Other Relative Humidity Slide Rules

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IM 2019 Humidity Slide Rules

In previous articles in the MIR Humidity Side Rules were discussed. This resulted in a presentation during the IM 2019 with an overview of the about 20 different types, which were produced in the past. During the discussion after the presentation, additional slide rule marks and also other typical aspects of establishing the humidity were mentioned. Reason for this article.

To compare the new items with those mentioned in the IM 2019 proceedings, the same layout of description and starting values are used. It is based on the barometer in figure 1.

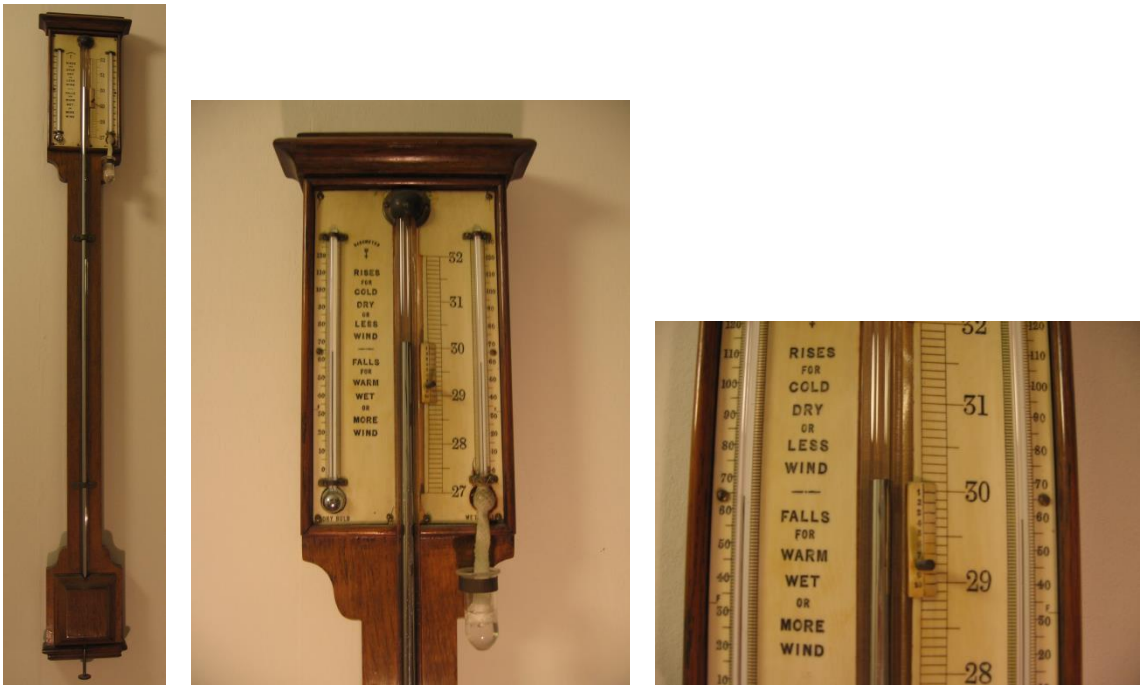


Fig. 1. Farmers Barometer with 2 thermometers: the dry bulb showing 64 °F and the wet bulb 58 °F.

Owner: Chris Hakkaart

The photos show the tube with water and the difference in temperatures.

These values will be used for the study of the various slide rules, charts and discs:

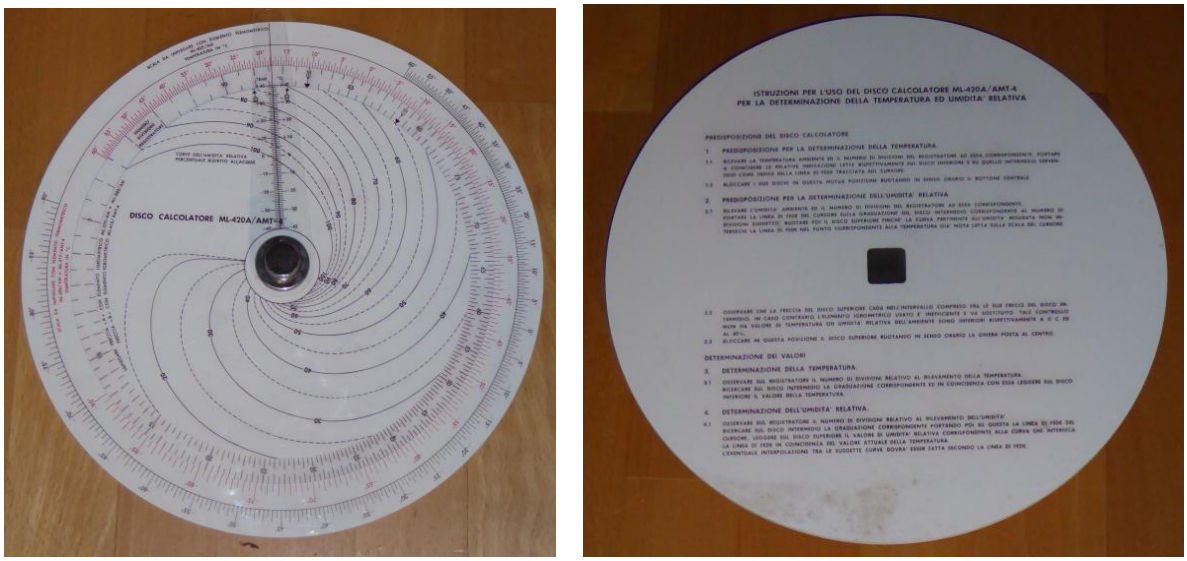
Dry bulb	17.7 °C (= 64 °F)	room (dry) temperature.
Wet bulb	14.4 °C (= 58 °F)	evaporation (wet) temperature.
Depression	3.3 °C (= 6 °F)	difference between dry and wet temperature.
Barometer	1019.3 mbar (= 30.1 inch = 764.5 mmHg = 101.9 kPa) air pressure.	

The difference between dry and wet temperature in combination with the actual dry temperature determines the RH.
The items can be divided in the following categories:

- Discs: These thick plastic discs also often have scales for HVAC.
- Slide rule: This type has common sizes as a slide rule. The method of input (static or sling) is not defined.
- Slide chart: These thin plastic slide charts often have scales for static and sling input.
- Specials: This concerns a wide range of alternative methods.

The items (A) to (E) described below in this article belong to the next category *disks*.

(A) Disco Calcolatore ML-420A/AMT-4



ML-420A/AMT-4, front. *ML-420A/AMT-4, back.*

Fig. 2. Disco Calcolatore ML-420A/AMT-4.

See figure 2.
Owner Francesco Basta discovered this disk at a fair.
Chris Hakkaart received this disk in the same period from Hubert Weikert, who reacted on the IM 2019 Proceedings. The next description is by Francesco.
Producer could be Felsenthal & Sons, Inc. but because the disk was used by several countries of the NATO other manufacturers are also possible.
Construction Figure 2 shows the front and back. As you see, there are three discs of decreasing diameter and a transparent cursor graduated in °C. The discs are made of white plastic, very well executed and clearly readable. The graduations on the cursor look etched and filled with ink. A central metal double knob keeps the three discs together and allows to block them and the cursor in any desired position. The scales are not linear, but they are certainly not logarithmic.

The outer ring presents a non-linear temperature scale from 60 °C to -90 °C for input from a ML 405/AM device. The second ring presents a non-linear temperature scale from 60 °C to -90°C for input from a ML 406/AM and ML 419/ AMT4 device. The third ring presents a non-linear range 3 Hz to 93 Hz? Radio frequencies? The middle ring presents curves from 15% to 100% Relative Humidity.

The cursor has a linear temperature scale from -40 °C to +40 °C.
All in all, a very good quality and visually appealing slide rule. Diameter is 28 cm.

This device is also available with English text with the name Felsenthal Acumat Ml 420A AMT4. See figure 3. Sometimes the name Acu-Math is used, which is a total different mark.

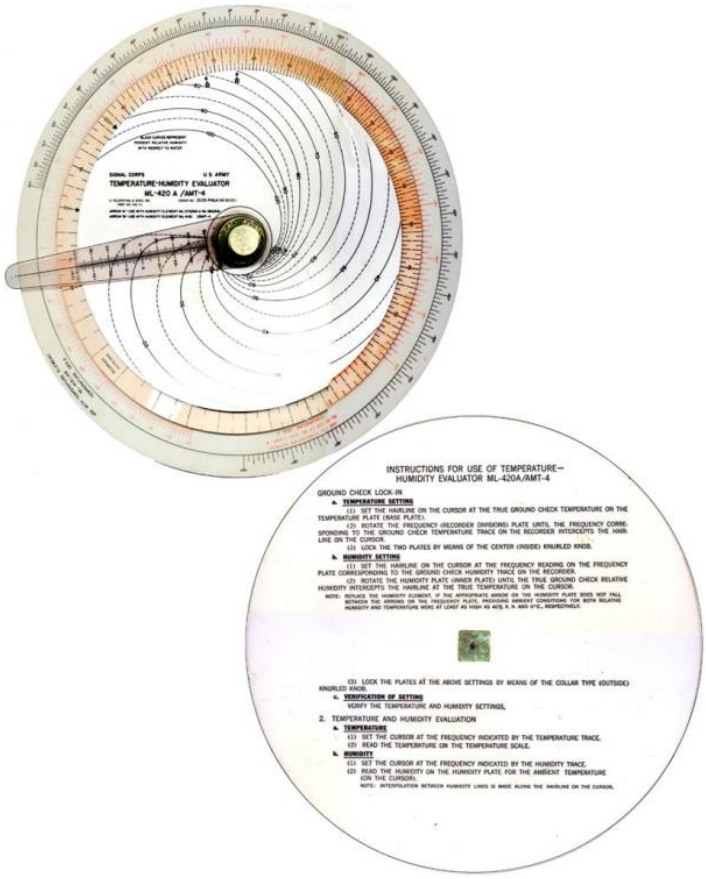


Fig. 3. Felsenthal Acumat Ml 420A AMT4

Calculation

The working of this slide rule is - due to the many scales - and the lack of a manual not clear. In the documentation it is called a Temperature-Humidity Evaluator. It has to be used to check and calibrate the sonde. It does not work with dry and wet temperatures.

Remarks

My (Francesco) friends and acquaintances know that I have another hobby, besides slide rules, amateur radio. Since I was fourteen I liked to listen to short wave radio, and after some years I've got my first radio amateur licence, with call sign I0VFB. Thanks to my licence I could receive and transmit and engage in conversations with like-minded people all over the world (ionospheric propagation permitting). I continued my activity in my many moves in Italy and abroad, and I still practice my preferred specialty, Morse radiotelegraphy, with my Dutch call sign, PE1F.

In the last 10 to 15 years I visited the largest radio amateur gathering and fair that takes place every year in Friedrichshafen (south-western Germany, near the Bodensee), around the end of June. This allows me to meet many of my radio friends from Italy and abroad, look at the latest equipment presented by the big Japanese and American companies and search for good bargains in a very large flea market.

Last year was no exception, so I went to the fair. When going up and down the flea market, my attention was drawn to a seller of military surplus equipment: not only electronics but also items of general interest like knives, old maps, backpacks and the like. On his bench I could see what looked like a rather large circular slide rule, with strange lines and red and black scales. The seller did not know much about the rule, but it looked interesting enough so I bought it for 15 euro.

All texts appearing on the rule are in Italian, and this is particularly uncommon in the world of slide rules, where Italy was surely not one of the superpowers like Germany or the USA. It was clear that the rule has something to do with humidity and temperature calculations – telltale keywords like *temperatura* and *umidita'* were all over the place. Also, it seemed that the raw data to be used with the rule came from well determined temperature and humidity probes (*elemento termometrico* ML406/AM or ML419/AMT4, calibrated in °C, and *elemento igrometrico* ML-379/AM, ML-380/AM or ML418/AMT4), as written on the top and bottom discs.

The instructions for calculations were on the back of the disk and in spite of being in plain Italian, were not immediately understandable. Surely there was no reference to temperatures measured by a dry or

wet bulb thermometers, so this disc cannot be considered a proper psychrometric disc. Luckily enough the Internet helped me to find some explanation.
I was able to find a Technical Manual of the US Department of the Army, TM 11-2433, titled “Radiosonde AN/AMT-2A”, dating back to 1950. See figure 4. The radiosonde presents data, which requires this disk to be processed.

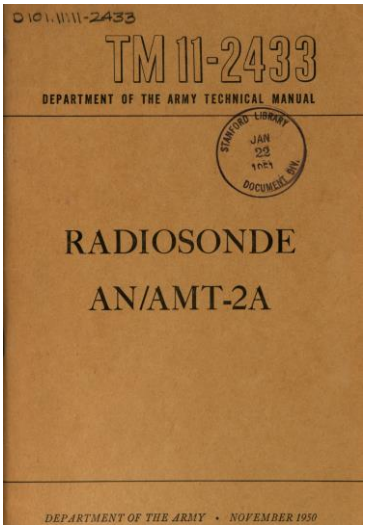


Fig 4a. Manual

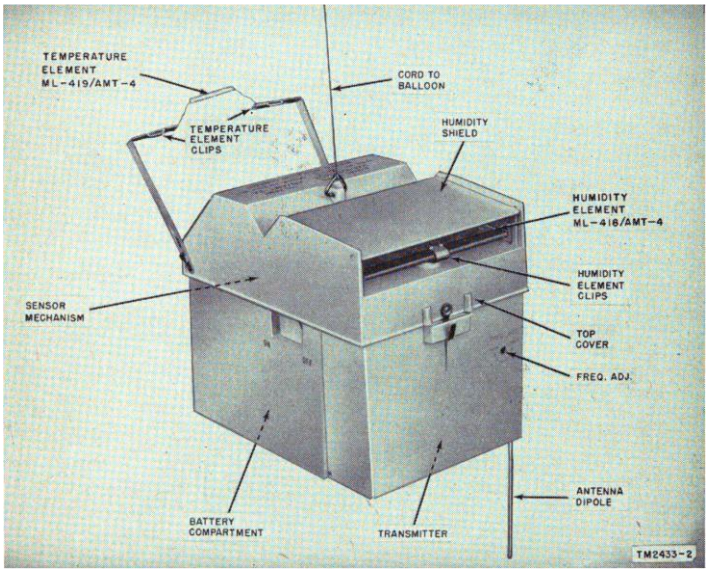


Fig. 4b. Radiosonde

The radiosonde has a plastic container and is attached to a balloon inflated with a light gas, like hydrogen or helium that takes it into the high atmosphere. It includes essentially three sensors: an aneroid barometer (used to determine pressure and hence the height of the sonde), a temperature element (ML-419/AMT-4) and a humidity element (ML-418/AMT-4). A transmitter is frequency modulated by the signals from the sensors. The carrier frequency is 403 MHz – the same frequency still used by radiosondes nowadays. A dipole antenna irradiates the output of the transmitter. It is to be noted that the transmitter is based on two vacuum tubes (a 5703 and a 5875). A battery provides the necessary power.

Sources
https://www.sliderulemuseum.com/HSRC/FELSENHAL.htmhttps://books.google.nl/books?id=sJRHAQAAI-AAJ&pg=PA20&lpg=PA20&dq=ml-420A/AMT-4&source=bl&ots=Y50erRxOdt&sig=ACfU3U1X6XPNpp4KGG2KlXhY-Ametk-Fbw&hl=nl&sa=X&ved=2ahUKEwix9YmvhanoAhVR2KQKHZ-vB9gQ6AEwAnoECAgQAQ#v=onepage&q=ml-420A%2FAMT-4&f=false

(B) Disco Calcolatore ML-322/UM

Fig. 5. ML-322/UM

Owner Manual.
Producer unknown.
Construction During the investigation of the ML 420A, the ML 322/UM was discovered.
Calculation This disk is made for Relative Humidity calculations based on wet and dry temperatures. It also calculates the dew point. The scales are difficult to read.
Manual The manual for the Psychrometer Calculator ML 322 dates from 1945.

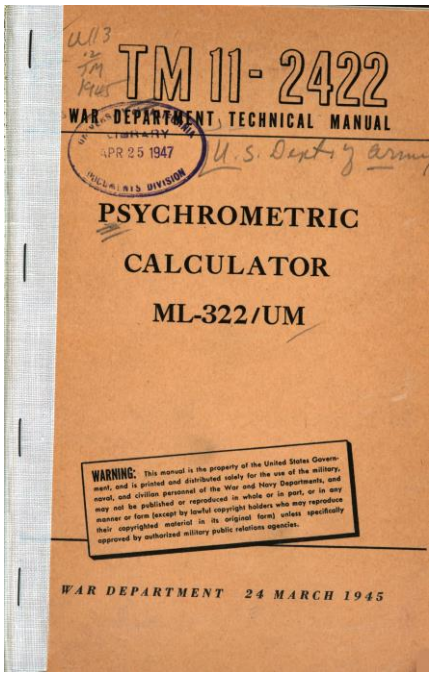


Fig. 6a. Manual ML322/UM

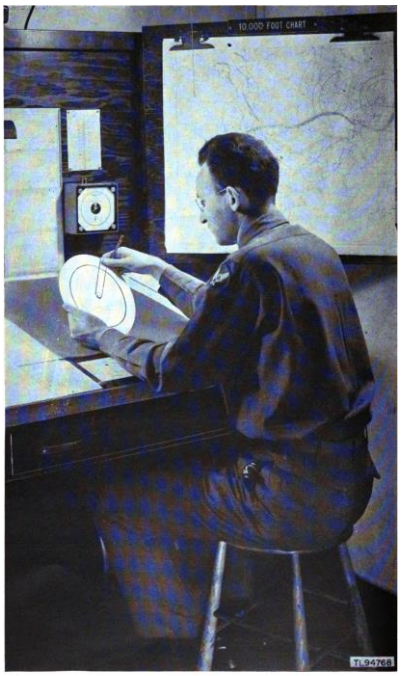


Figure 1. Psychrometric Calculator ML–322/UM in use.

Fig. 6b. Disk Operator

Photo pictures of people operating a disk are rare. This manual contains a photo of a person operating this disk. See figure 6b.

(C) Computer, psychometric CP-164/UM and CP-165A/UM

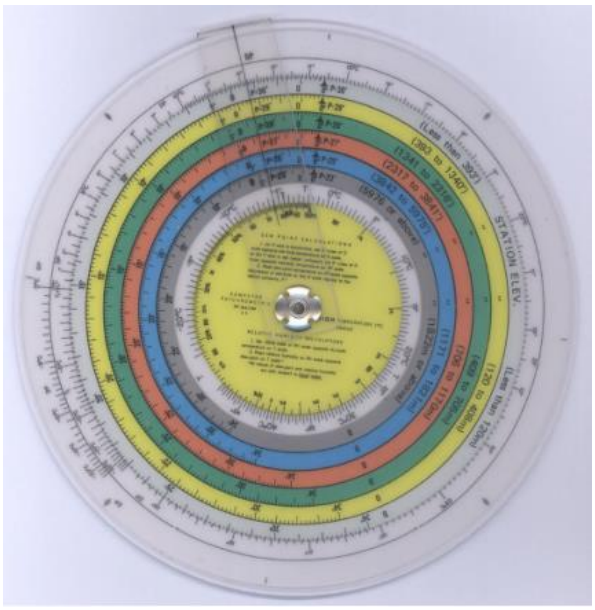


Fig. 7a. CP-164/UM high temperature side.

Fig. 7b. CP-165A/UM low temperature side.

Owner Ronald van Riet.
Producer Both are of military origin as their designation suggests.
The CP-164/UM has no manufacturer imprinted, the CP-165A/UM mentions the Bureau of Naval Weapons and Contract Number N383-92513A as well as the manufacturer Felsenthal Instruments Co. and the factory designations 22040 and FAS-21.

Construction The Cp-164/UM and the CP-165A/UM consist of a central plastic disk with at both sides a rotating transparent plastic disk with coloured circles. The cursors at both sides are coupled.
Calculation The scales are from the outside: DP (dew point temperature), Ti (temperature, in case the wet bulb is frozen), 6 D scales for different pressures at the ground station (23, 25, 27, 28, 29 and 30 inch Hg barometric pressure), T (temperature for the determination of the relative humidity) and RH (relative humidity).
These are the steps to take (similar for either one):

- Determine which side to use (depending on the wet bulb temperature).
- Set the 0 index of D scale nearest to the station pressure opposite the wet bulb temperature (14.4 °C) on the DP scale.
- Set the cursor on the respective D scale on the temperature difference between the wet and the dry bulb (3.3 °C).
- Read the dew point on the DP scale under the cursor (12.15 °C).
- Set the 100% mark of the RH scale opposite the dry bulb temperature (17.7 °C) on the T scale immediately opposite the RH scale.
- Read the relative humidity on the RH scale directly opposite the dew point temperature on the T scale (70.5%)

Remarks
These two computers are functionally identical, the main difference being that the CPU-164/UM has a diameter of 14.6 cm, whereas the CP-165A/UM has a diameter of 28.5 cm, with a correspondingly greater precision. They both have sides for high and low temperatures depending on the temperature of the wet bulb: if this is above freezing, use the high temperature side, if it is below freezing, use the low temperature side.
Interestingly, for pressure they both use inches, for temperature the CP-164/UM uses °C, whereas the CP-165A/UM uses °F.

Source:
https://books.google.nl/books?id=KwRPAQAAMAAJ&pg=PA82&lpg=PA82&dq=CP-164/UM&source=bl&ots=DrtUSmnDSA&sig=ACfU3U3nI4qNtu6uA-baKJDyT-tAjvS5a7A&hl=nl&sa=X&ved=2ahUKEwiKpbyc_6noAhUHy6QKHa2DCJ4Q6AEwAXoECAkQAQ#v=onepage&q=CP-164%2FUM&f=false

(D) Handcrafted French relative humidity slide rule

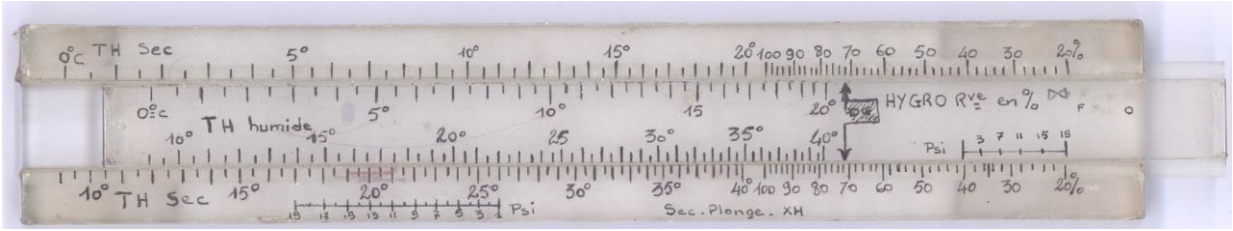


Fig. 8. French relative humidity slide rule.

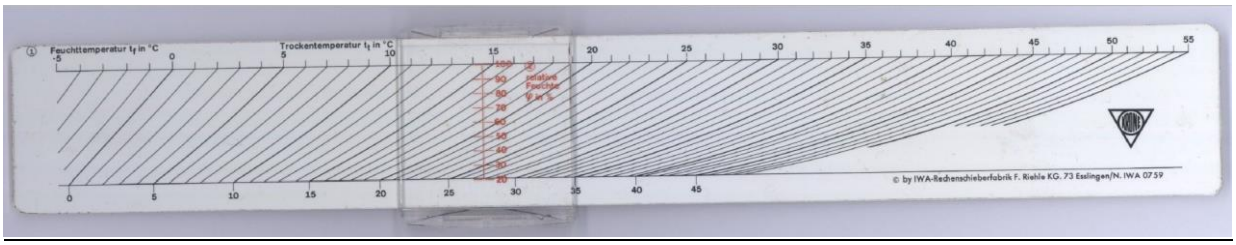
Owner Ronald van Riet.
Producer Home made, French.
Construction Plastic slide rule 20 cm long by 3.6 cm wide. It is handcrafted, probably a one-off.
Calculation

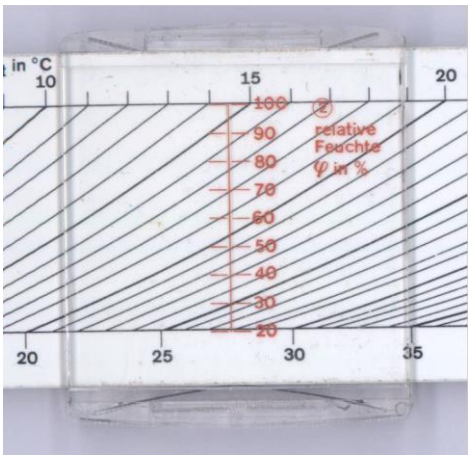
- The fixed scales on top and bottom are for dry temperature.
- The scales on the slide are for wet temperature.

- The two top scales range from 0 to 20 °C.
- The two bottom scales range from 10 to 40 °C.
- Set the wet temperature of 14.4 °C opposite the dry temperature of 17.7.
- Read the RH of 72 % at the black arrow (HYGRO R^{ve} en %) cursor on the slide.
- Because there are few subdivisions, the reading is extremely coarse, not more accurate than ± 1°C.

Remarks
The fixed body contains scales for dry bulb temperature (TH sec) on the top and on the bottom (with different temperature ranges) and scales for wet bulb temperature (TH humide) on the top and bottom of the slide. There are also scales marked Psi (perhaps for pressure: pounds per square inch), but their use is unknown. There is no cursor, nor is there any slit which could accommodate a cursor.
Correction for the air pressure is not possible.

(E) IWA 0759





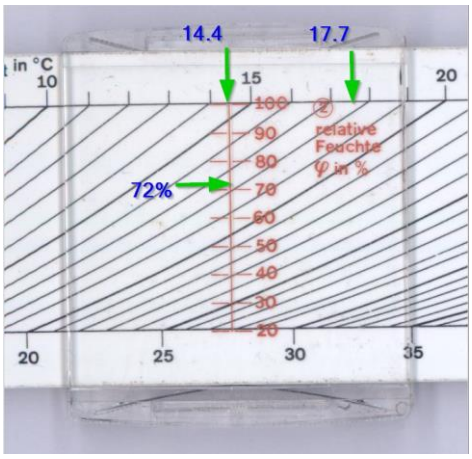


Fig. 9a. The IWA 0759.

Owner Ronald van Riet.
Producer IWA Rechenschieberfabrik F. Riehle KG.
Construction Plastic slide rule 28 cm long by 4 cm wide.
Calculation

- Set the cursor at the wet bulb temperature on the top scale at 14.4 °C.
- Select the dry bulb temperature at 17.7 °C on either scale and follow the curve to where it intersects the cursor.
- Read the Relative Humidity at this intersection: approximately 72 %.

The slide rule contains both at the top and at the bottom a scale for temperature and a set of curved lines connecting points of equal temperature on each of these. There are no subdivisions of the temperatures, meaning the reading is very coarse, not more accurate than ±2°C.

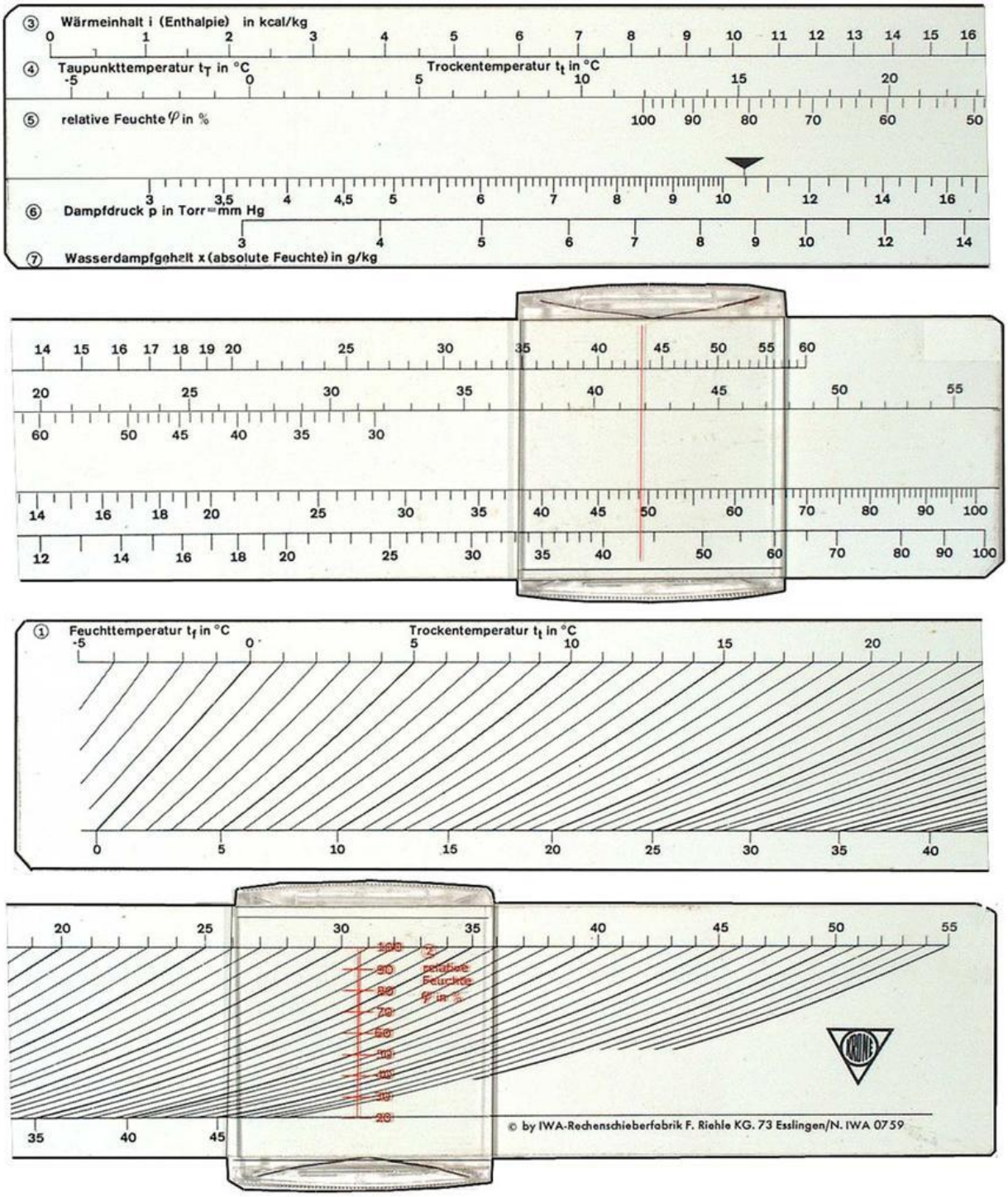


Fig. 9b. The IWA 0759.

Remarks

One side is used to calculate relative humidity, the other is used to calculate other air properties like heat content, dew point temperature, vapor pressure and percentage water vapor.

Bron https://www.sliderulemuseum.com/HSRC/28901.jpg

Special remark

In the presentation during the IM2019 I showed a birch tree which reacts on the humidity. Several people came with comparable examples in nature. In a discussion later on with a physics teacher of a secondary

school, she mentioned that the students had to perform a test with a pine cone which opens when it is dry and closes when it becomes wet. The impact of humidity in nature is present at several locations.