**Importance of Universal Time for celestial navigation**

In celestial navigation, the reference points used are the celestial bodies. But these move at high speed: 15°/h on average for the sun. Therefore the reference points (Gp) also move at the same speed on the surface of the earth (about 1600 km/h, for the sun). It is therefore essential to know exactly (to the nearest second) at what moment the body was sighted, in order to determine, using the Nautical Almanac, what its exact position was at that moment.

The watches used today are quartz, the mechanical models being generally very much inferior in precision, unless they are worth a fortune. However, quartz watches are not always strictly accurate and it is necessary to determine what is the difference, ahead or behind, by which the "raw" information given by the watch must be corrected to obtain the correct time.

In the past, this difference was determined by specialized marine watchmakers, located in the ports and to whom the officers on board entrusted their precious chronometers, for calibration, during a stopover. Thereafter, the ships which were equipped with radio receivers could receive the exact time a little like with the speaking clock which existed until recently in France.

Today, marine watchmakers have almost disappeared, and radio stations broadcasting time signals are becoming increasingly rare and therefore difficult to find. But there remains a now commonplace instrument which gives the exact time at all times, it is the GPS. Once the watch on board has been calibrated using a GPS, it can be put aside or even turned off.

The difference between the onboard clock and the exact time is made up of two parameters:

1 – the state of the watch: this is the initial advance or delay of the watch at a given moment,

2 – the rate of the watch: it is the small daily variation of the state, more or less.

If the value of the state does not have much importance, the rate on the contrary must be constant. A watch whose rate varies randomly day after day cannot be used for astronomical navigation because it will be impossible to deduce the exact time from its information.

The Excel "Correction HTU" table that we offer allows you to calculate in advance what will be the correction to be made to the time given by the quartz watch, depending on the date, to obtain the exact TU time that can be used in your calculations of astronomical navigation. This correction will be provided in the "Results" section, the green area of the table that you can print out to take with you on your trip.

**Advice :**

Carry out several successive calibrations to ensure that the rate of your watch is constant. If it varies, the watch will not be usable for celestial navigation. It is also preferable that this rate be less than ± 4s/day.

To obtain the most accurate gait assessment possible, the difference between the two measurement dates (Date 1 and Date 2) must be as large as possible.

We advise you, if possible, to make an adjustment of the initial state "late". This way the correction will be positive and additions are always easier than subtractions.

You should not reset your watch during the trip because you will then lose the assessment of its state and its rate. On the contrary, before your departure evaluate the corrections to be made thanks to the Excel table "Correction HTU" and then correct your calculations day by day of the value of the difference thus calculated.

**Instructions for use  
"Correction HTU" EXCEL™ worksheet**

This worksheet is intended to provide the correction to be made to the on-board clock indication to obtain the exact UT time, day by day. You must first fill in the differences between the watch to be calibrated and a reference watch that gives the exact UT time (GPS, radio time signals, etc.).  
It is preferable that the watch you take on your trip has a rate (daily variation) of less than ± 4s/day.

The areas to be filled in are tinted in pink. Their description is in *italics* below.  
Other areas should not be changed.

**1 – Determination of the error of the watch (blue zone):**

*Date 1: date of the first measurement  
Heure de ref. = Ref. time : Exact reference time during this first measurement (GPS, time signal, etc.)  
Heure Montre = Watch Time: Time given by the watch to be calibrated, for this same instant*Etat = State: Advance or delay of the watch for this first measurement

*Date 2: date of the second measurement  
Heure de ref. = Ref. time : Exact reference time during this second measurement (GPS, time signal, etc.)  
Heure Montre = Watch Time: Time given by the watch to be calibrated, for this same instant*Etat =State: Advance or delay of the watch for this second measurement

Ecart entre 1 et 2 = Difference between 1 and 2: number of days elapsed between the two measurements

Rate of the watch: Daily variation of the watch (minutes:seconds.1/100ths)

Note: For the same watch, this rate should in principle be constant. To check this, it is advisable to determine the error of the watch several times, on different days.

**2 – Dates for which you want the calculations (beige area)**

*Date début = Start date: date of the first day for which we want the results*Deviation: number of days elapsed since the first measurement (Date 1)

**3 – Results (green area) to print:**

For each day from the chosen start date, we obtain the correction to be made to the time of the watch.

In the example, the results table is limited to 60 days. It is possible to extend it by copy, down or to the right.

**Warning**: if negative time values are displayed #################, you must then change the Excel options:

Click File (top left), then Options (bottom left column), then Advanced Options (middle left column).

Scroll down to "When calculating this worksheet:", and check the line "Use calendar since 1904"

Note that this "option" will only apply to the current "HTU Correction" worhsheet. Your personal tables will not be modified in any way.

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