EXAMINATION OF TRAVELING STANDARD OF BAROMETER

JAPAN METEOROLOGICAL AGENCY

1. I

Mercury barometers are commonly used as the standard for the calibration of operational barometers around the world. The Japan Meteorological Agency (JMA) has also used Fortin type mercury barometers for the calibration of the operational electric barometers installed at local meteorological observatories. The mercury barometer requires specific skills and experiences to be manipulated by operational staff. In addition, it is very fragile and needs to be carefully treated especially during its transportation.

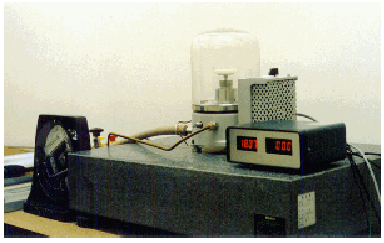
To solve these problems, JMA examined the feasibility of the replacement of Fortin mercury barometers with portable electric barometers as the traveling standard, which needs to be transported very frequently between meteorological observatories. The portable electric barometer as the traveling standard is required to keep its high accuracy for a long period and also needs to be stable in sudden changes of temperature or atmospheric pressure. In addition, it should be resilient enough to shocks and vibrations to be suffered during its transportation even though it is carefully packed in shock-absorbing materials.

After conducting indoor experiments in which instruments were undergone artificial changes of atmospheric pressure and temperature as well as vibrations, the actual transportation experiments were conducted in 2001 and 2002. As the result of these experiments, it is confirmed that the electric barometer has sufficient performance for the traveling standard of barometer.

2. I

i Tested barometers
Two *PTB220TS* (capacity type, three sensors, made by VAISALA corp., see Fig.1)

F 1. Tested barometer



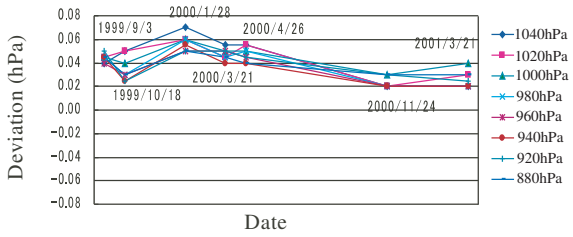
F 2. Dead weight tester

F 3. Working standard barometer

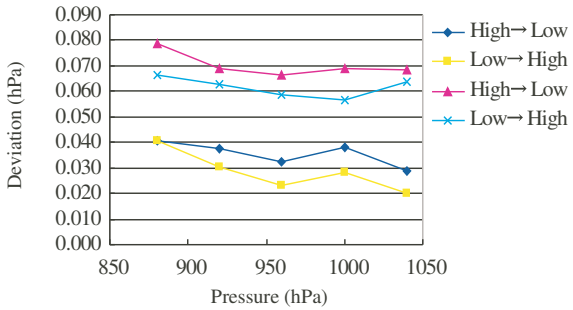
ii Standard of pressure
AV-02 Dead weight tester (made by FUTABA SOKKI CO.,LTD, see Fig.2)
iii Working standard barometer
MT110 digital pressure gauge 2562 (cylindrical vibration type, made by YOKOGAWA Electric corp., see Fig.3)

3. I

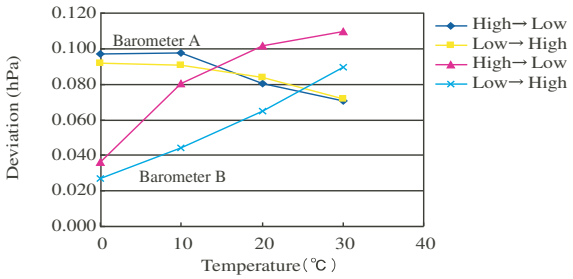
3.1. **Long term stability of the tested barometers.** One of the tested barometers has been used at the Meteorological Instruments Center in Tsukuba, Japan since September 1999, and long-term comparison has been conducted with the Dead weight tester. As shown in Figure 4, the comparison indicates that the barometer has sufficient durable stability within 0.07hPa.



F 4. Long-term stability of one of the tested barometers



F 5. Characteristics of hysteresis of the tested barometers



F 6. Temperature dependency of the tested barometers

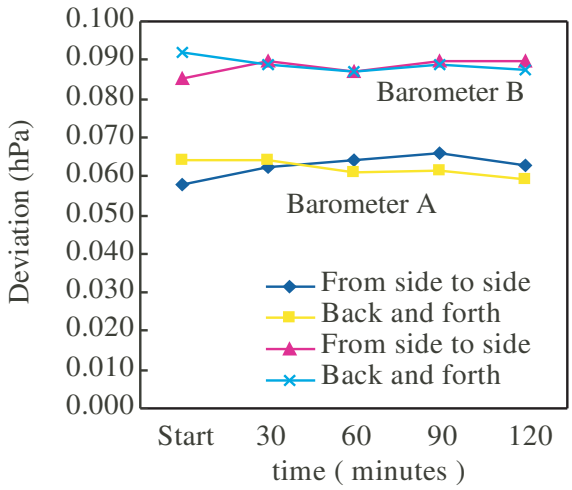
3.2. **Hysteresis of pressure change.** The pressure in a chamber was repeatedly changed from high to low and vice versa, and the observed values were compared with the working standard barometer at five points (1040, 1000, 960, 920 and 880hPa). As shown in Fig.5, the tested barometers have sufficient performance with 0.02hPa in maximum hysteresis.

3.3. **Stability in temperature change.** The temperature in the chamber was slowly changed from high to low and vice versa, and observed values of tested barometers were compared with the working standard barometer at four measurement points (30, 20, 10 and 0 degrees Celsius). As shown in Fig.6, the two barometers have sufficient performance with stability -0.00079hPa/deg and 0.00228hPa/deg of temperature - pressure coefficients.

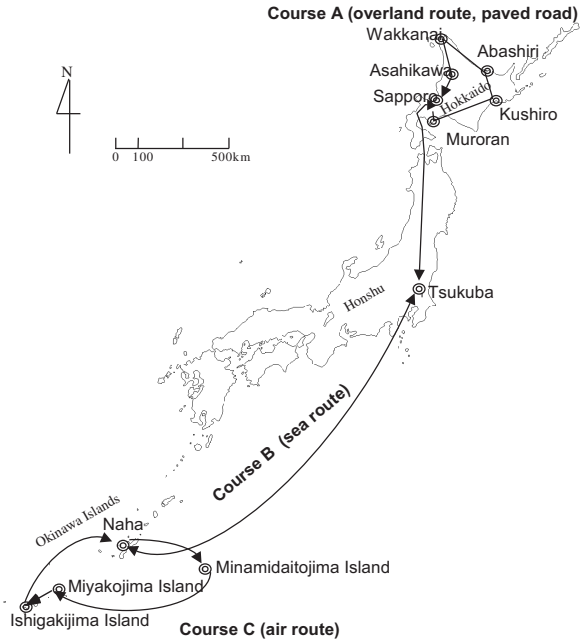
3.4. **Vibration test.** The tested barometers were vibrated with +/- 2mm in amplitude, 5Hz in frequency (300rpm as motor rotation) and directions of ”right and left” and ”front and rear” for 2 hours. As a result of the test, the deviation of pressure during the vibration was less than 0.01hPa in each barometer.

4. T

The actual transportation tests were conducted twice in 2001 and 2002. In 2001, the degree of the shock under transportation was examined. The barometers were packed together with acceleration recorders and traveled around several weather stations in Hokkaido, the north of Japan and Okinawa, the south of Japan. The course(A) to Hokkaido is the overland route with paved road while the course (B) and (C) to Okinawa are sea and air respectively as shown in Figure 8. The maximum magnitudes of shocks were 40m/s^2 on course(A) and 100m/s^2 on course(B) and (C).



F 7. Characteristics of vibration test



F 8. Courses of transportation experiments

In 2002, two containers for transportation of barometers were made and the barometers were transported on five courses in Honshu, the mainland of Japan, and on each course the barometer visited several JMA's local observatories to be compared with the Fortin barometers installed at each observatory.

The result of every examination showed that the barometers maintained the accuracy of +/-0.03hPa in errors after the transportation.

5. C

The experiments showed that portable electric barometers have sufficient performance as the traveling standard to maintain high accuracy of operational electric barometers installed at local observatories of JMA.