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Guidance for the Replacement of Mercury-Based and Obsolete Meteorological Instruments

Expert Team on Operational Metrology (ET-OpMet)

Ferdinand Barcenas, Mounir Aziz, Tilman Holfelder, Drago Groselj

Guidance for the Replacement of Mercury-Based and Obsolete Meteorological Instruments

Objective:

- To provide guidance to WMO members and users to help them to identify and replace mercury containing instruments and other outdated instruments experiencing problems with maintenance and/or calibration in observation systems.
- Alternative instruments are mercury-free instruments that comply with the requirements and standards for compatible and reliable measurement of meteorological parameters.
- This document also provides guidance for the safe disposal of mercury-based instruments.

Purpose:

to assist network managers identifying possible solutions and plan transition from mercury based and obsolete instruments.

Guidance for the Replacement of Mercury-Based and Obsolete Meteorological Instruments

The UNEP Minamata Convention on Mercury **comes into force globally in 2020** and bans all production, import and export of observing instruments (thermometers, barometers, etc.) containing mercury.

An appropriate alternative solution depends on many aspects:

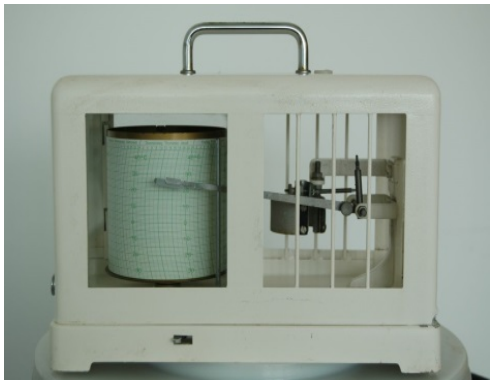
- stakeholder requirements,
- the meteorological and climatic conditions of the country
- the specific local conditions,
- the competence of staff,
- the existing economic situation.

It is not possible to define a general solution for transition path that could be applicable everywhere.

Identification of instruments to be replaced

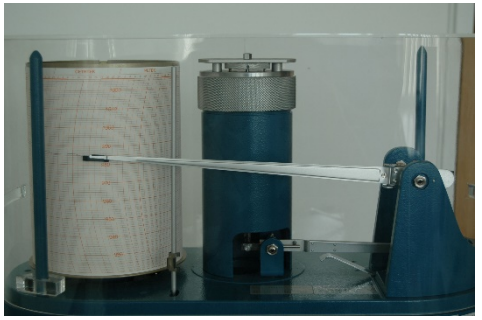
Temperature:

- Mercury-in-glass thermometers (field and laboratory)
- Thermographs
- Mercury-in-glass soil thermometers



Pressure:

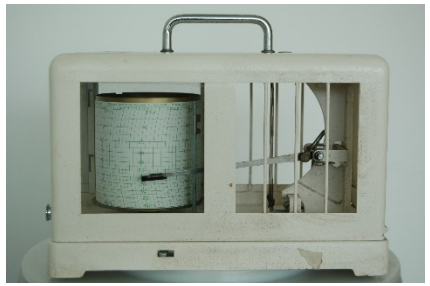
- Mercury barometers (field and laboratory)
- Barographs



Identification of instruments to be replaced

Humidity:

- Mercury-in-glass psychrometers
- Hygrographs



Other obsolete instruments:

- Anemographs
- Rain gauge recorder
- Sunshine recorders with glass sphere
- Classic evaporation pan using hook gauge

Available alternatives

Instruments for pressure, temperature, humidity, wind, precipitation, and other sensors/instruments should carefully be chosen by the Members. Most of these alternative instruments need power supply and are integrated with digital display or monitor for AWS system.

Temperature:

- Platinum resistance
- Thermistor
- Thermocouple
- Integrated semiconductor circuit
- Spirit of alcohol in glass
- Bimetallic

Pressure:

- Variable Capacitance
- Piezo-resistive
- Piezo-electric
- Resonant
- Optical
- Electromagnetic
- Variable Reluctance
- Potentiometric
- Mechanical instruments

Humidity:

- Electrical Capacitance
- Electrical Resistance
- Dry and wet bulb platinum resistance thermometer (PRT)
- Dew point hygrometer (Chilled-mirror)
- Hair hygrometer

Available alternatives

Precipitation:

- Tipping bucket rain gauge
- Weighing rain gauge

Wind speed / direction:

- Cup anemometer
- Ultrasonic anemometer
- Acoustic resonance anemometers

Short technology description used in alternative instruments

Quantitative advantages and disadvantages

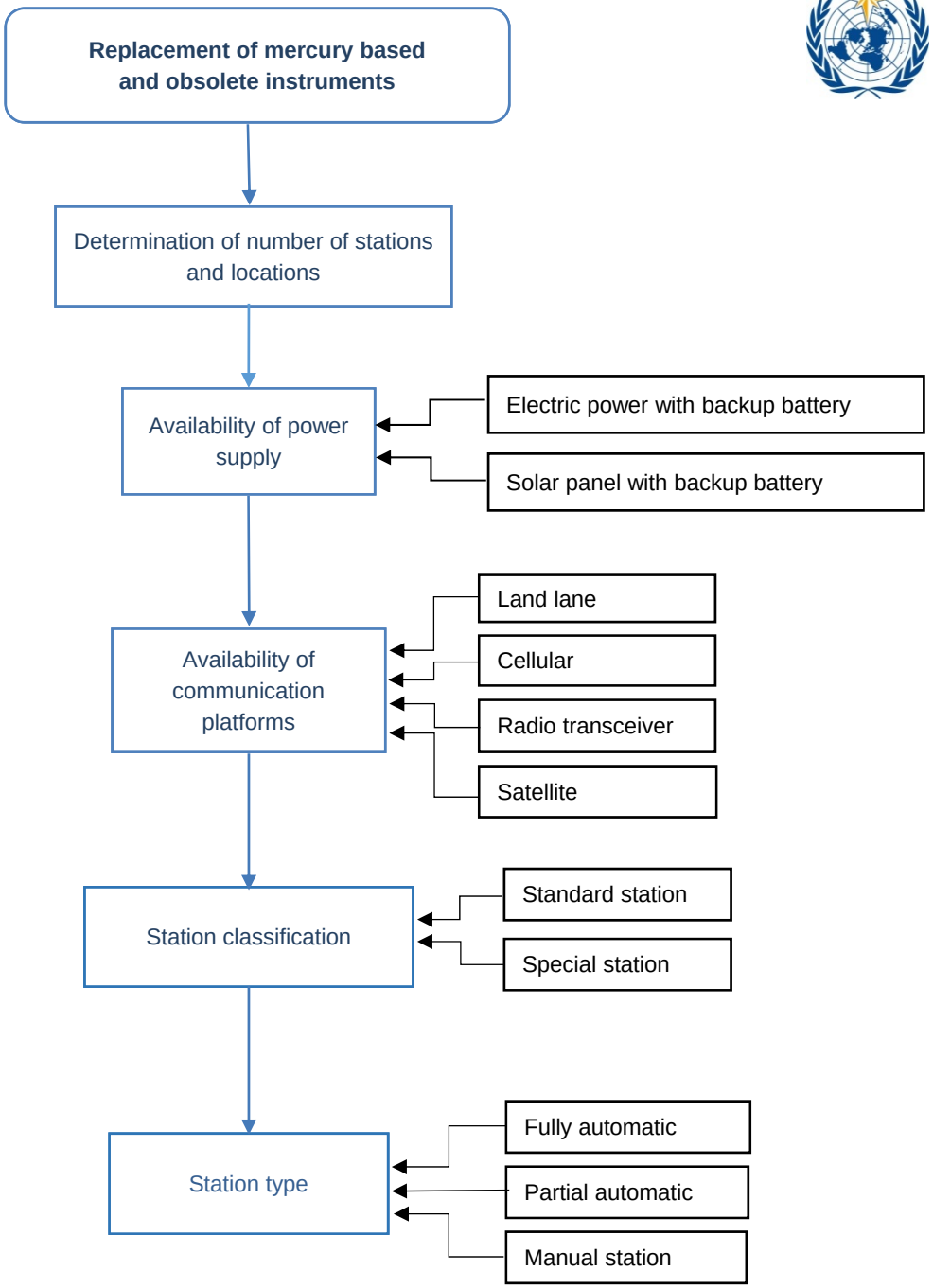
Summarising specification table

	Usage (AWS, manual)	Range**	Accuracy	Response time	Linearity	Stability	Calibration	Cost
Platinum Resistance	AWS, or manual with digital display	- 260°C to 1000°C	Depends on Class: ±0.15°C typical or better	30s to 120 s typical	Linear	Good to excellent	Easy to calibrate	Moderate to expensive
Thermistor	AWS, or manual with digital display	-90°C to 130°C	±0.1°C to ±0.2°C	5 s	Non-linear but can be compensated	Fair to good	Easy to calibrate when linearized	Low to moderate
IC Sensor	AWS, or manual with digital display	-55°C to +150°C	±0.3°C typical	4s to 60s	No linearization required	Long term stability, 0.1°C/month typical	Easy to calibrate	Inexpensive
Alcohol-in-glass	Manual	−200°C to 78°C	±0.2°C typical	100 s	Linear	Fair	Easy to calibrate	Inexpensive
Thermocouple	AWS, or manual with digital display	−200°C to 2500°C	±0.2% of full scale, ±0.2°C to ±0.25°C	<5 s	Fair and can also be compensated	Fair to Excellent	Hard to calibrate if not linearized	Low to moderate
Bimetallic	Manual, automatic recording by graph	-40°C to 500°C	Less accurate ±1% full-scale accuracy, ±0.5°C over range used	2-4 minutes	Linear	Poor; ±0.5°C to ±1.0°C/yr.	Easy to calibrate, Requires frequent calibration	Inexpensive
Mercury Thermometer*	Manual	-37°C to 356°C	±0.05°C to ±0.5°C depending on design	2 to 3 minutes	Linear	Good	Easy to calibrate	Expensive

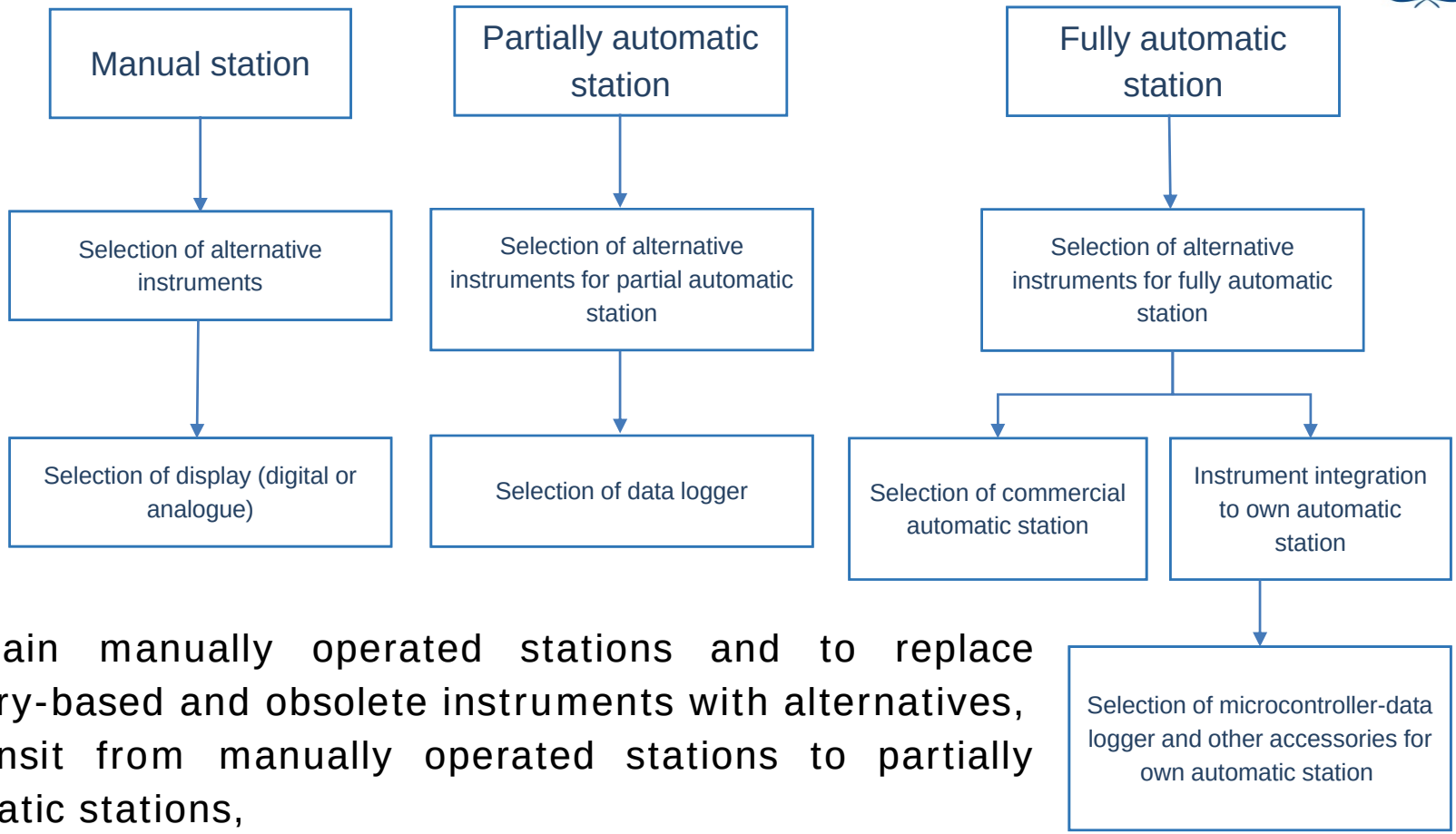
Possible transition paths

Considerations required:

- Determination of number of stations and locations to upgrade
- Power supply availability
- Communication network availability
- Station classification (standard, special)
- Type of station (AWSs, manual)



Level of automation



- to retain manually operated stations and to replace mercury-based and obsolete instruments with alternatives,
- to transit from manually operated stations to partially automatic stations,
- to transit from manually operated stations to fully automatic stations,
- to transit from partially automatic stations to fully automatic stations,
- to transit from obsolete automatic stations to modern, fully automatic stations.

Define the roadmap for the transition

A successful replacement of mercury-based and obsolete instruments needs a specific Project with appropriate project management dealing with many aspects, such as:

1. Involve stakeholders in the planning and implementation of the phase-out of dangerous and obsolete instruments.
2. Conduct or update an inventory to determine the quantity and location of dangerous and obsolete devices.
3. To choose the alternative solution, validate it with stakeholders and approve it by management.
4. Implement procedures of storage and clean-up of mercury containing devices.

Define the roadmap for the transition

5. Processes a pilot phase of trial alternative solution and after receiving feedback from stakeholders identify the final appropriate solution.
6. Develop a budget for replacement within a phase-in schedule taking into account period of parallel measurement by the both old and new systems.
7. Conduct training activities related to the phase–out of dangerous and obsolete instruments and the phase-in of the alternative solution.
8. Store dangerous instruments to an appropriate storage area and remove mercury in accordance with the local regulations on hazardous waste.

Competences of personnel

Maintenance and calibration challenges have become more complex and require a level of qualification in engineering, IT systems, electronics and automation. System performance, reliability and consequently data quality and availability depend on the skills of the personnel.

Disposal of mercury based instruments

Once Members begin to replace and dispose of mercury-containing instruments, the disposal must follow procedures regulated under state laws.

Conclusions

- The transition to modern automatic system and replacement of obsolete and unserviceable instruments requires a decision process that results in a cross-cutting activity.
- Several alternatives to dangerous and obsolete instruments are available, practical according to different specifications as well for developed countries as developing countries.
- There are neither maintenance-free alternative instruments nor automatic weather stations, but the selection of appropriate sensors can reduce inspections operations.
- Transition process should be prepared, planned and implemented with accompanying measures to ensure its success.

THANK YOU FOR YOUR ATTENTION