

The calibration of Hygrometer (Lecture and Training)

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Outline

1. Measurement methods of Humidity(*theory*)
2. Traceability in JMA
3. Calibration methods of Hygrometer
4. Practice
(Calibration and check of electric hygrometer)

1 . Measurement methods of humidity(theory)

1.1 Sorption method

- Changes of the dimensions
- Changes of electrical properties

1.2 Psychrometric method

- Difference between the dry-bulb and wet-bulb temperatures related to the ambient humidity

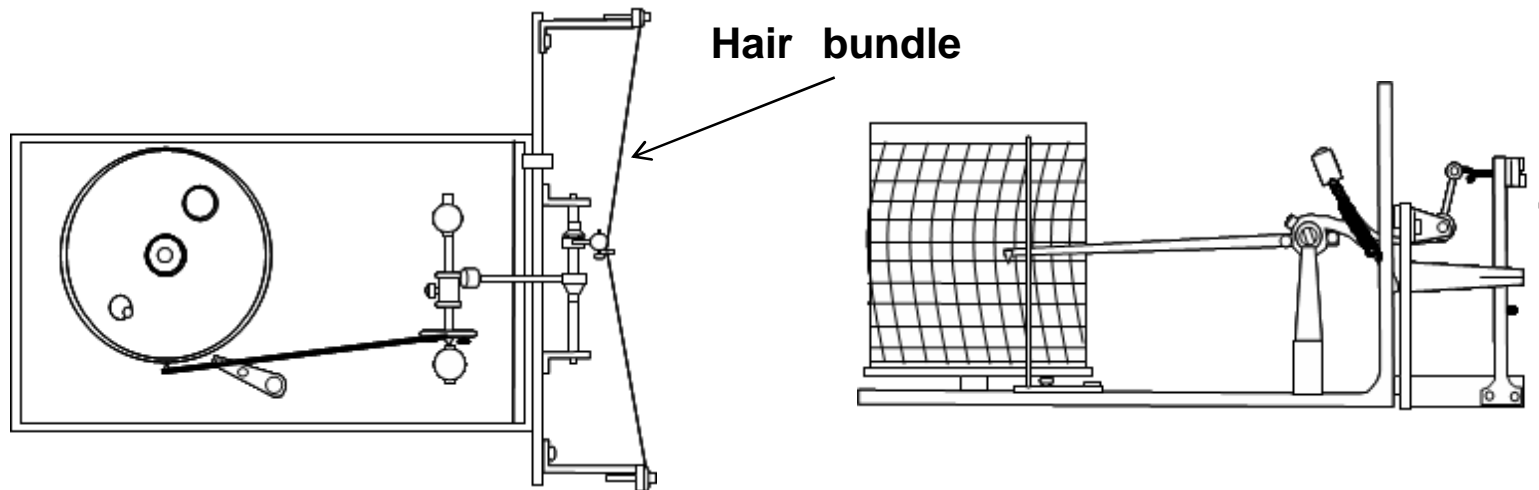
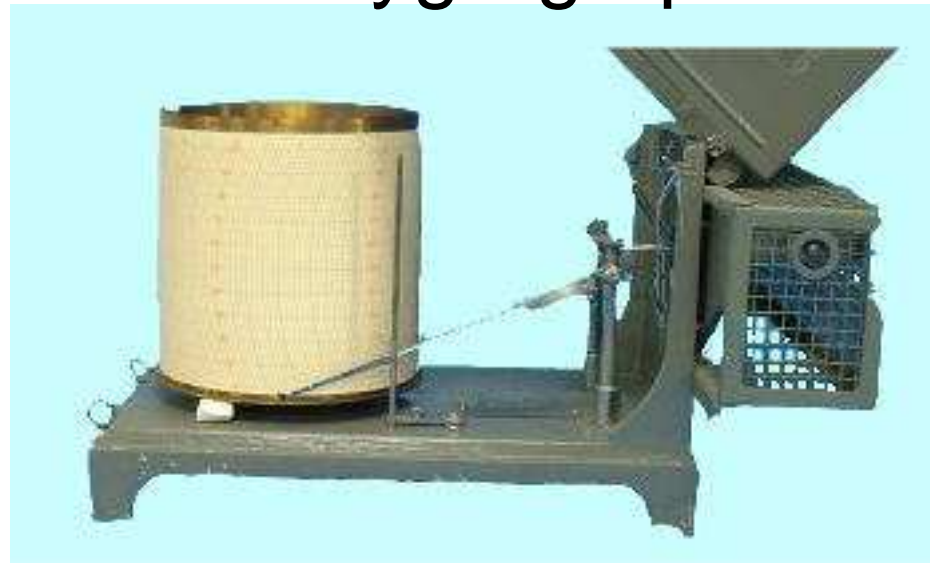
1.3 Condensation methods

- Equilibrium vapor pressure at the surface of a salt solution
- Sense condensation with an optical detector

1.1 Sorption method

Changes of the dimensions

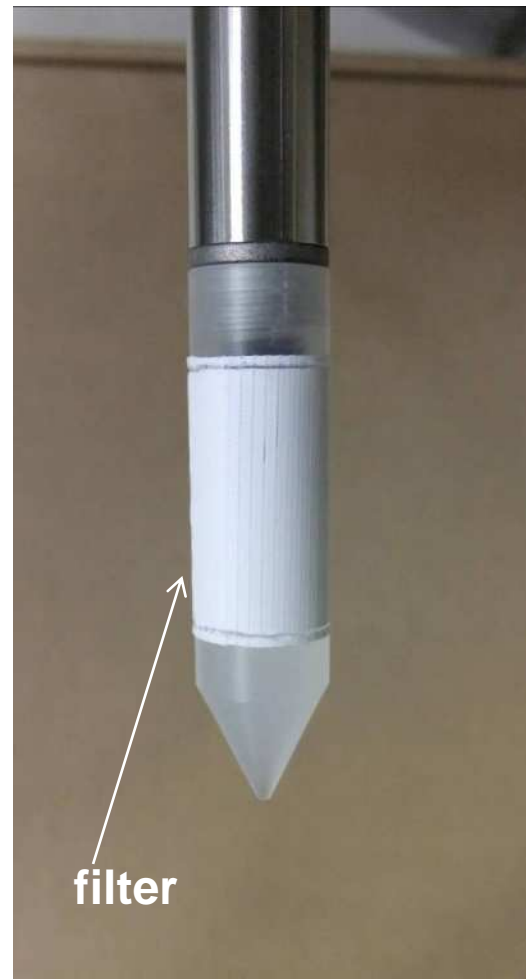
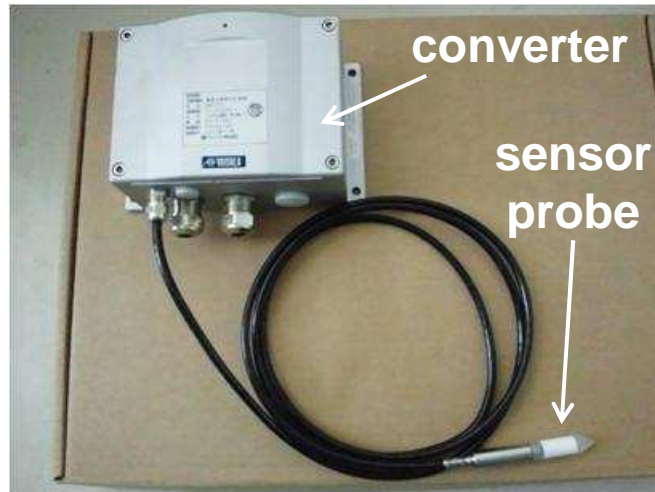
hair hygograph



1.1 Sorption method

Changes of electrical properties

electronic hygrometer(capacitive type)

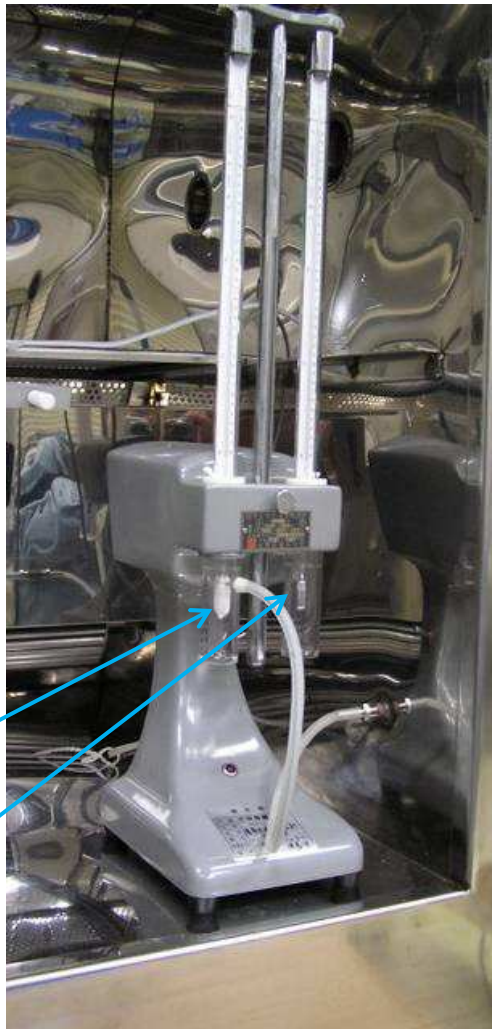


1.2 Psychrometric method

Difference between the dry-bulb and wet-bulb temperatures related to the ambient humidity

aspirated psychrometer

JMA type

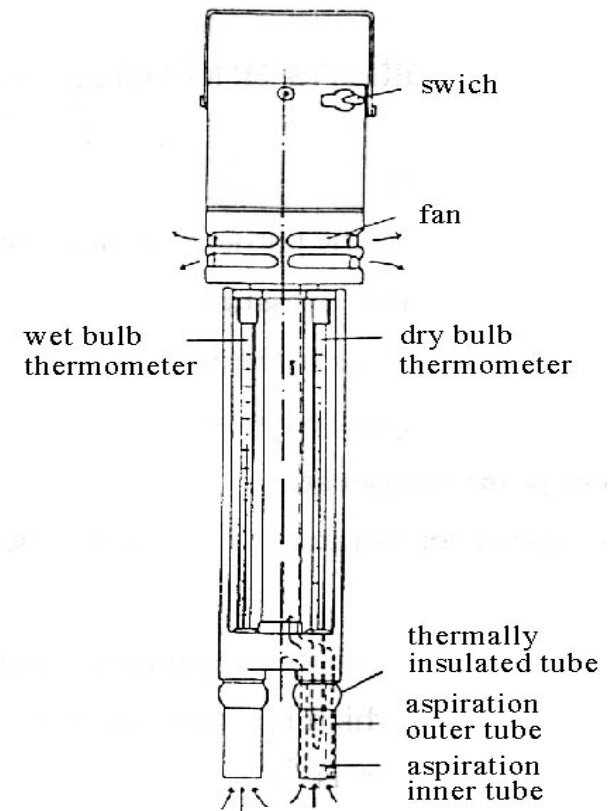


wet-bulb

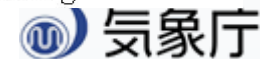
dry-bulb



Assuman type



direction of air flowing



Japan Meteorological Agency

1.2 Psychrometric method

Difference between the dry-bulb and wet-bulb temperatures related to the ambient humidity

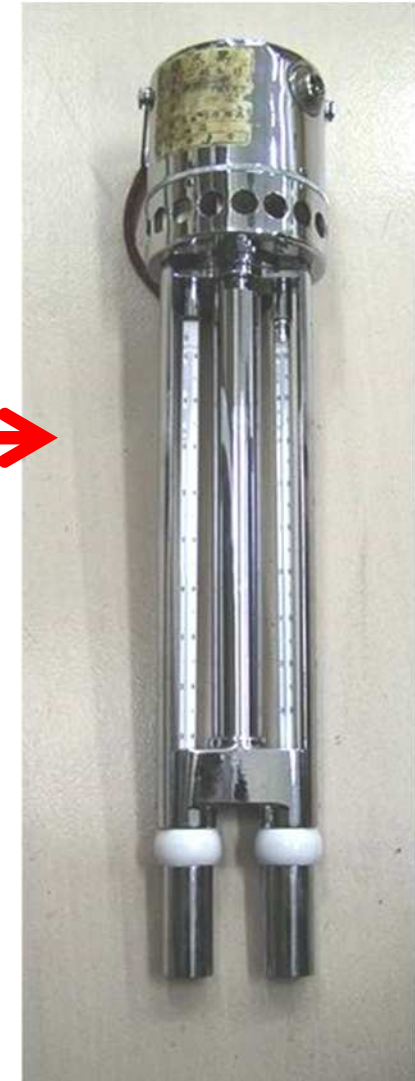
Manned Observatory , Special AWS



Ventilated shield
Electric thermometer
Electric hygrometer



Check
(every 3 months)

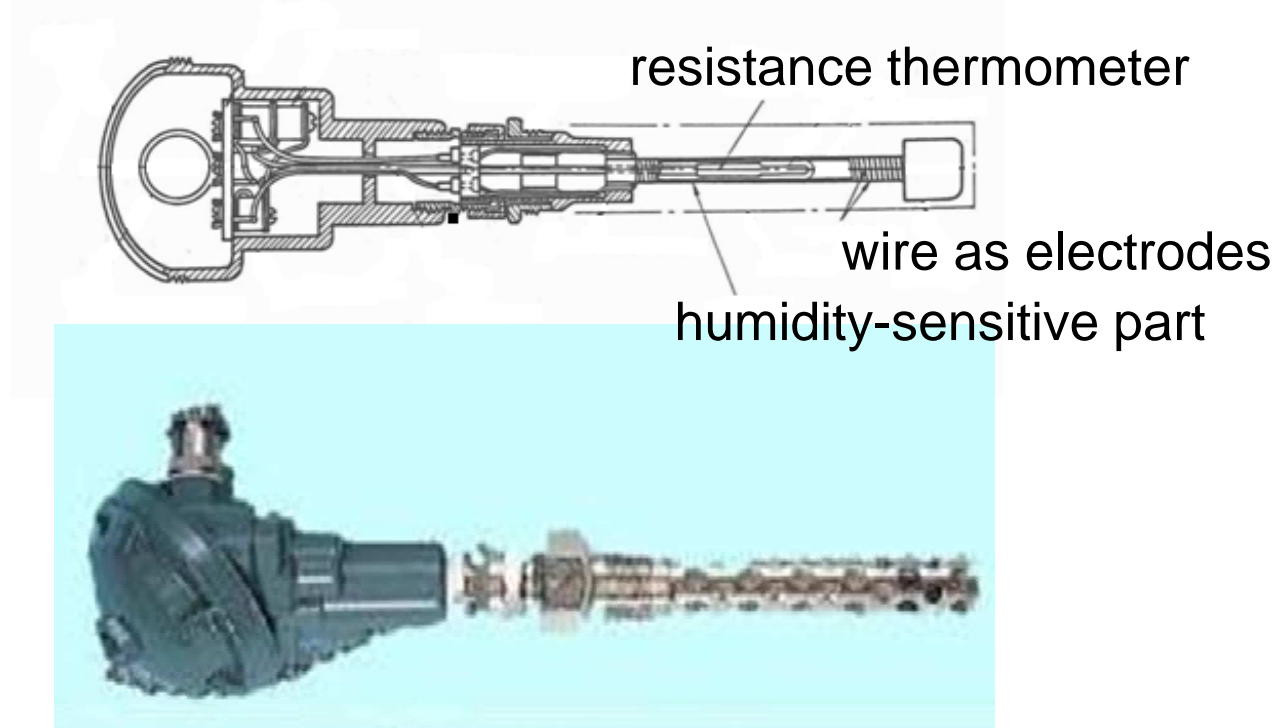


1.3 Condensation methods

Equilibrium vapor pressure at the surface of a salt solution

(Heated salt-solution method)

lithium chloride heated condensation dew point hygrometer (dew cell)



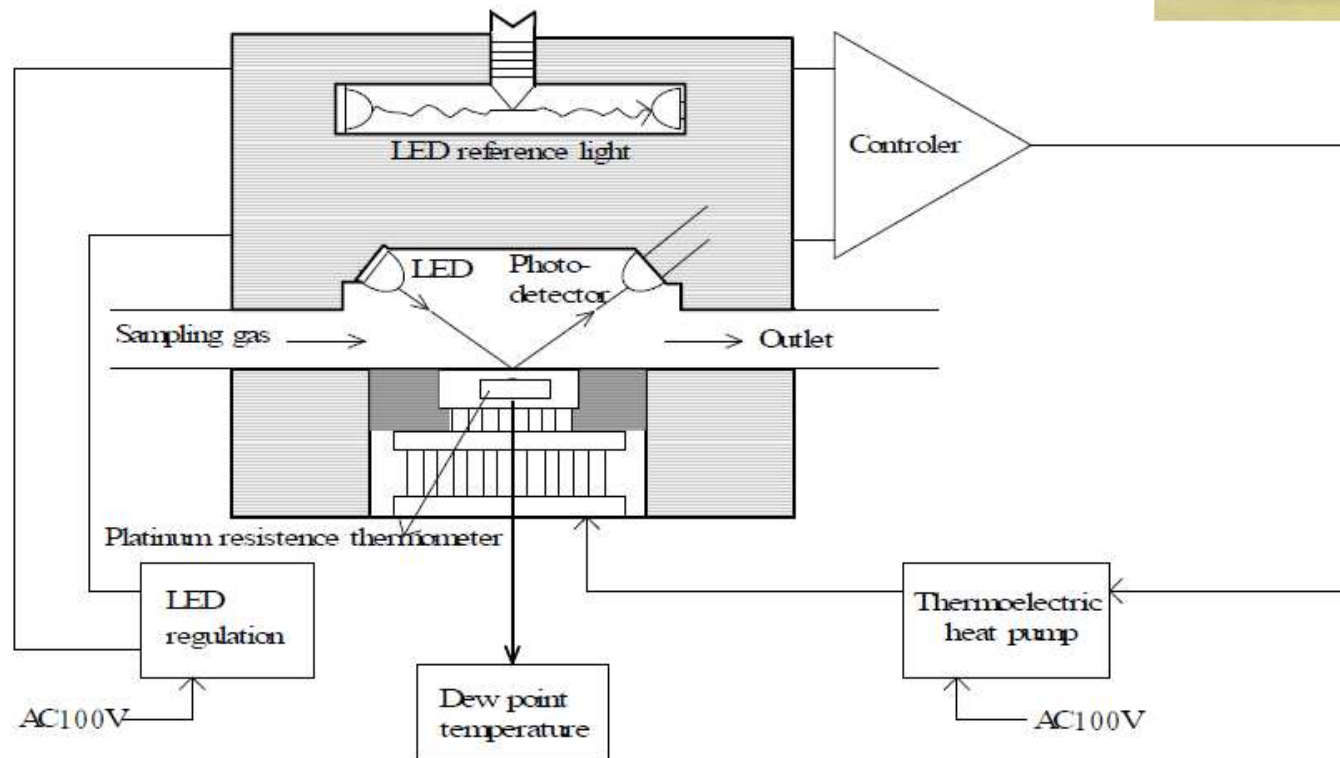
· An operational equilibrium temperature exists for the instrument, depending upon the ambient water vapor pressure. At the equilibrium temperature, neither evaporation nor condensation occurs because the equilibrium vapor pressure and the ambient vapour pressure are equal.

1.3 Condensation methods

Sense condensation with an optical detector

chilled-mirror dew point hygrometer

- measurement of T_d or T_f .
- small polished-metal reflecting surface cooled electrically by using a Peltier-effect device sense **condensation** with an optical detector. ·



JMA Standard



mirror

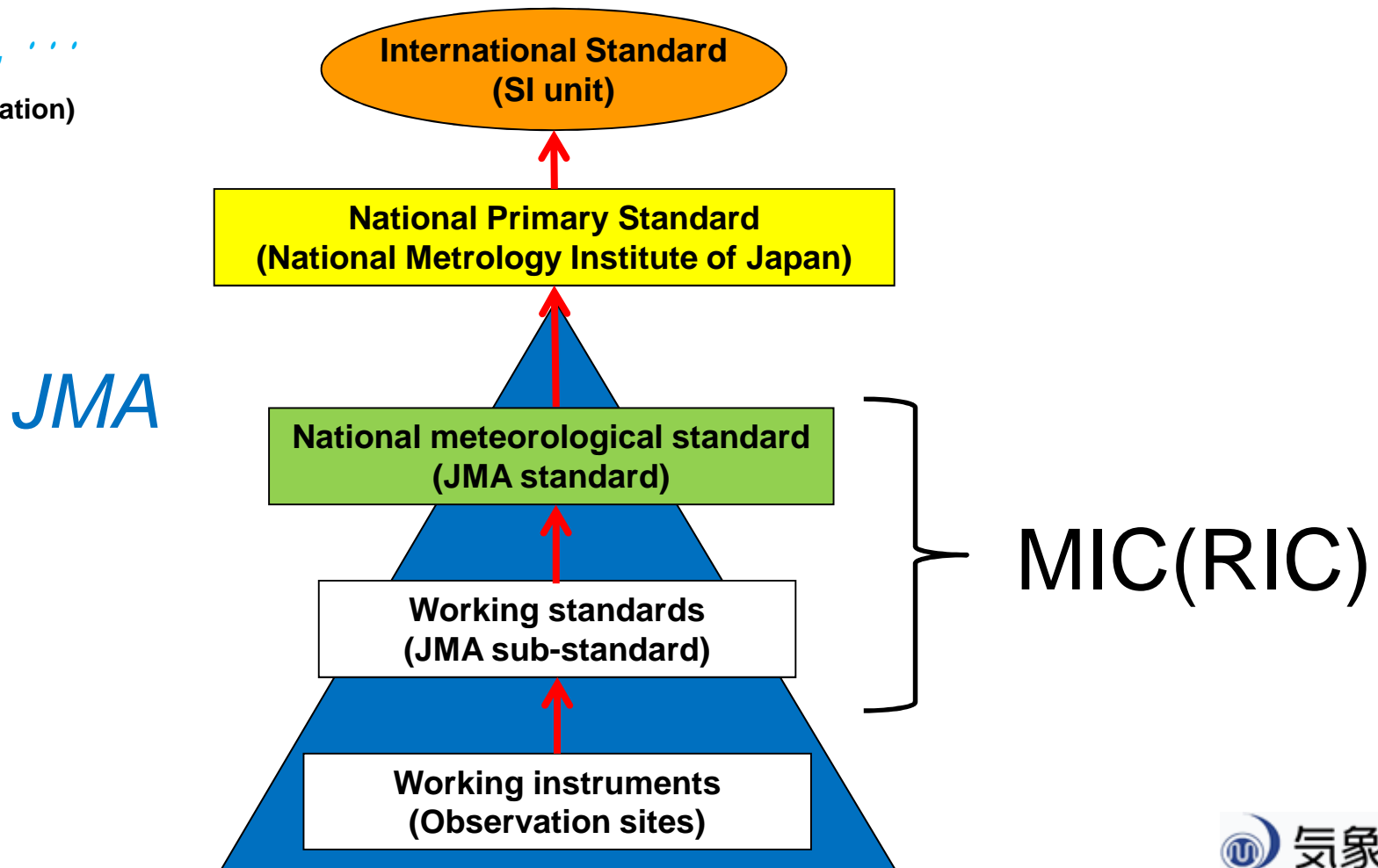
Outline

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2. Traceability and calibration methods in JMA

Temperature,
Humidity,
Pressure, ...
(Without radiation)

Traceability chart of JMA



Traceability of Humidity (JMA)

National Primary Standard

JMA Standard

Working Standard

Field Instruments

National Metrology Institute of Japan

Meteorological Instruments Center

Observatory

Standard humidity generator set

Calibration : every year

Chilled-mirror dew point hygrometer
 Hygrometer (display) DewStar S-1M-0 (Shinyei technology, Japan)
 Hygrometer (sensor) DewStar S-2S-0K (Shinyei technology, Japan)



Calibration : every year

Chilled-mirror dew point hygrometer
 Hygrometer (controller) Hygro M2 (General Eastern, USA)
 Hygrometer (sensor) D2 (General Eastern, USA)



Electronic hygrometer



Check:
 · every 3 months (manned observatory)
 · every year (automatic weather station)

Filter change: Every 6 months

Tolerable range : $\pm 4\%$

Aspirated psychrometer



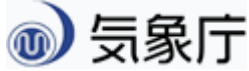
Check:
 at the time of installation

Lithium chloride dew point hygrometer



Mercury-in-glass thermometer (Assuman type psychrometer)

JMA Standard of thermometer



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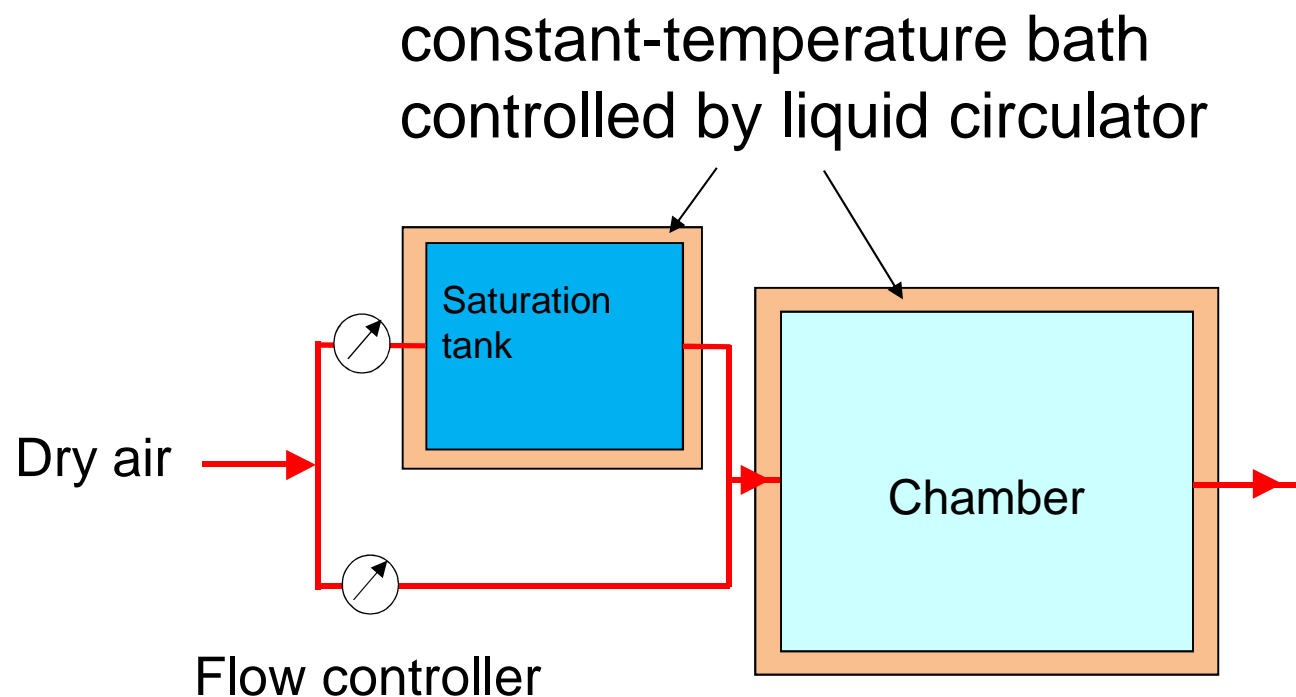
3. Calibration of Hygrometer

- Comparisons against a reference instrument under suitable steady conditions

We need...

- Humidity chamber
 - Wet and dry air mixed-flow generator (MIC using)
- ↓
- Calibration points (JMA)
 - Relative humidity
 - ex) 20[%], 40[%], 60[%], 80[%], 95[%] at 23[°C] ± 3[°C]
 - Dew point temperature
 - ex) -5[°C], 0[°C], 5[°C], 10[°C], 15[°C], 20[°C], 25[°C]

Calibration chamber for hygrometers (Wet and dry air mixing type)



[diagram of system]

Traceability of Humidity (JMA)

National Primary Standard

JMA Standard

Working Standard

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National Metrology Institute of Japan

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Electronic hygrometer



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Tolerable range : ± 4%

Aspirated psychrometer



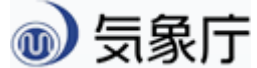
Check:
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Lithium chloride dew point hygrometer



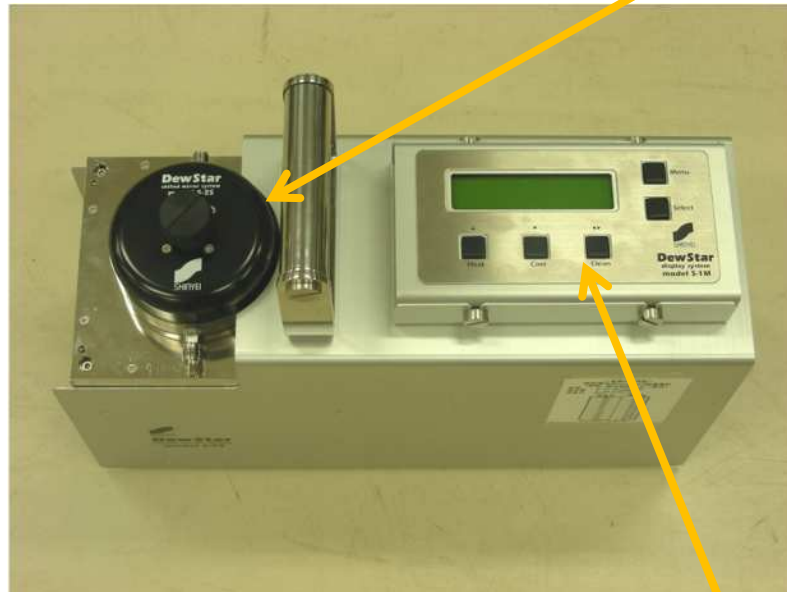
Mercury-in-glass thermometer (Assuman type psychrometer)

JMA Standard of thermometer



JMA Standard → Working Standard

Sensor unit

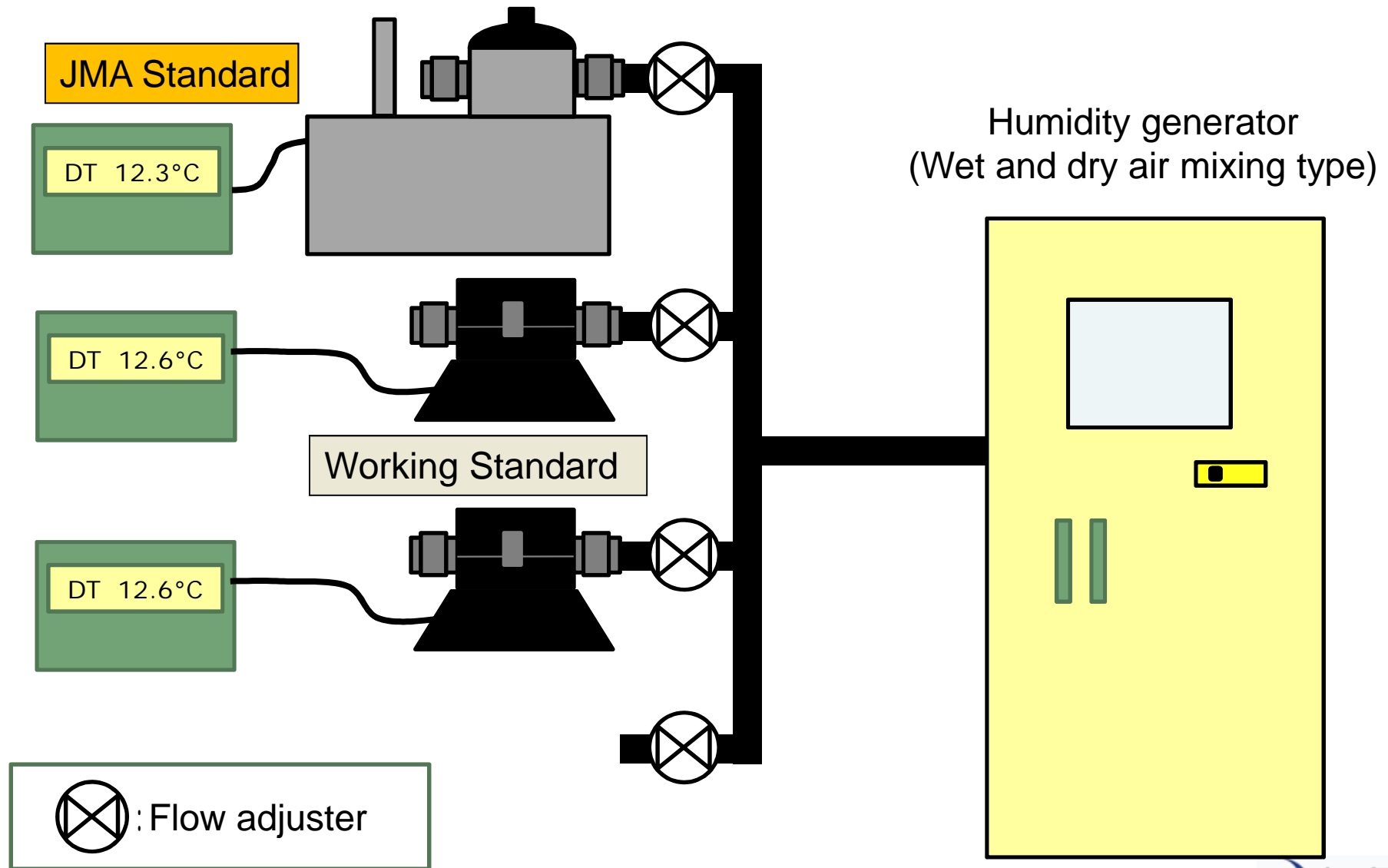


Monitor



Chilled-mirror dew point hygrometer

JMA Standard → Working Standard



Traceability of Humidity (JMA)

National Primary Standard

JMA Standard

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Electronic hygrometer



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Aspirated psychrometer



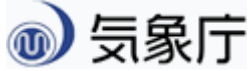
Check:
 at the time of installation

Lithium chloride dew point hygrometer

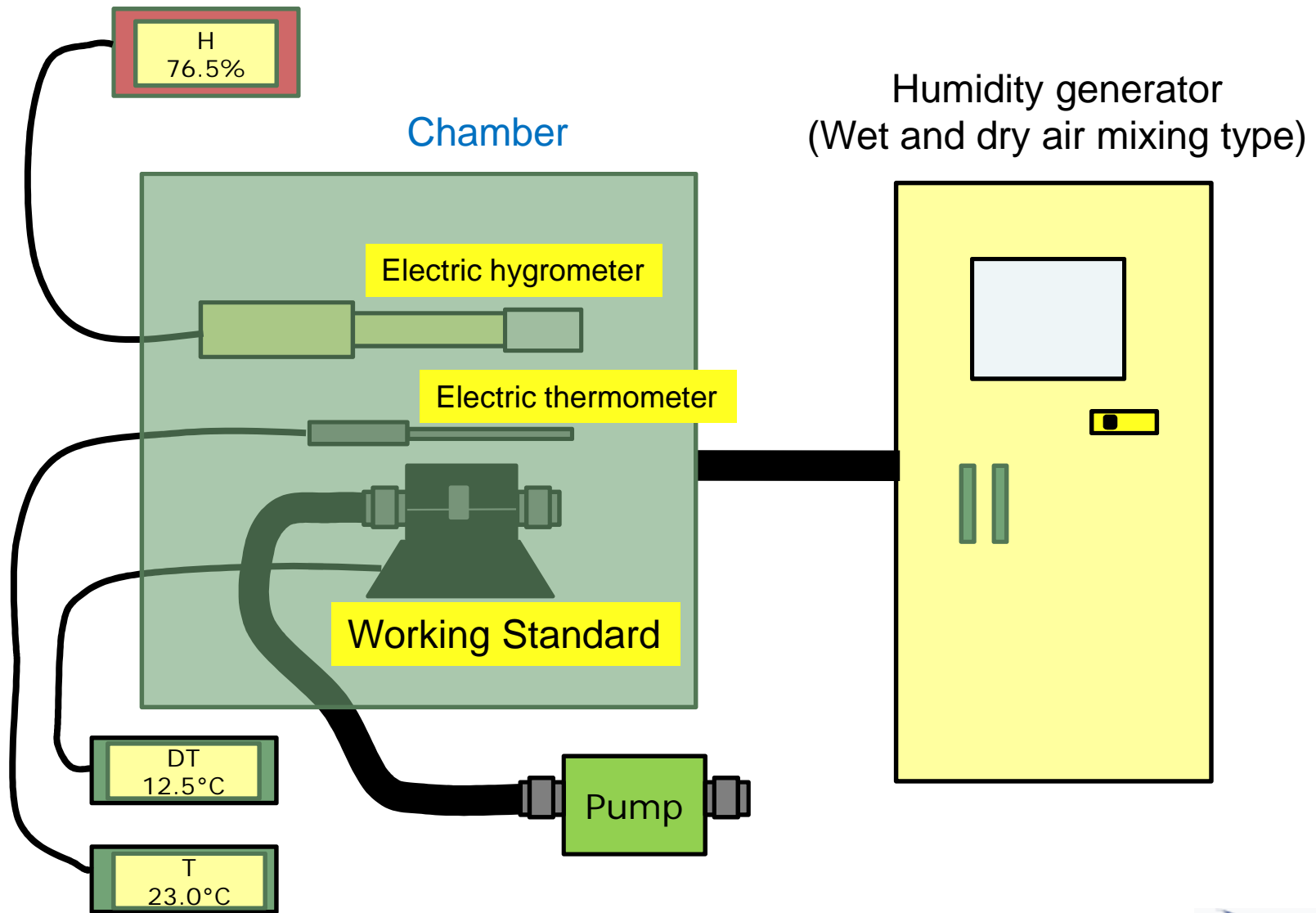


Mercury-in-glass thermometer (Assuman type psychrometer)

JMA Standard of thermometer



Working Standard → Field Instruments



Saturated salt solutions

Vessels containing saturated solutions of appropriate salts may be used to calibrate relative humidity sensors.

Barium chloride (BaCl_2): 90.3 %

Sodium chloride (NaCl): 75.3 %

Magnesium nitrate ($\text{Mg}(\text{NO}_3)_2$): 52.9 %

Calcium chloride (CaCl_2): 29.0 %

Lithium chloride (LiCl): 11.1 %

etc.

at 25°C

Saturated salt solutions kit



ex) Vaisala HMK15

Saturated salt solutions kit



HumiPump



4.Practice

Comparisons against a reference instrument
under the room conditions

Purpose: Check the difference between the Hygrometers.

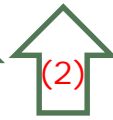
- 1.Calibrate : Electric hygrometer by HumiPump
- 2.Check : Electric hygrometer by Aspirated psychrometer

Comparison form

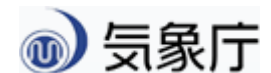
Hygrometer comparison form

date 8-Nov-16 Chamber: not use

		Aspirated psychrometer											Electronic hygrometer		
No.	Name	The time of reading hh:mm	Wet Bulb			Dry Bulb			T-Tw [°C]	Atmospheric pressure			Relative humidity※ [A] [%RH]	Reading [B] [%RH]	index error [B-A] [%RH]
			Reading [°C]	correction [°C]	corrected value(Tw) [°C]	Reading [°C]	correction [°C]	corrected value(T) [°C]		Reading [hPa]	correction [hPa]	corrected value [hPa]			
	(Example)	11:00	13.8	-0.2	13.6	21.8	-0.2	21.6	8.0	1013.68	+0.06	1013.74	39.7	42.00	2.3
1															
2															
3															
4															
5															
6															
7															
8															



Please write down ((1)→(5))



Thank you for your attention.