Guidelines for EPN Stations & Operational Centres

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Updates:
May 15, 2007: Section 3.7.4: update of mandatory messages
March 1, 2007: Section 3.7: update of mandatory messages
Dec. 5, 2006:
- Added guidelines for stations streaming real-time data
- Promote usage of multi-GNSS equipment
- Recommendation for new antennae/radomes or antenna/radome replacements to be absolutely calibrated

Very strict rules are inconsistent with the voluntary nature of the EUREF Permanent Network (EPN). However, stations participating to the EPN must agree to adhere to certain standards and conventions which ensure the quality of the EPN. This document lists the requirements that all EPN Stations and Operational Centres (OC) must follow, as well as some additional desirable characteristics, which are not mandatory, but enhance a station's or OC's value to the EPN.

For proposed EPN stations please refer to the document "Procedure for Becoming an EPN station":
http://epncb.oma.be/_organisation/guidelines/procedure_becoming_station.pdf .

For IGS tracking stations, please refer to "IGS Site Guidelines"
http://igscb.jpl.nasa.gov/network/guidelines/guidelines.html available from the IGS Central Bureau.

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1 Organization of the EPN Data Flow

1.1 Network Components

En route to Analysis Centres and other users, the tracking data collected by permanent GNSS receivers flow through the following components of the EPN network:

- **Tracking Station (TS)**: Sets up and operates the permanent GNSS tracking receivers and antennae on suitable geodetic markers.
- **Operational Centre (OC)**: Performs data validation, conversion of raw data to the Receiver Independent Exchange Format (RINEX), data compression, and data upload to the Data Centres through the Internet. For some sites, the OC is identical with the institution responsible for the respective site (i.e., the OC is identical with the TS).
- **Local Data Centre (LDC)**: Collects the hourly and daily data of all stations in a local network and distributes them to the users (local and EUREF). For many of the local networks, the LDC will be identical with the Operational Centre. The LDC will forward the data (or a selection) of the local sites to the Regional Data Centres. If there is no LDC available for a particular station, then its data will flow directly from the OC to the Regional Data Centres.
- **Regional Data Centre (RDC)**: It collects the hourly and daily data from all EPN stations. The RDC makes the data available to the local, regional and IGS users.
- **Local Broadcaster (LB):** It receives the real-time data streams from the stations in a local network and disseminates them, without changing them, on request to clients. Clients may be users, monitoring tools, data centers, or analysis centers.
- **Regional Broadcaster (RB):** It receives all the EPN real-time data streams and disseminates them, without changing them, on request to clients. Clients may be users, monitoring tools, data centers, or analysis centers.
- **High Rate Data Centre (HDC)**: It collects the real-time data from all EPN stations, archives them in RINEX format and makes them available to the users.

To guarantee the availability of the EPN data at the regional level, two RDCs are in operation. Each RDC makes available the data of all EPN stations.

In the following, we will use the wording “Data Centre” (DC) for both the RDC and LDC, and “Broadcaster” for both the LB and RB.

1.2 Schematic overview

EPN stations make their hourly and daily data routinely available at two DCs. The names of these DCs are indicated in the station site log as the “Primary Data Center” and “Secondary Data Center”. Based on this principle, each station/OC can distribute its data following one of the three standard data flow schemes given in Figure 1.

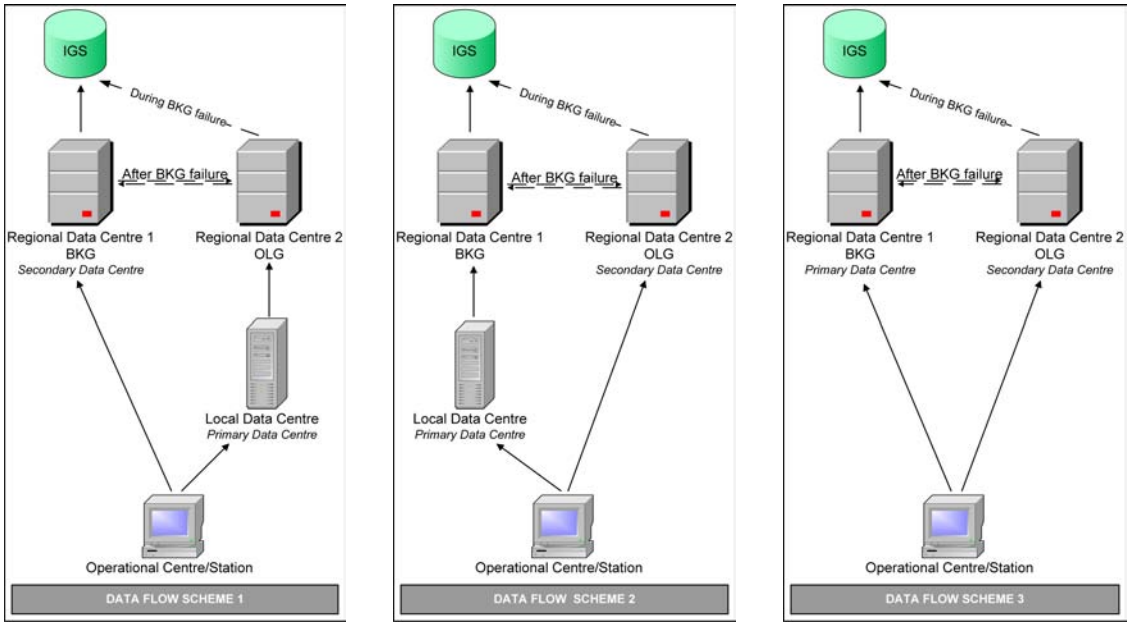

Figure 1: Standard data flow schemes for hourly and daily data within the EPN.

Exceptionally, if none of the schemes in Figure 1 can be applied, the scheme given in Figure 2 can be used. In this scheme, the station/OC submits its data only to one Data Centre, noted as the 'Primary Data Center' in the site log. In case of a failure of this LDC, the data flow will be interrupted. For this reason this last scheme is not considered as optimal.

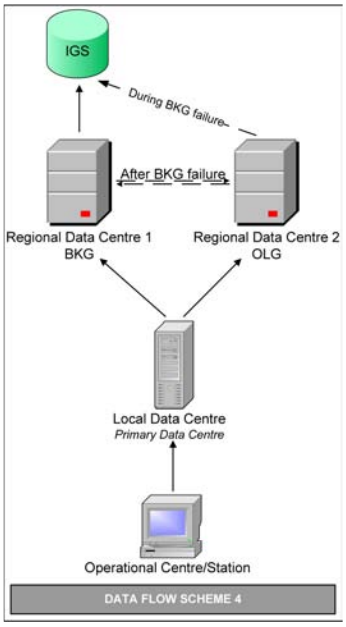

Figure 2: EPN data flow scheme for hourly and daily data, used only in case the standard data flow schemes cannot be implemented.

Stations streaming real-time data make their data available at the Regional Broadcaster who makes available all EPN real-time data streams. If the station is part of a local network, it can also make available its real-time data at a Local Broadcaster.

2 Requirements for Permanent Stations

For a station to be included in the EUREF Permanent Network, the following guidelines will be used to judge the merits of a candidate station. Please consult also the checklist of "Procedures for Becoming an EPN station":
http://epncb.oma.be/_organisation/guidelines/procedure_becoming_station.pdf .

2.1 Equipment and operation

2.1.1 The GNSS equipment, and its surroundings, must not be disturbed or changed unless a clear benefit outweighs the potential for discontinuities in the time series. Examples include
- Equipment failure
- Planned replacement of obsolete equipment
- Vendor-recommended firmware updates

Receiver

The GNSS receiver must

2.1.2 Track both GPS codes and phases on L1 and L2 under non-AS (Anti Spoofing) as well as AS conditions. Required observables are L1, L2, P2, and at least one of C1 or P1.

2.1.3 Be capable of, and set to, record data from at least 8 satellites in view, simultaneously.

2.1.4 Track at least with 30 seconds sampling rate. If the sampling rate is faster, the data should be decimated to 30 seconds prior to upload to the Primary and Secondary DCs.

2.1.5 Be set to record data down to a cut off of 5 degrees or less.

2.1.6 Synchronize the actual instant of observation with true GPS time within ± 1 millisecond of the full second epoch.

Additionally desired characteristics are:

2.1.7 Receiver capable of tracking all visible GNSS satellites ("all-in-view" tracking) is preferred.

2.1.8 The receiver tracking cut off is ideally zero degrees, especially for "all-in-view" receivers.

2.1.9 GNSS receivers and ideally other station equipment such as computers should be protected against power failures by providing surge protection and backup power wherever feasible.

2.1.10 Equipment never used before in the EPN/IGS should be avoided until tested and well understood by IGS or EPN Analysis Centres. Inform the EPN Central Bureau of proposed new types of equipment (any receiver or antenna+radome combination not found in ftp://epncb.oma.be/pub/station/general/euref.snx). Test data sets, and analysis of test data, will be helpful. Inform the CB whether these will be available.

2.1.11 Receivers should be set to record data from all satellites, including those newly launched or set 'unhealthy'.

2.1.12 Receivers and RINEX converters should not be set to smooth data.

Antenna

The GNSS antenna must

2.1.13 Be known to the IGS and EPN ; a standard name must be designated for the antenna in ftp://epncb.oma.be/pub/station/general/rcvr_ant.tab.

2.1.14 Be represented accurately in the EPN phase centre variation file epn_05.atx which contains the available individual antenna calibrations of EPN antenna+radome pairs and the antenna+radome type calibrations available from the IGS Central Bureau (containing absolute type calibrations obtained from a dedicated absolute calibration as well as values converted from relative calibrations). The EPN CB provides free access to the file epn_05.atx, but the file is password protected in to order to fulfil the requirements of any license protections. The following web-page can be used to request a username/password: http://www.epncb.oma.be/_trackingnetwork/equipment_calibration/userid_password_request.php

2.1.15 If no antenna radome is used, then, when antennae are introduced in the EPN (through new stations or when replacing an antenna at an existing station) the station manager should provide individual absolute calibrations to the EPN CB or the antenna should have true absolute type calibrations (not converted from relative) available from the IGS Central Bureau. The list of antennae that replies to this last requirement is given in ftp://epncb.oma.be/pub/station/general/calib_antenna.txt .

2.1.16 Be levelled and oriented to True North using the North reference mark and/or antenna RF connector.

2.1.17 Be rigidly attached, such that there is not more than 0.1 mm motion with respect to the antenna mounting point.

2.1.18 The eccentricities (easting, northing, height) from the primary marker to the antenna reference point (defined in ftp://epncb.oma.be/pub/station/general/antenna.gra) must be surveyed and reported in the site logs and RINEX headers to ≤1 mm accuracy.

2.1.19 The height eccentricity must be less than 10 m, the horizontal eccentricities must be below 5 m. (see also 2.2.5).

Additionally desired characteristics:

2.1.20 Choke ring antennae are preferred.

2.1.21 If no antenna radome is used, it is recommended to clean the antenna (without removing it!) at least once a year. During winter time, remove snow coverage as frequently as possible.

Radomes

2.1.22 Avoid using radomes unless required operationally, for instance due to weather conditions, antenna security, wildlife concerns, etc.

2.1.23 Non-hemispherical radomes especially must be avoided when the shape is not required by site characteristics (e.g. for snow rejection).

2.1.24 If a radome must be used, it must be known to the IGS and EPN ; a standard name must be designated for the radome in ftp://epncb.oma.be/pub/station/general/rcvr_ant.tab.

2.1.25 If a radome must be used, an entry for the antenna+radome pair must be in the EPN absolute phase centre variation file epn_05.atx which contains the available individual antenna calibrations of EPN antenna+radome pairs and the antenna+radome calibrations available from the IGS Central Bureau (containing both absolute type calibrations converted from relative as well as from a dedicated absolute calibration).
To use an antenna+radome pair not found in epn_05.atx, it will be necessary to provide individual absolute antenna calibrations for that antenna+radome pair to the EPN CB in order to include this information in epn_05.atx.
Exceptions are allowed for
- antenna+radome pairs
    - where the effect of the radome on the antenna phase centre is negligible

- which cannot be absolutely calibrated

- stations that provide a clear added-value to the EPN

In that case, the radome will be neglected and 2.1.14 will be applied.

2.1.26 If a radome must be used, then, when antenna+radome pairs are introduced in the EPN (through new stations or when replacing an antenna/radome at an existing station), the station manager should provide individual absolute calibrations to the EPN CB or the antenna+radome pair must have true absolute type calibrations (not converted from relative) available from the IGS Central Bureau. The list of antenna+radome pairs that replies to this last requirement is given in ftp://epncb.oma.be/pub/station/general/calib_antenna.txt.
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- antenna+radome pairs
  - where the effect of the radome on the antenna phase centre is negligible
  - which cannot be absolutely calibrated
- stations that provide a clear added-value to the EPN

Additionally desired characteristics are:

2.1.27 Radomes uniformly manufactured with less than 1 mm variability in thickness are preferred.

Operation

2.1.28 Stations must be permanent and continuously operating.

2.1.29 Following the procedures in the "Procedure for becoming an EPN station", http://epncb.oma.be/_organisation/guidelines/procedure_becoming_station.pdf :

- The station will have obtained a unique 4-character ID and an IERS DOMES number
- Each real-time data stream of the station will have obtained a 5-character ID (mountpoint) composed of the 4-character ID plus an integer number which indicates the format of the stream

2.1.30 The operating agency must always have the capability to repair or improve the station and its software systems, even if the original engineers are no longer available.

Additionally desired characteristics are:

2.1.31 Precise meteorological instrumentation is encouraged:

- Data are to be prepared in RINEX files. See the RINEX specification, ftp://epncb.oma.be/pub/data/format/rinex300.pdf .
- Observation interval must be no more than 60 minutes. An observation interval of 10 minutes is optimal.
- Pressure sensor noise must be no more than 0.5 hPa.
- Temperature sensor accuracy must be at least 1 Kelvin.
- Drift and bias must be minimized.
- Temperature effects on the pressure measurements should be minimized, e.g. with solar shielding or by placing the sensor in a nearby building if necessary.
- Measurement of the instrument height in relation to the GNSS antenna mark must have an accuracy of 1 m or better.
- Data is to be transmitted on the same schedule as the RINEX observation files (hourly for hourly sites; otherwise daily).
- Meteorological instruments are to be calibrated periodically according to the manufacturer's recommendations. It is recommended to do a periodic calibration against a pressure/temperature sensor operated by a local weather authority and keep a record of the calibration in the site log.

2.1.32 Anticipate upgrades to new equipment types, including support to new GNSS signal types, while paying attention to data overlap to avoid discontinuity.

2.1.33 Station infrastructure should include:

- Ample, reliable power and communications (preferably Internet) to enable reliable data transfer
- Physical site security appropriate to local necessity.

2.1.34 Other equipment to observe geophysical signals -- such as SLR, VLBI, DORIS, absolute or superconducting gravimeters, Earth tide gravimeters, seismometers, strain meters, ocean tide gauges -- are also desirable and will enhance the value of the station for multi-disciplinary studies.

2.1.35 The levelling connection to the UELN and the national precision levelling network is desirable. For the connection, the ECGN guidelines should be used (http://gibs.bkg.bund.de/ecgn).

2.1.36 Other scientific systems which rely on accurate positioning, such as timing labs, are also recommended where appropriate.

2.2 Marker

2.2.1 The marker should fulfil standard requirements for a first order geodetic monument with respect to stability, durability, long-term maintenance, documentation and access. The marker description should be fully documented in the EPN site log file.

2.2.2 Obstruction should be minimal above 15 degrees elevation, but satellite visibility at lower elevations is encouraged whenever possible.

2.2.3 Signal reception quality has to be verified, especially with respect to interference of external signal sources like radars, and with respect to multipath.

2.2.4 Local ties to other markers on the sites should be determined in the ITRF coordinate system to guarantee 1-mm precision in all three dimensions. Offsets are given in delta-X, delta-Y, delta-Z, where X, Y, Z are the geocentric Cartesian coordinates (ITRF).

Additionally desired characteristics are:

2.2.5 The antenna reference point ideally will be mounted directly vertically above the marker (i.e., horizontal eccentricities ideally are zero).

2.2.6 Additional monuments are desirable for surveys and testing, but it is preferable to maintain one antenna + receiver pair as the best site for the EPN, rather than to submit more than one "site" to the EPN.

2.2.7 3-dimensional local ties between the GNSS marker, collocated instrumentation (e.g. DORIS, SLR, VLBI, gravity, tide gauge, levelling) and other monuments should be re-surveyed regularly (ideally each 2 years) to an accuracy of 1-mm and reported in ITRF.

- The marker → antenna reference point (ARP) 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 markers, should be rigorously reduced in a geocentric frame related to ITRF (preferably ITRF itself) and the results be made available in SINEX format (defined at http://www.iers.org/documents/ac/sinex/sinex_v210_proposal.pdf), including full variance-covariance information.

2.2.8 When antenna changes are planned, operate both the new and old antennae at the same time first (if an additional monument and receiver are available), and announce to EUREF mail how analysts may get the test data set.

2.2.9 Agencies are encouraged to select potential new sites which meet most of the following features, and work toward these characteristics at existing sites.
The site location should:
- be on a stable regional crustal block, away from active faults or other sources of deformation, subsidence, etc. Contact the Reference Frame Coordinator, or the CB for assistance in determining the stability of a particular area, if it is not clear.
- be on firm, stable material, preferably basement outcrop
- have a clear horizon with minimal obstructions above 5 degrees elevation

The site location should not:
- be located on soil that might slump, slide, heave, or vary in elevation (e.g. because of subsurface liquid variations)
- have significant changes to the surroundings (changes to buildings or trees; new construction, etc) foreseen or likely
- have excessive radio frequency 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.

A physical marker should be provided, to allow the assignment of an M-type IERS DOMES number (see http://lareg.ensg.ign.fr/ITRF/DOMES_DESC.TXT).

2.3 Documentation

Site logs

2.3.1 Whenever there is a change to the site information as documented in the station log, the log must be updated:
- The EPN site description file (site log file) should be updated out and sent to the EPN CB. Refer to ftp://epncb.oma.be/pub/station/general/sitelog_instr.txt for detailed site log preparation instructions. Use the automated site log tester (epcnbslt@oma.be) to verify the format and contents of your site log. Submit the site log using the automated site log submission (epcnbsls@oma.be). Refer tohttp://epncb.oma.be/_trackingnetwork/sitelog_sub_test.php for detailed instructions. If necessary, site descriptions (photos, maps, etc) should be sent to the Central Bureau.
- Updates must be sent to the EPN CB within one business day of any change. An announcement of the change must be posted through EUREF mail (http://epncb.oma.be/_newsmails/EUREFmail/)

2.3.2 If an advisory of site log inconsistencies is received from the CB, the site log must be corrected as soon as possible.

EUREF mailing list messages

2.3.3 When sending a message to the EUREF mailing list about a particular station or stations, place the 4-character site ID(s) in the Subject. Instructions on sending a EUREF mail can be found in http://epncb.oma.be/_newsmails/mail_rulings.php?community=EUREF .

2.3.4 An advisory EUREF mail message should be sent in the following cases, in advance if possible, otherwise within one business day:
- Changes in antenna, radome, monument, receiver, cabling, frequency standard, receiver settings such as elevation cut off angle, or environment (such as tree removal or building

construction); in general, any change which can affect position solutions. Briefly describe in the message what was changed.
- If a RINEX file must be resubmitted to a DC due to corruption, incorrect metadata, etc.
- If a station is expected to be unavailable for more than one week.
- When a site is decommissioned permanently.
- When a problem or error in the station or its site log is discovered and corrected. Briefly describe in the message what was changed.

2.3.5 The agency accepting responsibility for proper station operation must follow the EUREF mail list on a regular basis, either by subscribing or regularly checking the web archive. See http://epncb.oma.be/_newsmails/mail_rulings.php?community=EUREF for subscription information.

2.4 Location

2.4.1 The site must occupy a relevant location into the EUREF Permanent Network:
- For stations installed primarily to contribute to the maintenance of the ETRS89, a minimal distance of 300 km to already existing EPN stations is required, accepting the interest of each nation to have at least one EPN station.
- Exceptions to this rule are possible for stations submitting hourly data, contributing to EPN Special Projects or collocated with other instruments relevant to the purposes of the EPN (e.g. tide gauges, time laboratories).

2.5 Switch between operational and inactive status

When a station has been excluded from the EUREF combined solution for more than 3 months, the EPN CB labels this station as inactive. Stations can be classified as inactive for several reasons, e.g.:
- the station is excluded from the EPN due e.g. bad data quality or meta data inconsistencies
- the station has been destroyed and is in the process of reconstruction
- the station has temporarily stopped submitting RINEX data

2.5.1 Inactive stations can recover the operational status when they fulfil the requirements for EPN stations again.

3 Requirements for Operational Centres

3.1 Responsibilities

The Operational Centres control the sites of a particular (local) network from the operational point of view. They form a link between the sites, the Data Centres and the Broadcaster (if applicable). The Data Centres and Broadcaster then make available the data to the Analysis Centres, other Data Centres and individual users.

The Operational Centres are responsible for
- the download of the raw data from the receivers of the local network
- the archiving of the raw data
- the reformatting of the data into the agreed-upon exchange format (RINEX)
- the quality check of the data on a station by station basis (the use of Unavco's QC program is strongly recommended, see 3.5.3)
- the generation of status messages (abnormal conditions), which have to be announced through EUREF mail
- the alert/engagement of on-site staff (abnormal conditions)

- the upload of the data (daily and hourly) to the Data Centres at agreed-upon times
- if applicable, the real-time upload of the data to the Broadcaster, and this in the agreed upon format

There are many independent tracking sites that are not part of a local or special network. As such, they are not connected to an actual OC. In this case the organization operating the site also performs the tasks outlined above.

The EPN CB makes available a blank form (ftp://epncb.oma.be/epncb/center/oper/BLNKFORM.OC) for an Operational Centre. This form should be filled out by the Operational Centre or by the agency operating an independent permanent GNSS station and sent to the EPN Central Bureau.

3.2 Hourly and Daily Data flow

3.2.1 All data files are to be transmitted in quick succession, to two data centres (the "Primary" and "Secondary Data Centers" in the site log) using one of the standard Data Flow Schemes given in Figure 1. If none of the standard Data flow Schemes can be implemented, then apply the Data Flow Scheme in Figure 2.

3.2.2 The minimal requirement for data submission is daily (24 hour) files with a 30 second sampling interval.

3.2.3 For some stations it is mandatory (see 2.4.1) to submit hourly data.

3.2.4 All data handling, including receiver communication, reformatting, quality check, and transmission to the DC, should be automated by computer(s).

3.2.5 Transmission of the data to each DC must be verified to be uncorrupted. In addition, the upload should be retried after failure.

3.2.6 For standard operations, the data delivery to the DCs must be done as quickly as possible which means within 10 minutes after closing time of the file. For remote sites, or sites with difficult communications, the daily data should at least be available within the same delay as the satellite orbits become available (currently 12 days).

3.2.7 If an upload fails, then a retry should be made as quickly as possible. At least a second retry should be done within the hour.

3.2.8 Hourly files, which could not be sent, or have to be updated, must arrive within three days. After that date, updates must be done through the upload of the appropriate daily file.

3.2.9 After a communication outage between the station and the OC, or between the OC and the DCs, all recovered data files must be submitted to the DCs.

Additionally desired characteristics are:

3.2.10 The automated use of a quality check program is recommended to verify data quality (not just metadata correctness), prior to transmission to a DC.

3.2.11 Hourly data is preferred, especially in cases where there are few nearby hourly stations in the region.

3.2.12 In case of reliable hourly data upload, it is possible to discontinue the submission of the daily files. The following procedure must be adopted:

1) Send an e-mail to the DC some days before you intend to cancel the transfer of daily files announcing that intention
2) Wait for the confirmation of the DC
3) If the DC agrees, stop the transfer of daily files

3.2.13 In addition to the standard data flow, stations are encouraged to make their data available in real-time using the Ntrip-technology and contribute to the EUREF-IP project (also see http://epncb.oma.be/_organisation/projects/euref_IP/).

3.3 Real-time Data Flow

3.3.1 For standard operations the data should be sent in real-time using the Ntrip-server software (http://igs.bkg.bund.de/index_ntrip.htm) to the Regional Broadcaster. The minimal requirement for data submission is 1 Hz containing full code and carrier phase observations.

3.3.2 After a communication outage or reception of a NABU message, the data flow should be restored as quickly as possible, preferable using an automated procedure.

Additionally desired characteristics are:

3.3.3 In addition to the data upload to the Regional Broadcaster, stations are encouraged to upload their data to a Local Broadcaster.

3.4 Data Archiving

3.4.1 The station operating agency must archive the raw GNSS data, or arrange for this at a suitable agency such as a partner agency, or an Operational Centre.

3.5 Data Validation

3.5.1 Data should be checked before being sent to a Data Centre. A minimum verification should consist of a check of

- the total number of observations
- the total number of observed satellites
- the date of the first observation record in the file
- the station name, receiver/antenna types, antenna height

3.5.2 Files, which do not meet the minimum verification, should not be sent to a Data Centre.

Additionally desired characteristics are:

3.5.3 The use of an up to date true quality check program is highly recommended, e.g. the QC program, which can be obtained from Unavco (see http://facility.unavco.org/software/teqc/teqc.html).

3.6 Format of Hourly and Daily Data

3.6.1 GNSS data (observations and broadcast ephemeris) are to be prepared and distributed in the RINEX format, version 2.00 or greater, as specified in ftp://epncb.oma.be/pub/data/format/rinex300.pdf

- Observation files will normally be exchanged in the Hatanaka Compact form. See the RINEX specification ftp://epncb.oma.be/pub/data/format/rinex300.pdf and confirm with your DC.
- All files are ordinarily UNIX compressed (.Z) for transmission to DCs. Confirm with your DC. The RINEX navigation, meteo and summary files are prepared in a compressed form using the standard UNIX compress program.
- File naming conventions set forth in the RINEX specification ftp://epncb.oma.be/pub/data/format/rinex300.pdf, section 4, "The Exchange of RINEX

files", will be followed. Some DCs implement lower-case file type codes and/or site IDs. Confirm with your DC. Case must not be used to distinguish between unique files.

3.6.2 The daily observation files contain the observations collected between 00:00:00 and 23:59:59 GPS time.

3.6.3 The sampling rate (observation interval) of the daily observation file must be the adopted standard, currently 30 sec. Even if the receiver sampling interval is less than 30 seconds, the data submitted to EUREF archives must have a 30 second interval, with observations aligned to :00 and :30 epochs.

3.6.4 The daily (24 hour) navigation message file contains all messages with TOC/TOE (time of clock, time of ephemeris) at and between 00:00 and 23:59 GPS time of the respective day. It is recommended to generate a combined daily RINEX navigation file containing non-redundantly all navigation messages collected by all sites of a local network. The filename (part "ssss", see below) should then contain a 4-character code of the Operational Centre.

3.6.5 For hourly data uploads,

- Each file contains the data of one hour, synchronized with GPS time.
- Files are named as in section 4 of the RINEX specification, but with the file sequence letter "f" replaced with an hour sequence code ('a'=00:00UT to 00:59UT .. 'x' = 23:00UT to 23:59UT).
- As last file to each group of station files, a flag file with the same name as the observation files but with "flg" (or "FLG") as extension needs to be uploaded. This file contains a list of the uploaded files (excluding the flag file) together with the file sizes (in bytes) so that the receiving data centre can check if the transfer was completely successful (File sizes determined on VMS systems are rounded to the next 512 bytes block).
  Example: Transmission of: `zimm123a.98d.Z`, `zimm123a.98n.Z`, `zimm123a.98m.Z` is followed by the transmission of `zimm123a.flg` (as last file!).
  `zimm123a.flg` contains:

```
zimm123a.98d.Z      234567
zimm123a.98n.Z      12345
zimm123a.98m.Z      9876
```

  If the generation of the file list with file size is not possible, an empty flag file properly named can be uploaded instead.

3.6.6 The header information, especially the 4-character site ID, receiver and antenna information, IERS DOMES number, and antenna eccentricities, must be up-to-date and strictly follow the agreed-upon conventions.

- Specifically, they must match the information in the site log and therefore observe the same equipment naming conventions found in ftp://epncb.oma.be/pub/station/general/rcvr_ant.tab .
- A radome identifier code from ftp://epncb.oma.be/pub/station/general/rcvr_ant.tab must be found in the ANT TYPE field, in columns 17-20 of this field.
- The RINEX headers must begin showing an equipment change as near as possible to the actual time of the change.
- If an advisory of RINEX header inconsistencies is received from the CB, the headers must be corrected as soon as possible and the corresponding data files must be resubmitted to the DCs.

3.6.7 Metadata correctness for daily (24 hour) data files must be minimally verified prior to transmission to a DC. Site name, number of observations, epoch, equipment types, interval, and eccentricities must be verified to be correct prior to transmission.

Additionally desired characteristics are:

3.6.8 Stations equipped with high-precision weather sensors are encouraged to submit the daily RINEX meteo files too (see 2.1.31).

3.6.9 The summary output of the quality check run can be sent to (and made available by) the data centres.

- File name conventions are similar to the RINEX data files, but using "S" for the file name type, e.g. ZIMM1230.99S.
- Quality check data is to be transmitted on the same schedule as the RINEX observation files (hourly for hourly sites; otherwise daily).

3.6.10 The S1 and S2 observables should be included in RINEX files.

3.6.11 For data transfer to and from the LDC's, the use of the Hatanaka compression is also recommended.

3.7 Format of real-time data

3.7.1 EPN real-time data streams must contain code and carrier phase observations and therefore only formats allowing this possibility are accepted, eg RTCM (2.1, 2.2, 2.3, 3.0 or 3.1, see http://www.rtcm.org/), some raw data formats or the SOC data format, developed by the IGSRT working group (see http://igscb.jpl.nasa.gov/projects/rtwg/). Raw data formats and the SOC data format are only accepted if the software to convert the format to RINEX is freely available for several platforms (eg teqc).

3.7.2 RTCM code and phase observations should not be corrected to refer to the antenna reference point (correction is typically known as the antenna phase center correction).

3.7.3 Stations streaming RTCM2.x (x=1, 2, 3) must at least stream message types 3, 18 and 19 (see Table 1).
The coordinates in message type 3 should be in accordance with the agreed upon coordinate table available from the EPN Central Bureau.
If other message types containing meta-data are streamed, their information should be in full accordance with the site log information, and antenna description and calibration file available from the EPN CB.

Message type	Content
3	(X,Y,Z) coordinates of antenna phase center, cm-precision
18	Code data
19	Carrier phase data
22	(dX, dY, dZ) corrections to message 3 coordinates to achieve mm-precision for L1 and L2 antenna phase center + height of antenna phase center above marker
23	Antenna and radome type definition
24	(X,Y,Z) coordinates of the antenna reference point

Table 1: RTCM 2.x (x=1, 2, 3) message types

3.7.4 Stations streaming RTCM3.x (x=0,1) must at least stream message types 1004 (use 1003 only if 1004 is not available), 1006 (or 1005) and 1008 (or 1007) (see Table 2). GPS/GLONASS stations streaming RTCM 3.x should stream in addition message type 1011 (use 1012 only if 1011 is not available).
The coordinates in message type 1006 (1005) should be in accordance with agreed upon coordinate table available from the EPN Central Bureau.
If other message types containing meta-data are streamed, their information should be in full accordance with the site log information, and antenna description and calibration file available from the EPN CB.

Message type	Content
1003	GPS code and carrier phase observations
1004	GPS code and carrier phase observations + CNR (carrier to noise ratio) + code ambiguity
1005	(X,Y,Z) coordinates of the antenna reference point
1006	(X,Y,Z) coordinates of the antenna reference point + height of antenna reference

	point above marker
1007	Antenna and radome type definition
1008	Antenna and radome type definition + antenna serial number
1011	GLONASS code and carrier phase observations + CNR (carrier to noise ratio) + code ambiguity
1012	GLONASS code and carrier phase observations

Table 2: RTCM 3.x (x=0,1) message types

Additionally desired characteristics are:

3.7.5 The preferred format for real-time data streams is RTCM3.x (x=0,1) and stations are encouraged to use this format.

3.7.6 Stations streaming RTCM 2.x (x=1, 2, 3) are encouraged to stream messages types 22, 23 and 24 in addition to message types 3, 18 and 19.

4 Acknowledgment

This document was assembled from many preceding documents, including the previous version of "Standards for EPN Stations and Operational Centres", "Procedures for Becoming an EPN Station" and the latest version of "IGS Site Guidelines". Thanks are due to EUREF colleagues that have provided suggestions on this version.
Maintenance of this document is managed by the EPN Network Coordinator at the EPN Central Bureau. Please direct comments, questions, and suggestions to epncb@oma.be.