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| **World Meteorological Organization****Commission for Instruments and Methods of Observation** **Joint Session of the Expert Team on Operational In Situ Technologies (ET-OIST) and the Expert Team on Developments in In Situ Technologies (ET-DIST)**Geneva, Switzerland, 21-23 June 2017 | **CIMO/ET-A1-A2/Doc. 5.3(3)**  |
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**Further develop and finalize guidelines on migration from manual to automated observations**

**Includes editing after discussion in ET**

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| **Summary and purpose of document**1. This document provides information on an outline of a request to WMO to develop a training course (rather than a document)

There is a demand on CIMO for help with transition from manual to automatic stations. However, here it is proposed that the need is not a further CIMO or WMO document (these exist), but rather a training scheme to prepare NMHS local staff to implement a migration project. For a project of that nature, which is a considerable task, written guidance alone is unlikely to sufficient, to be successful it will involve* Project Management skills
* People and process change skills Planning to make the new system to be sustainable (support/maintenance, comms, theft)
* Budgeting and Procurement
* Network planning for and quality and lifetime (strategic advice from CBS)
* Equipment (strategic advice from CIMO).

This can be summarised as ‘How far should you automate?’ and ‘Don’t go shopping too soon!’These are approximately in order. There are many topics here so the course could be lead by CIMO or another Programme within WMO in line with strategic ‘best fit’. Other WMO programmes should be included.The requests to help with guidelines on migration from manual to automatic observations have a long history in CIMO (for example, see reference 1 from 2008). However, there is well written and relevant material available, for example see ref 3 and ref 4. The continuing requests for help are discussed by Dr Jitze van der Meulen (of the CIMO Management Committee) at ref 2, and it was discussed in session at TECO 2016. |

**Action proposed**

1 The Meeting is invited to consider the proposal and recommend (firstly for agreement with CIMO Management) that training material is developed in conjunction with the appropriate structures in WMO. In detail, I propose that this issue is best answered by two WMO training courses including video conferences and e-learning, aimed at the staff who will make these projects work. Course outlines are proposed in Appendix II below. The attendees on the first courses can be supported by CIMO mentors who can offer advice. The course should be created and led by an expert trainer who will select and establish the material and how present it with WMO, CIMO and other relevant experts. (see Appendix 1 below). Note that the proposal is that Courses 1 and 2 are both needed to enable the work of the project to be a success; it is unlikely to be a success if not carried out completely.

2 Review the course content below (Appendix II) in the ET meeting in June - done

3 Possibly present material from 2) at the AWS Conference in October – Author may not be able to attend

4 I also suggest that the course itself is a rich source of planning and that records are kept to improve the process. For example a Risk Register can be started to be held firstly in CIMO as a live spreadsheet and then placed on the CIMO pages assuming it is ‘moderated’. This becomes a more ‘living’ document and will be a very useful up-to-date extra. This would cover many of the issues that can impact on projects of this nature. Additionally, to be positive in our approach we should also seek ‘Success stories’ to lead by example. (Note we had an offer of this form within the ET and also note the presentations given by NZ at TECO Madrid and Tim Oakley at GCOS)

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**Appendix I**

How to prepare the material and the delivery of the training

Set up expert training provider, with track record of work in WMO or NHMS. Include input and guest lectures and mentoring, from various selected experts. This can be improved by dial in or VC and the development of e-learning modules.

The teaching material can be given in the first case in Geneva or a regional workshop using some test candidates in an open environment supported by CIMO ET members.

The course material is likely to develop into a mix of documents, resources and videos. It would be wise to include a ‘model’ exercise of planning a network or similar, or possibly preparing outlines for the key documents for a project.

The course should include a system of ‘mentors’ in various NMHSs which are assigned to be available to help and advise during the course or provide consultancy during the project for say 4 years (matching CIMO Congress periods)

Early modules on Management and Project Management are assumed to have been passed within WMO, these can be gained from existing courses. In future, the project and network can draw working expertise from RICs and E-learning such as under development

**Appendix II**

**Course One**

For Network managers and decision makers

At the end of this course attendees will understand how to create a successful transition project

Assumptions – attendees have Project management and people skills training

Outline of material

Procurement\*

* Why do we need Procurement systems and not just buy what we like
* How to find out what procurement laws apply
* Procurement law internationally and nationally
* A good example of how to specify and buy equipment
* How to make a procurement plan
* Who can help

\*Procurement is the act of acquiring, buying goods, services or works from an external source, often via a tendering or bid process. It is favourable that the goods, services or works are appropriate and that they are procured at the best possible cost to meet the needs of the acquirer in terms of quality and quantity, time, and location. Corporations and public bodies often define processes intended to promote fair and open competition for their business while minimizing exposure to fraud and collusion.

\* It is likely that you need specialist people in the project, who are working on **what** you and your customer requirements are (e.g. meteorological requirements, hard- and software infrastructure, total cost of acquisition and ownership, availability) and **how to get these requirements fulfilled** (e.g. adaption to common law: requirements must be specified, tested and accepted).

Running a good project - recap

* Why do we need to run a project
* Where do we get training
* How to make a project plan
* Who can help

Planning a good network

* What do we want – requirements from users and WMO (RRR process)
* Requirements for the transition (parallel measurements, homogenization of data series)
* As a station is converted, how long can it be ‘out of service’
* What goes into it

Operating concept (Monitoring, Support and maintenance (contract and in-house), Lifecycle) **2.** Management of technical changes Before equipment work starts, all process-branches must be well-defined covering everything between long-term/high cost changes with high effort (e.g. like a new sensor being added) and short-term/low cost changes with lower effort (but essential for the system) like software updates.

Also

* Safety / security / power supply should be performed according to national regulations and the level of availability needed.
* All changes that have influence on the functionality, measurement uncertainties and site-classification (e.g. changing flora and surrounding property, dirt/dust (on optical instruments), insects, technical effects (e.g. drift), effects of lightning) should be considered and the counteractions to every point determined (technical, organizational, personnel - e.g. plausibility checks on redundant measurements and equipment, technical monitoring, quality control of data (fit to data of neighbor sites, current regional weather and model data), regular visits for cleaning, de-icing and gardening).
* Calibration-process for instruments must be defined and performed or controlled.

**Running the operations**

Technical staff is needed for installation, deconstruction and technical documentation with long-term management skills (capacity building).

* Metrology: basic concepts of measurements and calibration
* What to do with the data
* What else does it need (power, comms, security)
* How good does it have to be (not perfect! But with metadata)
* Who can help

People

* Who have you got – what will you do with them (move, retrain, retire)
* Who will run the network
* What skills do they need
* What facilities do they need (transport stores etc)
* How to get good people
* How to train them
* Who can help

Lessons learned – Risks – and how to handle them – these can be added to a CIMO ‘live’ risk log as above

* Short term funding
* Sustaining timeseries, 20 stations for 10 years or 10 stations for 20 years?
* (Predators (defences against sharp practice)????) Delete if not appropriate??
* Success stories, WMO projects are often presented at TECO meetings so a history of success stories can be found (The centennial station in Moncalieri was included in the WMO video and has a nice story to tell linking change with metrology… if needed.)
* Risks, CIMO ET members may be able to help with some of the risks to be considered

Further discussions

Only at this stage should an initial outline of the type of system be drawn up. It should be used to inform the decisions for the team trained in course 2 below. At this stage it should be limited to an outline of the type of system to be used and that can be sustained and supported by the people available. Some guided web based investigation of HMEI equipment can be held. Limit this to the highest level. For example, Broad history timeline in the UK – but is likely to be widely applicable. This material will be repeated in course 2.

To help the discussion on how far to automate I outline four stages of Weather stations – a rough timeline on development of measurements and systems

a Analogue instruments (or handheld non-logged digital instruments) and subjective observations – paper records at station – messages via analogue comms. Staff’s main focus is to create good measurements, while maintaining the safety and security of the stations.

Most maintenance processes can be carried out by local staff - largely by swap in swap out of simple instruments.

These simple solutions provide highly resilient and flexible operation in emergencies or outages since staff are well placed to make decisions and understand the importance of the work.

Quality control is assumed to be minimal as long as the transcription of records is accurate. Little effort required at centre to run this solution.

b Some digital instruments and some analogue, subjective observations. Data may be typed into system for electronic transmission of coded observations. Local staff can handle most problems. Some equipment needs off site engineering support.

c Mostly digital instruments; Many of these have local communication to a logger or data processing system so that there is little staff intervention in real time. Staff may have other duties so that the main focus is meteorology rather than measurement. System capable of semi automatic creation of digital messages so that it can run without staff interaction for some time (for example overnight) with little reduction of capability.

Maintenance of much equipment has to be carried out by highly trained engineers

d All digital instruments (or logger based) site capable of months of operation without degrading measurement quality. Messages composed and sent automatically. This could be an long term goal and may not be achievable quickly without risk. It would be

*An affordable station or network of stations without permanent local staff, that provides 24/7 digital data of meteorological parameters with known meta-data and measurement uncertainties according to customer demands and to WMO (ICAO) regulations of all measurements in all (or all main) meteorological situations.*

However, although this is ‘automatic’ a lot of skilled support is required

* Highly skilled engineers
* IT systems at HQ to gather and check data
* System managers and planners
* Data checking by IT and staff
* Highly secure site to run without loss of power of theft for many months
* Local maintenance for reducing vegetation in secure area

Note that I imply there is a risk of jumping too far too fast.

Measurements and beyond

Automatic measurements still require staff! CIMO and HMEI can guide users on available equipment which can be specified and tested for suitability of performance. However, to sustain these measurements, people are still needed. This also involves a lot of other processes and software to gather and check automatic measurements. It is very hard to give general advice on these processes for two reasons. Firstly the user’s needs and the software ‘look and feel’ are very much down to local decisions. Secondly these facilities are improving all the time, so they need to be considered as the project is carried out.

Changes within the system

A successful system will be sustained over time but that means it has to be somewhat changeable too. So experience shows that systems are not fixed.

Here are some of the ways in which systems can need change and note these changes can be a lot of work!

* The AWS software or its operating system needs an update,
* Comms methods change or improve
* Components are no longer available
* Sensors drifts between calibration is found excessive
* There is demand to add another sensor
* There is demand for more sites
* WMO output codes are updated
* **Adapt number of stations for different purposes**
* Due to new generations of meteorological satellites in orbit soon customer wishes like: increase number of stations with specific or new measurements and decrease amount of stations with complete climatological bundle are foreseeable. This could be part of future medium- and long-term strategy and should be considered in the courses too.

These changes often go on to make the system more valuable

**Course Two**

*For experts and technicians responsible for the installation and operation of the new network*

*At the end of the course you will understand the key elements needed to specify, install and run a sustainable network.*

*Assumptions – attendees have basic Meteorological and/or Engineering training*

It is assumed that the material in Course One above has been learned by other project team members and that an initial outline plan of the whole system is passed to Course Two

Presentation and discussion of the detailed material in WMO/TD 862

1. Introduction

2. General Requirements

3. Siting Considerations

4. Sensor Related Matters

5. Data, Formats, Message Preparation, and Coding

6. Design Features

7. Performance Versus Cost

A1. Quantities and Specifications for their Measurement

A2. Evaluating uncertainty in instrument change

A3. Check List For AWS Users

A4. Data Processing and Formats

Further discussion sessions

2 Working with the suitable level of automation, which will have a large impact on how the specification is written

This is a complex process but I suggest it is best carried in 3 stages

a Concept stage – translate the plan into technology. What is needed and what could work, consider solutions from exhibitions, web search etc, discuss with suppliers and CIMO experts. Estimate rough costs and plans. Gain broad agreement with Project staff, funders and stakeholders.

b Feasibility study – detailed look at some of the best possible solutions, check that they will work in budget, visit suppliers or they visit you. Get indicative quotes, make more detailed plans and costings. Formal sign-off from stakeholders. Test the biggest risks or issues.

c Implement – development of detailed requirement. Competition to procure systems and services (Tender). Set up proving and test scheme. Rollout.

3 Mercury – transition – optional inclusion

Since mercury replacement is a current issue at time of writing a session on how to transition from Mercury to alternatives (see Workplan of the Expert Team on Operational Metrology (2014-2018))

4 Measurement Standards

WMO rightly sets very high standards and expectations for measurements, in the case of safety critical aviation measurements or pivotal climate data requirements are indeed very strict. However, this needs to be carefully framed. High standards are important, but lower quality data can be important too. As long as some best practices are considered and the metadata is well founded we now understand that some data is better than none. This is captured in the CIMO site classification system – encouraging the use of a wide variety of sites but showing how they can be improved over time.

References

Ref 1

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

OPAG-SURFACE

EXPERT TEAM ON SURFACE TECHNOLOGY AND MEASUREMENT TECHNIQUES

Second Session (GENEVA, SWITZERLAND, 22-26 SEPTEMBER 2008)

CIMO/OPAG-SURFACE/ET-ST&MT-2/Doc. 5.3 (20.VIII.2008) ITEM: 5.3

Ref 2

Overarching Automated Weather Stations (AWS) Issues – presentation by Dr Jitze van der Meulen, KNMI available at <http://www.wmo.int/pages/prog/www/IMOP/publications/IOM-125_TECO_2016/Discussion_session/PD_1_Discussion_AWS_Issues.pdf>

Ref 3

CIMO Guide Part II Chapter 1 (contains 25 pages of guidance)

Ref 4

1997: Guidance on Automatic Weather Systems and their Implementation. Instruments and Observing Methods Report No. 65 (WMO/TD-No. 862). Geneva. (Contains approx 75 pages of guidance) available at <https://library.wmo.int/pmb_ged/wmo-td_862.pdf>