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GUIDE02 INSTALLATION, OPERATION AND REGISTRATION OF SIRGAS-CON STATIONS

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DOCUMENT CHANGE LOG

Version 2.0, 12.2021
(Previous edition: Version 1.4, 03.2017)

12.2021: *Merger between guides:*
1. Guide for the installation of SIRGAS-CON stations
2. Procedure to register a new station in the SIRGAS-CON network
Generating a unique guide:
2. Guide02 Installation, operation and registration of SIRGAS-CON stations
A general review of the content is made, internet links and additional details related to the Analysis Centers, the structure of SIRGAS and Working Group I are updated. Most of the texts prepared in previous versions by L. Sánchez, C. Brunini, S. Costa , V. Mackern and V. Cioce remains. As of this version, the writing team is indicated in the source of this document..

03.2017: *Some links on the Internet were updated.*

03.2013: *Some links on the Internet were updated.*

09.2010: *The new SIRGAS FTP server was included.*

09.2008: *Merger between the "Guide for the installation of SIRGAS-CON stations" and the "Procedure to register a new station in the SIRGAS-CON network".*

08.2007: *2.b is integrated into 1.c. 1.g, 2.e, 2.f and 3.3.d are added.*

08.2007: *Sub-items 5.a, 5.b, 5.c, 5.e, and 5.i are included in item 4. The rest of Section 5 disappears and Item 6 becomes No. 5.*

The objective of this document is to establish the indications for the installation and operation of the GNSS continuous operation stations for the SIRGAS Continuous Operation Network (SIRGAS-CON). The document has been prepared by the SIRGAS-GTI (Working Group I) and further complemented by recommendations made by various colleagues. SIRGAS is most grateful for this valuable collaboration.

In order to keep this document up-to-date, you are cordially invited to send your comments, questions or suggestions to the chair of the SIRGAS-GTI, whose contact details may be found at https://sirgas.ipgh.org/.

Related documents:

- Guide01 SIRGAS Network Coordination
- Guide03 Processing guidelines for the SIRGAS Analysis Centers.

1. INTRODUCTION

One of the most important aspects to reach international geodetic standards in relation to the materialization and densification of modern geodetic reference frames,[1], [2] is the selection of sites and geodetic instruments with certain characteristics, for the installation, operation and registration of a new station in the SIRGAS Continuous Operation Network (SIRGAS-CON).

Based on **"Guide01 SIRGAS Network Coordination"** which establishes the components of SIRGAS-CON, detailing their responsibilities and interaction, this document provides the guidelines, recommendations and commitments involved in the installation, operation and registration of a station in the SIRGAS-CON geodetic network.

2. LOCATION OF THE OBSERVATION SITE

The location selected for the installation of a SIRGAS-CON station must guarantee its long-term operability and adequate operation, in terms of permanence, accessibility, power supply, internet connection and security. This is required to ensure the timely availability of the observations recorded throughout its useful life.

The following recommendations are thus indicated to ensure the appropriate environmental conditions for GNSS tracking according to the requirements of any geodetic reference station:

1. The station should be located in a stable regional block, avoiding proximity to active faults or other sources of surface deformation due to geological causes.
2. It should be built on stable ground, preferably bedrock. Areas with a propensity for landslides, subsidence, vertical variations due to groundwater, river damage, etc., should be avoided.
3. The site selected for the station should not be affected by any future changes to the surrounding environment, such as tree growth, building construction, roof additions, antenna masts, etc.
4. The installation site should not be affected by excessive vibrations either of natural or artificial origin.
5. The horizon around the station must be free of natural or artificial objects having the potential to obstruct the path of the GNSS signals. At all events, the presence of obstructions should be minimal, below 5° degrees of elevation.
6. Any onsite radio interference with the GNSS signals, as well as reflective surfaces which could influence the multipath, should be avoided.
7. Installing stations directly on buildings is not suggested, however in these cases, it is preferable for the monument to coincide with a structural beam/column of the building.

3. STATION MONUMENTATION

The station must meet the standards defined for the physical realization of geodetic points designed to make up the reference framework in terms of stability, durability, long-term maintenance, accessibility and documentation. Thus:

1. The physical realization of the station must allow an IERS (International Earth Rotation and Reference Systems Service) DOMES number of type M to be assigned, indicating that the antenna is referenced to a physical point on a monument or pillar according to https://itrf.ign.fr/domes_desc.php.[3]
2. The structure of the monument must be rigid enough to ensure that any movement detected at the station is due to effects of a geophysical or geodynamic kind, and not attributable to the monument itself.
3. It is recommended that monumentation employs concrete columns or pillars, whose foundations are buried in the subsoil layer to make them are as stable as possible, or isolated from surface effects. As an alternative, monumentation may also involve metal masts and/or braces, with similar considerations in relation to the depth of the foundations.
4. The construction of monuments for SIRGAS purposes will be evaluated by Working Group I.
5. If the monument is erected on a building, checks must be carried out to verify that the structure has settled for at least five years since construction, and similarly, the building must not present structural damage of any kind.
6. The materials used for monumentation, such as concrete, metal masts, turnbuckles, supports, paint, and any others, must be resistant to long-term environmental effects and not be prone to rusting, erosion, corrosion, etc.
7. Since the station has to operate continuously, its monument should only allow the forced centering of the GNSS receiving antenna, ensuring that this remains permanently attached to the top of the monument.
8. Care must be taken to ensure that the monument only allows the GNSS receiving Antenna Reference Point (ARP) to be located in a vertical direction on the geodetic mark, thus avoiding any horizontal eccentricities of the antenna with respect to the monument.
9. It is emphatically recommended that two or three (eccentric) witness points are set up in the immediate surroundings to the main station (no more than 200 m apart), so that local displacements or deformations can be observed by means of annual periodic surveys.
10. The monument should not be built in places where electromagnetic signals can be received from other sources (radio, television, cell phones, radars, others), or where there are objects which could cause a multipath to the GNSS signal.
11. It is recommended that protective elements be added around the monumentation to shield it against electrical discharges from the atmosphere. Typically, these include lightning rods (preferably of the ionizing type), arrestors in the wiring between the antenna and the receiver, and ensuring the antenna is located in such a way as to guarantee safety within the protective cone cast by the lightning rod.
12. It is recommended that the station is linked to the national leveling network by at least precision trigonometric leveling and ideally geometric leveling.
13. The description of the monumentation's physical characteristics must be fully documented in a log file, **as detailed in Item 5.1**.

For more information on the physical characteristics of geodetic monuments, see:

a) "Monumentation Design and Implementation Recommendations".[4]

b) "IGS Site Guidelines".[5]

c) "Physical site specifications: geodetic site monumentation".[6]

d) "GNSS station monumentation".[7]

4. EQUIPMENT

The GNSS instruments to be installed in a SIRGAS-CON station must meet all the requisite technical specifications to guarantee the quality of the observations throughout the useful life of its components, e.g., receiver, antenna, radome, firmware. As its continuous operation is essential, the station **must not be disturbed, turned off or removed (especially the antenna)** unless this becomes strictly necessary because items have been damaged, or to carry out repairs, equipment updates or replacements.

If GNSS instruments have been replaced for the reasons previously indicated, the Operating Center and/or National Data Center responsible for the station must immediately notify the network using the SIRGAS Mail (**see details in Item 11**) as well as the corresponding instances within the SIRGAS-GTI, in order to take the appropriate action.

The station must have a permanent supply of electricity and internet, and it is advisable to take measures to avoid any interruptions or fluctuations in the service. In the same way, protection against electric discharges from the atmosphere should be considered.

It is desirable that the station is co-located with other geodetic and/or geophysical techniques, if the corresponding instruments are installed, such as laser telescope, radio telescope, spirit level, gravimeter, seismometer, tide gauge, meteorological sensors, etc. It is essential to know precisely the relative location of the markings made by each of the stations involved.

4.1. RECEIVER

The GNSS receiver must comply with the following:

1. The GNSS receiver must be included in the catalogue of the IGS https://files.igs.org/pub/station/general/rcvr_ant.tab.[8]
2. It is necessary for the receiver to have multi-constellation tracking capabilities, at least GPS + GLONASS, and be able to register all the observables (codes and carriers) available. The observables should not be modified or smoothed at receiver level.
3. Taking into account the limitations of the operator or person in charge of the station, if the only receivers available are GPS-only, they must be able to track at least the L1 and L2 carriers, and the PRN C/A and P codes. In the case of updating constellations, see Item 2 for application.
4. In the same way, the receiver must be capable of tracking all visible satellites, regardless of the health status declared in their navigation message or through external means.
5. It must be configured to track satellites with a 0° elevation mask.
6. Code and phase smoothing should be disabled. In case these are activated, this must be notified via SIRGAS Mail, leaving it disabled again.
7. Changing or replacing the receiver is highly recommended inasmuch as the Operator Center and/or National Data Center responsible for the station are able to do so, taking into account technological innovations in GNSS, as this helps to improve and upgrade the performance of SIRGAS-CON. However, this change should not be made frequently as it could lead to considerable variations in position.
8. Any changes involving the receiver implies the respective update to be made to the station log file and notification via the SIRGAS Mail.

An important part of the receiver is the receiver firmware, which must satisfy the following:

9. The GNSS receiver must work with the latest firmware version available. The Operator Center and/or National Data Center responsible for the station must maintain effective communication channels with the manufacturer to keep abreast of the latest updates.
10. Receiver firmware must be updated periodically according to the manufacturer's provisions, aiming to ensure the optimal functioning of the receiver in terms of the internal treatment of the signal and elaboration of the observables.

11. Any changes related to the firmware must be reported via SIRGAS Mail and to the corresponding instances of SIRGAS Working Group I, and similarly warrant the respective update to be made to the station log file.

As well as the features detailed above, the following is recommended:

12. The receiver must be capable of observing the Galileo, Beidou and SBAS (Satellite Based Augmentation System) constellations and be upgradeable via firmware.
13. The receiver must be able to observe the third GNSS frequency for all constellations.
14. The receiver must be connected to power sources that are able to avoid shutting down in the event of a power outage or failure.
15. The receiver allows the broadcast of observables via NTRIP (Networked Transport of RTCM via Internet Protocol).

4.2. ANTENNA

The GNSS receiver must comply with the following:

1. The GNSS antenna must be included in the IGS catalogue https://files.igs.org/pub/station/general/rcvr_ant.tab.[8]
2. The description of the antenna must be included in the IGS file https://files.igs.org/pub/station/general/antenna.gra.[9]
3. It is indispensable for the antenna to have absolute values of the corrections for variations of the center of phase PCV (*Phase Center Variations*) according to IGS specifications https://files.igs.org/pub/station/general/pcv_archive/.[10]
4. The GNSS antenna must have a high gain pattern that allows it to receive the satellite signal from any azimuth and elevation angle.
5. Choke ring-type antennas are preferred but at all events, the antenna must have adequate protection against the effects of multipath or similar.
6. The antenna must be installed in such a way as to guarantee total stability, meaning that it must not have any movements greater than 0.1 mm with respect to the mark materialized by the station.
7. The antenna needs to be completely horizontal (level) and oriented to true north NRP (North Reference Point), using the corresponding reference mark for this purpose.
8. ARP eccentricities (east, north and vertical) (defined in https://files.igs.org/pub/station/general/antenna.gra[9]) with respect to the mark materialized by the station, should be measured to an accuracy better than ±1.0 mm and reported both in the log file and in the header of the observational RINEX files (Receiver Independent Exchange Format).
9. If a protective cover (radome) is not used for the antenna, the antenna should be cleaned at least once a year. However, the antenna should not be removed for this purpose, and the corresponding instances of SIRGAS Working Group I should be informed.
10. When the antenna and/or its radome need to be changed for maintenance purposes, or replaced due to damage or because of a station upgrade, this should take place, if possible, at the end or beginning of the GPS week (Saturday or Sunday).
11. Any change related to the antenna requires the respective update of the station's log file, as well as its notification via SIRGAS Mail.

4.3. PROTECTIVE COVERS OR RADOMES

If protective covers or radomes are used, the following should be taken into account:

1. Using radomes should be avoided, as they are only recommended when the climatic or security conditions at the station warrant their use and their installation becomes essential.

2. The GNSS receiver must be included in the corresponding IGS catalogue https://files.igs.org/pub/station/general/rcvr_ant.tab.[8]
3. This device must have absolute values of the corrections to the PCV considering the antenna + radome combination, according to the IGS specifications. https://files.igs.org/pub/station/general/pcv_archive/.[10]
4. The radome must be fitted to the antenna body using the original manufacturer's hardware in plastic or non-conductive alloys.
5. Any changes in the antenna+radome configuration related to maintenance, replacement, and partial or temporary deletion, demands that the respective updates be made to the station's log file, and that a notification be sent through the SIRGAS Mail.

4.4. METEOROLOGICAL SENSOR

The co-location of a meteorological sensor together with the GNSS station is recommended, but it is not an essential requirement. This type of instrument offers data of interest for the development of specific investigations on certain aspects of atmospheric sciences which are supported by SIRGAS.

If the operator or person in charge of the GNSS station is able to also install a meteorological sensor, it must comply with the following indications:

1. The device must record the temperature and atmospheric pressure as minimum requirements, at a sampling interval of between 10 to 60 minutes.
2. Temperature and atmospheric pressure must be measured with an accuracy of ± 1 K and ± 0.5 hPa, respectively. Consequently, the sensor to be installed must meet these instrumental specifications.
3. The height of the meteorological sensor should be determined with respect to the GNSS antenna using an uncertainty of up to one meter.
4. The sensor must be periodically calibrated according to the manufacturer's indications and/or the agencies responsible for meteorology and climatology in the country.
5. Any changes involving the receiver warrant the respective update to be made to the station log file, as well as notification via the GNSS Mail.

5. OPERATION OF SIRGAS-CON STATIONS

The rigorous (or scientific) GNSS processing platforms used by the SIRGAS Analysis Centers require the observations recorded by the stations to be in standard RINEX format, and only the observation files are necessary, meaning those containing the observables on the basis of PRN codes and carrier phases. It is recommended that the navigation RINEX be stored by the Operator Center and/or National Data Center, while the meteorological RINEX remain available for research purposes.

5.1. STATION IDENTIFICATION AND REGISTRATION

The identification and registration of the observations made by the GNSS geodetic station is performed as follows:

1. The station must be registered in the IERS (International Earth Rotation and Reference Systems Service) http://www.iers.org.[11] For this, the identification of each station must be defined, corresponding to a code or abbreviation of four alphanumeric characters and a DOMES Number assigned by the IERS. To avoid duplication between the names of the stations, the availability of the proposed code should be checked at ftp://igs-rf.ign.fr/pub/DOMES/codomes.snx.[12]

2. Apply to the IERS for a DOMES Number to be assigned to the new station, at: https://itrf.ign.fr/domes_request.php.[13] The conventional name provided by the IGS for the station receiver, antenna and radome should be used. The conversion table between the names given by the manufacturer and the conventional ones used by the IGS can be found at https://files.igs.org/pub/station/general/rcvr_ant.tab.[8] **See details in 7**.

3. The primary designation of the station will consists of **identifier code** of four alphanumeric characters provided by the station operator and the **DOMES Number** assigned by the IERS. Access the IERS database to ensure that the identifier code is not a duplicate of another station. Example:

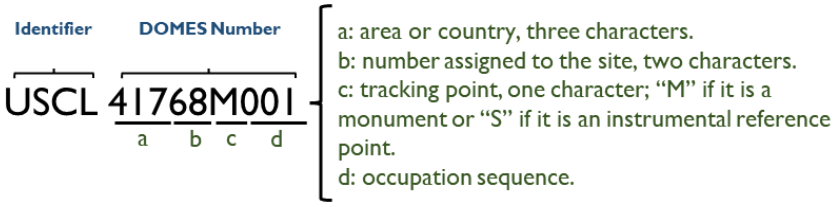

Figure 1 Dome Number according to IERS

4. For the purposes of the disposition of the observations, and to notify any eventuality regarding the station through the pertinent channels, such as the SIRGAS Mail, the IGS convention should be used. This integrates the same alphanumeric code mentioned in the previous item, with the three-character alphabetic code assigned to each country according to the ISO 3166-1 alpha-3 standard, which meets the provisions agreed in the RINEX v3.x transition plan. Example:

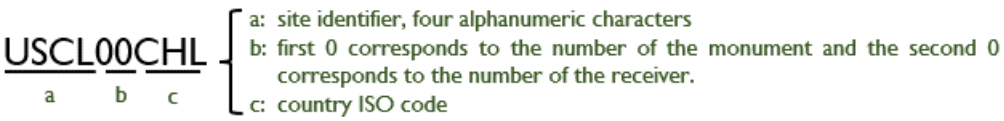

Figure 2 IGS stations name

5. The operator or person in charge of the station **must keep the station log file up-to-date** (see https://www.igs.org/site-log-manager-user-guide/.[14]) gathering the metadata and describing its operational history, which is extremely relevant to processing of GNSS observations.

6. Log file updates **are mandatory** when there are changes to any of the station's instrumental components (receiver, antenna, radome, firmware), the instrumental co-location with other techniques, and regarding the contact details of the operator or manager.

7. If there are no changes to those mentioned in the previous item, the Network Coordinator will ask the operator or person in charge of the station to confirm a revised version of the log file, at least once a year, as well as new photographs.

5.2. OBSERVATION

The observations made by the SIRGAS-CON geodetic station will be carried out as follows:

1. The GNSS receiver must record phase and code measurements (at least one of each) on at least two frequencies (three frequencies are expected for new receivers). For two-frequency GPS and GLONASS, this includes: P1 (and/or C1), L1, L2, P2, (and C2, if available in the receiver).

2. The operation of the station must allow for the reception of the signal emitted by a minimum of ten satellites for each constellation it is capable of tracking.

3. Tracking and receiving the GNSS signals from an elevation of 0° is recommended, but if the station environment does not allow for this, then an elevation mask equal to 5° above the horizon of the antenna should be set, this must be approved by SIRGAS-GTI.

4. The receiver must synchronize the actual instant of measurement with true GPS time to within ±1 millisecond of the whole second of the observation epoch.

5. For the purposes of processing and analysis undertaken by the SIRGAS-CON network (see **"Guide03 Processing of SIRGAS-CON Analysis Centers"**), the observations must be arranged at a sampling interval of 30 seconds. This does not limit their recording being made at longer intervals (e.g. 15, 10, 5, 1 second), leaving this at the discretion of the operator or person responsible for the station.

6. Station observations will only be made available in standard RINEX format. Converting files in binary format (raw data) to RINEX should preferably be done using the software provided by the manufacturer.

7. The GNSS station must provide RINEX mixed format observation files (RINEX M) tagged in GPS time. The IGS RINEX working group is responsible for maintaining the definition of RINEX up-to-date, which is currently version 2.11 (as of May 16, 2011), or version 3.0x.[1]

8. The RINEX files must cover daily GNSS observation sessions, that is, between 00h00m00s and 23h59m30s. Similarly, files covering shorter sessions should also be made available.

9. The RINEX version to be used must be the one that groups together all the available GNSS observables in the best possible way. In this sense, the operator or person in charge of the station will take the necessary measures to offer the data in version 3.0x or later of the aforementioned format. Only when this cannot be satisfied, may the version used be 2.11.

10. The name or denomination given to the RINEX observation files must adhere to that established in its definition. See further details at https://www.igs.org/.[15]

In this sense, RINEX v2.x files are organized according to the following nomenclature:

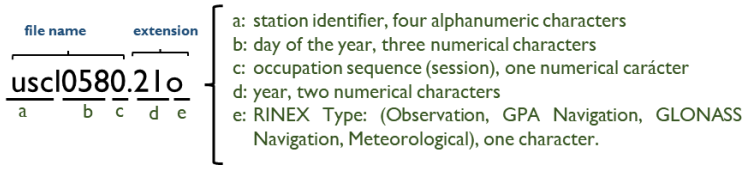

Figure 3 Description of RINEX v2.x file names

[1] IGS is currently implementing RINEX 4

RINEX v3.x files are organized according to the following nomenclature:

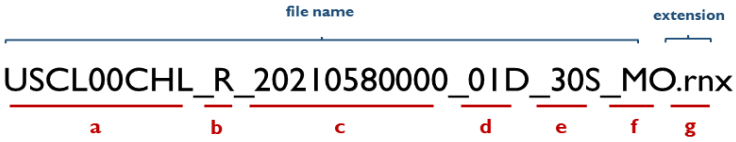

Figure 4 Filename RINEX v3.x

a: station identifier, **see Item 5.1**
b: data origin, generally **R** (receiver)
c: date, **yyyy**:year; **ddd**: day of the year; **hhmm**: hour and minute of the start of the observation.
d: duration of session, generally one day or **01D**
e: sampling interval and unit, generally 30 seconds or **30S**
f: data type, generally **MO** (Mixed Observations), **GO** (GPS Observations) or **MM** (Meteorological observations)
g: file format, **rnx**: RINEX; **crx**: compressed RINEX (Hatanaka)

Figure 5 Description of file names RINEX v3.x

It is imperative to respect the characters according to whether they are uppercase or lowercase, in order to avoid creating problems between different operating systems. Over time, taking into account the transition plan towards RINEX 3 implemented by the IGS, the use of RINEX 2.11 will cease to have effect. This means that each Operator Center and/or National Data Center will have to start providing observation data files in RINEX v3.0x and any subsequent formats.[11] For this reason, it is necessary to become familiar with the new nomenclature previously defined for RINEX.

11. The information indicated in the header of the RINEX files must be fully consistent with that given in the station log file. Special care is required for the following records:

HEADER RECORD	CORRESPONDING ATTRIBUTE
MARKER NAME	Four-character alphanumeric code identifying the station.
Task Number	DOMES NUMBER assigned by the IERS.
REC # / TYPE / VERS	Serial, receiver and firmware version. The name of the receiver must conform strictly to the one assigned by the IGS catalog.
ANT # / TYPE	Serial and type of antenna with its radome (if applicable). The name of the antenna must strictly conform to the one assigned by the IGS catalog.
ANTENNA: DELTA H/E/N	The eccentricities (east, north and height) from the physical materialization of the station to the ARP (defined for each type of antenna in https://files.igs.org/pub/station/general/antenna.gra [16]) must be measured and reported in the site logs and RINEX headers with an accuracy of ≤1mm.

Table 1 Attributes corresponding to the RINEX header

In addition to the regular flow of GNSS observations in standard RINEX format, the Operator Center of the stations to be incorporated in SIRGAS-CON must ensure the consistency of the information contained in the header of these files with that in the log files. Obviously, both must correspond to the station's characteristics and real conditions, and in the event of any change or alteration, the necessary announcements must be made as indicated in this document.

12. The Operator Center and/or National Data Center must submit the observation files in RINEX format to a double compression process to optimize storage capacity, and the Analysis Centers must do the same for download capacity. The first compression should be done using the Hatanaka format,[17] and subsequently the Gzip compression.[18] This optimizes resources for data storage, transfer and download. Considering the co-existence of RINEX files in different versions, the following convention must be applied regarding the extensions of the files involved.

TYPE OF FILE	**EXTENSION**
Observation RINEX, v2.x	*.yyo (yy:year)
Observation RINEX, v3.x	*.rnx
Observation RINEX, v2.x with Hatanaka compression	*.yyd (yy:year)
Observation RINEX, v2.x with Hatanaka and Gzip compression	*.yyd.gz (yy:year)
Observation RINEX, v3.x with Hatanaka compression	*.crx
Observation RINEX (any version) with Gzip compression	*.yyo.gz
Weather RINEX, v2.x	*.yym
Weather RINEX, v2.x with Gzip compression	*.yym.gz

Table 2 Extensions according to the RINEX file type

13. To carry out the quality control of the observations, as well as to convert RINEX3 to RINEX2, the BNC applications[19] should be used, or GFZ2RNX.[20] A minimum control includes: total number of observations, total number of satellites observed, date and time of the first observation contained in the file, name of the station, instruments (receiver, antenna, radome and firmware version) and the height of the antenna. A general report on this prior verification should be made available to the Analysis Centers. It is recommended to consider the following reference values for quality control:

- Effect of multipath < 0.3 m
- Number of cycle jumps: < 1 per 1000 observations
- Tracking conditions > 95% of expected.

14. Any change in the station's instrumental configuration, in addition to being duly and timely reported in the log file, must also be reflected in the RINEX headers and notified to the SIRGAS Mail network.

5.3. DISPOSITION OF OBSERVATIONS

To ensure that deadlines are met, the disposition of the observations will be as follows:

1. They will be made available to the SIRGAS Analysis Centers during the **two days following each session**, although it is recommended that this is done immediately after the session ends. SIRGAS will use them in strict adherence to the data policy described in the DATA POLICY section of this document.
2. Data access by the operator or manager must ensure the use of automated mass download tools. This can be done through HTTP or FTP protocols, although the latter are recommended, in order to facilitate the collection of observations by the Analysis Centers.
3. The operator or person in charge of the station must guarantee the storage and protection of the data recorded throughout their useful life, both in the receiver's native format and in the RINEX standard format, keeping a true record of their history to be reviewed in the log file.
4. If the GNSS station is co-located with a meteorological sensor, these data should be made available with the same latency and in RINEX format.
5. If the operator or person in charge of the station is additionally listed as a Data Center, the data should be stored on their server, following the same structure as the directories managed by the IGS. This is done using HTTP or FTP protocols, although the latter are preferable. As the Analysis Centers download the observation files using automated tools, it is important to maintain a **uniform directory structure** for storage purposes, and it is advisable to adopt the one used by the IGS.

   Example:

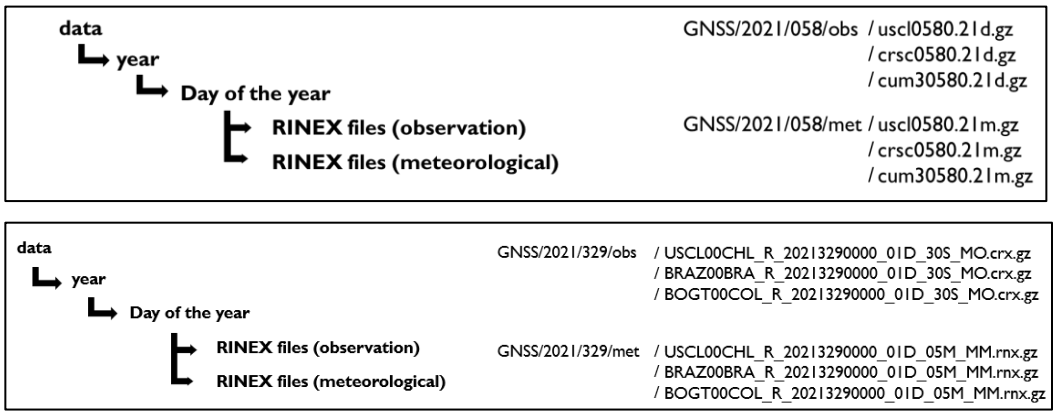

Figure 6 Folder structure

6. Any change to the flow of the observation files preventing their timely acquisition by the Analysis Centers (such as server maintenance, Internet service failures, change of addresses and access codes, etc.), must be notified in a timely manner through the SIRGAS Mail network.

5.4. START-UP

For SIRGAS, any station that meets the following is considered operational:

1. Compliance with the guidelines detailed above regarding EQUIPMENT, STATION IDENTIFICATION AND REGISTRATION, OBSERVATION and the DISPOSITION OF OBSERVATIONS.
2. Continuous operability, so that the infrastructure can ensure the permanent and timely flow of data. Similarly, the Operator Center and/or National Data Center responsible will have to take the necessary actions for this purpose.
3. It is suggested that the station form part of the country's geodetic control, otherwise, the operator or person in charge is advised to take the relevant measures to apply for inclusion before the corresponding authorities.

6. GENERAL CONDITIONS FOR INTEGRATING STATIONS TO SIRGAS-CON

The general conditions required to integrate a geodetic station to SIRGAS-CON are:

1. The stations should only be operated by the member country's governing agencies in the areas of geodesy, cartography and related matters, and/or by public or parastatal academic or scientific entities, without exception, in order to guarantee a not-for-profit collaborative framework.
2. The station meets the requirements for EQUIPMENT and OPERATION OF SIRGAS-CON STATIONS.
3. The Operated Center is in a position to fulfill the responsibilities described in the document **"Guide01 SIRGAS Network Coordination"**
4. It is suggested that the stations form part of each member country's geodetic control, otherwise, SIRGAS may provide the corresponding advice for this purpose.
5. The location of the new station must complement the SIRGAS-CON network in such a way that it contributes to the spatial densification of the network together with the current stations of the SIRGAS network. The new station may not be located within 50 km of any other SIRGAS-CON station, unless the area in which the new station is to be located corresponds to an area of high deformation, i.e., the displacement of the area is not homogeneous. Any exception to this will be agreed within the SIRGAS-GTI, attending to SIRGAS's own needs.
6. The Operating Center and/or National Data Center responsible for the stations will expressly state their acceptance of the data policy in accordance with the provisions given in the DATA POLICY section.

7. INSTRUCTIONS FOR REGISTERING STATIONS WITH SIRGAS-CON

For a new station to be registered in the SIRGAS-CON network, the following must be done:

1. Contact the SIRGAS-GTI Chair, and notify the intention to integrate or install a new permanent station, including the installation schedule, and express the desire for this station to be integrated into the SIRGAS-CON network. The SIRGAS-GTI Chair will provide advice accordingly.
2. Prepare the new station's log files (for instance, files containing station metadata such as location, monumentation, date of installation, equipment, managers, etc.). This must be completed with the DOMES Number assigned by the IERS. The format of the log file is available at https://files.igs.org/pub/station/general/blank.log.[21] and may be complemented with the following video https://www.youtube.com/watch?v=68YxpzMpNWQ&t=35s.[22] The set of instructions for its proper preparation are available at: https://www.igs.org/site-log-manager-user-guide/.[14] The SIRGAS-CON stations' log files may be found at ftp://ftp.sirgas.org/pub/gps/DGF/station/log.[23] Below is an example of the format used to name these *.log files.

   Example:

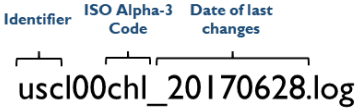

*Figure 7 File name format *.log*

3. Report if there are co-located instruments (tide gauge, meteorological sensor, seismometer, gravity, etc.)
4. Inform the connection to the national leveling network.
5. Once the station enters into operation and all the information required in Items 4.1, 4.2, 4.3 and 4.4 are available, send a communication to the SIRGAS-GTI Chair announcing that the station is in operation. This communication should include:

   a) Acknowledgment letter or electronic message, to the Principal or Acting National Representative before SIRGAS.

b) The station log file in its duly completed with generic data (e-mail address, telephone, other) in order to comply with the General Data Protection Regulation.

c) Digital photographs showing the following: the monumentation (pilaster, tower, staff, etc.) together with the antenna and its surroundings; another close-up of the detail of the coupling of the antenna with the monument; and two additional ones identifying the name, model and serial numbers of both antenna and receiver. It is important for SIRGAS to know the station's physical, instrumental and environmental characteristics, hence, for the incorporation process, the operator or manager is asked to supply photographs allowing these aspects to be appreciated in full. The Photographs should be submitted in digital image format, considering the orientation as if the station were taking the photograph in the direction of the cardinal point. The nomenclature to be assigned is indicated below:

SSSS00ISO_cod_yyyymmdd.jpg

SSSS:	station identifier
00.	occupancy (maintained as indicated)
ISO:	country code according to ISO standard
cod:	identifier code
yyyy:	year
mm:	month
dd:	day

Example:

USCL00CHL_ANT_20170628.jpg

Promotional code	
Monument	**MON**
Receiver	**REC**
Antenna	**ANT**
Radome	**RDM**
serial receiver	**SRE**
Antenna signal	**SAN**
Radome serial	**SRA**
North view	**NOR**
South view	**SOU**
East view	**EST**
West view	**WST**

As regards what is established in Item 5.1, which guarantees the time control of the station, the operator or station manager must send updated photographs once a year together with the revised/updated version of the log file.

d) Indications for accessing the observations, such as the server address, access code, accommodation directory, etc. Access should preferably be provided through the FTP and/or HTTPS protocol, thus facilitating the collection of observations by the Analysis Centers.

e) The format and organization of the data are detailed in the DISPOSITION OF OBSERVATIONS section.

8. INCORPORATION PROCESS

This process is realized by the SIRGAS-GTI Chair based on the information received from the operator or station manager, to determine the viability of the station's effective integration into the network. The process includes the organization of the information from the Operator Center and/or National Data Center responsible, as described in the section on OPERATION OF SIRGAS-CON STATIONS, verifying compliance according to the standards established for:

1. The station log file, which must be properly completed.
2. Instrumental characteristics, such as the type of receiver, antenna calibration, etc.
3. Data availability, for instance, timely access, RINEX consistency, compression format, organizational structure within the server, others.
4. The Quality Control run for the tasks completed.

If the station satisfies the criteria outlined above, the SIRGAS- GTI Chair, proceed with its official inclusion in the network. The corresponding notice will be sent through the SIRGAS Mail network and any other means of dissemination used by SIRGAS. The Operator Center and/or National Data Center responsible for the station will be asked for their SIRGAS Mail subscription.

The new station will be assigned to the Processing Centers, and the weekly processing of its observations must begin as from the GPS week proposed by the SIRGAS- GTI Chair.

9. RESPONSIBILITIES OF OPERATOR CENTERS

In addition to the general functions indicated in Item 3.1 of the document **"Guide01 SIRGAS Network Coordination"**, the SIRGAS-CON Station Operator Centers must guarantee that they can:

1. Maintain effective communication with the SIRGAS-CON Coordinator and the rest of the SIRGAS community in order to report on the current status of the stations. For this, the subscription to SIRGAS Mail is essential.
2. Store, in the long term and in organized fashion, the original RINEX observations recorded by the stations under their responsibility. These observations should be available even in the distant future, should reprocessing be required in the SIRGAS-CON network.
3. Monitor station operations, notifying any problem that could affect the continuity of the observations made to the SIRGAS Mail network.
4. Keep the station information up-to-date, annotated in the log file, particularly when changing or updating the receiver, antenna, radome and firmware. Any changes made must be notified in timely fashion to the SIRGAS Mail network and the updated log file sent to the network coordinator. It is also recommended that photographs be taken to show any changes at the station.

10. EXCLUSION OF SIRGAS-CON STATIONS

A GNSS continuous operation station incorporated into SIRGAS-CON may be excluded from the network following the express request of the operator or person in charge, for whatever reasons warranting its removal, such as, for example, the station's destruction or its irreparable damage, or other reasons of force majeure.

However, SIRGAS reserves the right to exclude a station in the following cases:

1. No effective communication with your operator or manager to report problems or changes at the station.
2. Low quality of the observations evidenced during network processing and analysis.
3. Impossibility of replacing or updating the instruments by the station operator.
4. Replacement of instruments by those that do not meet the specifications indicated in the **4.**
5. Temporary irregularity in the availability of data as indicated in **Item 5.2.**
6. Absolute lack of data for six continuous months without prior notice.
7. Presence of inconsistencies between the information contained in the RINEX headers and the log file.
8. Not having received information from the operator or person in charge about the state of the station's instruments.
9. Considerable variations in the position or environment undermining the quality of the coordinates.

An exclusion will be submitted under the condition of **temporary retirement** or **definitive withdrawal** as decided by SIRGAS Working Group I, and the respective announcements will be made on a weekly basis through the SIRGAS mail network. A station with any of these conditions may be reinstated once compliance with the provisions of this document is verified.

11. USE OF SIRGAS MAIL

SIRGAS Mail is the channel established by SIRGAS to transmit all the information related to SIRGAS-CON stations. The station operator or manager, as well as any member of the SIRGAS community, may register by following the instructions given in http://sirmail.dgfi.tum.de/.[24]

The type of information generally disclosed through the SIRGAS Mail covers the following: the incorporation or withdrawal of stations from the network; changes or instrumental updating and the consequent log file adaptation; reports on tracking problems or inconsistencies of observations, combination reports, etc. Hence, the importance of subscribing to the contact list.

For the purposes of operating a SIRGAS station, t**he use of the SIRGAS Mail channel is mandatory for the operator or person in charge** when any of the events listed below occurs:

1. Changes in the station's receiver, antenna, radome and firmware, as well as any other event that, in one way or another, may modify GNSS tracking conditions as far as the instruments are concerned.
2. Variations in the station environment, for example, removal or addition of obstacles, deterioration or destruction of the monument, etc.
3. Detection and correction of errors in the configuration of the equipment or in the log file documentation. The corresponding change must be described and communicated.
4. Interruption of the operation of the station for more than one day, also notifying the reasons for this.
5. Permanent withdrawal of the station.
6. Notification of changes in the access data used to download observations.
7. Detection and correction of errors compromising the integrity of the RINEX data available on the respective servers.
8. Any other event related to the operation of the station.

Common procedures for the dissemination of messages through the SIRGAS Mail channel envisage that:

1. The text may be written in English, but if done in Spanish or Portuguese, it must be accompanied by a translation into English.
2. The subject of the message must begin with the coding or nomenclature assigned to the station, followed by the subject.
3. The message should be sent if possible, before an event happens, if not, at the latest within the following two business days.

Below are some examples of how to communicate using the SIRGAS Mail channel:

```
Re: [Sirgas-Mail] N. XXXX: (station): data gap
Author: "Name of Person in Charge"
Dear Colleagues,

Station (reference name) (location) has a data gap between days: (dd/mm/yyyy) (day/gps/yyyy)
to (dd/mm/yyyy) (day gps/yyyy).

E.g.,
Station MSCG (Campo Grande) has a data gap between days: 12/12/2020 (347/2020) to 18/12/2020
(353/2020).
Best regards,
```

Figure 8 SIRGAS-Mail Station data gap

```
Re: [Sirgas-Mail] N. XXXX: (station): back in operation and data gap
Author: "Name of Person in Charge"
Dear Colleagues,

Station (reference name) (location) is back in operation.
There is a data gap between days: (dd/mm/yyyy) (day/gps/yyyy) to (dd/mm/yyyy) (day gps/yyyy).

E.g.,
Station UBE1 (Uberlandia - CEMIG) is back in operation.
There is a data gap between days: 05/02/2021 (36/2020) to 18/02/2021 (49/2021).
Best regards,
```

Figure 9 SIRGAS-Mail Station back in operation and data gap

```
Re: [Sirgas-Mail] No. XXXX: (station): out of operation
Author: "Name of Person in Charge"
Dear Colleagues,

Station (reference name) (place) is out of operation since (dd/mm/yyyy) (day/gps/yyyy).

E.g.,
Station UBE1 (Uberlandia) is out of operation since day 05/02/2021 (36/2021).
Best regards,
```

Figure 10 SIRGAS-mail Station out of operation

12. DATA POLICY

The Operator Centers (OC) and the National Data Centers (NDC) are entities functioning in a SIRGAS member country and are willing to provide the observations from one or more GNSS stations operating continuously for a long period of time free of charge to SIRGAS.

SIRGAS will respect the corresponding copyright every time products are published based on the processing of GNSS observations offered by the Operator Centers and National Data Centers.

It is important to note that the SIRGAS Analysis Centers are not authorized to transfer the RINEX files of the processed stations to third parties.

13. ATTENTION TO THE OPERATOR OR PERSON IN CHARGE OF THE STATION

Any inquiry or request for information by the operator or person in charge of the station regarding what is established in this document, may be channeled through SIRGAS Working GroupI, by contacting the Working Group Chair and/or the SIRGAS-CON Network Coordinator. Their email addresses are listed in https://sirgas.ipgh.org/[25].

14. BIBLIOGRAPHY

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[24] SIRGAS, "SIR-Mail Mailing List." http://sirmail.dgfi.tum.de/ (accessed May 04, 2021).

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15. WEB LINKS

NOAA / NGS Guidelines for establishing and operating CORS
http://www.ngs.noaa.gov/PUBS_LIB/CORS_guidelines.pdf

Procedure for becoming an EPN station
http://www.epncb.oma.be/_documentation/guidelines/procedure_becoming_station.pdf

Guidelines for EPN stations and operational centers
http://www.epncb.oma.be/_documentation/guidelines/guidelines_station_operationalcentre.pdf

16. ACRONYMS

AAC: Atmospheric Analysis Centers

ARP: Antenna Reference Point

CC: Combination Centers

CODE: Center for Orbit Determination in Europe

CORS: Continuously Operating Reference Station

EOP: Earth Orientation Parameters

EPC: Experimental Processing Centers

ERP: Earth Rotation Parameter

FTP: File Transfer Protocol

GNSS: Global Navigation Satellite System

HTTPS: HyperText Transfer Protocol Secure

IERS: International Earth Rotation and Reference Systems Service

IGS: International GNSS Service

ITRF: International Terrestrial Reference Frame

LPC Local Processing Centers

NDC: National Data Centers

NRP: North Reference Point

NTRIP: Networked Transport of RTCM via Internet Protocol

OC: Operator Centers

PCO: Phase Centre Offset

PCV: Phase Centre variation

PRN: Pseudorandom noise

RDC Regional Data Center

RINEX: Receiver Independent Exchange Format

RMS: Root Mean Square

TEC: Total Electron Content

VMF: Vienna Mapping Function