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| **World Meteorological Organization** | **Cg-17/Doc. 4.2.2(3)** |
| **SEVENTEENTH CONGRESS** | Submitted by: | Secretary-General |
| Date: | 1.IX.2014 |
| Geneva, 25 May to 12 June 2015 | Original Language:  | English |
| Status: | **DRAFT 1** |

EXPECTED RESULT 4

## AGENDA ITEM 4: Advancing Scientific Research and Application, as well as Development and Implementation of Technology

## AGENDA ITEM 4.2: WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS) – Priority

**(Agenda 4.2.2) WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)**

**WMO Technical Regulations (WMO-No. 49) - Manual on WIGOS**

SUMMARY

### DECISIONS/ACTIONS REQUIRED:

(a) Adopt the text in Appendix A;

(b) Adopt draft Resolution: 4.2.2(3)/1(Cg-17);

### CONTENT OF DOCUMENT:

The Table of Contents is available only electronically as a Document Map[[1]](#footnote-1)\*.

**APPENDIX A:**

 **DRAFT TEXT FOR INCLUSION IN THE GENERAL SUMMARY**

**4 ADVANCING SCIENTIFIC RESEARCH AND APPLICATION, AS WELL AS DEVELOPMENT AND IMPLEMENTATION OF TECHNOLOGY**

## WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS) – Priority

## 4.2.2 WMO Integrated Global Observing System (WIGOS) (Agenda 4.2.2)

##  … … …

## WMO Technical Regulations (WMO-No. 49) – Manual on WIGOS

### 4.2.2(3).1 Congress noted that the Commission for Basic Systems (CBS-Ext.(2014)) recommended that the *Manual on WIGOS* (as a future Annex to the WMO *Technical Regulations* (WMO-No. 49)) be adopted by the Cg-17.

4.2.2(3).2 Congress adopted Draft Resolution 4.2.2(3)/1 (Cg-17).

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**APPENDIX B:
DRAFT RESOLUTION**

## Draft Resolution 4.2.2(3)/1 (Cg-17) –

## WMO TECHNICAL REGULATIONS (WMO-No. 49) – MANUAL ON WIGOS

THE WORLD METEOROLOGICAL CONGRESS,

**Having considered** the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

**Noting:**

(1) Articles 2 (a), 2 (c) and 8 (d) of the Convention of the World Meteorological Organization,

(2) Resolution 45 (Cg-XVI) – Technical Regulations of the World Meteorological Organization,

(3) Resolution 50 (Cg-XVI) – Implementation of the WMO Integrated Global Observing System,

(4) Resolution 26 (EC-64) – Amendments to the Technical Regulations,

(5) Recommendation 2.4/1 (CBS-Ext.(2014)) – Revised Manual on the GOS,

(6) Recommendation 3.1(1)/1 (CBS-Ext.(2014)) – WIGOS Regulatory Material,

(7) Draft Resolution 4.2.2(1)/1 (Cg-17) – Preoperational Phase of WIGOS,

(8) Draft Resolution 4.2.2(2)/1 (Cg-17) –WMO Technical Regulations (WMO-No. 49), Volume I, Part I – WIGOS,

**Recalling:**

That the Sixteenth World Meteorological Congress emphasized that the implementation of WIGOS must be reflected in the revised WMO *Technical Regulations* (WMO-No. 49), documenting the WIGOS concept of operations and contributions of all observing components,

**Considering** the draft Manual on WIGOS recommended by the Commission for Basic Systems for adoption by the Congress,

**Noting** that the draft Manual on WIGOS was circulated to all WMO Members and comments submitted by WMO Members were incorporated accordingly in the document,

**Decides** to approve the *Manual on WIGOS* as provided in Annex to this resolution, with effect from 1 July 2016;

**Affirms** the authority of the Executive Council to approve any amendments to the *Manual on WIGOS* if required before the next Congress;

**Further decides:**

(1) That the Commission for Basic Systems shall act as the lead technical commission for managing changes to the *Manual on WIGOS*;

(2)That the “simple”, “standard” and “complex” procedures defined in Recommendation 15 (CBS Ext.(2014)) *– Procedures for maintaining Manuals and Guides managed by the Commission for Basic Systems* shall also apply to maintaining the *Manual on WIGOS*.

**Requests** the Secretary-General:

(1) To publish the *Manual on WIGOS* in all WMO official languages;

(2) To ensure the editorial consistency of the relevant documents;

(3) To bring this resolution to the attention of all concerned.

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Annex: 1

## Annex to Draft Resolution 4.2.2(3)/1 (Cg-17)

## WORLD METEOROLOGICAL ORGANIZATION

**MANUAL ON THE**

**WMO INTEGRATED GLOBAL OBSERVING SYSTEM
(WIGOS)**

**Annex IX to the WMO Technical Regulations**

**(2015 edition)**

 **(Version 0.11)**

**DRAFT**

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WMO-No. XXXX

**VERSION CONTROL**

|  |  |  |  |
| --- | --- | --- | --- |
| Version | Summary of change | By | Date  |
| 0.1 | first full compilation of (mostly) completed and reviewed sections, for presentation to ICG-WIGOS-3 | Chair TT-WRM | 2014-02-06 |
| 0.2.0 | Review of 2.6 | T. Goos, L. Nunes | 2014-02-19 |
| 0.2.1 | Comments on the review of 2.6 | I. Zahumensky | 2014-02-25 |
| 0.2.2 | Review | T. Goos, L. Nunes | 2014-03-10 |
| 0.2.3 | Final review | I. Zahumensky | 2014-03-13 |
| 0.2.4 | Review | I. Zahumensky, T. Goos, L. Nunes | 2014-03-21 |
| 0.3 | Review | R. Stringer, I. Zahumensky, T. Goos | 2014-04-04 |
| 0.3.1 | Re-attached draft content for Appendix 2.3 (clearly labelled as "indicative only – final draft pending") | R. Stringer | 2014-04-06 |
| 0.4 | Revised version  | R. Stringer, I. Zahumensky, T. Goos, L. Nunes | 2014-04-09 |
| 0.5 | Updated Appendix 2.3;“WIGOS Core Metadata” was replaced by “WIGOS Metadata Standard” in the whole document; Provision 2.5.1.1, Note 2 | WIGOS-PO | 2014-06-30 |
| 0.6 | Minor editorial | WIGOS-PO | 2014-07-15 |
| 0.7 | Feedback from all TCs, EC-PORS, TT-WQM, Secretariat | R. Stringer, T. Goos, L.P. Riishojgaard, I. Zahumensky | 2014-08-07 |
| 0.8 | Minor editorial | I. Zahumensky | 2014-08-08 |
| 0.9 | Feedback from Secretariat (DPMU, OBS) and editorial | R. Stringer, M. Ondras,L.P. Riishojgaard, I. Zahumensky | 2014-08-27 |
| 0.10 | Feedback from CBS-Ext.(2014) | L.P. Riishojgaard | 2014-09-11 |
| 0.11 | Feedback by Members, and editorial | WIGOS-PO | 26-01-2015 |
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**INTRODUCTION**

**PURPOSE AND SCOPE**

1. The Manual is designed:

(a) To specify obligations of Member countries in the implementation and operation of the WIGOS;

(b) To facilitate cooperation in observations between Member countries;

(c) To ensure adequate uniformity and standardization in the practices and procedures employed in achieving (a) and (b) above.

2. The Manual is an Annex to the WMO Technical Regulations and should be read in conjunction with the four Volumes and the set of Annexes which together comprise the Technical Regulations. In particular the *Manual on the GOS* (WMO-No. 544) is closely related and will over time disappear as its content is progressively moved into this Manual.

3. Members will implement and operate their observing systems in accordance with decisions of Congress, the Executive Council, the technical commissions and regional associations. Where those decisions are technical and regulatory in nature, they will in due course be documented in the Technical Regulations.

4. This is the first edition of the Manual on the WMO Integrated Global Observing System (WIGOS), developed following the decision of the Sixteenth World Meteorological Congress to proceed with the implementation of WIGOS, approved by the Seventeenth World Meteorological Congress and issued as the 2015 edition.

5. The Manual was developed by the Executive Council through its Inter-Commission Coordination Group on WIGOS (ICG-WIGOS), specifically its Task Team on WIGOS Regulatory Material (TT-WRM). This represents a collaborative approach involving all interested technical commissions under the technical leadership provided through CBS and CIMO.

6. Gradually, all technical regulations for all WMO component observing systems will be included under the identity of WIGOS. For reasons of practicality, the *Manual on the GOS* (WMO-No. 544) is a companion to this Manual during a certain period. However all the practices will over time be described in this Manual.

7. In essence, the Manual specifies what is to be observed, following what practices and procedures, in order to meet the relevant observational requirements of Members. These requirements may arise directly at a national level or collectively through WMO Programmes at global or regional levels, and are expressed through the Application Areas of the Rolling Review of Requirements process. A number of other Manuals and Guides provide more practices and procedures on the operation of observing systems including stations and platforms, instruments and methods of observation, and the reporting and management of observation and observational metadata.

**TYPES OF REGULATION**

8. The Manual comprises ***standard*** practices and procedures(**standards**), and ***recommended*** practices and procedures(**recommendations**). The definitions of these two types are as follows:

9. The ***standard*** practices and procedures:

(a) Are those practices and procedures which it is ***necessary*** that Members follow or implement; and therefore

(b) Have the status of ***requirements*** in a technical resolution in respect of which ***Article 9 (b)*** of

the Convention is ***applicable***; and

(c) Are invariably distinguished by the use of the term ***shall*** in the English text and by suitable equivalent terms in the French, Russian and Spanish texts.

10. The ***recommended*** practices and procedures:

(a) Are those practices and procedures which it is ***desirable*** that Members follow or implement; and therefore

(b) Have the status of ***recommendations*** to Members to which ***Article 9 (b)*** of the Convention ***shall not be applied***; and

(c) Are distinguished by the use of the term ***should*** in the English text (except where specifically otherwise provided by decision of Congress) and by suitable equivalent terms in the French, Russian and Spanish texts.

11. In accordance with the above definitions, Members shall do their utmost to implement the standard practices and procedures. In accordance with Article 9 (b) of the Convention and in conformity with the provisions of Regulation 128 of the General Regulations, Members shall formally notify the Secretary-General, in writing, of their intention to apply the “standard practices and procedures” of the Manual, except those for which they have lodged a specific deviation. Members shall also inform the Secretary-General, at least three months in advance, of any change in the degree of their implementation of a “standard practice or procedure” as previously notified and of the effective date of the change.

12. In the case of hydrological observations, there is not a widely implemented base of global exchange and global standard practices and procedures. Technical Regulations Volume III -Hydrology provides Members with predominately recommended practices and procedures to be followed. In order to help ensure the quality and comparability of observations within WIGOS, Members making their hydrological observations available through the WMO Hydrological Observing System (WHOS) are requested to comply with the provisions specified within this Manual. For this reason, a number of provisions listed herein which are recommended practices and procedures for hydrology in Technical Regulations Volume III – Hydrology have become standard practices and procedures, similar to efforts made by Members for the other WIGOS component observing systems. It is recognized that some of the WIGOS standard practices and procedures might not easily be widely and quickly implemented by all Members for their hydrological observations. Nonetheless, Members are urged to make their best efforts to implement the WIGOS standard practices and procedures in the collection and exchange of hydrological observations and to make such observations available through WHOS.

13. With regard to the recommended practices and procedures, Members are urged to comply with these, but it is not necessary to notify the Secretary-General of non-observance.

14. In order to clarify the status of the various regulatory material, the standard practices and procedures are distinguished from the recommended practices and procedures by a difference in typographical practice, as indicated in the Editorial note.

**APPENDICES**

15. Material presented in Appendices has full status as part of the Technical Regulations. Appendices are used where a set of provisions on a single topic might, due to their detailed nature and length, otherwise interrupt the flow of the relevant section of this Manual. Also, Appendices are used to facilitate the ongoing review and update process by identifying sub-sections which fall under the specific responsibility of a particular group.

**NOTES AND ATTACHMENTS**

16. Notes and Attachments are included in the Manual for explanatory purposes. They do not have the status of WMO Technical Regulations.

17. The words “shall” and “should” in any notes and attachments have their dictionary meanings and do not have the regulatory character of standard and recommended practices and procedures mentioned above.

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| --- |
| **EDITORIAL NOTE[[2]](#footnote-2)**The following typographical practice has been followed:Standard practices and procedures have been printed in Arial bold.Recommended practices and procedures have been printed in Arial. Notes have been printed in smaller type, Arial, and preceded by the indication: Note. |

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**DEFINITIONS**

**Note 1:** Other definitions related to observing systems may be found in the Volume I of the WMO Technical Regulations and the *Manual on the GOS* (WMO-No. 544). Definitions are not duplicated between Manuals hence it is important to consult all documents.

**Note 2:** Further definitions may be found in the *Manual on Codes* (WMO-No. 306), *Manual on the Global Data Processing and Forecasting System* (WMO-No. 485), Volume I, *Manual on the Global Telecommunication System* (WMO-No. 386); Volume I, and other WMO publications.

**Note 3:** Definitions, terminology, vocabulary and abbreviations used in relation to quality management are those of the ISO 9000 family of standards for quality management systems, in particular those identified within ISO 9000:2005, Quality Management Systems – Fundamentals and vocabulary.

The following terms, when used in the *Manual on WIGOS* (WMO-No. XXXX), have the meanings given below.

***Accuracy***. The extent to which the results of the readings of an instrument approach the true value of the calculated or measured quantities, supposing that all possible corrections are applied.

***Accreditation.*** The formal recognition by an independent body, that the staff has been trained and have mastered the processes to meet the requirements. Accreditation is not mandatory but it adds another level of confidence, as ‘accredited’ means the certification body has been independently checked to make sure it operates according to international standards.

***Acoustic Doppler Current Profiler (ADCP).*** Hydroacoustic current meter to measure the velocity of water over a range of depths in a column using the Doppler Effect, with the overall depth of water usually being measured simultaneously.

***Acoustic Velocity Meter.*** System that uses the difference in travel time of acoustic (ultrasonic) pulses between transducers in a stream to determine the mean velocity on the signal path.

***Adaptive maintenance.*** Modification of an instrument, software etc. performed after installation to keep the product usable in a changed or changing environment.

***Bank***. (1) Rising land bordering a river, usually to contain the stream within the wetted perimeter of the channel. (2) Margin of a channel at the left-hand (right-hand) side when facing downstream.

***Cableway***. Cable stretched above and across a stream, from which a current meter or other measuring or sampling device is suspended, and moved from one bank to the other, at predetermined depths below the water surface.

***Calibration (rating) Tank***. ***(Straight Open Tanks)***  Tank containing still water through which a current meter is moved at a known velocity for calibrating the meter.

***Catchment Area***. Area having a common outlet for its surface runoff.

***Certification***. The provision by an independent body, generally known as an accreditation body, of written assurance (a certificate) that the product, service or system in question meets specific requirements.

***Compliance.*** May be an internal code of conduct where employees follow the principles of one of the Quality Management Standards series (such as the ISO standards) or other internationally recognized practices and procedures. It may also represent an external stamp of approval by an accreditation firm when customers or partners request documented proof of compliance.

***Confidence Level***. Probability that the confidence interval includes the true value.

***Control***. Physical properties of a channel which determine the relationship between stage and discharge at a location in the channel.

***Control Structures.*** Artificial structure placed in a stream such as a low weir or flume to stabilize the stage-discharge relation, particularly in the low flow range, where such structures are calibrated by stage and discharge measurements taken in the field.

**Co-sponsored observing system.** An observing system from which some but not all observations are WMO observations

***Cross-section***. Section perpendicular to the main direction of flow bounded by the free surface and wetted perimeter of the stream or channel.

***Current meter***. Instrument for measuring water velocity.

***Current meter, propeller type.*** A current meter the rotor of which is a propeller rotating around an axis parallel to the flow.

***Data archiving***. Storage of data on a set of catalogued files which are held in some backup storage medium and not necessarily permanently online.

***Data compatibility.*** The capacity for two systems to exchange data without having to be altered to do so including making any changes in data formats.

***Data processing***. Treatment of observational data until they are in a form ready to be used for a specific purpose.

***Data quality objectives***. Define qualitatively and quantitatively the type, quality and quantity required of primary data and derived parameters to yield information that can be used to support decisions.

***Discharge***. Volume of water flowing through a river (or channel) cross-section per unit time.

***Drainage basin***. (See Catchment area)

***Elevation***. Vertical distance of a point or level, on or affixed to the surface of the ground, measured from mean sea level.

***Estuary***. Broad portion of a stream near its outlet to a sea, lake or sabkha.

***Flood***. (1) Rise, usually brief, in the water level of a stream or water body to a peak from which the water level recedes at a slower rate. (2) Relatively high flow as measured by stage height or discharge.

***Flood-proofing***. Techniques for preventing flood damage in a flood-prone area.

***Gauge boards (Staff Gauge).*** Graduated vertical scale, fixed to a staff or structure, on which the water level may be read.

***Gauge datum***. Vertical distance between the zero of a gauge and a certain datum level.

***Gauging station***. Location on a stream where measurements of water level and/or discharge are made systematically.

***GAW Station Information System (GAWSIS).*** The official catalogue for monitoring sites/platforms/stations operating within Global Atmosphere Watch (GAW) as well as related programmes providing station metadata and serving as the clearing house for unique station identifiers. GAWSIS represents the metadata source for OSCAR for GAW observations.

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***Hydrograph***. Graph showing the variation in time of some hydrological data, such as stage, discharge, velocity and sediment load.

***Hydrological Forecast****.* Estimation of the magnitude and time of occurrence of future hydrological events for a specified period and for a specified locality.

***Hydrological observation***. Direct measurement or evaluation of one or more hydrological elements, such as stage, discharge and water temperature.

***Hydrological observing station***. Place where hydrological observations or climatological observations for hydrological purposes are made.

***Hydrological warning***. Emergency information on an expected hydrological event which is considered to be dangerous.

***Hydrometric station***. Station at which data on water in rivers, lakes or reservoirs are obtained on one or more of the following elements: stage, streamflow, sediment transport and deposition, water temperature and other physical properties of water, characteristics of ice cover and chemical properties of water.

***Intercomparison.*** A formalized process to assess the relative performance of two or more systems (observing, forecasting, etc.)

***Moving-Boat Method***. Method of measuring discharge which uses a boat to traverse the stream along the measuring section and continuously measure velocity, depth and distance travelled

***Quality***. The degree to which a set of inherent characteristics fulfils requirements.

***Quality Assurance***. That part of quality management focused on providing confidence that quality requirements will be fulfilled.

***Quality Control.*** That part of quality management focused on fulfilling quality requirements.

***Quality Management***. The coordinated activities to direct and control an organization with respect to quality.

***Rating curve***. Curve showing the relation between stage and discharge of a stream at a hydrometric station.

***Recession***. Period of decreasing discharge as indicated by the falling limb of a hydrograph starting from the peak.

***Registration***. Certification is very often referred to as registration in North America.

***Reservoir***. Body of water, either natural or man-made, used for storage, regulation and control of water resources.

***River***. Large stream which serves as the natural drainage for a basin.

***Stage***. See water level.

***Stage-discharge relation***. Relationship between water level and discharge for a river cross-section, which may be expressed as a curve, a table or an equation.

***Streamflow***. General term for water flowing in a watercourse.

***Uncertainty***. Estimate of the range of values within which the true value of a variable lies.

***Upstream***. Direction from which a fluid is moving.

***Verification.*** The process of establishing the truth, accuracy, or validity of something.

***Water level***. Elevation of the free water surface of a water body relative to a datum level.

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**1.** **INTRODUCTION TO WIGOS**

**1.1 Purpose and Scope of WIGOS**

1.1.1 The WMO Integrated Global Observing System (WIGOS) shall be a framework for all WMO observing systems and the contributions of WMO to co-sponsored observing systems in support of all WMO Programmes and activities.

Note: The co-sponsored observing systems are the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS), the WMO-IOC-UNEP-ICSU Global Ocean Observing System (GOOS) and the WMO-IOC-UNEP-ICSU Global Terrestrial Observing System (GTOS).

1.1.2 The WIGOS shall facilitate the use by WMO Members of observations from systems that are owned, managed and operated by a diverse array of organizations and programmes.

1.1.3 The principal purpose of WIGOS shall be to meet the evolving requirements of Members for observations.

1.1.4 The interoperability (including data compatibility) of WIGOS component observing systems shall be achieved through their common utilization and application of internationally accepted standards and recommended practices and procedures. Data compatibility shall also be supported through the use of data representation standards.

**1.2 WIGOS component observing systems**

1.2.1 The component observing systems of WIGOS shall comprise the Global Observing System (GOS) of the World Weather Watch (WWW) Programme, the observing component of the Global Atmosphere Watch (GAW) Programme, the WMO Hydrological Observing System (WHOS) of the Hydrology and Water Resources Programme (HWRP) and the observing component of the Global Cryosphere Watch (GCW), including their surface-based and space-based components.

Note: The above component systems include all WMO contributions to the co-sponsored systems, as well as the WMO contributions to the Global Framework for Climate Services (GFCS) and Global Earth Observation System of Systems (GEOSS).

**1.2.1 Global Observing System of the World Weather Watch**

1.2.1.1 The Global Observing System (GOS) shall be constituted as a coordinated system of observing networks, methods, techniques, facilities and arrangements for making observations on a world-wide scale and defined as one of the main components of the World Weather Watch.

1.2.1.2 The purpose of the Global Observing System shall be to provide the meteorological observations from all parts of the globe that are required by Member countries for operational and research purposes through all WMO and co-sponsored programmes.

1.2.1.3 The Global Observing System shall consist of: (i) a surface-based sub-system composed of regional basic networks of stations and platforms, and other networks of stations and platforms; and (ii) a space-based sub-system composed of: (a) an Earth observation space segment; (b) an associated ground system for data reception, dissemination and stewardship; and

(c) a user segment.

1.2.1.4 The Global Observing System shall comply with the provisions specified in the sections 1, 2, 3, 4 and 5.

**1.2.2 Global Atmosphere Watch (observing component)**

1.2.2.1 The Global Atmosphere Watch (GAW) shall be a coordinated system of observing networks, methods, techniques, facilities and arrangements encompassing the many monitoring and related scientific assessment activities devoted to the investigation of the chemical composition and related physical characteristics of the atmosphere.

total atmospheric deposition areas

1.2.2.2 The purpose of the Global Atmosphere Watch shall be to provide data and other information on the atmospheric chemical composition and related physical characteristics of the background, unpolluted atmosphere, as defined in section 6, from all parts of the globe, required to reduce environmental risks to society and meet the requirements of environmental conventions, strengthen capabilities to predict the state of climate, weather and air quality, and contribute to scientific assessments in support of environmental policy.

1.2.2.3 The observing component of GAW shall consist of a surface-based system composed of networks for observation of specified variables, complemented by space-based observations.

1.2.3.4 The observing component of the Global Atmosphere Watch Programme shall be operated in accordance with the provisions specified in the sections 1, 2, 3, 4 and 6.

**1.2.3 WMO Hydrological Observing System**

1.2.3.1 The WMO Hydrological Observing System (WHOS) shall comprise hydrological observations, initially focusing on water level and discharge.

Note: The composition of the WMO hydrological observing systems is provided in the Volume III – Hydrology, Chapter D.1.2 of the *WMO Technical Regulations* (WMO-No. 49).

1.2.3.2 The WMO hydrological observing systems shall expand to include other elements identified through the application of the Rolling Review of Requirements (RRR) process (specified in section 2.2.4 and Appendix 2.3) at the national, regional and global levels.

1.2.3.3 The purpose of the WHOS shall be to provide real time stream data (both water level and discharge) from participating Members.

1.2.3.4 Members making their hydrological observations available through the WMO Hydrological Observing System (WHOS) shall comply with the provisions specified in the sections 1, 2, 3, 4 and 7.

Note: Volume III – Hydrology, the *Guide to Hydrological Practices* (WMO-No. 168), and the *Manual on Stream Gauging* (WMO-No. 1044) and the *Manual on Flood Forecasting and Warning* (WMO-No. 1072) provide the necessary information to operate hydrological stations to prescribed standards.

**1.2.4 Global Cryosphere Watch (observing component)**

1.2.4.1 The Global Cryosphere Watch (GCW) shall be a coordinated system of observing networks, methods, techniques, facilities and arrangements encompassing monitoring and related scientific assessment activities devoted to the investigation of the Cryosphere.

1.2.4.2 The purpose of the Global Cryosphere Watch shall be to provide data and other information on the cryosphere, from a local to the global scale, to improve understanding of its behaviour, interactions with other components of the climate system, and impacts on society.

1.2.4.3 The GCW observing network and its standardized core network (CryoNet) shall build on existing observing programmes and promote the addition of standardized cryospheric observations to existing facilities.

1.2.4.4 The observing component of the Global Cryosphere Watch shall comply with the provisions specified in the sections 1, 2, 3, 4 and 8.

**1.3 Governance and Management**

**1.3.1 Implementation and Operation of WIGOS**

1.3.1.1 Members shall be responsible for all activities connected with the implementation and operation of WIGOS on the territories of their individual countries.

1.3.1.2 Members should, as far as possible, use national resources for the implementation and operation of WIGOS, but, where necessary and so requested, assistance may be provided in part through:

(a) The WMO Voluntary Cooperation Programme (VCP);

(b) Other bilateral or multilateral arrangements including the United Nations Development Programme (UNDP) which should be used to the maximum extent possible.

1.3.1.3 Members should participate voluntarily in the implementation and operation of WIGOS in regions outside the territories of individual countries (e.g. outer space, oceans, the Antarctic), if they desire and are able to contribute by providing facilities and services, either individually or jointly.

**1.3.2 WIGOS Quality Management**

Note 1: Provisions relating to the WMO Quality Management Framework, WMO QMF, are provided in the *Technical Regulations* (WMO-No. 49), Volume IV – Quality Management, 2011 edition).

Note 2: Within the WMO Quality Management Framework, WIGOS provides the procedures and practices with regard to the quality of observations and observational metadata that should be adopted by Members in establishing their quality management system for the provision of meteorological, hydrological, climatological and other related environmental observations.

Note 3: Section 2.6 provides detailed provisions on WIGOS Quality Management.

**1.3.3 WIGOS High Level Processes**

1.3.3.1 Members should adopt a process-based approach to the management of WIGOS observing systems as described in Attachment 1.

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**ATTACHMENT 1**

**WIGOS High Level Processes**

Many of the WIGOS activities may be represented together as a series of high level processes.

Figure 1 provides a schematic description of the processes (horizontal bars), the collaborating entities (vertical columns) and those having primary involvement in each process (marked by solid circles). In reality the processes have more complex interrelationships and sequences than shown by the arrows – the most extreme case is the capacity development (including training) process which is not shown as a step in the sequence since it has important inputs to most of the other processes.



FIGURE 1: Schematic diagram of WIGOS high-level processes (horizontal bars), the collaborating entities (vertical columns) and those having primary involvement in each process (marked by solid circles).

These processes are carried out by Members through one of the following modes of collaboration:

* Data Users in Application Areas: Members collaborate by selectively contributing Application experts and information to provide the capability to undertake the relevant WIGOS process(es),
* WMO regional associations: Members collaborate by working together in a geographical grouping, and by selectively contributing experts for regional teams, to undertake the relevant WIGOS process(es),
* WMO technical commissions: Members collaborate by selectively contributing technical experts for global teams to undertake the relevant WIGOS process(es),
* WMO Members: as individual operators and managers of observing systems, Members directly undertake the relevant WIGOS process(es),
* WMO designated Centres for performance monitoring (including Lead Centres, and Monitoring Centres): individual Members or groups of Members operate a WMO centre designated for performance monitoring, including Lead Centres or Monitoring Centres, to undertake the relevant WIGOS process(es).

In the case of WIGOS processes being undertaken by the WMO Secretariat or other entities funded by WMO Programmes, the mode of collaboration is through the overall operation of the WMO.

The following example illustrates the relation between the WIGOS high-level processes and the structure of the regulatory material. In section 2 the standard and recommended practices and procedures relevant to each WIGOS process can be found in the following sub-sections:

* Determination of user requirements: 2.1, 2.2
* Design, planning and evolution of WIGOS: 2.2
* Development and documentation of standard and recommended practices and procedures for observing systems: 2.3
* Implementation of observing system by owners and operators: 2.3, 2.4
* Observing system operation and maintenance including fault management and audit: 2.4
* Observation quality control: 2.4, 2.6
* Observations and observational metadata delivery: 2.4, 2.5
* Performance monitoring: 2.4, 2.6
* User feedback and review of requirements: 2.2, 2.6
* Capacity development (including training): 2.7

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**2.** **COMMON ATTRIBUTES OF WIGOS COMPONENT SYSTEMS**

**2.1 Requirements**

2.1.1 Members shall take steps for collecting, recording, reviewing, updating, and making available their observational user requirements.

2.1.2 Members shall convey their observational user requirements, for each of the WMO application areas, to the Rolling Review of Requirements (RRR) process specified under 2.2.4 and Appendix 2.3.

**2.2 Design, Planning and Evolution**

**2.2.1 General**

2.2.1.1 The WIGOS shall be designed as a flexible and evolving system capable of continuous improvement.

Note: Factors which drive the evolution of WIGOS component observing systems include technological and scientific progress and cost-effectiveness, changes in the needs and requirements of WMO, WMO co-sponsored programmes and international partner organizations at national, regional and global levels, and changes in the capacity of Members to implement observing systems. It is important to identify the impact on all users before a change is made.

2.2.1.2   Members shall plan and operate their networks in a sustainable and reliable manner utilizing WIGOS standard and recommended practices and procedures, and tools.

Note: Sustainability over at least a ten year period is recommended; however, this depends on paying sufficient attention to maintenance and operations following the original establishment.

**2.2.2 Principles for Observing Network Design and Planning**

**2.2.2.1** **Observing Network Design Principles**

2.2.2.1.1 Members should follow the principles specified in Appendix 2.1 when designing and evolving their observing system networks.

2.2.2.1.2 Members should conduct network design studies which address national, regional and global scale questions about the optimum affordable mix of components to best satisfy the requirements for observations.

**2.2.2.2 GCOS Climate Monitoring Principles**

2.2.2.2.1 Members designing and operating observing systems for monitoring climate should adhere to the principles specified in Appendix 2.2.

Note: Fifty Essential Climate Variables (ECVs) have been identified for GCOS, which are required to support the work of the United Nations Framework Convention on Climate Change (UNFCCC) and the Inter-governmental Panel on Climate Change (IPCC). The ECVs cover the atmospheric, oceanic and terrestrial domains, and all are technically and economically feasible for systematic observation. Further information about the ECVs is in the "Implementation Plan for the Global Observing System for Climate in support of the UNFCCC (2010 Update)" (GCOS-138, also identified as WMO-TD/No.1523).

**2.2.3 Vision for WIGOS Observing Systems**

2.2.3.1 Members shall take into account the “*Vision for the global observing system in 2025”*when planning the evolution of their observing networks.

Note 1: The “*Vision for the global observing system in 2025*” provides high-level goals to guide the evolution of the WMO integrated global observing systems in the coming decades. The Vision is updated on a multi-year time scale (typically decadal).

Note 2: The “*Vision for the global observing system in 2025*” is available at: http://www.wmo.int/pages/prog/www/OSY/gos-vision.html

**2.2.4 The Rolling Review of Requirements (RRR) Process**

2.2.4.1 Members, both directly and through the participation of their experts in the activities of regional associations and technical commissions, shall contribute to the Rolling Review of Requirements (RRR) process and assist the designated Points of Contact (PoCs) for each Application Area in performing their roles in the RRR.

Note: Appendix 2.3 provides further details on the RRR process.

**2.2.5 Observation Impact Studies**

2.2.5.1 Members, or groups of Members within regions, should conduct and/or participate in observation impact studies and related scientific evaluations to address WIGOS network design questions.

2.2.5.2 Members should provide expertise for synthesizing the results of impact studies and making recommendations on the best mix of observing systems to address the gaps identified by the RRR process.

Note: Impact studies using Observing System Experiments (OSEs), Observing System Simulation Experiments (OSSEs), Forecast Sensitivity to Observations (FSO) studies and other assessment tools are used to assess the impact of the various observing systems on Numerical Weather Prediction model analyses and predictions, hence their value and relative priority for addition or retention for these Application Areas.

**2.2.6 Evolution of WIGOS Observing Systems**

2.2.6.1 Members should follow the plans published by WMO for evolution of WIGOS component observing systems when planning and managing their WIGOS observing systems.

Note1: The planning and coordination of the evolution of WIGOS observing systems is steered by the Executive Council and undertaken by Members individually and through regional associations, technical commissions and relevant steering bodies of WMO co-sponsored observing systems.

Note 2: The current WMO plan for the evolution of WIGOS observing systems was published as the "*Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)*" (WIGOS Technical Report No. 2013-4). It contains guidelines and recommended actions to be undertaken by Members, technical commissions, regional associations, and satellite operators and other relevant parties in order to stimulate cost-effective evolution of the WMO observing systems to address in an integrated way the requirements of WMO Programmes and co-sponsored programmes.

Note 3: The WMO plan for the evolution of WIGOS observing systems is regularly updated and new versions are published on a multi-year time scale (typically decadal), taking into account the Vision for the WIGOS observing systems, and the advice of technical commissions and regional associations, concerned and relevant WMO co-sponsored observing systems, and international experts in all application areas.

2.2.3.6.2 Members shall coordinate the activities by agencies within their country including the National Meteorological and Hydrological Services (NMHSs) and other relevant agencies, in addressing relevant actions of the WMO plans for evolution of WIGOS observing systems.

2.2.3.6.3 In the cases where Member countries cover small areas and are geographically close or already have established multilateral working relationships, Members should consider a sub-regional or transboundary river basin approach, in addition to national, to WIGOS observing systems planning.

2.2.3.6.4 In this case, Members concerned should work in close cooperation to prepare sub-regional or transboundary river basin reviews of requirements to be used as a basis for detailed planning at that scale.

**2.2.6.1 Monitoring the Evolution of WIGOS Observing Systems**

2.2.6.1.1 Members should contribute to the monitoring of the evolution of WIGOS observing systems by providing their national progress reports on a yearly basis through nominated national focal points.

Note: The Commission for Basic Systems, in collaboration with other technical commissions, regional associations, and co-sponsored programmes, regularly reviews progress of actions of the plan for evolution of WIGOS observing systems, and provides updated guidance to Members regarding the evolution of global observing systems.

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**APPENDIX 2.1**

**Observing System Network Design (OSND) Principles**

1. SERVING MANY APPLICATION AREAS

Observing networks should be designed to meet the requirements of multiple application areas within WMO and WMO co-sponsored programmes.

2. RESPONDING TO USER REQUIREMENTS

Observing networks should be designed to address stated user requirements, in terms of the geophysical variables to be observed and the space-time resolution, uncertainty, timeliness and stability needed.

3. MEETING NATIONAL, REGIONAL AND GLOBAL REQUIREMENTS

Observing networks designed to meet national needs should also take into account the needs of the WMO at the regional and global levels.

4. DESIGNING APPROPRIATELY SPACED NETWORKS

Where high-level user requirements imply a need for spatial and temporal uniformity of observations, network design should also take account of other user requirements, such as the representativeness and usefulness of the observations.

5. DESIGNING COST-EFFECTIVE NETWORKS

Observing networks should be designed to make the most cost-effective use of available resources. This will include the use of composite observing networks.

6. ACHIEVING HOMOGENEITY IN OBSERVATIONAL DATA

Observing networks should be designed so that the level of homogeneity of the delivered observational data meets the needs of the intended applications.

7. DESIGNING THROUGH A TIERED APPROACH

Observing network design should use a tiered structure, through which information from reference observations of high quality can be transferred to and used to improve the quality and utility of other observations.

8. DESIGNING RELIABLE AND STABLE NETWORKS

Observing networks should be designed to be reliable and stable.

9. MAKING OBSERVATIONAL DATA AVAILABLE

Observing networks should be designed and should evolve in such a way as to ensure that the observations are made available to other WMO Members, at space-time resolutions and with a timeliness to meet the needs of regional and global applications.

10. PROVIDING INFORMATION SO THAT THE OBSERVATIONS CAN BE INTERPRETED

Observing networks should be designed and operated in such a way that the details and history of instruments, their environments and operating conditions, their data processing procedures and other factors pertinent to the understanding and interpretation of the observational data (i.e. metadata) are documented and treated with the same care as the data themselves.

11. ACHIEVING SUSTAINABLE NETWORKS

Improvements in sustained availability of observations should be promoted through the design and funding of networks that are sustainable in the long-term including, where appropriate, through the transition of research systems to operational status.

12. MANAGING CHANGE

The design of new observing networks and changes to existing networks should ensure adequate consistency, quality and continuity of observations across the transition from the old system to the new.

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**APPENDIX 2.2**

**GCOS Climate Monitoring Principles**

***Effective monitoring systems for climate should adhere to the following principles:***

1. The impact of new systems or changes to existing systems should be assessed prior to implementation;
2. A suitable period[[3]](#footnote-3) of overlap for new and old observing systems is required;
3. The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata) should be documented and treated with the same care as the data themselves;
4. The quality and homogeneity of data should be regularly assessed as a part of routine operations;
5. Consideration of the needs for environmental and climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities;
6. Operation of historically-uninterrupted stations and observing systems should be maintained;
7. High priority for additional observations should be focused on data-poor regions, poorly observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution;
8. Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation;
9. The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted;
10. Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems;

Furthermore, operators of satellite systems for monitoring climate need to:

(a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system; and

(b) Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be resolved.

***Thus satellite systems for climate monitoring should adhere to the following specific principles:***

1. Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained;
2. A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations;
3. Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured;
4. Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured;
5. On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored;
6. Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate;
7. Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained;
8. Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when these exist on decommissioned satellites;
9. Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation;
10. Random errors and time-dependent biases in satellite observations and derived products should be identified;

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 **APPENDIX 2.3**

**The RRR Process**

The WMO Rolling Review of Requirements (RRR) process compiles information on Members evolving requirements for observations in the application areas that directly use observations; the extent to which current and planned WIGOS observing systems satisfy those requirements; guidance from experts in each application area on the gaps and the priorities for addressing the deficiencies and opportunities in WMO observing systems; and hence plans for the future evolution of WIGOS observing systems.

The Application Areas are:

• Global numerical weather prediction (GNWP);

• High-resolution numerical weather prediction (HRNWP);

• Nowcasting and very short range forecasting (NVSRF);

• Seasonal and inter-annual forecasting (SIAF);

• Aeronautical meteorology;

• Atmospheric chemistry;

• Ocean applications;

• Agricultural meteorology;

• Hydrology;

• Climate monitoring (as undertaken through the Global Climate Observing System, GCOS);

• Climate applications;

• Space weather.

Note 1: A detailed and up-to-date description of the RRR process is available on the WMO website at <http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html>.

In addition, observational requirements for WMO polar activities and the Global Framework for Climate Services (GFCS) are also being considered. The observational needs of the former application area "Synoptic meteorology" are now captured and reviewed along with those for NVSRF.

An expert is identified for each Application Area to be the Point of Contact (PoCs). That expert has a very important role as the conduit to the RRR for input and feedback from the entire stakeholder community for that Application Area.

The nominated Point of Contact should coordinate with their Application Area community (technical commission, or programme or co-sponsored programme as appropriate) as needed in order to perform the following tasks:

(1) Investigate whether it is appropriate to represent the Application Area in several sub-applications;

(2) Submit the quantitative observational user requirements to the OSCAR/Requirements database (see <http://www.wmo.int/oscar>), review and keep up-to-date these requirements, and make changes as needed (the PoCs are provided with the required access rights);

(3) Produce, review and revise the Statement of Guidance for the Application Area;

(4) Review how requirements for cross-cutting activities (e.g. Cryosphere, climate services) are taken into account in the user requirements database and in the Statement of Guidance for the Application Area.

Note 2: The observational user requirements compiled through the RRR process are stored and made available by the WIGOS Operational Information Resource (WIR) (OSCAR/Requirements database) as described in detail in Attachment 2.2.

The RRR process consists of four stages:

(1) A review of technology-free (that is, not constrained by any particular type of observing technology) users requirements for observations, within each of the WMO Application Areas (see section 2.1);

(2) A review of the observing capabilities of existing and planned observing systems, both surface- and space-based;

(3) A Critical Review, a comparison of requirements with the observing system capabilities; and

(4) A Statement of Guidance providing a gap analysis with recommendations on addressing the gaps for each Application Area.



Figure 2: Schematic representation of the steps included in the Rolling Review of Requirements process.

**1) Review of observational user requirements**

Note 1: This stage of the RRR is described briefly in section 2.1.

Note 2: Regional associations examine and provide to PoCs additional details for the compiled user requirements, taking into account the particular requirements of the Region and transboundary river basin authorities.

**2) Review of current and planned observing systems capabilities**

Members shall take steps for collecting, reviewing, recording, and making available current and planned capabilities of observing systems.

Note: Information on observing system capabilities is in the form of metadata and is to be made available for global compilation according to the provisions of section 2.5.

**3) The critical review**

Note: This WMO Programme activity proceeds with assistance from the PoCs of the Application Areas. It compares the quantitative observational user requirements of each Application Area with the observing systems capabilities.

**4) Statements of Guidance**

Note 1: The Statement of Guidance interprets the output of the critical review as a gap analysis and identifies priorities for action – the most feasible, beneficial and affordable initiatives to close the identified gaps or shortcomings in WMO observing systems for an Application Area. This draws on the subjective judgement and experience of the PoC and all of the experts and other stakeholders they consult within their Application Area.

Note 2: This stage of the RRR requires the Application Area PoCs to coordinate with their Application Area community and stakeholders as needed in order to produce, review and revise the Statement of Guidance for the Application Area.

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**2.3 Instrumentation and Methods of Observation**

**2.3.1 General Requirements**

Note: Details are provided in the *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), *Weather Reporting* (WMO-No. 9), Volume D – Information for Shipping, and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information.

2.3.1.1 Members should ensure that observations and observational metadata are traceable to International Standards (SI), where these exist.

Note: Traceability to International Standards (SI) is an area where concerted effort is required to increase-improve compliance.

2.3.1.2 Members should employ properly calibrated instruments and sensors that provide observations satisfying at least measurement uncertainties that meet the specified requirements.

Note 1: Achievable measurement uncertainty is specified in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.6.5.2), Annex 1.D.

Note 2: A number of operational, financial, environmental and instrumental issues may cause the system to not always satisfy the specified requirements, e. g. Annex 1.D (the column „achievable“) provides a list of the achievable and affordable measurement uncertainties which in some cases might not satisfy specified requirements.

2.3.1.3 Members should describe uncertainty of observations and observational metadata as specified in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.6).

Note 1: The corresponding text from the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.6) will be included as an Appendix in a future edition.

Note 2: The definition of uncertainty in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter1 (1.6) is consistent with international standards approved by the International Committee for Weights and Measures (CIPM).

2.3.1.4 Members should follow the definitions and specifications for the calculation of derived observations specified in the WMO Technical Regulations.

Note 1: Further methods provided or referenced by the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information could be also considered.

Note 2: Such derivations can take many forms, such a statistical processing of average or smooth values, or multivariate algorithm to determine streamflow discharge.

Note 3: The corresponding text from the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) will be included as an Appendix in a future edition.

**2.4 Operations**

**2.4.1 General Requirements**

Note: Provision 2.4.1.1, Volume I, Part I of the *Technical Regulations* (WMO-No. 49) applies.

2.4.1.1 WMO observing stations and platforms shall be uniquely identified by a WIGOS station identifier.

Note: The structure of WIGOS station identifiers is specified in Attachment 2.12.4.1.2 Members shall issue WIGOS station identifiers for observing stations and platforms within their geographic area of responsibility that contribute to a WMO or co-sponsored programme and shall ensure that no WIGOS station identifier is issued to more than one station.

Note: Members may issue WIGOS station identifiers for observing stations and platforms within their geographic area of responsibility that do not contribute to a WMO or co-sponsored programme, provided that the operator has committed to providing and maintaining WIGOS metadata.

2.4.1.3 Before issuing a station identifier, Members should ensure that the operator of a station or platform has committed to providing and maintaining WIGOS metadata for that station or platform.

Note 1: In circumstances when a WIGOS identifier is required for a station or platform to support a WMO or co-sponsored programme and no Member is in a position to issue one (e.g. Antarctica), the Secretary-General may issue a WIGOS station identifier for that station or platform provided that its operator has committed to:

(a) Providing WIGOS metadata; and

(b) Conforming to relevant Technical Regulations.

Note 2: In circumstances where a WIGOS identifier is required for a station or platform to support a WMO or co-sponsored programme and a Member is not able to issue a WIGOS identifier, the Secretary-General will work with the Member concerned to issue a WIGOS station identifier for that station or platform provided that its operator has committed to:

(a) Providing WIGOS metadata; and

(b) Conforming to relevant Technical Regulations.

2.4.1.4 Members shall make available to WMO the updated metadata each time a new station identifier is issued.

2.4.1.5 Members shall operate their observing systems with properly calibrated instruments and adequate observing and measuring techniques.

Note 1: Detailed guidance on observing practices of meteorological observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

Note 2: Detailed guidance on observing practices of hydrological observing systems and instruments is given in the *Guide to Hydrological Practices* (WMO-No. 168); the Manual on Flood Forecasting and Warning (WMO-No. 1072), and the *Manual on Stream Gauging* (WMO-No. 519).

Note 3: Detailed guidance on observing practices of GAW observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

2.4.1.6 Members should address the requirements for uncertainty, timeliness, temporal resolution, spatial resolution, and coverage which result from the RRR process specified in section 2.2.4 and in accordance with the details provided by other sections as appropriate.

2.4.1.7 Members shall ensure that proper safety procedures are specified, documented and utilized in all its operations.

Note: Safety practices and procedures are those that are concerned with assuring the welfare of staff while promoting overall efficiency and effectiveness of the NMHS and responding to national laws, regulations and requirements for occupational health and safety.

**2.4.2 Observing Practices**

2.4.2.1 Members should ensure that their observing practices are adequate to comply with the observational user requirements.

Note: Observing practices is inclusive of station operation, data processing practices and procedures, applied calculation rules, documentation on calibration practices and associated metadata.

**2.4.3 Quality Control**

2.4.3.1 Members shall ensure observations provided through their WIGOS component observing systems are quality controlled.

2.4.3.2 Members shall implement real-time quality control prior to exchange of observations via the WMO Information System.

Note 1: Quality control of observations consists of examination of observations at stations and at data centres to detect errors so that observations may be either corrected or flagged. A quality control system should include procedures for returning to the source of observations to verify them and to prevent recurrence of errors. Quality control is applied in real time, but it also operates in non-real-time, as delayed quality control. Observations quality depends on the quality control procedures applied during observations acquisition and processing and during preparation of messages, in order to eliminate the main sources of errors and ensure the highest possible standard of accuracy for the optimum use of these observations by all possible users.

Notes 2: Quality control on a real-time basis also takes place in the Global Data-Processing and Forecasting System, prior to the use of the meteorological and climatological observations in data processing (i.e. objective analysis and forecasting).

Note 3: Recommended minimum standards of quality control of the meteorological and climatological observations at the level of the National Meteorological Centre are given in the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), Volume I – Global Aspects, Appendix II-1, Table I. The *Guide on the Global Data-processing System* (WMO-No. 305) should be consulted for more detailed guidance.

Note 4: Recommended practices and procedures for quality control of hydrological observations are given in the *Manual on Flood Forecasting and Warning* (WMO-No. 1072), Chapter 6 and the *Guide to Hydrological Practices* (WMO-No. 168).

Note 5: Recommended practices and procedures regarding the quality of observations for GAW requirements are formulated in Measurement Guidelines through Data Quality Objectives.

2.4.3.3 Members not capable of implementing these standards should establish agreements with an appropriate Regional Meteorological Centre or World Meteorological Centre to perform the necessary quality control.

2.4.3.4 Members shall also perform quality control of observations on a non-real-time basis, prior to forwarding the observations for archiving.

2.4.3.5 Members should develop and implement adequate quality control processes.

Note 1: Quality control processes include (but are not necessarily limited to): (a) validation; (b) cleaning; (c) monitoring.

Note 2: Further guidance is available in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), *Guide to Climatological Practices* (WMO-No. 100), *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information, and *Guide to the Global Observing System* (WMO-No. 488).

**2.4.4 Data and Metadata Reporting**

2.4.4.1 Members shall report and make available observations in standard formats specified by the *Manual on Codes* (WMO-No. 306).

2.4.4.2 In the case of GAW observations, Members shall report and make available observations in standard formats as advised by GAW data centres, in accordance with the provisions in section 6.

Note: Members are to report and make available up-to-date WIGOS metadata as specified in section 2.5.2.

**2.4.5 Incident Management**

2.4.5.1 Members should implement incident management to detect, identify, record, analyse and respond to any incident for restoring a normal observing system operation as quickly as possible, minimizing the negative impact, and preventing a future re-occurrence.

2.4.5.2 Members shall implement procedures to detect, analyse and respond to system faults and human errors at the earliest stage possible.

2.4.5.3 Members should record and analyse incidents as appropriate.

**2.4.6 Change Management**

2.4.6.1 Members should carefully plan and control changes to ensure continuity and consistency of observations and record any modification related to the observing system.

Note: This requirement relates to any change in the observing system, including an observing station, observing programme, instruments, methods of observation, etc.

2.4.6.2 In the case of significant changes in instruments or methods of observation used or the location in which observations are made, Members should ensure a sufficiently long period (to capture all expected climatic conditions) of overlap with dual operation of old and new systems to identify biases, inconsistencies and inhomogeneities.

**2.4.7 Maintenance**

2.4.7.1 Members shall ensure that each observing system is rigorously maintained.

2.4.7.2 Members shall perform regular preventive maintenance of their observing systems including their instruments.

Note: Carefully organized preventive maintenance of all system components is recommended to minimize corrective maintenance and to increase the operational reliability of an observing system.

2.4.7.3 Members shall determine the frequency and timing (schedule) of the preventive maintenance taking into account the type of the observing system, environmental and climate conditions of the observing site and platform, and the instrumentation installed.

2.4.7.4 Members shall perform corrective maintenance in case of observing system component fault as soon as practically possible once the problem has been detected.

2.4.7.5 Members shall employ adaptive maintenance that satisfies the requirements for stability, continuity and consistency of observations through time.

Note: Detailed guidance on maintenance of observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) including all of the GAW measurement guides as referenced in Chapter 16 of the Guide, the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

**2.4.8 Inspection**

2.4.8.1 Members shall arrange periodic inspection of their observing systems.

Note: Such inspection could be undertaken directly or remotely as necessary to monitor correct functioning of observing platform and instruments.

**2.4.9 Calibration procedures**

2.4.9.1 Members shall ensure that measurement systems and instruments are calibrated regularly in accordance with adequate procedures for each type of system and instrument, as described in the relevant sections.

Note 1: Where international or national standards are not available, the basis for calibration is defined or supplied by the manufacturer or by the Scientific Advisory Groups for GAW observations.

Note 2: Detailed guidance on calibration procedures is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

Note 3: In the GAW Programme, World Calibration Centres perform the audit of the stations and require that every laboratory is traceable to the single network standard.

2.4.9.2 Members shall ensure that the measuring devices they use are:

(a) Calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards. Where no such standards exist, the basis used for calibration or verification shall be recorded.

(b) Adjusted or readjusted as necessary, but at the same time safeguarded from adjustments that would invalidate the measurements;

(c) Identified, enabling the calibration status to be determined; and

(d) Protected from damage and deterioration during handling, maintenance and storage.

Note: Details regarding the hydrological observations are given in the WMO *Technical Regulations* (WMO WMO‑No. 49), Volume III – Hydrology; guidance is available in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

2.4.9.3 When the equipment is found not to conform to requirements, the Member shall assess and record the validity of previous measuring results, and take appropriate action on the equipment and the products affected.

2.4.9.4 Members shall record and maintain the results of calibration and verification.

**ATTACHMENT 2.1**

**Structure of WIGOS Station Identifiers**

The structure of the WIGOS Identifier is shown in Figure 1. The meaning of the components of the WIGOS identifier is given in Table 1.

|  |  |  |  |
| --- | --- | --- | --- |
| WIGOS Identifier series | Issuer of Identifier | Issue Number | Local Identifier |

**Figure 1**. Structure of WIGOS identifier

**Table 1**. Allocating the component parts of a WIGOS station identifier

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Description** | **Initial Range – series 0 (Stations)** |  |
| WIGOS Identifier Series | This is used to distinguish between different systems for allocating identifiers. It allows future expansion of the system so that entities do not have to be issued with new identifiers if the structure of the WIGOS identifiers proves unable to meet future requirements. Different values of the WIGOS Identifier Series may correspond to different structures of the WIGOS identifier. Initial permitted range: 0-14 | 0 |  |
| Issuer of Identifier | A number that is used to distinguish between identifiers issued by different organizations. It is allocated by WMO to ensure that only one organization can create a given WIGOS station identifier. | 0-65534 |  |
| Issue Number | An identifier that an organization responsible for issuing an identifier may use to ensure global uniqueness of its identifiers. For example, allocating one issue number for hydrological stations and another for voluntary climate observing stations would enable the managers of the two networks to issue Local Identifiers independently without needing to check with each other that they were not duplicating identifiers.  | 0-65534 |  |
| Local Identifier | This is the individual identifier issued for each entity. An organization issuing identifiers must ensure that the combination of Issue Number and Local Identifier is unique; in that way global uniqueness is guaranteed. | 16 characters  |  |

Notes:

(1) The structure of WIGOS station identifiers has been designed to be general enough to identify other entities, such as individual instruments; however, this has not yet been implemented.

(2) Although the table proposes initial ranges of permitted values of the components that make up a WIGOS identifier, future changes in requirements may result in these ranges being increased. IT systems must, therefore, be designed to process identifiers whose components are of arbitrary length. BUFR encodings will need to be prepared for WIGOS identifiers to allow efficient representation and these may use code lists to represent components of the WIGOS identifier that are shared by many entities. Currently, station identifier = 0.

**Notation for the WIGOS identifier**

The convention for writing the WIGOS identifier (in the context of WIGOS) is:

<WIGOS Identifier series>-<Issuer of Identifier>-<Issue Number>-<Local Identifier>

*Note:* as an example the WIGOS Identifier

|  |  |  |  |
| --- | --- | --- | --- |
| **WIGOS Identifier series** | **Issuer of Identifier** | **Issue Number** | **Local Identifier** |
| 0 | 513 | 215 | 5678 |

would be written as 0-513-215-5678.

**Representing the WIGOS identifier in contexts outside WIGOS**

The following conventions should be used to represent the WIGOS identifier in contexts outside WIGOS or to show the relationship between the WIGOS identifier and an identifier that has been defined in a different context.

|  |  |  |
| --- | --- | --- |
| int.wmo.wigos | WIGOS identifier | WIGOS supplementary identifier |

**Figure 2**. Structure of an extended WIGOS identifier. Both the int.wmo.wigos and the WIGOS supplementary identifier elements are optional.

*int.wmo.wigos*

The first component of the extended WIGOS identifier (int.wmo.wigos) allows the identifier to be recognized as a WIGOS identifier when used in contexts where it may be ambiguous as to what type of identifier is being used. This is optional and need not be represented in BUFR, because the entries for the WIGOS identifier provide this information.

*WIGOS identifier*

The second component (WIGOS identifier) is defined above. Within a WIGOS context it is the only component of the WIGOS identifier that is always required.

*WIGOS supplementary identifier*

The final component of the extended WIGOS identifier (WIGOS supplementary identifier) is optional and is used to associate identifiers issued using other systems to be associated with the WIGOS unique identifier. A single WIGOS identifier may be associated with many WIGOS supplementary identifiers (such as an observing site that is used for both synoptic and aviation reporting), and a WIGOS supplementary identifier may be associated with many WIGOS unique identifiers (such as a World Weather Watch drifting buoy identifier that has been issued to many drifting buoys). In BUFR, this would be specified through a specific table entry (such as IIiii for World Weather Watch station identifier).

*Note*: if above example of a WIGOS identifier (0-513-215-5678) was also associated with an identifier (MYLOCATION) issued by another authority, a valid extended WIGOS identifier would be int.wmo.wigos-0-513-215-5678-MYLOCATION.

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**2.5. Observational Metadata**

**2.5.1 Purpose and scope**

Note 1: Observational metadata are essential as they enable users of observations to assess their suitability for the intended application and managers of observing systems to monitor and control their systems and networks. WMO Members benefit from sharing observational metadata which describe quality of observations and provide information about stations and networks used to collect those observations.

Note 2: Discovery metadata, defined in the *Manual on the WMO Information System* (WMO-No. 1060), are concerned with discovering and accessing information, including observations and their observational metadata. Requirements for discovery metadata are specified in the *Manual on the WMO Information System* (WMO-No. 1060) and are not considered further here.

2.5.1.1 For all WIGOS observations they make available internationally, Members shall record and retain the observational metadata specified as mandatory in the WIGOS Metadata Standard defined in Appendix 2.4.

Note 1: The WIGOS Metadata Standard defines a common set of requirements for elements to be provided in observational metadata. It includes a detailed list of mandatory, conditional and optional metadata.

Note 2: A record of “not available”, "unknown" or "not applicable" are valid values for many elements of the WIGOS Metadata Standard. This assists Members to achieve compliance with the standard, particularly in a transitional step towards capability to report actual values.

2.5.1.2 For all WIGOS observations they make available internationally, Members shall record and retain the observational metadata specified as conditional in the WIGOS Metadata Standard in Appendix 2.4 whenever the related condition is met.

2.5.1.3 For all WIGOS observations they make available internationally, Members should record and retain the observational metadata specified as optional in the WIGOS Metadata Standard in Appendix 2.4.

Note 1: Further requirements for observational metadata beyond the WIGOS Metadata Standard are stated in the following sections. In the case of the Global Observing System, as noted in section 5, the *Manual on the GOS* (WMO-No. 544) provides further provisions for GOS metadata.

Note 2: Further guidance on metadata, and on sound metadata practices, is provided in Guides and guidance documentation associated with the individual observing system components.

**2.5.2 Exchanging and archiving observational metadata**

2.5.2.1 Members shall make available internationally and without restriction, those mandatory and conditional (whenever the condition is met) observational metadata supporting observations that are made available internationally.

2.5.2.2 Members making observations available internationally shall retain and make available, without restriction, observational metadata for at least as long as they retain the observations described by the observational metadata.

2.5.2.3 Members making available internationally archived observations shall ensure that all WIGOS metadata describing the observations remain available, without restriction, for at least as long as the observations are retained.

2.5.2.4 Members making available internationally archived observations should ensure that any additional observational metadata describing the observations remain available, without restriction, for at least as long as the observations are retained.

**2.5.3 Global compilation of observational metadata**

2.5.3.1 Members shall make available to WMO for global compilation those components of the WIGOS metadata that are specified as mandatory or conditional (whenever the condition is met).

Note: global compilations of WIGOS metadata are held in several databases. The Observing Systems Capabilities Analysis and Review tool (OSCAR) database of the WIGOS Operational Information Resource (WIR) is the key source of information for WIGOS metadata. Other global compilations of specific components of WIGOS metadata include elements of the GAWSIS, the JCOMMOPS database and others. Purposes and management of WIGOS Operational Information Resource (WIR) and OSCAR are described in Attachment 2.2.

2.5.3.2 For all WIGOS component observing systems they operate, Members shall keep the relevant WMO observational metadata databases updated with the required WIGOS metadata.

2.5.3.3 Members shall routinely monitor the content of WIGOS metadata databases, and provide feedback to WMO Secretariat on identified discrepancies, possible errors, and required changes with respect to the WIGOS component observing systems they operate.

2.5.3.4 Members shall designate their national focal points responsible for making available metadata and monitoring content of WMO observational metadata databases, and inform the Secretariat accordingly.

2.5.3.5 Members delegating the responsibility of the national focal point for all or part of the observing networks they operate to a global or regional entity shall inform the Secretariat accordingly.

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**APPENDIX 2.4**

**The WIGOS Metadata Standard**

***General***

This Appendix refers to the “*WIGOS Metadata Standard*”, which consists of the set of observational metadata elements to be made available internationally. They are required for the effective interpretation of observations from all WIGOS component observing systems by all observational data users, allowing them to access important information about why, where, and how an observation was made, along with how the raw data has been processed and the quality of the data. Note that WIGOS metadata which is required from specific components or sub-systems is detailed in the sections 3-8.

The table below presents categories (or groups) of metadata, each containing one or more elements. Each element is classified (using the same terminology as is used by ISO) as either mandatory (M), conditional (C), or optional (O).

The definition of each metadata element, together with notes and examples, as well as the explanation of the condition to apply to the conditional elements are specified in the WIGOS Metadata Standard , Attachment to this Appendix.

***Members’ obligations***

Mandatory metadata elements shall always be made available. The content of the corresponding fields shall never be empty, either the metadata “value” or the reason for no-value, shall be made available.

Conditional metadata elements shall be made available when the specified condition or conditions are met, in which case the content of the corresponding fields shall never be empty, either the metadata “value” or the reason for no-value, shall be made available.

Optional metadata elements should be made available, as they provide useful information that can help to better understand an observation. These elements are likely to be important for a particular community, but less so for others.

***Adoption through a Phased Approach***

Making available WIGOS metadata will generate substantial benefits for Members, but developing the capacity to make available these metadata also requires a substantial effort on the part of (meta)data providers. To help Members comply with reporting obligations, guidance material will be developed and provided.

Moreover, reporting obligations will be enforced in phases, in order to allow Members sufficient time to develop the capacity to comply. Balancing the effort required to generate and make available individual elements, and the need to have this information to make adequate use of observations, implementation will proceed through three phases as shown in the table below. Importantly, elements required by the end of **Phase I** are either the mandatory elements in WMO Publication No. 9, Vol. A or are of critical importance for the Observing Systems Capability Analysis and Review (OSCAR) tool of the WIR, and are considered of benefit for all WMO Application Areas. **Phase II** adds elements recognized to be more challenging for Members, but the knowledge of which is still of rather immediate need for the adequate use of observations, in particular for assessing quality of observations. **Phase III** adds the remaining elements specified in this version of the standard.

Elements emerging as being important for specific application areas or observing programmes will be added to the standard as it evolves.

**List of elements specified in the WIGOS metadata standard and the phases for Members implementation**

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Phase I** | **Phase II** | **Phase III** |
|  | **2016** | **2017-2018** | **2019-2020** |
| 1. Observed variable | **1-01 Observed variable – measurand (M)** | 1-05 Representativeness (O) |  |
|  | **1-02 Measurement unit (M)** |  |  |
|  | **1-03 Temporal extent (M)** |  |  |
|  | **1-04 Spatial extent (M)** |  |  |
| 2. Purpose of observation | **2-01 Application area(s) (M)** |  |  |
| **2-02 Programmes/Network affiliation (M)** |  |  |
| 3. Station/Platform | *3-01 Region of origin of data (C)*  | **3-04 Station/platform type (M)** | **3-05 Station/platform model (M)** |
|  | *3-02 Territory of origin of data (C)*  | 3-08 Data communication method (O) |  |
|  | **3-03 Station/platform name (M)** |  |  |
|  | **3-06 Station/platform unique identifier (M)** |  |  |
|  | **3-07 Geospatial location (M)** |  |  |
|  | **3-09 Station status (M)** |  |  |
| 4. Environment |  | 4-04 Events at Station/platform (O) | *4-01 Surface cover (C)*  |
|  |  | 4-05 Site information (O) | *4-02 Surface Cover classification scheme (C)*  |
|  |  |  | *4-03 Topography or Bathymetry (C)*  |
| 5. Instruments and Methods of Observation | **5-01 Source of observation (M)** | 5-11 Maintenance party (O) | 5-04 Instrument operating status (O) |
| **5-02 Measurement/observing method (M)** | *5-12 Geospatial location (C)*  | *5-06 Configuration of instrumentation (C)* |
|  | **5-03 Instrument specifications (M)** | *5-15 Exposure of instrument (C)* | *5-07 Instrument control schedule (C)*  |
|  | *5-05 Vertical distance of sensor (C)*  |  | *5-08 Instrument control result (C)*  |
|  |  |  | *5-09 Instrument model and serial number (C)*  |
|  |  |  | *5-10 Instrument routine maintenance (C)*  |
|  |  |  | 5-13 Maintenance Activity (O) |
|  |  |  | 5-14 Status of observation (O) |
| 6. Sampling | 6-03 Sampling strategy (O) | **6-05 Spatial sampling resolution (M)** | 6-01 Sampling procedures (O) |
|  | **6-07 Diurnal base time (M)** |  | 6-02 Sample treatment (O) |
|  | **6-08 Schedule of observation (M)** |  | **6-04 Sampling time period (M)** |
|  |  |  | **6-06 Temporal sampling interval (M)** |
|  |
| 7. Data Processing and Reporting | **7-03 Temporal reporting period (M)** | 7-02 Processing/analysis centre (O) | 7-01 Data processing methods and algorithms (O) |
| *7-04 Spatial reporting interval (C)* | 7-06 Level of data (O) | 7-05 Software/processor and version (O) |
|  | *7-11 Reference datum (C)*  | **7-09 Aggregation period (M)** | **7-07 Data format (M)** |
|  |  | **7-10 Reference time (M)** | **7-08 Version of data format (M)** |
|  |  |  | 7-12 Numerical resolution (O) |
|  |  |  | **7-13 Latency (of reporting) (M)** |
| 8. Data Quality |  | *8-01 Uncertainty of measurement (C)* |  |
|  |  | *8-02 Procedure used to estimate uncertainty (C)* |  |
|  |  | **8-03 Quality flag (M)** |  |
|  |  | **8-04 Quality flagging system (M)** |  |
|  |  | *8-05 Traceability (C)* |  |
| 9. Ownership and Data Policy | **9-02 Data policy/use constraints (M)** | **9-01 Supervising organization (M)** |  |
| 10. Contact | **10-01 Contact (Nominated Focal Point) (M)** |  |  |

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**ATTACHMENT 2.2**

**The WIGOS Information Resource (WIR)**

**Purpose of the WIR**

The WMO Integrated Global Observing System (WIGOS) Information Resource (WIR) is a tool designed to provide WIGOS stakeholders (observing network decision makers, managers, supervisors, implementation coordination groups, observational data users) with all relevant information on the operational status and evolution of WIGOS and its observing components, the operational requirements of WIGOS, including standard and recommended practices and procedures, best practices and procedures used in the WIGOS framework, and their capabilities to meet observational user requirements of the WMO Application Areas. The WIR serves a number of purposes, and brings the following benefits to WMO Members:

(i) To provide general information on WIGOS, its benefits to Members, and the impacts on Members of addressing WIGOS requirements;

(ii) To provide an overall description of the WIGOS component observing systems that are currently in place (list of observing networks, stations, their characteristics (metadata) including information on observational products they deliver);

(iii) To monitor the evolution of the observing systems and compare this with the plans, to ascertain progress;

(iv) To outline existing national and regional plans for evolution of WIGOS component observing systems;

(v) To assist Members and those in charge of observing network design and implementation to understand the requirements for the relevant observing systems, including standard and recommended practices and procedures, and observational user requirements, in order for them to make appropriate decisions;

(vi) To assist Members to identify observational gaps through critical review and to conduct network design studies, in order for them to address those gaps;

(vii) To assist Members to understand the full potential of the current observing systems with regard to the WMO Application Areas, including those systems operated by partner organizations, to enhance: (a) the scope and availability of observations made by specific observing stations; (b) collaborations; (c) data sharing; and (d) data exchange;

(viii) To provide data users with immediate access to the list of WIGOS component observing systems, with a basic set of observational metadata for each (specified by WMO Technical Regulations), and with links to the appropriate national databases where more detailed information is available in those cases where such databases exist;

(ix) To provide developing countries with guidance on observing network implementation, and tools they can readily use to document their own observing systems (e.g. by using the OSCAR tool of the WIR, they could avoid the need to develop a database nationally); and

(x) To provide a mechanism for matching specific needs (capacity building, gaps, etc.) with resources (via knowledge sharing, donor contributions etc.).

Note 1: Observing stations refer to all types of observing sites, stations and platforms relevant to WIGOS, whether they are surface-based, or space-based, on land, at sea, lake, river, or in the air, fixed, or mobile (incl. in the air), and making in-situ or remote observations.

Note 2: Gaps are expressed in terms of required space, and time resolution, observing cycle, timeliness, and uncertainty for the WMO Application Areas.

**The Observing Systems Capabilities Analysis and Review tool (OSCAR)**

The Observing Systems Capabilities Analysis and Review tool (OSCAR) of the WIR is a key source of information for WIGOS metadata. The surface- and space-based capabilities components of the OSCAR is intended to record observing platform/station metadata according to the WIGOS metadata standard described in the *Manual on WIGOS* (WMO-No. XXXX), and to retain a record of the current and historical WIGOS metadata.

**Management of OSCAR**

The management of OSCAR (i.e. functional specifications and their evolution, and information content management) and its components is overseen by the WMO Secretariat in liaison with relevant expert groups and bodies, and in accordance with the WIGOS agreed upon standard and recommended practices and procedures.

**OSCAR content management**

The OSCAR will be managed to provide the availability needed to address its purpose. WIGOS metadata is maintained under the authority of the Permanent Representatives with WMO.

The operator of OSCAR will collect feedback from Members on noted discrepancies, possible errors, and required changes, so that the OSCAR information content reflects the reality of the surface and space-based capabilities of the observing platforms/stations they operate, including instrument, and platform/station metadata.

The WMO Secretariat is responsible to coordinate management of the information content of OSCAR, with assistance from designated experts and focal points.

Current information can be seen at: <http://www.wmo.int/oscar>.

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**2.6. Quality Management**

Note 1: The *Technical Regulations* (WMO-No. 49), Volume IV – Quality Management, 2011 edition, provides provisions relating to the WMO Quality Management Framework, WMO QMF.

Note 2: Detailed guidance on how to develop and implement a quality management system (QMS) to ensure and enhance the quality of NMHS products and services is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100), 2013 edition).

Note 3: Definitions, terminology, vocabulary and abbreviations used in relation to quality management are those of the ISO 9000 family of standards for quality management systems, in particular within ISO 9000:2005, Quality Management Systems – Fundamentals and vocabulary.

Note 4: A QMS can only be implemented by the body which has the resources and the mandate to manage the observing system. While for consistency with the WMO QMF, it is Members who are urged to follow the standard and recommended practices and procedures associated with implementation of a QMS, in practice it is one or more organizations within the Member’s country that own and operate observing systems and provide observations and observational metadata, most notably the NMHSs. In practice, then, implementation of the WMO QMF relies on the Member making arrangements for such organizations to implement a QMS.

Note 5: The term “observations” include also “observational metadata” everywhere in the section 2.6.

**2.6.1 Scope and Purpose of WIGOS Quality Management**

Note: WIGOS practices and procedures enable Members to comply with the WMO QMF in relation to the quality of observations.

**2.6.2 WIGOS Component of the WMO Quality Management Framework**

**2.6.2.1 Quality Policy**

2.6.2.1.1 In the establishment and maintenance of WIGOS observing systems, Members should ensure optimum affordable quality for all observations.

2.6.2.1.2 Members should, through a process of continual improvement, pursue effective and efficient management and governance of observing systems.

**2.6.2.2 Application of the eight Principles of Quality Management**

2.6.2.2.1 Members should apply the eight Principles of Quality Management to the implementation of WIGOS as specified in Appendix 2.5.

Note: The eight principles of QM are specified in Volume IV of WMO the *Technical Regulations* (WMO-No. 49).

**2.6.3 WIGOS Quality Management Processes**

Note: The processes and roles of various entities are described in Attachment 1.

**2.6.3.1 Determination and Maintenance of User Requirements**

Note: The WMO RRR process for compiling observation user requirements is described in section 2.2.4 and Appendix 2.3.

**2.6.3.2 Development and Documentation of Observing Systems Standards and Recommendations**

2.6.3.2.1 Through involvement in the work of technical commissions, Members should participate in the development of observing system standard and recommended practices and procedures.

**2.6.3.3 Training of Personnel and Capacity Development**

2.6.3.3.1 Members should ensure appropriate planning and implementation of training and capacity development activities.

**2.6.3.4 Performance Monitoring**

2.6.3.4.1 Members should use and respond to the results, advice and reports of designated monitoring centres and any subsequent advice of expert groups.

**2.6.3.5 Feedback, Change Management and Improvement**

2.6.3.5.1 Members should ensure that inconsistencies (problems) identified by WIGOS Lead and Monitoring Centers are rectified in a timely manner and that a process for their documentation and rectification is implemented and maintained.

2.6.3.5.2 Members should, upon identification or notification of observation quality related inconsistencies, and problems analyze the detected problem and implement necessary improvements to operational practices and procedures so as to minimize their negative impacts and prevent their future reoccurrence.

2.6.3.5.3 Members should ensure that changes to operational practices and procedures are accordingly documented.

**2.6.4 WIGOS aspects of the Development and Implementation of the QMS of Members**

Note: This section specifies requirements for the integration of WIGOS practices and procedures into the QMS of Members. The requirements are based on the eight clauses of the ISO 9001 standard. The *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition provides extensive explanatory notes about the eight clauses. The five subsections which follow correspond to the last five of the clauses, providing further details about the elements required in a QMS.

**2.6.4.1 General requirements for the content of a QMS**

2.6.4.1.1 Members should identify their high level processes and their interactions that lead to the provision of observations.

Note: In addition to WIGOS specific provisions, there are many other general requirements for the content of a QMS which are not unique to WIGOS observations hence are not repeated here.

**2.6.4.2 Requirements related to management and planning**

2.6.4.2.1 Members should clearly demonstrate and document their management commitment to the integration of WIGOS quality management practices within their QMS.

2.6.4.2.2 Members should carefully identify and routinely review user requirements for observations prior to attempting to meet user needs.

2.6.4.2.3 Members should ensure that their published quality policy is consistent with the WIGOS quality policy.

2.6.4.2.4 Members should establish and make known objectives for their future provision of observations so as to provide guidance to stakeholders, users and clients on the expected evolution of and changes to the observing systems that they operate as a contribution to WIGOS.

Note: The objectives referred to in this provision constitute the WIGOS quality objectives.

2.6.4.2.5 Members should appoint a quality manager.

**2.6.4.3 Requirements related to resource management**

2.6.4.3.1 Members should determine and provide the resources needed to maintain and continuously improve the effectiveness and efficiency of their processes and procedures.

2.6.4.3.2 Members should define the competencies required for staff involved in the provision of observations.

2.6.4.3.3 Members should take steps to rectify any competency shortcomings identified for new or existing employees.

2.6.4.3.4 Members should implement policies and procedures to maintain the infrastructure required for the provision of observations.

**2.6.4.4 Requirements related to the provision of observations**

2.6.4.4.1 Members should undertake sound planning for the provision of observations.

Note: Such planning includes the following activities and processes:

* Determination and continuous review of user and client requirements;
* The translation of user and client requirements into objectives and targets for observations and observing system design;
* Initial and ongoing allocation of adequate resources for all aspects of the design, implementation and maintenance processes of observing systems;
* Implementation of design processes and activities, including communication strategies and risk management, that will ensure and confirm the development and implementation of observing systems that meet objectives and user and client requirements; and,
* Appropriate and ongoing documentation of planning processes and their results.

2.6.4.4.2 Members should identify their users and establish and document their users' requirements for observations.

Note: The means for doing this include:

i. The WMO Rolling Review of Requirements (RRR) process, described in sections 2.2.4 and Appendix 2.3;

ii. Other processes to establish user requirements within WMO Programmes through the activities of WMO technical commissions;

iii. Regional processes through the activities of WMO regional associations and other multi-lateral groupings of Members: and,

iv. National processes.

2.6.4.4.3 Members should have a clear description of the requirements that are agreed upon.

Note: It is important to note the difference between aspirational requirements and agreed requirements. Once requirements are established, this will provide essential information for the monitoring and measurement of conformance.

2.6.4.4.4 Members should identify and adhere to any statutory or regulatory requirements in relation to the provision of observations.

2.6.4.4.5 Members should design and develop, or otherwise implement, observing systems to satisfy the agreed user requirements.

2.6.4.4.6 Members should use a formal change management process to ensure that all changes are assessed, approved, implemented and reviewed in a controlled manner.

2.6.4.4.7 Members should conduct purchasing in a controlled manner.

Note: Observing systems often require large expenditure and are highly specialized, and therefore clear and concise specifications are needed. Staff responsible for purchasing orders or for providing information to suppliers must ensure that the information and specifications provided are clear, unambiguous and based on meeting the design objectives and system requirements to enable the supply of the appropriate and correct products and services. The undertaking of purchasing in a controlled manner entails application of the following activities and processes:

i. Undertaking written specification of all performance requirements for equipment and/or services;

ii. Ensuring that purchasing is subject to a competitive process of more than one candidate for supply of equipment or services;

iii. Assessment of candidates for supply of equipment or services based on merit and suitability for purpose, which can be discerned from:

a. Written tendering or quotation of candidates;

b. Experience or reliable anecdotal evidence of past performance: and,

c. Recommendation of Member or recognized organizations and agencies; and,

iv. Documentation of the purchasing process and outcomes.

2.6.4.4.8 Members should include in their QMS the WIGOS provisions covering methods of observation, calibration and traceability, operational practices, maintenance, and observational metadata.

2.6.4.4.9 Members should implement practices and procedures which ensure that observations remain accurate.

Note: Observations need to be checked as they are produced to ensure they meet the agreed requirements. The means to do this include automated algorithms, manual inspection and oversight.

**2.6.4.5 Requirements for monitoring, performance measurement, analysis and improvement**

2.6.4.5.1 Members should use the agreed user requirements for observations (see 2.6.4.4) as a basis for defining and implementing appropriate measures of performance and success.

Note: It is important to gain a clear understanding of how satisfied users are with observations. It requires the monitoring of information relating to users’ perception and whether their expectations have been met. Surveys are commonly used for this purpose.

2.6.4.5.2 Members should implement activities to gain information on the satisfaction of users of observations.

2.6.4.5.3 Members should ensure that staff are made aware of the methods that have been employed for determining user perceptions and expectations and that they are applied consistently.

2.6.4.5.4 Members should regularly conduct and analyse the results of internal audits of WIGOS processes and procedures as part of the management processes of the observing system.

Note: A detailed explanation on the requirements of the internal audit process is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition, section “8.2.2 Internal audit”.

2.6.4.5.5 Members should monitor the degree of adherence to the defined processes and requirements for producing observations.

Note: Ideally performance monitoring will be conducted against specific Key Performance Indicators and target levels of performance.

2.6.4.5.6 Members should monitor and measure the fitness for purpose and the quality of their observations as they are produced in order to compare their characteristics with the agreed requirements.

Note: The means to do this include:

i. The devising, implementation and routine analysis of manually or automatically generated Key Performance Indicators and their associated targets; and,

ii. Manual inspection and oversight of observational data produced.

2.6.4.5.7 Members should record instances of non-conformity with requirements, and endeavour to rectify problems in a timely manner.

2.6.4.5.8 Members should maintain a documented corrective action procedure relevant to observations.

2.6.4.5.9 Members should specify and implement procedure(s) that describe(s) how non-conforming observations or observational metadata are identified, how they are dealt with, who is responsible for deciding what to do, what action should be taken and what records are to be kept.

Note: A detailed explanation on the requirements of the corrective action process is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition, section “8.2.3 and 8.2.4 Monitoring and measurement of processes and products”.

2.6.4.5.10 Members should analyse monitoring results to detect any performance related changes, trends and deficiencies and use the results and analyses as input to activities aimed at continual improvement.

Note: Analysing trends and taking action prior to the occurrence of a case of non-conformity helps to prevent problems.

2.6.4.5.11 Members should maintain documented preventive action procedures relevant to observing systems and ensure that staff are aware of and, if necessary, trained in their routine application.

Note: Due consideration might be given to combining the preventive and the corrective action procedures for efficiency and to simplify the process.

**2.6.5 Compliance, Certification and Accreditation**

Note: While WMO encourages the certification of Member quality management systems by recognized accreditation agencies, unless otherwise specified as a requirement of a particular WIGOS Component System or subsystem, there is no general regulated requirement for certification of QMS for WIGOS observing systems.

**2.6.6 Documentation**

2.6.6.1 Members should include the WIGOS quality policy (2.6.2.1) and objectives (2.6.4.2) in their QMS Quality Manual.

2.6.6.2 Members should include in their QMS documentation those documents that describe the procedures related to WIGOS, including in particular those relating to control of non-conforming observations, corrective actions and preventive actions.

2.6.6.3 Members should include in their QMS documentation those documents that describe the procedures required to ensure the effective planning, operation and control of its WIGOS processes.

2.6.6.4 Members should include in their QMS documentation those records required by the ISO 9001 standard.

Note: More detailed information on Documentation requirements is provided in the *Guide to the implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition, section “4.2 Documentation requirements”.

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**APPENDIX 2.5**

**Eight Principles of Quality Management of the WMO Quality Management Framework applied to WIGOS**

1. User and client focus

Members should identify, document and understand the current and future needs of their users and clients for meteorological, climatological, hydrological, marine and related environmental observations.

Note: The means to achieve this includes participation in and the application of the WMO Rolling Review of Requirements (RRR) process (see section 2.2.4 and Appendix 2.3).

2. Leadership

Members should clearly define the goals and directions of their observing systems and create an environment in which staff are encouraged to work in that direction.

Note: The relevant WMO technical commissions provide technical guidance and leadership for the implementation of WIGOS. They provide information on WIGOS goals and directions, and stimulate the active involvement of technical experts from Member countries.

3. Involvement of people

Experts from Member countries should be fully involved in the implementation of regulations pertaining to WIGOS quality management.

4. Process approach

Members should adopt a process-based approach to management of observing systems.

5. System approach to management

Members should identify, understand and manage WIGOS observing systems as sets of processes that may be operational, scientific or administrative, with the overall objective of producing the required observations outputs.

6. Continual improvement

Members should ensure that continual improvement is an integral and permanent component of WIGOS observing systems and is implemented through a range of processes and activities that include: active participation in the WMO RRR; auditing of observing systems and sites; data quality monitoring and evaluation, and ensuring routine consultation with, and review of feedback from, WIGOS users and Application Areas, primarily through the WMO Rolling Review of Requirements.

Note: The resulting outcome is the improvement of either the quality of observations or the efficiency of observing systems.

7. Factual approach to decision-making

Members should ensure that decisions, requirements and regulations associated with the design, development, implementation, operation, maintenance and evolution of WIGOS observing systems are based on scientifically, factually and analytically derived information.

Note: The above mentioned information is available to Members through tools such as the WMO RRR, the WIGOS Information Resource (WIR), the Observing Systems Capability Analysis and Review (OSCAR) tool, and through WMO endorsed planning documents such as the “*Implementation Plan for Evolution of Global Observing Systems*” (WIGOS Technical Report No. 2013-4) and others. For further information see section 2.2.4, Appendix 2.3 and Attachment 2.2.

8. Mutually beneficial supplier relationships

Members should participate in, and share with each other and with suppliers, information and results of, tests, trials and intercomparisons of instruments and systems, for the mutual benefit of both WIGOS and suppliers.

Note: Suppliers of instruments, systems and related products should be evaluated and selected on the basis of their ability to meet requirements and on the past performance of their products and services.

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**2.7 Capacity Development**

**2.7.1** **General**

2.7.1.1 Members should identify their needs for capacity development in all activity areas of WIGOS.

2.7.1.2 Members should develop plans to meet their capacity development needs.

Note: In addition to national resources allocated to National Meteorological and Hydrological Services, other support may be available to Members such as: other domestic agencies, their WMO regional association, other Members through bilateral or multilateral arrangements, and WMO Programmes (including appropriate technical commissions).

2.7.1.3 Members should establish bilateral and multi-lateral collaborations (within and beyond their Region) where necessary to address significant capacity development needs.

2.7.1.4 When planning capacity development activities, Members should take a holistic approach considering institutional, infrastructural, procedural, and human resources requirements to support both the current and continuing resource requirements for installation, operation, maintenance, inspection, and training. For this purpose, Members should prepare specific capacity development plans with measurable objectives to enable effective implementation, monitoring, and assessment.

Note: Funds to meet these requirements should be planned well ahead, subject to national policies of Members, to assure long-term sustainable networks.

**2.7.2 Training**

2.7.2.1 Members shall provide adequate training for their staff, or take other appropriate actions to ensure that all staff are suitably qualified and competent for the work assigned to them.

Note: This requirement is applied both to initial recruitment or introductory training and to continuing professional development.

2.7.2.2 Each Member should ensure that the qualifications, competencies, skills (and thus training) and numbers of their personnel or other contractors are well matched to the range of tasks to be performed.

2.7.2.3 Each Member should communicate to the staff their role and how they contribute to the achievement of the quality objectives.

**2.7.3 Infrastructural Capacity Development**

2.7.3.1 Members should regularly review their infrastructure for collecting and making available observations and observational metadata and, as necessary, develop prioritized plans and priorities for capacity development.

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**3.** **ATTRIBUTES SPECIFIC TO THE SURFACE-BASED SUB-SYSTEM OF WIGOS**

**3.1. Requirements**

Note: the observational user requirements of WMO Application Areas are expressed in a technology free manner. Hence they apply to all of WIGOS in common, not to any specific sub-system. The provisions of section 2.1 apply across all WIGOS sub-systems.

**3.2. Design, planning and evolution**

**3.2.1 Composition of the surface-based sub-system of WIGOS**

3.2.1.1 The WIGOS surface-based sub-system shall be composed of surface stations within the component networks (i.e. GOS, GAW, WHOS, GCW).

3.2.1.2 Members should implement elements of the WIGOS surface-based sub-system under the coordination of regional associations when appropriate.

Note: Information regarding the current capabilities of the surface-based subsystem is to be available through the Observing Systems Capability Analysis and Review Tool (OSCAR) at: http://[www.wmo.int/oscar](http://www.wmo.int/oscar).

**3.3. Instrumentation and Methods of Observation**

**3.3.1 General Requirements**

3.3.1.1 Members shall classify their surface meteorological and climatological observing stations on land.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, (1.1.2), Annex 1.B provides guidelines on the classification of surface observing sites on land to indicate their representativeness for the measurement of different variables.

Note 2: The content of Annex 1.B will be included as an Appendix in a future edition.

3.3.1.2 Members should locate each observing station at a site that permits instrument exposure against the requirements of the particular applications and enables satisfactory non-instrumental observations.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, Annexes 1.B and 1.C provides further guidelines.

Note 2: Requirements for GAW stations are formulated in section 6.

3.3.1.3 Members shall accurately know and refer the position of a station to the World Geodetic System 1984 (WGS-84) and its Earth Geodetic Model 1996 (EGM96)

Note 1: Guidelines are provided in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.3.3.2).

Note 2: This geodetic system is currently not in general use in hydrology.

Note 3: Its description will be included as an Appendix in a future edition.

3.3.1.4 Members shall define the elevation of the station.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, (1.3.3.2(c)) provides guidelines on defining the elevation of a station.

Note 2: This material will be included as an Appendix in a future edition.

3.3.1.5 If a station is located at an aerodrome, Members shall specify the official elevation of the aerodrome in accordance with the WMO *Technical Regulation* (WMO-No. 49), Volume II, [C.3.1.], Appendix 3, 4.7.2).

3.3.1.6 Members operating Regional Instrument Centres should follow the guidelines concerning capabilities and corresponding functions.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Annex 1.A provides guidelines concerning capabilities and corresponding functions.

Note 2: This material will be included as an Appendix in a future edition.

3.3.1.7 Members operating Regional Marine Instrument Centres should follow the guidelines concerning capabilities and corresponding functions.

Note 1: The Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8), Part II, Chapter 4, Annex 4.A provides guidelines concerning capabilities and corresponding functions for operating Regional Marine Instrument Centres.

Note 2: The content of Annex 4.A will be included as an Appendix in a future edition.

**3.3.2 Requirements on Sensors**

3.3.2.1 Members shall avoid the use of mercury in their observing systems. Where mercury is still in use, Members shall obey the safety precautions provided.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 3 (3.2.7) provides safety precautions

Note 2: This material will be included as an Appendix in a future edition.

3.3.2.2 For inflation of meteorological balloons, Members should prefer helium over hydrogen. If hydrogen is used, however, Members shall obey to the safety precautions provided.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part II, Chapter 10 (10.6.1) provides safety precautions.

Note 2: This material will be included as an Appendix in a future edition.

3.3.2.3 Members shall calibrate all pyrheliometers, other than absolute pyrheliometers, by comparison using the sun as the source with a pyrheliometer that has traceability to the World Standard Group and a likely uncertainty of calibration equal to or better than the pyrheliometer being calibrated.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 7 (7.2.1.4) provides the detailed guidelines.

3.3.2.4 Members shall compare, calibrate and maintain barometers according to the guidelines.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 3 (3.10), provides guidelines on the comparison, calibration and maintenance of barometers.

Note 2: This material will be included as an Appendix in a future edition.

**3.4. Operations**

**3.4.1 General Requirements**

3.4.1.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.1.

**3.4.2 Observing Practices**

3.4.2.1 Members shall ensure that the exposure, when applicable, of instruments for the same type of observation at different stations be similar in order that observations may be compatible.

3.4.2.2 Members shall determine a reference height for at each surface observing station or system.

Note: A reference height is defined as follows:

1. Elevation of the station. It is the datum level to which barometric pressure reports at the station refer; such current barometric values being termed "station pressure" and understood to refer to the given level for the purpose of maintaining continuity in the pressure records; or

2. For stations not located on aerodromes: elevation of the ground (height above mean sea level of the ground on which the raingauge stands or, if there is no raingauge, the ground beneath the thermometer screen. If there is neither raingauge nor screen, it is the average level of terrain in immediate vicinity of station) in metres rounded up to two decimals; or

3. For stations located on aerodromes it is an official altitude of the aerodrome.

**3.4.3 Quality Control**

3.4.3.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.3.

**3.4.4 Data and Metadata Reporting**

3.4.4.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.4.

**3.4.5 Incident Management**

3.4.5.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.5.

**3.4.6 Change Management**

3.4.6.1 Members should compare observations from new instruments over an extended interval before the old measurement system is taken out of service or when there has been a change of site. Where this procedure is impractical at all sites, Members should carry out comparisons at selected representative sites.

Note 1: This does not apply to all types of stations and among the exceptions are hydrological stations.

Note 2: Further details can be found in the *Guide to Climatological Practices* (WMO-No. 100), including the required minimum intervals for such comparison.

**3.4.7 Maintenance**

3.4.7.1 Observing sites and instruments should be maintained regularly so that the quality of observations does not deteriorate significantly between station inspections.

Note: Detailed guidance on maintenance of observing sites, observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168, 2008) and the *Manual on Stream Gauging* (WMO-No. 1044, 2010).

**3.4.8 Inspection and Supervision**

3.4.8.1 Members shall arrange for its surface observing site, station, system to be inspected at sufficiently frequent intervals to ensure that a high standard of observations is maintained; instruments and all their indicators are functioning correctly; and the exposure, when applicable, of the instruments has not changed significantly.

Note 1: Reference is made to the sections 5-8 for the frequency intervals specified for the different types of WIGOS surface observing stations.

Note 2: Detailed guidance on the inspection including the frequency is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part III, Chapter 1.

Note 3: Reference is made to the *Technical Regulations* (WMO-No. 49), Volume II for provisions on the inspection of aeronautical meteorological stations including its frequency.

3.4.8.2 Members shall ensure that inspection is performed by qualified and adequately trained staff.

3.4.8.3 When performing inspection, Members should ensure that:

(a) The siting, selection and installation, as well as exposure when applicable, of instruments are known, recorded and acceptable;

(b) Instruments have approved characteristics, are in good order and regularly verified against relevant standards;

(c) There is uniformity in the methods of observation and in the procedure for reduction of observations.

Note: Detailed guidance on inspection and supervision of observing systems and sites is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) including all of the GAW measurement guides as referenced in Chapter 16 of the Guide, the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

**3.4.9 Calibration Procedures**

3.4.9.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.9.

* 1. **Observational Metadata**

Note: Detailed guidance regarding the establishment, maintenance and update of metadata records is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.3.4 and Part III, Chapter 1, 1.9; *Guide to Climatological Practices* (WMO-No. 100), Chapter 3, 3.3.4; *Guide to the Global Observing System* (WMO-No. 488), Appendix III.3, and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 10.

3.5.1 Members operating surface-based observing systems shall follow the provisions of the section 2.5.

Note: Further provisions specific to the WIGOS component observing system appear in sections 5, 6, 7 and 8.

**3.6. Quality Management**

3.6.1 Members operating surface-based observing systems shall follow the provisions of the section 2.6.

Note: Further provisions specific to the WIGOS space-based sub-system appear in section 4; specific to the WIGOS component observing system appear in sections 5, 6, 7 and 8.

**3.7. Capacity Development**

3.7.1 Members operating surface-based observing systems shall follow the provisions of the section 2.7.

Note: Further provisions specific to the WIGOS space-based sub-system appear in section 4; specific to the WIGOS component observing system appear in sections 5, 6, 7 and 8.

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**4. ATTRIBUTES SPECIFIC TO THE SPACE-BASED SUB-SYSTEM OF WIGOS**

**4.1.** **Requirements**

* + 1. **General**

4.1.1.1 Members shall strive to develop, implement and operate a space-based environmental observing system in support of WMO Programmes as described in Attachment 4.1.

Note: The space-based sub-system of WIGOS is established through dedicated satellites, remotely observing the characteristics of the atmosphere, the earth and the oceans.

* + 1. **Observed Variables**

4.1.2.1 This sub-system shall provide quantitative data enabling, independently or in conjunction with surface-based observations, the determination of variables including but not limited to:

(a) Three-dimension fields of atmospheric temperature and humidity;

(b) Temperature of sea and land surfaces;

(c) Wind fields (including ocean surface winds);

(d) Cloud properties (amount, type, top height, top temperature, and water content);

(e) Radiation balance;

(f) Precipitation (liquid and frozen);

(g) Lightning;

(h) Ozone concentration (total column and vertical profile);

(i) Greenhouse gas concentration;

(j) Aerosol concentration and properties;

(k) Volcanic ash cloud occurrence and concentration;

(l) Vegetation type and status and soil moisture;

(m) Flood and forest fire occurrence;

(n) Snow and ice properties;

(o) Ocean colour;

(p) Wave height, direction and spectra;

(q) Sea level and surface currents;

(r) Sea ice properties;

(s) Solar activity;

(t) Space environment (electric and magnetic field, energetic particle flux, electron density).

Note: Information regarding the current capabilities of the space-based subsystem is available through the Observing Systems Capability Analysis and Review Tool (OSCAR) at: http://[www.wmo.int/oscar](http://www.wmo.int/oscar).

* + 1. **Observing performance requirements**

4.1.3.1 Satellite operators providing observational data to WIGOS shall strive to meet, to the extent possible, the uncertainty, timeliness, temporal and spatial resolution, and coverage requirements of WIGOS as defined in the WIGOS Information Resource (WIR), based on the Rolling Requirements Review process described in section 2.

Note 1: The term “satellite operators” is used in the *Manual on WIGOS* (WMO-No. XXXX) to refer to “Members or coordinated group of Members operating environmental satellites”.

Note 2: A coordinated group of Members operating environmental satellites is a group of Members acting jointly to operate one or more satellites through an international space agency such as the European Space Agency or EUMETSAT

Note 3: These requirements are recorded and maintained in the requirements database: <http://www.wmo.int/oscar>.

* + 1. **Global planning**

4.1.4.1 Satellite operators shall cooperate to ensure that a constellation of satellite systems is planned and implemented to guarantee the continuous provision of space-based observations in support of WMO Programmes.

Note: Collaboration is pursued within the Coordination Group for Meteorological Satellites, which includes all Members operating space-based observation systems in support of WMO Programmes.

* + 1. **Continuity**

4.1.5.1 Satellite operators working together under the auspices of the Coordination Group for Meteorological Satellites or otherwise, should ensure the continuity of operation, and of the data dissemination and distribution services of the operational satellites within the sub-system through appropriate contingency arrangements and re-launch plans.

* + 1. **Overlap**

4.1.6.1 Satellite operators should ensure an adequate period of overlap of new and old satellite systems in order to determine inter-satellite instrumental biases and maintain the homogeneity and consistency of time series observations, unless reliable transfer standards are available.

* + 1. **Interoperability**

4.1.7.1 Satellite operators shall achieve the greatest possible interoperability of their different systems.

4.1.7.2 Satellite operators shall make available sufficient technical details about the instruments, data processing, transmissions, and the dissemination schedules for Members to fully exploit the data.

**4.2.** **Design, planning and evolution**

Note: The space-based sub-system is composed of:

a. An Earth observation space segment;

b. An associated ground segment for data reception, processing, dissemination, and stewardship;

c. A user segment.

**4.2.1** **Space segment architecture**

Note: The overall architecture of the space segment is described in Attachment 4.1.

It is defined and evolves in consultation with the Coordination Group for Meteorological Satellites.

It includes:

* A constellation of geostationary satellites;
* A core constellation of sun-synchronous satellites distributed over three separated orbital planes;
* Other operational satellites operated on either sun-synchronous orbits or other appropriate Low-Earth orbits;
* Research and Development satellites on appropriate orbits.

**4.2.2 Space programme life cycles**

4.2.2.1 Satellite operators shall consider a trade-off between the need for a long series to pay-off the development cost and the user learning curve, on one hand, and the need to develop a new generation in order to benefit from state-of-the-art technology, on the other hand.

Note 1: The development of an operational satellite programme is conducted in several phases including: user requirements definition, feasibility assessment at system level, preliminary design, detailed design, development and testing of the subsystems, integration of all subsystems, system testing, launch campaign, and on-orbit commissioning. The overall duration of these development phases is typically of the order of 10 to 15 years.

Note 2: The exploitation phase for an operational programme including a series of recurring satellites is typically of the order of 15 years.

**4.3. Instruments and Methods of Observation**

Note 1: Space-based observation relies on a wide range of sensor types, e.g. active or passive, operating in various spectral ranges, with various scanning or pointing modes. Information on the principles of Earth Observation from space, the different types of space-based instruments and the derivation of geophysical variables from space-based measurements can be found in the *Guide to Instruments and Methods of Observation*, (WMO-No. 8), Part III.

Note 2: Detailed characteristics of current and planned systems of environmental satellites are available in the satellite module of the Observing System Capabilities Analysis and Review tool (OSCAR), which is available on line (<http://www.wmo.int/oscar/space>). It also contains an indication of the main instruments that are relevant for each specific variable observable from space, with their potential performance for the respective variables.

**4.3.1 Calibration and Traceability**

4.3.1.1 Satellite operators shall perform a detailed instrument characterization before launch.

Note: Members must strive to follow the pre-launch instrument characterization guidelines recommended by the Global Space-based Inter-calibration System.

4.3.1.2 After launch, satellite operators shall calibrate all instruments on a routine basis against reference instruments or calibration targets.

Note 1: Advantage should be taken of satellite collocation to perform on-orbit instrument intercomparison and calibration.

Note 2: Calibration must be done in accordance with established and documented methodologies by the Global Space-based Inter-calibration System and the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation.

4.3.1.3 Satellite operators shall ensure traceability to International Standards (SI) according to international approved standards.

Note: The Implementation Plan for the Global Climate Observing System (WMO/TD-No. 1253) calls for sustained measurement of key variables from space traceable to reference standards, and recommends implementing and evaluating a satellite climate calibration mission.

4.3.1.4 To ensure traceability to International Standards (SI), satellite operators shall define a range of ground-based reference targets for calibration purposes.

**4.4. Space Segment Implementation**

**4.4.1 Operational satellites on Geostationary Earth Orbit**

4.4.1.1 Satellite operators should implement an operational constellation of satellites in geostationary orbit as described in Attachment 4.1.

4.4.1.2 Satellite operators shall ensure that the constellation of satellites in geostationary orbit provides full disc imagery at least every 15 minutes, and achieves coverage of all longitudes, throughout a field of view between 60° S and 60° N.

Note: This implies the availability of at least six operational geostationary satellites if located at evenly distributed longitudes, with in-orbit redundancy.

4.4.1.3 Satellite operators should implement rapid-scan capabilities where feasible.

4.4.1.4 For the imagery mission in geostationary orbit, satellite operators should ensure an availability rate of rectified and calibrated data of at least 99 percent as a target.

4.4.1.5 To meet the essential requirement for continuity of data delivery, satellite operators, shall strive to implement contingency plans, involving the use of in-orbit stand-by flight models and rapid call-up of replacement systems and launches.

**4.4.2 Core operational constellation on sun-synchronous Low Earth Orbits (LEO)**

4.4.2.1 Operators of LEO satellites should implement a core operational constellation of satellites in three regularly distributed sun-synchronous orbits as described in Attachment 4.1.

4.4.2.2 Operators of the core constellation of environmental LEO satellites on three sun-synchronous orbital planes in early morning, mid-morning and afternoon orbit, shall strive to ensure a high level of robustness allowing the delivery of imagery and sounding data from at least three polar orbiting planes, on not less than 99 percent of occasions.

Note: This implies provisions for a ground segment, instrument and satellite redundancy, and rapid call-up of replacement launches or on orbit spares.

**4.4.3 Other capabilities on Low Earth Orbits**

4.4.3.1 Operators of environmental LEO satellites should implement capabilities in appropriate orbits as described in Attachment 4.1.

**4.4.4 Research and Development satellites**

4.4.4.1 Operators of Research and Development satellites shall consider providing the following observing capabilities:

1. Advanced observation of the parameters necessary to understand and model the water cycle, the carbon cycle, the energy budget and the chemical processes of the atmosphere;
2. Pathfinders for future operational missions.

Note: For WMO, the main benefits of Research and Development satellite missions are:

* Support of scientific investigations of atmospheric, oceanic, and other environment related processes,
* Testing or demonstration of new or improved sensors and satellite systems in preparation for new generations of operational capabilities to meet WMO observational requirements.

4.4.4.2 Members shall strive to optimize the usefulness of observations from Research and Development satellites for operational applications. In particular, operators of Research and Development satellites shall make provisions, where possible, to enable near real-time data availability to promote the early use of new types of observations for operational applications.

Note 1: Although neither long-term continuity of service nor a reliable replacement policy are assured, research and development satellites provide, in many cases, observations of great value for operational use.

Note 2: Although they are not operational systems, Research and Development satellites have proven to support operational meteorology, oceanography, hydrology and climatology substantially.

**4.5 Ground Segment Implementation**

**4.5.1 General**

4.5.1.1 Satellite operators shall make observational data available to Members over the WMO Information System (WIS) in accordance with the provisions in the *Manual on the WMO Information System* (WMO-No. 1060). Satellite operators shall inform Members of the means of obtaining these data through catalogue entries and shall provide sufficient metadata to enable meaningful use of the data.

4.5.1.2 Satellite operators shall implement facilities for the reception of remote-sensing data (and Data Collection System data when relevant) from operational satellites, and for the processing of quality-controlled environmental observation information, with a view of further near real-time distribution.

4.5.1.3 Satellite operators shall strive to ensure that data from polar-orbiting satellites are acquired on a global basis, without temporal gaps or blind orbits, and that data latency meets WMO timeliness requirements.

**4.5.2 Data dissemination**

4.5.2.1 Satellite operators shall ensure near real-time data dissemination of the appropriate data sets, per the requirement of Members, either via an appropriately designed ground segment, by direct broadcast, or by re-broadcast via telecommunication satellites.

4.5.2.2 In particular, operators of operational sun-synchronous satellites providing the core meteorological imagery and sounding mission should ensure inclusion of Direct Broadcast capability as follows:

1. Direct broadcast frequencies, modulations, and formats should allow a particular user to acquire data from either satellite by a single antenna and signal processing hardware. To the extent possible, the frequency bands allocated to Meteorological Satellites should be used.
2. Direct broadcast shall be provided through a high data rate stream, such as the High Resolution Picture Transmission (HRPT) or its subsequent evolution, to provide meteorological centres with all the data required for numerical weather prediction (NWP), Nowcasting, and other real-time applications;
3. If possible, a low data rate stream should also be provided, such as the Low Rate Picture Transmission (LRPT), to convey an essential volume of data to users with lower connectivity or low-cost receiving stations.

4.5.2.3 Satellite operators shall consider implementing re-broadcast via telecommunication satellites to complement and supplement direct broadcast services, to facilitate access to integrated data streams including data from different satellites, to non-satellite data and to geophysical data products.

4.5.2.4 Operators of operational geostationary meteorological satellites with rapid-scan capabilities shall strive to provide meteorological centres with data in near-real time as required for nowcasting, numerical weather prediction (NWP) and other real-time applications.

**4.5.3 Data Stewardship**

4.5.3.1 Satellite operators shall provide full descriptions of all processing steps taken in the generation of satellite data products, including algorithms, characteristics, and outcomes of validation activities.

4.5.3.2 Satellite operators shall preserve long-term raw data records and ancillary data required for their calibration, reprocessing as appropriate, with the necessary traceability information to achieve consistent Fundamental Climate Data Records.

4.5.3.3 Satellite operators shall maintain Level 1B satellite data archives including all relevant metadata pertaining to the location, orbit parameters and calibration procedures used.

4.5.3.4 Satellite operators shall ensure that their archiving system is capable of providing on-line access to the archive catalogue with a browsing facility, provides adequate description of data formats, and will allow users to download data.

**4.5.4 Data collection systems**

4.5.4.1 Satellite operators with a capability to receive data and/or products from Data Collection Platforms (DCP) shall maintain technical and operational coordination under the auspices of CGMS in order to ensure compatibility.

4.5.4.2 Satellite operators shall maintain a number of “international” DCP channels identically on all geostationary satellites to support the operation of mobile platforms moving across all individual geostationary footprints.

4.5.4.3 Satellite operators shall publish details of the technical characteristics and operational procedures of their data-collection missions, including the admission and certification procedures.

**4.5.5 User Segment**

4.5.5.1 Operators of research and development satellites shall implement capabilities enabling Members to access the data in one of the following ways: via downloading data from server(s), via receiving data from a re-broadcasting service, or via receiving from a direct broadcast capability.

4.5.5.2 Members shall endeavour to install and maintain in their territory at least one system enabling access to digital data from both LEO and geostationary operational satellite constellations, either a receiver of re-broadcast service providing the required information in an integrated way, or a combination of dedicated direct readout stations.

4.5.5.3 Where appropriate, Members should strive to utilize fixed or moving DCP systems (for example to cover data-sparse areas) to take advantage of the data-collection and relay capability of the environmental observation satellites.

**4.6. Observational Metadata**

4.6.1 For each space-based system they operate, satellite operators shall record, retain and make available observational metadata in accordance with the provisions of section 2.5.

**4.7.** **Quality Management**

**4.7.1 Quality Indicators**

4.7.1.1 Satellite operators shall include appropriate quality indicators in the metadata for each datasets, in accordance with the provisions of section 2.5.

**4.8.** **Capacity Development**

**4.8.1 Centres of Excellence**

4.8.1.1 Satellite operators, and other Members having the capability to do so, shall provide support to education and training of instructors in the use of satellite data and capabilities e.g. at specialized Regional Meteorological Training Centres or other training institutes designated as Centres of Excellence in satellite meteorology, in order to build up expertise and facilities at a number of regional growth points.

**4.8.2 Training strategy**

4.8.2.1 Satellite operators should focus their assistance, to the extent possible, on one or more of these Centres of Excellence within their service areas and contribute to the Virtual Laboratory for Training and Education in Satellite Meteorology.

Note: The aim of the Education and Training strategy implemented through the Virtual Laboratory is to systematically improve the use of satellite data for meteorology, operational hydrology, and climate applications, with a focus on meeting the needs of developing countries.

**4.8.3 User preparation for new systems**

4.8.3.1 In order to facilitate a smooth transition to new satellite capabilities, satellite operators should make provisions for appropriate preparation of the users through training, guidance to necessary upgrades of receiving equipment and processing software, and information and tools to facilitate the development and testing of user applications.

4.8.3.2 In addition to working through the Virtual Laboratory, Members should, as appropriate, exploit partnerships with organizations providing education and training in environmental satellite applications, depending on their specific needs.

**4.8.4 Engagement between Users and Data Providers**

4.8.4.1 In order to achieve the most effective utilization of satellite data, Members should pursue the close engagement between users and data providers at a regional level.

4.8.4.2 Working with their regional association, Members should follow systematic steps to document the regional requirements for satellite data access and exchange.

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**ATTACHMENT 4.1**

**CGMS BASELINE FOR THE OPERATIONAL CONTRIBUTION TO THE GOS**

*(adopted by CGMS-39 on 6 October 2011)*

**FUTURE SATELLITE MISSIONS TO BE PERFORMED
ON OPERATIONAL/SUSTAINED BASIS**

**Introduction**

In support of the programmes coordinated or co-sponsored by WMO for weather and climate, CGMS Members plan to maintain the operational capabilities and services described below, that constitute the “CGMS baseline for the operational contribution to the GOS”.

While this particular document focuses on missions that are decided and managed in an operational or sustained framework, with a perspective of long-term follow-on, this in no way precludes the importance of other missions undertaken e.g. on a research or demonstration basis. First of all, because today’s research and development are the foundation of tomorrow’s operational missions. Furthermore, because many missions initiated in an R&D framework for a limited duration are eventually extended well beyond their design life time and provide longstanding support to both scientific and operational activities.

This baseline defines a constellation of geostationary satellites, a core meteorological mission on three sun-synchronous orbits, other missions in sun-synchronous orbits, missions in other Low Earth Orbits, and contains cross-cutting considerations on contingency planning, inter-calibration, data availability and dissemination.

**I. Constellation in geostationary orbit**

At least six geostationary satellites shall be operated at evenly distributed locations with in orbit

redundancy, and perform the following missions:

1. Advanced visible and infrared imagery (at least 16 spectral channels, 2km resolution) over the full disc at least every 15 minutes
2. Infrared sounding (hyperspectral on some positions)
3. Lightning detection
4. Data collection
5. Space environment monitoring

On selected positions, the following missions shall be performed:

1. Earth Radiation Budget monitoring
2. High spectral resolution UV sounding
3. Solar activity monitoring

**II. LEO sun-synchronous missions**

Operational sun-synchronous satellites shall be operated around three orbital planes in mid-morning (“am”, nominally 09:30 descending, 21:30 ascending ECT), afternoon (“pm”, nominally 13:30 ascending ECT) and early morning (nominally 05:30 descending, 17:30 ascending ECT) and, as a constellation, shall perform the following missions:

1) Core meteorological mission nominally on 3 orbital planes

1. Multispectral visible and infrared imagery
2. Infrared hyperspectral sounding (at least am and pm)
3. Microwave sounding
4. Microwave imagery

2) Other missions on sun-synchronous orbits

1. Wind scatterometry over sea surfaces (at least two orbital planes)
2. Ocean surface topography by radar altimetry (at least on am and pm orbits, supplemented by a reference mission on a high-precision, inclined orbit)
3. Radio-occultation sounding (at least am and pm, supplemented by a constellation in specific orbits)
4. Broadband VIS/IR radiometer for Earth Radiation balance (at least am and pm)
5. Total Solar Irradiance (at least one)
6. Contribution to atmospheric composition observations (at least am and pm)
7. Narrow-band Vis/NIR imagers (at least one sun-synchronous, am spacecraft) for ocean colour, vegetation and aerosol monitoring
8. High-resolution multi-spectral Vis/IR imagers (constellation of sun-synchronous satellites, preferably in am)
9. IR dual-angle view imagery for high-accuracy SST (at least one am spacecraft)
10. Particle detection and/or electron density (at least am and pm)
11. Magnetic field (at least am and pm)
12. Solar activity (at least two)
13. Data collection

**III. Other LEO missions**

The following missions shall be performed on an operational basis by Low Earth Orbit satellites on appropriate orbits:

1. Ocean surface topography by radar altimetry (A reference mission on high-precision, inclined orbit, complementing two instruments on sun-synchronous am and pm orbit)
2. Radio-Occultation sounding (dedicated constellation of sensors on appropriate orbits)

**IV. Contingency Planning**

The CGMS baseline is associated with contingency plans for geostationary and polar-orbiting satellite systems, which are detailed in the CGMS Global Contingency Plan[[4]](#footnote-5).

**V. Inter-calibration**

Instruments should be inter-calibrated on a routine basis against reference instruments or calibration sites. The routine and operational inter-calibration and corrections shall be performed in accordance with standards as agreed by the Global Space-based Inter-calibration System (GSICS).

**VI. Data availability and dissemination**

VI.1. Data open availability with suitable timeliness

All operational environmental observation satellite systems should be designed to ensure the provision of data with suitable timeliness, as appropriate for their intended applications. Data should be preserved for the long term and documented with metadata allowing their interpretation and utilization. The satellite operators should establish dissemination contents and schedules that take into account the data requirements of users. Re-broadcast via telecommunication satellites should complement and supplement direct broadcast services, which allows cost-efficient access to integrated data streams including data from different satellites, non-satellite data and geophysical products. The dissemination systems should utilize all-weather resilient telecommunication means.

VI.2. Direct broadcast for core meteorological missions in LEO

The core meteorological satellite systems in LEO orbits, and other operational observation satellite systems when relevant, should ensure near real-time data dissemination of imagery, sounding, and other real-time data of interest to Members by direct broadcast. Direct broadcast frequencies, modulations, and formats for polar-orbiting satellites should allow a particular user to acquire data from either satellite by a single antenna and signal processing hardware. Direct Broadcast should use allocations in all-weather resilient frequency bands.

**VII. Note**

The present update of the CGMS baseline is adopted in the light of satellite mission plans as they are known in October 2011.

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**5 ATTRIBUTES SPECIFIC TO THE**

**6 ATTRIBUTES SPECIFIC TO THE OBSERVING COMPONENT OF THE GLOBAL ATMOSPHERE WATCH**

Note: The provisions of sections 1, 2, 3 and 4are common to all WIGOS component observing systems, including the GAW. The further provisions of section 6are specific to GAW.

**6.1. Requirements**

6.1.1 Members should perform the observations of atmospheric composition and related physical parameters using a combination of surface-based stations and platforms (fixed stations, mobile platforms and remote sensing) and space-based platforms.

6.1.2 Members should use the requirements from the RRR process, particularly in the atmospheric chemistry application area in developing their GAW stations.

Note 1: The user requirements are reviewed on a regular basis through the RRR process by the Scientific Advisory Groups for each variable, in consultation with the user community and input from Members. The RRR process is described in section 2.2.4 and Appendix 2.3.

Note 2: Scientific Advisory Groups exist for the six GAW focal areas and their terms of reference are defined by the Commission for Atmospheric Sciences.

6.1.3 Members should follow the Data Quality Objectives specified by the GAW Programme for the individual variables observed.

6.1.4 Members should establish and operate their GAW stations such that they satisfy the station requirements specified in Attachment 6.1.

6.1.5 Members operating GAW stations shall undertake long-term and uninterrupted operation with stability and continuity of data collection that is adequate for purpose outlined in 6.2.1.

**6.2. Design, Planning and Evolution**

6.2.1 Members should design, plan and further evolve their GAW observing network and stations to address the user requirements and, in particular those that concern key environmental issues and application areas, including but not limited to the following areas:

• Stratospheric ozone depletion and the increase of ultraviolet (UV) radiation.

• Changes in the weather and climate related to human influence on atmospheric composition, particularly, related to the changes in greenhouse gases, ozone and reactive gases, and aerosols.

• Risk assessment of air pollution and UV on human health and the environment and issues involving long-range transport of air pollution and its deposition.

6.2.2 Members should contribute observations through operating or supporting suitable platforms at GAW stations and/or through contributing networks.

6.2.3 When doing so, Members shall register their contribution in the GAW Station Information System (GAWSIS), and submit their observations to the relevant GAW Data Centre.

6.2.4 Members operating a contributing network shall provide a description of the network and register the stations in GAWSIS and provide corresponding metadata.

6.2.5 Members should ensure that the frequency and spacing of the various observations is suited to the temporal and spatial requirements of the specific issues addressed in section 6.2.1.

**6.3. Instrumentation and Methods of Observation**

**6.3.1 General requirements of Instruments**

6.3.1.1 Members should use recommended types of instruments or methods of observation for variables observed at their stations, and follow further guidance available.

Note 1: Guidance is provided in the Standard Operating Procedures (SOPs) and Measurement Guidelines (MG).

Note 2: Instruments suitable for use at GAW sites are defined by the Scientific Advisory Groups for each parameter, in terms of stability, precision and accuracy.

Note 3: SOP describe the standard approach to operate this kind of instrument.

Note 4: MG describe the standard approach for this kind of measurement regardless of the instrument.

**6.3.2 Calibration and Traceability**

6.3.2.1 Members shall perform calibrations and maintain traceability to the GAW primary standards, where available.

Note 1: GAW primary standard is a single network standard, assigned by WMO. In the case of contributing networks the network observations are traceable to the network standard, which in turn is traceable to GAW primary standard.

Note 2: Details on calibrations are specified by the Standard Operating Procedures and Measurement Guidelines.

6.3.2.2 Members should utilize GAW central facilities to sustain the global compatibility of observations.

Note: GAW central facilities include: Central Calibration Laboratories, World Calibration Centres, Regional Calibration Centres, and Quality Assurance/Scientific Activities Centres.

**6.4. Operations**

**6.4.1 Observing system implementation monitoring**

6.4.1.1 Members shall monitor the operation of GAW stations for which they are responsible and ensure that they follow the relevant procedures for quality assurance and data submission. Members shall seek assistance from Central Facilities, Scientific Advisory Groups and Expert Teams if operational problems cannot be solved locally.

Note: The procedures to be used in monitoring the operation of GAW are determined within the Commission for Atmospheric Sciences (CAS) in consultation with the participating Members.

6.4.1.2 Members should systematically monitor compliance with GAW regulations, in collaboration with relevant constituent bodies and the Secretariat, in order to identify critical cases of non-compliance (deficiencies) and undertake measures for their timely resolution.

**6.4.2 Quality Assurance**

6.4.2.1 Members should follow specified quality assurance practices and procedures.

Note: Details are given in the GAW Standard Operational Procedures and Measurement Guidelines, and further documents provided by the Scientific Advisory Groups and Central Facilities.

6.4.2.2 Members shall maintain detailed metadata records in accordance with procedures and practices specified in this Manual.

6.4.2.3 Members should participate in independent evaluation of quality of observations, including intercomparisons and system audits, as appropriate to the observed variables.

6.4.2.4 Members shall permit World Data Centres to perform independent evaluation of the data quality of their observations.

**6.4.3 Data and Metadata representation and format**

6.4.3.1 Members shall submit their observational data and associated metadata to the relevant GAW World Data Centres for the variables observed at the station within agreed time limits.

6.4.3.2 Members shall use the formats specified by the relevant World Data Centre when submitting their observational data and metadata.

**6.5. Observational Metadata**

Note: the general provisions on observation metadata are specified in section 2.5.

6.5.1 Members shall provide metadata associated with instrumentation, site or platform, calibration history as requested by the World Data Centre for each parameter, and by GAWSIS.

6.5.2 Members shall provide such additional metadata as required by GAWSIS and any World Data Centre to which they contribute that are necessary to understand their observations.

**6.6. Quality Management**

Note: the general regulations on Quality management are specified in section 2.6

**6.7. Capacity Development**

Note: General provisions for capacity development are provided in sections 2.7, 3.7 and 4.7.

6.7.1 Members not capable of implementing required standards should establish agreements with appropriate Central Facilities or establish partnership with more experienced stations in the form of stations twinning.

Note: In some regions of the world, and for some GAW variables, where there is a clear lack of capacity, Members may be requested to help support a station, or existing stations may be approached to become a part of GAW. Such requests and invitations come after approval by the appropriate Scientific Advisory Group (SAGs).

6.7.2 Members should use the GAW Training and Education Centre (GAWTEC) programme, as available for capacity building and staff training in measurement of the specific GAW variables.

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**ATTACHMENT 6.1**

**General requirements for GAW stations**

**Essential characteristics of GAW Regional Stations**:

1. The station location is chosen such that, for the variables measured, it is regionally representative and is normally free of the influence of significant local pollution sources.

2. There are adequate power, air conditioning, communication and building facilities to sustain long term observations with greater than 90% data capture (i.e. <10% missing data).

3. The technical support provided is trained in the operation of the equipment.

4. There is a commitment by the responsible agency to long-term observations of at least one of the GAW variables in the GAW focal areas (ozone, aerosols, greenhouse gases, reactive gases, UV radiation, and precipitation chemistry).

5. The GAW observations made are of known quality and linked to the GAW Primary Standard.

6. The data and associated metadata are submitted to one of the GAW World Data Centres, typically no later than one year after the observations are made. Changes of metadata including instrumentation, traceability, observation procedures, are reported to the responsible WDC in a timely manner.

7. If required, observations are submitted to a designated data distribution system in near real-time.

8. Standard meteorological in situ observations, necessary for the accurate determination and interpretation of the GAW variables, are recommended to be made with known quality.

9. The station characteristics and observational programme are updated in the GAW Station Information System (GAWSIS) on a regular basis.

10. A station logbook (i.e. record of observations made and activities that may affect observations) is maintained and is used in the data validation process.

***Additional Essential characteristics needed for a GAW Global Station:***

In addition to the essential characteristics of Regional stations, a GAW Global station should fulfil the following additional requirements, namely:

11. Measure variables in at least three of the six GAW focal areas.

12. Have a strong scientific supporting programme with appropriate data analysis and interpretation within the country and, if possible, the support of more than one agency.

13. Provide a facility at which intensive campaign research can augment the long term routine GAW observations and where testing and development of new GAW methods can be undertaken.

**GAW Contributing Networks**

GAW contributing networks involve observations from multiple stations. The stations comprising contributing networks should satisfy the criteria of either regional or global stations adjusted by the contributing network regulations (e.g. within the contributing network data submission requirements or standard used can differ from those required for regional and global stations). In the case of standards different from the WMO standards, the network standards must have a confirmed traceability to the WMO standards in the cases where such standards exist. Data submission regulations for the contributing networks must be not worse than the ones required within GAW. A station designation of global or regional, if it already exists for individual stations, always takes precedence. To be used in global assessments data from the contributing stations must be submitted to the GAW World Data Centres.

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**7. ATTRIBUTES SPECIFIC TO THE WMO HYDROLOGICAL OBSERVING SYSTEM**

Note: The provisions of sections 1, 2, 3 and 4are common to all WIGOS component observing systems, including the WHOS. The further provisions of section 7are specific to the WHOS.

**7.1 Requirements**

7.1.1 Members shall establish and operate a hydrological observing system according to its national requirements.

7.1.2 Members should also operate their hydrological observing systems to address the requirements of the RRR process, in particular for the hydrology application area.

Note 1: A hydrological observing system includes networks of hydrological observing stations as defined in Technical Regulations Volume III – Hydrology, Chapter D.1.1 which should make observations of elements as described in Chapter D.1.2 Hydrological Observations.

Note 2: Chapter D.1.4 Hydrological Data Transmission states “Transmission facilities should be organized for the international exchange of hydrological data, forecast and warnings on the basis of bilateral or multilateral agreement.” Further provisions for data transmission and international exchange through the WMO Information System (WIS) are given in the *Technical Regulations*, Volume I, Part II and the *Manual on WMO Information System* (WMO-No. 1060) and the *Manual on Global Telecommunication System* (WMO-No. 386), Volume I.

7.1.3 Members shall provide on a free and unrestricted basis those hydrological data and products which are necessary for the provision of services in support of the protection of life and property and for the well-being of all peoples.

7.1.4 Members should also provide additional hydrological data and products where available, which are required by WMO Programmes and its Members as specified in 7.1.2.

7.1.5 At a global level, the WMO Hydrological Observing System (WHOS) shall allow access to sources of hydrological observations in near-real time from Members around the world.

Note: Currently, many Members are making such observations publically available on the Internet.

7.1.6 Members should provide these sources of observations to the WHOS.

Note: Hydrological observations available through WHOS will initially comprise stage (water level) and discharge. This will likely expand over time to include other elements as identified in the Rolling Review of Requirements process at the national, regional and global levels.

**7.2 Design, planning and evolution**

Note: Design, planning and evolution is common to all WIGOS component observing systems.

7.2.1 Members should design and plan their observing network considering the review of the current and planned WMO Hydrological Observing System capabilities, undertaken as outlined in the Rolling Review of Requirements (RRR) as described in section 2.2.4.

**7.3 Instrumentation and Methods of Observation**

**7.3.1 General Requirements of Instruments**

7.3.1.1 Members should equip their stations with properly calibrated instruments and should arrange for these stations to follow adequate observational and measuring techniques to ensure that the measurements and observations of the various hydrological elements are accurate enough to address the needs of hydrology and other applications areas.

Note: Technical Regulations Volume III provides that Members should use instruments for measurement of stage (water level) in conformance with the specifications of its Annex II — Water level measuring devices.

7.3.1.2 Members should ensure that the uncertainty in the observation of the stage (water level) of rivers, estuaries, lakes, and reservoirs not exceed:

(a) In general, 10 mm at the 95 per cent confidence level;

(b) Under difficult conditions, 20 mm at the 95 per cent confidence level.

Note: Stage (Water level) observations are used primarily as an index for computing streamflow discharge when a unique relation exists between stage (water level) and discharge.

**7.3.2 Stage and discharge observations from hydrometric stations**

Note: Technical Regulations, Volume III provides that Members should establish and operate hydrometric stations for measuring stage (water level), velocity and discharge in conformance with the specifications of its Annex VI — Establishment and operation of a hydrometric station.

7.3.2.1 Members should ensure that the number of discharge measurements at a stream gauging station are adequate to define the rating curve for the station at all times.

Note 1: Technical Regulations, Volume III provides that Members should use the methods for determining the stage-discharge relation (rating curve) of a station as specified in its Annex VII — Determination of the stage-discharge relation.

Note 2: Technical Regulations, Volume III provides that Members should, when undertaking moving-boat discharge measurements, ensure that equipment and operational procedures are as specified in its Annex XII — Discharge measurements by the moving-boat method.

7.3.2.2 Members should measure river discharges to an accuracy commensurate with flow and local conditions. Percentage uncertainty of the discharge measurement should not exceed:

(a) In general, 5 per cent at the 95 per cent confidence level;

(b) Under difficult conditions, 10 per cent at the 95 per cent confidence level.

Note 1: Technical Regulations, Volume III provides that Members should evaluate the uncertainty in discharge measurements in conformance with the specifications in its Annex VIII — Estimation of uncertainty of discharge measurements.

Note 2: Discharge measurements are taken to establish and verify the stability of a rating curve. Stage (water level) observations are converted to estimates of discharge using the rating curve on an on-going basis.

**7.3.3 Calibration Procedures**

Note 1: Technical Regulations, Volume III provides that Members should adhere to the specifications of facilities, equipment and procedure for the calibration of current meters as specified in its Annex I — Calibration of current meters in straight open tanks.

Note 2: Technical Regulations, Volume III provides that Members should ensure that operational requirements, construction, calibration and maintenance of rotating element current meters are as specified in its Annex IV — Rotating element type current meters.

7.3.3.1 Members should recalibrate acoustic velocity meters on a routine basis to ensure stability of the calibration, using measurement standards traceable to international or national standards. Where no such standards exist, Members should record the basis used for calibration or verification.

Note: Additional information pertaining to the calibration of instruments can be found in the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, and the *Manual on Stream Gauging* (WMO-No. 1044).

**7.4 Operations**

**7.4.1 Observing Practices**

7.4.1.1 Members should collect and preserve their hydrological records.

7.4.1.2 Members should make the necessary arrangements to facilitate the retrieval and analysis of their hydrological observations by automatic data-processing equipment.

7.4.1.3 Where automatic registration is not available, Members should ensure the observations of elements for hydrological purposes are made at regular intervals appropriate for the elements and their intended purposes.

7.4.1.4 Members should maintain in their archives an up-to-date inventory of their hydrological observations.

7.4.1.5 Members should generally ensure uniformity in time of observations within a catchment area.

7.4.1.6 Members should select the time units used in processing hydrological data for international exchange from the following:

(a) The Gregorian calendar year;

(b) The months of this calendar;

(c) The mean solar day, from midnight to midnight, according to the zonal time, when the data permit;

(d) Other periods by mutual agreement in the case of international drainage basins or in the case of drainage basins in the same type of region.

7.4.1.7 For hydrometric stations where data are internationally exchanged, Members should process the following characteristics for each year:

(a) Maximum instantaneous and minimum daily mean values of stages (water levels) and discharge;

(b) mean daily stages (water levels) and/or mean daily discharges.

7.4.1.8 For rivers under flood conditions or where there are variable controls, Members should make special measurements at intervals frequent enough to define the hydrograph.

7.4.1.9 When sudden and dangerous increases in river levels occur, Members should make and report observations as soon as possible without regard to the usual time of observation, to meet the intended operational use.

7.4.1.10 Members should measure and store stage (water level) observations as instantaneous values rather than averaged values.

**7.4.2 Quality Control**

7.4.2.1 Members should maintain detailed records for each station and for each parameter, containing metadata related to the measurements, maintenance and calibration of equipment.

7.4.2.2 Members should perform periodic audits of their stations and collected data.

7.4.2.3 Members should ensure that recorded hydrological observations are converted to a form suitable for archiving and retrieval.

Note: Observations may be initially recorded using various media from paper to electronic digital form. As computer archiving has become a standard practice by most Members, it is advantageous to convert data to the required format early in the process.

7.4.2.4 Members should ensure their data undergo, at various stages, a range of checks to determine their uncertainty and correctness.

7.4.2.5 With accelerating developments in technology, Members should ensure that data-processing and quality control systems are well-organized and that the relevant staff are trained to understand and use them.

Note: Data are collected and recorded in many ways, ranging from manual reading of simple gauges to a variety of automated data-collection, transmission and filing systems.

7.4.2.6 Members should consider the adoption of a quality management system, as described in section 2.6.

Note: Organizations usually employ an accredited certification agency to provide independent verification.

7.4.2.7 Members should undertake data processing and quality control as described in relevant publications.

Note: Such publications include the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 9, the *Manual on Flood Forecasting and Warning* (WMO-No. 1072), Chapter 6 and the *Manual on Stream Gauging* (WMO-No. 1044), Volume II, Chapter 6.

**7.4.3 Observations and Observational Metadata Reporting**

7.4.3.1 Members should ensure when making available hydrological information for international purposes the use of open text or appropriate code forms as specified on the basis of bilateral or multilateral agreements.

7.4.3.2 Members should ensure that transmission facilities are organized for the international exchange of hydrological observations on the basis of bilateral or multilateral agreement.

7.4.3.3 In order to make data globally available for real-time exchange and for discovery, access and retrieval, Members should report stage and discharge observations in compliance with WMO Information System (WIS) metadata standards.

Note 1: WIS may also be used for access to hydrological observations not required in real time.

Note 2: The regulation governing exchanges in international code forms, are specified in the *Manual on Codes* (WMO-No. 306), Volume I).

Note 3: Coded information exclusively for bilateral or multilateral exchange amongst Members may be in other forms by mutual agreement.

**7.4.4 Incident Management**

Note: General provisions for Incident Management are provided in section 2.4.5.

**7.4.5 Change Management**

Note: General provisions for Change Management are provided in section 2.4.6.

**7.4.6 Maintenance**

7.4.6.1 Members should determine the frequency and timing of visits to recording stations by the length of time that the station can be expected to function without maintenance and the uncertainty requirements of the data.

Note 1: There is a relation between the frequency of the visits and the resultant quality of the data collected. Too long a time between visits may result in frequent recorder malfunction and, thus, in loss of data, while frequent visits are both time consuming and costly.

Note 2: Some data collection devices may suffer a drift in the relationship between the variable that is recorded and that which the recorded value represents. An example of this is a non-stable stage-discharge relationship.

Note 3: Two visits per year are considered an absolute minimum, and preferably more often to avoid the dangers of losing data and/or having data severely affected by problems such as silting, vandalism or seasonal vegetative growth.

7.4.6.2 Members should schedule periodical visits to the station to recalibrate the equipment or the measurement equations.

7.4.6.3 Members should periodically inspect stations using trained personnel to ensure the correct functioning of instruments.

7.4.6.4 Members should ensure a formal written inspection is done routinely, preferably each year, to check overall performance of instruments (and local observer, if applicable).

7.4.6.5 Members, when routinely inspecting sites, should:

(a) Measure gauge datum to check for and record any changes in levels:

(b) Check the stability of the rating curve, review the relationships between the gauges and permanent level reference points to verify that no movement of the gauges has taken place;

(c) Review the gauging frequency achieved and the rating changes identified; and

(d) Undertake a number of maintenance activities as described in section 7.4.6.8 and 7.4.6.9.

Note: It is vital, for the quality of data, that resources for gaugings be allocated and prioritized using rigorous and timely analysis of the probability and frequency of rating changes.

7.4.6.6 Members should ensure maintenance activities are conducted at data-collection sites at intervals sufficient to ensure that the quality of the data being recorded is adequate.

7.4.6.7 Members should ensure such activities are conducted by the observer responsible for the sites, if there is one. Members should ensure such activities are also occasionally performed by an inspector.

7.4.6.8 Members should undertake the following maintenance activities at all collection sites:

1. Service the instruments;
2. Replace or upgrade instruments, as required;
3. Retrieve or record observations;
4. Perform the recommended checks on retrieved records;
5. Carry out general checks of all equipment, for example, transmission lines;
6. Check and maintain the site to the recommended specifications;
7. Check and maintain access to the station;
8. Record, in note form, all of the above activities;
9. Comment on changes in land use or vegetation;
10. Clear debris and overgrowth from all parts of the installation.

7.4.6.9 Members should undertake the following maintenance activities at discharge collection sites:

1. Check the bank stability, as necessary;
2. Check the level and condition of gauge boards, as necessary;
3. Check and service the flow-measuring devices (cableways, etc.), as necessary;
4. Check and repair control structures, as necessary;
5. Regularly survey cross-sections and take photographs of major station changes after events or with vegetation or land-use changes;
6. Record, in note form, all of the above activities and their results; and
7. Inspect the area around or upstream of the site, and record any significant land-use or other changes in related hydrological characteristics, such as ice.

Note: Further details are found in the *Manual on Stream Gauging* (WMO-No. 1044).

7.4.6.10 Members should have a well-trained technician or inspector visit stations immediately after every severe flood in order to check the stability of the river section and the gauges. If there is a local observer, Members should train this person to check for these problems and communicate them to the regional or local office.

7.4.6.11 Members should not programme flood gaugings as part of a routine inspection trip because of the unpredictable nature of floods.

7.4.6.12 Members should establish a flood action plan prior to the beginning of the storm or flood season and should specify priority sites and types of data required.

Note: If flood gaugings are required at a site, the preparations ideally would be made during the preceding dry or non-flood season so that all is ready during the annual flood season.

7.4.6.13 Members should consider undertaking the following additional measures if severe flooding is likely:

(a) Upgrade site access (helipad, if necessary);

(b) Equip a temporary campsite with provisions;

(c) Store and check gauging equipment; and

(d) Flood-proof instrumentation such as stage recorders.

7.4.6.14 Following the recession of floodwaters, Members should pay particular attention to ensuring the safety and security of the data-collection site and to restoring normal operation of on-site instrumentation.

Note: In some cases, redesign and reconstruction of the site may be required. Such work would ideally take into account information obtained as a result of the flood.

**7.4.7 Calibration procedures**

Note: Determination of a rating curve is described in section 7.3.2. Calibration procedures for current meters, is described in section 7.3.3.

**7.5 Observational Metadata**

Note 1: Provisions for describing observational metadata, for recording and retaining observational metadata, and for exchanging and archiving observational metadata are provided in section 2.5. These apply to all WIGOS component observing systems including the WHOS. Further provisions specific to WHOS are stated here.

Note 2: The contents of observational metadata are detailed in Appendix 2.4including WIGOS metadata and other metadata of specific relevance for WHOS.

Note 3: Within an organization or country, a hydrological information system or a station registration file and a historical operations file (as indicated in the Guide to Hydrological Practices, WMO–No.168) or similar repositories may be used as a convenient means to compile a set of metadata about a hydrological station and its observations.

7.5.1 In addition to the provisions in section 2.5, Members should record, retain and make available the WIGOS observational metadata and also the additional observational metadata specified in the Appendix 2.4.

7.5.2 Members who use their own station identifiers for hydrological stations should maintain the means to match these with the WMO station identifiers, as specified in Appendix 2.4.

7.5.3 Members should collect and record additional detailed observational metadata identifying the purpose of the station in accordance with provisions in section 2.5.

Note: Further details are found in the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 10.

**7.6 Quality Management**

Note 1: Provisions for the implementation of quality management in WIGOS are provided in section 2.6. These apply to all WIGOS component observing systems including the WHOS.

Note 2: The WMO Hydrology and Water Resources Programme has developed material on the implementation of the WMO Quality Management Framework in Hydrology and for adopting this in national operations. Some Members have achieved compliance with the ISO 9001:2008 standard and examples have been documented to assist other Members.

**7.7 Capacity Development**

Note 1: Provisions for the implementation of capacity development in WIGOS are provided in section 2.7.

Note 2: Whatever the level of technical sophistication of a data-collection authority, the quality of its staff remains its most valuable resource.

7.7.1 Members should undertake careful recruitment, training and management to attain and maintain the appropriate personnel with the most appropriate skill sets.

7.7.2 Members should pursue a carefully structured training programme for all personnel engaged in field and office practices pertaining to data collection because they are in a strong position to influence the quality of the final data.

Note: Formal training ideally will aim at providing both a general course in first principles, plus training modules to teach in-house field and office procedures. All material is to be relevant and current.

7.7.3 Members should provide training classes, follow-up exercises, and on-the-job training to field personnel before they make streamflow and survey measurements using various technologies such as Acoustic Doppler Current Profiler (ADCP) and mechanical current meters.

7.7.4 Members should provide training classes, follow-up exercises, and on-the-job training on data collection practices and processing of data to increase employee productivity and programme effectiveness.

7.7.5 Members should have appropriate technologies in place, such as hydrological information systems, to allow for streamflow data processing and to allow the effective and efficient delivery of metadata, data and data products to users.

7.7.6 Members should have adequate number of stations to meet priority needs and ensure sufficient resources to maintain and operate sites to attain required accuracies and reliability of data for their intended use.

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**8ATTRIBUTES SPECIFIC TO THE**

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8.3 CryoNet shall be structured in two different classes of observational sites: Basic Sites and Integrated Sites with the following requirements:

* Basic Sites shall monitor single or multiple components of the cryosphere (glaciers, ice shelves, ice sheets, snow, permafrost, sea ice, river/lake ice, and solid precipitation) and shall observe multiple variables of each component. They shall measure auxiliary meteorological variables, shall comply with GCW agreed practices, shall be currently active, shall have long term financial commitment and shall make data freely available, whenever possible in (near) real time. Basic Sites should be suitable for the assessment of long-term changes of the cryosphere as well as for the validation of satellite data and related models.
* CryoNet Integrated Sites shall promote, through worldwide scientific collaboration, progress in the scientific understanding of the processes that change the cryosphere. These sites shall integrate in situ and space-based observations and create platforms of cryospheric observatories. In addition to the requirements for Basic Sites, CryoNet Integrated Sites shall monitor at least one of the other spheres (such as, hydrosphere, biosphere and atmosphere), have a broader research focus, have supporting staff and have training capability. Integrated Sites are particularly important for the study of feedbacks and complex interactions between the atmosphere, cryosphere, biosphere and ocean.
* CryoNet Sites contain one or more CryoNet Stations:
	+ Primary Stations shall have target of long-term operation and a four (4) year initial commitment.
	+ Baseline stations shall have long-term operational commitment and long-term (more than 10 years) records.

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cryospheric components the surrounding region

best There shall be a commitment to continue measurements for a minimum of four (4) years.

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WIGOS

**Attachment to Appendix 2.4: WIGOS Metadata standard**

*[See document Cg-17-d04-2-2(3)-WIGOS-Metadata-draft1\_ADD1\_en.docx]*

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**APPENDIX C:**

**PROGRESS REPORT FOR INFORMATION –**

**NOT TO BE INCLUDED IN THE GENERAL SUMMARY**

**WMO Technical Regulations (WMO-No. 49) - Manual on WIGOS**

### References:

* + - 1. [Sixteenth World meteorological Congress (2011) (WMO-No. 1077)](http://library.wmo.int/opac/index.php?lvl=notice_display&id=6907)
			2. [Executive Council - Sixty-fourth session (2012) (WMO-No. 1092)](http://library.wmo.int/opac/index.php?lvl=notice_display&id=12753)
			3. [Executive Council - Sixty-fifth session (2013) (WMO-No. 1118)](http://library.wmo.int/opac/index.php?lvl=notice_display&id=15859)
			4. [Executive Council - Sixty-sixth session (2014) (WMO-No. 1136)](http://library.wmo.int/opac/index.php?lvl=notice_display&id=16315)
			5. [Final Report from the Second Session of the Inter-Commission Coordination Group on WIGOS (ICG-WIGOS), Geneva, 18-22 March 2013](http://www.wmo.int/pages/prog/www/WIGOS-WIS/reports.html)
			6. [Final Report from the Third Session of the Inter-Commission Coordination Group on WIGOS (ICG-WIGOS), Geneva, 10-14 February 2014](http://www.wmo.int/pages/prog/www/WIGOS-WIS/reports.html)
			7. [Final Report from the Fourth Session of the Inter-Commission Coordination Group on WIGOS (ICG-WIGOS), Geneva, 17-20 February 2015](http://www.wmo.int/pages/prog/www/WIGOS-WIS/reports.html)
			8. [Final Reports from the sessions of ICG-WIGOS TT-WRM and TT-WMD](http://www.wmo.int/pages/prog/www/WIGOS-WIS/reports.html)
			9. [WIGOS Framework Implementation Plan (WIP), version 3.0, adopted by EC-66](http://www.wmo.int/pages/prog/www/wigos/documents.html)
			10. [Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems (WMO-No. 1140)](http://cbs-ext2014.wmo.int/documents-english)
			11. Cg-17/Doc. 4.2.2(1)
			12. Cg-17/Doc. 4.2.2(2)
			13. Cg-17/Doc. 13.4(1)

Background

Following the decision of the Sixteenth World Meteorological Congress (2011) to proceed with the implementation of the WMO Integrated Global Observing System (WIGOS), the drafts of the WMO *Technical Regulations* (WMO-No. 49), Volume I, Part I - WIGOS, and the *Manual on WIGOS* (a future Annex to the Volume I) were developed by the Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) through its Task Team on WIGOS Regulatory Material.

Following Resolution 10 (EC-64) – WMO Integrated Global Observing System Framework Implementation Plan, the draft *WIGOS Metadata Standard*, an attachment to the *Manual on WIGOS*, was developed by the Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) through its Task Team on WIGOS Metadata.

EC-64 (2012) recognized the need to revise the WMO *Technical Regulations* (WMO-No. 49), Volume I; it considered the outline of its new structure as provided in Annex VIII to the Abridged Final Report, and decided on a process for its revision in line with the up-to-date and emerging WMO systems and services.

EC-65 (2013) agreed that the proposed eight chapter headings of the Technical Regulations (WMO-No. 49), Volume I, Part I – WIGOS and the Manual on WIGOS provide a consistent structure between these two documents with additional details provided in the latter. Accordingly, the Council decided that the Structure of the Technical Regulations agreed by EC-64, Annex VIII, be adjusted as described in Annex V to the Abridged Final Report. The Council agreed that compliance with the WIGOS technical regulations, in particular the mandatory elements, would be necessary to achieve its effective implementation.

EC-66 (2014) supported the position taken by PTCs that a formal endorsement of the draft WIGOS Regulatory Material by a regular session of each technical commission would not be mandatory. However, it was deemed important to ensure support and input from all technical commissions involved. In this regard, the Council endorsed the timelines agreed upon by PTCs for the review process of WIGOS Regulatory Material leading up to submission of the draft WIGOS Regulatory Material to Cg-17. It noted that the process ensured sufficient consultation with TCs and ICG-WIGOS.

The draft documents were reviewed by all WMO technical commissions, including CBS, in the period from early April through early July 2014, and feedback was provided to the WMO Secretariat. The feedback had been incorporated in the subsequent revised draft versions, which were submitted to the extraordinary session the Commission for the Basic Systems (CBS-Ext.(2014)).

CBS-Ext.(2014) was highly appreciative of the development of the WIGOS regulatory material and recommendedthat Volume I, Part I – WIGOS, of the WMO *Technical Regulations* (WMO-No. 49), and *Manual on WIGOS* as provided in Annex 1 and Annex 2, respectively, to the Recommendation 3.1(1)/1 (CBS-Ext.(2014)) – WIGOS Regulatory Material, be adopted by the Cg-17, with effect from 1 January 2016.

The drafts endorsed by CBS-Ext.(2014) were available for a review by WMO Members during a period extending over three months from 30 September until 31 December 2014. They were accessible at the WMO web page: <http://www.wmo.int/pages/prog/www/wigos/WRM.html>. This review process was established in accordance with the General Provisions of the WMO *Technical Regulations* (WMO-No. 49), that any amendments to the Technical Regulations submitted by Members or by constituent bodies should be communicated to all Members at least three months before they are submitted to Congress.

The comments provided by Members during this review period were considered by the Secretariat in January-February 2015 for the draft WMO *Technical Regulations (WMO-No. 49)*, Volume I, Part I - WIGOS submitted to Cg-17.

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1. \* In MS Word 2007 or 2003, go to “View” > “Document Map”. In MS Word 2010, go to “View” > “Navigation Pane”.
In MS Word on a Mac, go to “View” > “Navigation Pane”, select “Document Map” in the drop-down list on the left. [↑](#footnote-ref-1)
2. This Editorial Note will be applied for the distribution of the Drafts to WMO Members. [↑](#footnote-ref-2)
3. a suitable period of dual operations, under the same climatic conditions, of the current and new observing systems, which is adequate to identify and record any impact of the change [↑](#footnote-ref-3)
4. The Global Contingency Plan (http://www.wmo.int/pages/prog/sat/documents/CGMS\_Contingency-Plan-2007.pdf) should be updated accordingly. It should indicate that in case of potential gaps on core sun-synchronous missions, absolute priority should be given to observation from mid-morning and early afternoon orbits, in order to maintain the continuity of these datasets. [↑](#footnote-ref-5)