WMO SPICE

SITE COMMISSIONING PROTOCOL

**V2.0**

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# ORGANIZATION OF THE DOCUMENT

The Commissioning Protocol is organized into four parts:

1. **The site components,** data transfer and sharing pathways, and project organizational structure are outlined in Section 3;
2. **The site commissioning procedures**, including pre-commissioning activities and the Interaction with the Instrument Providers, Sections 4 to 6;
3. **SPICE Data Archive,** Section 7**.**
4. **Appendix A: the template for the Proof of Performance (POP) Report**, in which all site configuration details and commissioning activities are documented.

Appendix B outlines the SPICE Data Levels and Data Sets, and Appendix C includes a list of acronyms used throughout the document.

The first two sections are intended to provide background information on the commissioning process within the scope of the SPICE project, while the Appendix A contains the forms which are required to be filled out as part of the commissioning of the site. Once completed, these forms become the Commissioning Report.

The SPICE data archive section outlines the requirements regarding the SPICE data levels and datasets and the planned strategy for the archival of SPICE data to a central location(s).

# PURPOSE AND SCOPE

*This document is prepared by the WMO SPICE IOC. It outlines the procedures for post-installation testing and commissioning of the sites participating in the WMO SPICE experiment and documents the responsibilities for each aspect of the commissioning process.*

Commissioning of a WMO SPICE site refers to the act of “turning it on” and marking the start of the collection of the “official” observations and measurements from the instruments included in the intercomparison (reference, instruments under test, ancillary measurements), and their archival on the designated Site Data Archive.

For this purpose, each site will designate a location for the Site Data Archive, which must protect the integrity of the intercomparison data.

End-to-end data quality and integrity for each instrument on each SPICE site will be verified before the commissioning can take place. It is essential that:

* Only agreed upon instruments are to be installed, in an accepted and standardized configuration;
* Each component be properly tested, and its performance verified, prior to commissioning;
* The transfer of instrument data to the Site Data Archive is validated and the archive secured.

Various individuals and organizations are referred to in this document as having responsibilities.

* SPICE IOC
* SPICE Project Team
* SPICE Data Analysis Team
* Site Manager
* Site (SPICE) Project Team
* ER refers to the Evaluation Representative, an individual named by the SPICE IOC
* IR, the Installation Representative, is identified by the Site Manager, responsible for the site configuration.
* Instrument Providers

# CONFIGURATIONS AND ASSOCIATED COMMISSIONING REQUIREMENTS

## SPICE Site Components

The SPICE Components include all or some of the following components:

* Field working reference systems (R3, and where applicable R2, and R1: site-specific)
* Reference measurements for snow on the ground (where applicable)
* Instruments under test provided by the host;
* Instruments under test supplied by the Instrument Providers;
* Ancillary measurements (both required and desired measurements listed):
* Precipitation occurrence/intensity/size/type
* Station pressure
* Temperature/dew point
* Relative humidity
* Wind speed/direction (2-D and/or 3-D): different heights;
* Manual observations
* Vertical particle velocity
* Net radiation
* Snow Water Equivalent (SWE)
* Icing occurrence
* Visibility
* Sky condition
* Derived or modeled ancillary parameters: wet bulb temperature, upper air temperature, snow particle density;
* Photography and video equipment for recording and archival of site conditions;

## Communication Interfaces

The SPICE site teams are led by their respective Site Managers and are responsible to setup and manage an effective data communication system collecting, transmitting and archiving the site dataset, continuously, or at predefined intervals (e.g. daily) on the Site Data Archive.

As stated in the report of the SPICE IOC-2 meeting (Boulder), it is recommended that 6 s data be collected for gauges in reference systems and instruments under test, where possible; alternatively, 10 s or 60 s sample intervals can be used.

The frequency of the collection of ancillary measurements will be similar to that of the instruments under test, to the extent possible.

Data communication for SPICE includes the following components:

* Instrument to data logger (site specific);
* Instrument to a site data acquisition system located on site, site specific;
* Transmission of SPICE data from the site to a designated Site Data Archive;
* Transmission of SPICE data from the Site Data Archive to SPICE Archive(s) (See Section 7);
* Transmission of gauge-specific and requisite ancillary SPICE data to Instrument Providers for review.

The communication components and any future changes that may impact the availability of instruments will be documented. Any change to the configuration will be subject to a period of testing to ensure that the availability of instrument data is not affected. The IOC will review and accept the final configuration.

## 3.3 SPICE Site Project Team

The Site Manager will document the membership of the SPICE Site Project Team, including the names of the individuals who are engaged in the SPICE experiment on the respective site. This information will include reference to the roles relative to the SPICE experiment.

During the project, the participation in the SPICE Site Project Team could change. The Site Manager will to update the Site Documentation to reflect the changes (people, roles).

# PRE-COMMISSIONING ACTIVITIES

The pre-commissioning activities are an integral part of the process of ensuring the quality of the experiment. The following sections detail the pre-commissioning activities ensuring that site infrastructure and procedures are properly managed and documented.

## Station Installation and Scheduling

The IOC and the Site Managers will develop target dates for the installation and commissioning of each SPICE Site. An Installation Representative will be identified by the Site Manager to manage the installation. Site drawings, instrument siting and installation according to national standards, IOC agreed guidelines, or manufacturer recommendations, and exceptions will be documented as part of the POP Report.

## Testing of Instruments Included in the Intercomparison

The testing of instruments is conducted by the SPICE Site Project Team. Based on the results, the Site Manager will determine the readiness of instruments and the site for the formal phase of the experiment.

### 4.2.1 Site Documentation

Technical documentation for each SPICE component will include, but not limited to, the site layout, instruments details and configuration, data collection (including the data format), number of similar instruments, installation details, maintenance standards.

Specific information on the Site Documentation is provided in Appendix A.

### 4.2.2 Monitoring of Performance

The Site Manager will establish feasible procedures for monitoring the performance of instruments, identifying problems with the data, and initiating and tracking remedial actions. This may include:

* Review data, diagnostic data, quick view plots, QC reports, etc.
* Establishing Site Journals/Blogs documenting the performance and intervention on the instruments (directly – e.g. snow clearing - or indirectly – e.g. system reset - )

### 4.2.3 Site Maintenance

The SPICE Site Manager will ensure that site maintenance is available to limit the periods or data outage.

# COMMISSIONING ACTIVITIES

The commissioning of a SPICE site is led by the Site Manager. The SPICE POP Report will document the status of the site operation at the start of the intercomparison.

The site commissioning process consists of the following steps:

* Determine the instrument readiness, including;
* Installation and configuration of the instruments participating in the experiment;
* Data integrity confirmation at the Site Data Archive;
* Review and approval of the POP Report by the IOC;
* Agreement on the official start of the experiment on the site.

## 5.1 Determination of Site Readiness

This sub-section details the activities to be conducted following the installation of instruments, and which are completed prior to the official start of the SPICE experiment on the site.

### 5.1.1 Site Readiness Evaluation

The Site Manager will initiate the evaluation of the SPICE Site and will provide to the IOC adequate notice of the SPICE site commissioning.

The IOC will name a representative (the ER) to conduct the evaluation of the Site Documentation prepared by the Site Manager. The ER will work with the Site Manager on the l evaluation of the POP Report.

The site readiness evaluation should be sufficient to ensure proper operation of all instruments and interfaces. The assessments will include:

* Satisfactory performance of the field reference system(s).
* Satisfactory performance of each instrument under test.
* Satisfactory performance of instruments providing ancillary measurements.
* Satisfactory performance of site communication components and interfaces.
* Satisfactory performance of the data transmission to the Site Data Archive;
* Proper functioning of service backup capabilities for that particular site, if available.
* Maintenance capacity.

### 5.1.2 Completion of POP Report

The SPICE Site POP Report documents the readiness of the site and is approved by the IOC.

The POP Report includes:

* A form for recording station information and configuration, including the site layout;
* A form for documenting the configuration of SPICE field working reference configurations, including both manual and automatic measurements;
* Forms for recording the specifications of instruments under test and instruments used to provide ancillary measurements ;
* Details of tests conducted for instrument data validation;
* Details of tests conducted for end-to-end data validation;
* A checklist for all additional documentation to be recorded and submitted ;
* A table for recording commissioning milestones.

The Site Manager will provide the POP Report to the IOC, for final review.

### 5.1.3 Invoking Workarounds

A workaround is a temporary solution to a system limitation that requires special attention and will be removed eventually. Any workarounds will be documented and included as part of the POP Report. Each work-around will be tracked as an open item until resolved.

## 5.2 Approval of Site Commissioning

The Site Manager will notify and update the IOC on the organization and completion of the tests outlined in Appendix A. Once all tests results are verified, the IOC and the Site Manager will agree on the start date of the formal experiment on the site.

In case some of the instruments under test are not ready for the start of the experiment as planned (currently Nov. 15, 2012), the experiment could commence in steps, provided that all field references and key ancillary parameters (wind speed and direction, temperature) have been commissioned.

Commissioning of additional instruments would follow as their configurations are finalized; this will allow for their inclusion in the experiment as early as feasible, with no compromise to the data quality. The Data Analysis Team will take into consideration the commissioning data for each instrument.

## 5.3 Implementation of Approved SPICE Site Commissioning

Upon commissioning, the site will commence the official collection of the SPICE project dataset and ancillary measurements/observations.

# Interaction with the Instrument Providers

Instrument Providers are responsible for the delivery of their instruments to the SPICE Sites and for supporting the Site Managers in verifying their proper functioning before and during SPICE.

## 6.1 Pre-Commissioning Activities: Engagement of the Instrument Providers

During the installation, the Site Manager or a representative will engage the Instrument Provider regarding the preparation of their instruments, to ensure the operation within recommended standards.

The Site Manager would confirm with the Instrument Provider the functioning of the instrument prior to the commissioning of the site. This could be done by the sharing of instrument and/or ancillary data and pictures, coordinated site visits, or any other method agreed upon by the two parties.

The Site Manager should be able to indicate in the Commissioning Report the confirmation from the Instrument Provider that the instrument operates as expected.

## 6.2 Engagement of Instrument Providers during the Experiment

During the experiment, each Instrument Providerwill be given access to the unprocessed output from its own instrument(s), and a minimum set of corresponding ancillary data consisting of air temperature, relative humidity, and wind speed. These data are provided only for ensuring the proper functioning of the instruments, and will neither be reported nor published prior to publication of the SPICE Final Report.

The Site Manager will coordinate the data transfer to the Instrument Provider(s), including such aspects as the frequency, methodology, etc. It is desired that this data transfer is in place prior to the start of the experiment. The Instrument Provider is expected to alert the Site Manager in the event that a malfunction of an instrument is noted, and provide support to the Site Project team (including site visits), if needed, to address the failure.

The Instrument Providers could visit the intercomparison sites, after prior arrangements are made with the Site Manager.

# SPICE Data Archival

The SPICE Project Team will establish and maintain a SPICE Archive on at least one SPICE designated Server where will store the Site Intercomparison Datasets and the Input Documentation. This will facilitate the preparation of data for the individual and comparative data analysis and the preparation of the Final Report. A description of the data levels and datasets for SPICE, as currently defined, is provided in Appendix B.

At the time of the preparation of this document, the National Centre for Atmospheric Research (NCAR), USA, has offered to host the SPICE Archive and provide quick view capabilities of (near) real time data.

Options for a second SPICE Archive are being explored by Environment Canada, Canada.

Each Site Manager will work towards preparing the transfer of Level 1 and Level 2a datasets to the SPICE Archive(s). The IOC will provide to the Site Managers the requirements regarding the data transfer to enable the preparation of datasets (format change, setup of data uploads/availability, etc…)

The data transfer between the Site Data Archive and the SPICE Archive is expected to be established and validated within 3 months of the official start of the experiment, and implemented based on site specific conditions and limitations.

# APPENDIX A: PROOF OF PERFORMANCE (POP) Forms

## SECTION A1: Station Information

|  |  |
| --- | --- |
| Station name |  |
| Reference town |  |
| Station latitude |  |
| Station longitude |  |
| Station elevation in metres |  |

**A Site Layout** is required indicating the location of SPICE references and all instruments, including distances and the direction of the prevailing winter winds.

## SECTION A2: SPICE Field Working Reference System configuration

#### Field Reference Type R1 (Manual)

|  |  |
| --- | --- |
| Measurement frequency, planned |  |
| Measurement methodology planned (volume, weight, etc) |  |

**Additional information required:** Provide details of the planned measurement procedure.

*Configuration of the DFIR fence*

|  |  |
| --- | --- |
| Description of surrounding obstacles (including distance/direction from, height, and type) |  |
| Diameter |  |
| Height of the outer fence (measured at the top) |  |
| Height of the inner fence (measured at the top) |  |
| Length of slats |  |
| Width of slats |  |
| Slat material |  |

*Collector and shield specifications*

|  |  |
| --- | --- |
| Model |  |
| Inlet area |  |
| Installation height (measured at the top of the collector) |  |
| Number of collectors available for the experiment |  |
| Shield type |  |

#### Field Reference Type R2 (Automatic)

*Configuration of the DFIR fence*

|  |  |
| --- | --- |
| Description of surrounding obstacles (including distance/direction from, height, and type) |  |
| Diameter |  |
| Height of the outer fence (measured at the top) |  |
| Height of the inner fence (measured at the top) |  |
| Length of slats |  |
| Width of slats |  |
| Slat material |  |

*Single Alter shield*

|  |  |
| --- | --- |
| According to the SPICE instructions? | Yes  No |
| Attached to the post of the weighing gauge? | Yes  No |
| If different, provide details: |  |

*Weighing gauge (WG)*

|  |  |
| --- | --- |
| Make and model |  |
| Serial number |  |
| Firmware version (if applicable) |  |
| Number of transducers (if applicable) |  |
| Height of installation (measured from the top of the gauge) |  |
| Heater configuration and algorithm |  |
| Output data message format |  |
| Frequency of data sampling |  |

*Precipitation detector*

|  |  |
| --- | --- |
| Make and model |  |
| output data message format |  |
| Data sampling frequency |  |
| Height of installation (at or above gauge height to avoid measuring blowing snow) |  |
| Location of installation relative to WG in reference system. Close proximity (without obstructing flow) is desired, but central location also possible. IOC recommended installation outside the wind shield, depending on specific configuration employed. |  |

#### Field Reference Type R3 (Automatic)

|  |  |
| --- | --- |
| Presence of a WG with a single Alter shield? | Yes  No |
| Presence of a WG with no shield? | Yes  No |
| Description of surrounding obstacles (including distance/direction from, height, and type) |  |
| Distance between WGs (as close as possible, but exceeding minimum distance between gauges for a Class 1 siting configuration (as per WMO guidelines):Generally a flat area within 10m of instrument. This area surrounded by generally open space with a slope of less than 1:3 (19°) that is considered to be representative of the large scale area. |  |

*Weighing gauge (1 of 2)*

|  |  |
| --- | --- |
| Make and model |  |
| Serial number |  |
| Firmware version (if applicable) |  |
| Number of transducers (if applicable) |  |
| Height of installation (measured from the top of the gauge) |  |
| Heater configuration and algorithm |  |
| Output data message format |  |
| Frequency of data sampling |  |

*Weighing gauge (2 of 2)*

|  |  |
| --- | --- |
| Make and model |  |
| Serial number |  |
| Firmware version (if applicable) |  |
| Number of transducers (if applicable) |  |
| Height of installation (measured from the top of the gauge) |  |
| Heater configuration and algorithm |  |
| Output data message format |  |
| Frequency of data sampling |  |

*Single Alter shield*

|  |  |
| --- | --- |
| According to the SPICE instructions? | Yes  No |
| Attached to the post of the weighing gauge? | Yes  No |
| If different, provide details: |  |

*Precipitation detector*

|  |  |
| --- | --- |
| Make and model |  |
| Data output format |  |
| Data sampling frequency |  |
| Height of installation (at or above gauge height to avoid measuring blowing snow) |  |
| Location of installation relative to WGs in reference system. Close proximity (without obstructing flow) is desired, but central location also possible. IOC recommended installation outside the wind shield, depending on specific configuration employed. |  |

#### Field Reference for the Measurement of Snow on the Ground

|  |  |
| --- | --- |
| Method used |  |
| Equipment used |  |
| Frequency of measurement |  |

## SECTION A3: Instrument Metadata Report

For each instrument under test and each instrument used to provide ancillary measurements, an Instrument Metadata Reportshould be completed in full and submitted as part of the POP Report.

**Instrument Metadata Report**

*IMPORTANT: Please copy this form (as necessary) and complete separately for each instrument under test and each instrument that will be used to provide ancillary measurements during WMO SPICE.*

Instrument Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Instrument number \_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| Manufacturer |  |
| Model |  |
| Serial number |  |
| Firmware version (if applicable) |  |

*Field configuration*

|  |  |
| --- | --- |
| Location on site |  |
| Orientation |  |
| Height (measured at top) |  |
| Shield (if applicable) |  |
| Heating (if applicable) |  |

*Data output*

|  |  |
| --- | --- |
| Data communication protocol |  |
| Output data message format (include description of fields) |  |
| Data sampling frequency |  |

## SECTION A4: Confirmation of Experiment Configuration

### TEST 1: Instrument Calibration and Checks

The Site Manager will organize the check and calibration of each instrument included in the experiment (as part of the reference, or as an instrument under test). The check sheet and the calibration results will become part of the POP Report, Section A5, Site Documentation.

* The calibration and check of the WG used as part of the reference will be conducted based on the guidelines adopted by the SPICE IOC.
* The calibration and check of the instruments under test will be conducted as specified by the manufacturer prior to the installation on the SPICE site, as well as following the installation in the field.

### TEST 2: Instrument Validation

After the field installation of each instrument (both those that are part of the reference and those that are instruments under test), at the minimum, a **continuous 48 hour data set** of the entire test setup will be stored and examined as an indication of instrument performance**.** The data sets for each instrument included in the intercomparison will be reviewed for data integrity and representativeness, against the predefined data format.

It is recommended that the evaluation of the instrument performance at this stage is conducted using time series plots.

Any discrepancies will be investigated, addressed, and documented. Following the resolution of the discrepancies, the 48-hour end to end (e2e) test will be repeated. The readiness state of each instrument will be reported using the table format below and included in Section A5, Site Documentation.

**Instrument Data Validation[[1]](#footnote-1)**

|  |  |  |
| --- | --- | --- |
| Instrument | Readiness  (if Yes, indicate the date) | Comments |
|  |  |  |
|  |  |  |

**Additional information required:**

Include the Instrument Data Validation datasets and plots as part of Section A5.

### TEST 3: Site Validation Test

At the SPICE Site Data Archive, collect SPICE data over a 7 day period and compare the data stored on site with the data received at the Site Data Archive, to ensure that the SPICE data is transmitted and archived accurately. Any discrepancies will be addressed. Following the resolution of the discrepancies, repeat the 24-hour end to end test.

Include the e2e datasets and plots and any available discrepancy report, as part of the Commissioning Protocol documentation.

*IMPORTANT:*

*Test 2 and Test 3 may be conducted simultaneously, depending on the site configuration.*

## 

## SECTION A5: Site Documentation

The site documentation will include all documents, data sets , and plots referenced in sections A1 to A4, details of any workarounds, and a complete set of pictures documenting the overall site installation ( views from N, NE, NW, S, SE, SW E, W) and each instrument installation.

A **Site Documentation Checklist** is provided below to track the the requisite documentation.

**Site Documentation Checklist**

|  |  |
| --- | --- |
| Site information and layout | Included |
| Details of manual measurement procedure | Included  Not Applicable |
| Instrument Metadata Reports for all instruments under test and all instruments used to provide ancillary measurements | Included |
| Calibration results and check sheets for all instruments | Included |
| Instrument data validation: datasets, daily time series plots | Included |
| Instrument data validation: discrepancy reports | Included  Not Applicable |
| End-to-end data validation: datasets daily time series plots for 1 week. | Included |
| End-to-end data validation: discrepancy reports | Included  Not Applicable |
| Details of any workarounds | Included  Not Applicable |
| Complete set of pictures documenting the overall site installation (views from N, NE, NW, S, SE, SW E, W) and individual instrument installations | Included |

# APPENDIX B: SPICE DATA LEVELS AND DATASETS

Details of the different levels of data and associated datasets for SPICE are included below. **The present document addresses only data up to and including Level 2a.** Data of higher levels, and the associated datasets, are tentatively defined here for completeness.

**Data Levels:**

**Level 1** data: are those collected as the output of each individual instrument, which have been converted into geophysical measurements (e.g. weight, mass, intensity), generally with high temporal resolution, and before any significant data quality control has been applied. A **Level 1** dataset contains data from only one instrument at one site.

**Level 2a** data: are time-synchronized data resulting from the sampling, averaging or some other signal/data processing having been applied to **Level 1** data from an individual instrument in order to separate signal from noise. These data have not been quality controlled, and should be used only for monitoring an instrument’s status. A **Level 2a** dataset contains data from only one instrument at one site.

**Level 2b** data: are time-synchronized **Level 2a** data after a basic data quality control procedure has been applied. Basic data quality flags for validity and quality have been added. Missing records have been created and filled with a missing data quality indicator. A **Level 2b** dataset contains data from only one instrument at one site.

**Level 3** data: derived by combining and further processing all **Level 2b** datasets from a site. At this level, advanced and multiple instrument data quality techniques have been applied. A **Level 3** dataset contains data from all instruments at an individual site.

**Level 4** data: derived after performing an intercomparison of the **Level 3** data from one or more sites, taking into account snow climatology, wind regimes, temperatures, etc., and where applicable, differences in these from one site to another.

**Datasets:**

**SPICE Site Dataset:** A dataset comprising all **Level 1,** **2a, 2b and 3** datasets from that Intercomparison Site.

**SPICE Intercomparison Dataset:** this is the Level 4 datasetthat combines the **Level 3** data from all SPICE intercomparison sites. The **Project Team** will develop the **SPICE Intercomparison Dataset** using the Level 3 datasets from each **Intercomparison Site.** It contains summary Level 3 data and intercomparison data for all instruments and all sites.

**The SPICE Dataset**: The total SPICE dataset including all **SPICE Site Datasets**, **Site Documentation** and **Instrument Documentation** for all participating sites and instruments, the **SPICE Intercomparison Dataset,** and all SPICE analysis and assessment documentation.

# APPENDIX C: ACRONYMS AND ABBREVIATIONS

DFIR Double-Fence Intercomparison Reference

e2e End-to-end

ER Evaluating Representative

IOC International Organizing Committee

IR Installation Representative

NCAR National Center for Atmospheric Research (USA)

POP Proof of Performance

QC Quality control

R1 Working field reference configuration 1: manual precipitation gauge in DFIR

R2 Working field reference configuration 2: automatic weighing gauge in DFIR

R3 Working field reference configuration 3: two automatic weighing gauges;

one shielded (single-Alter), one unshielded

SPICE Solid Precipitation Intercomparison Experiment

SWE Snow water equivalent

WG Weighing gauge

WMO World Meteorological Organization

1. It is strongly recommended that the evaluation of instrument performance is completed using time series plots. [↑](#footnote-ref-1)