GPS time 00:00:00 and 23:59:59.

4.1.3 The observation files must be provided in the RINEX format, directly generated from the receiver's native data files.

4.1.4 It is recommended to submit observation files in the RINEX 3 format. If this is not possible, then the RINEX 2 format can be accepted. Use the current RINEX standard recommended by the EUREF and the IGS, see http://epncb.oma.be/_documentation/formats/rinex.php.

4.1.5 Observation files will be exchanged in the Hatanaka Compact form.

- All observation files are then compressed (UNIX compressing .Z – for RINEX 2 format) or gzipped (.gz – for RINEX 3 format).
- File naming conventions described in the RINEX 2 and 3 format descriptions must be used.

4.1.6 RINEX observation header information, especially the station ID, receiver and antenna information, DOMES number (if available), and antenna eccentricities, must be up-to-date and must match the information in the station log. The following conventions are used:

- The 4-character station ID (or 9-character for RINEX 3 data) must be found in the "MARKER NAME" field
- If available, the DOMES number must appear in the "MARKER NUMBER" field.
- The receiver serial number, type and firmware must be found in the "REC # / TYPE / VERS" fields.
- The antenna serial number, antenna type and radome type (if no radome, use "NONE") must be found in the "ANT # / TYPE" fields. If individual calibrations are available, this serial number must be in agreement with the serial number in the individual antenna calibration file.
- The RINEX headers must begin showing an equipment change at the actual time of the change.

Additionally-desired characteristics are:

4.1.7 After a communication outage between the station and the Data Repository, the recovered data files should be submitted to the repository as quickly as possible. The usage of automated procedures is strongly recommended.

4.1.8 The signal-to-noise observables (S1, S2, etc…) should be included in RINEX files.