

# THE METROLOGICAL CONFIRMATION PROCESS IN THE PROVISION OF METEOROLOGICAL SERVICE TO THE AERIAL NAVIGATION OF THE SPANISH METEOROLOGICAL SERVICE

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## ABSTRACT

The Spanish Met Office (AEMET) has been doing important efforts during the last years because of the creation of the Single European Sky, in order to obtain the meteorological supply certification to support the aerial navigation.

According to its Business Plan, the AEMET has established two strategic goals:

1. Providing with high quality services and meteorological products that will satisfy the necessities of the population.
2. Efficiency in the elaboration of these products.

The metrology confirmation process of the aeronautical equipments of ground meteorological observations is a supporting process of the Meteorological Service for Aerial Navigation.

One of the parts of operational goals refers to the achievement of the metrology requirements in the process of checking the equipments which are in the airports.

The activities put into practice to surveil this metrological control will be presented. Controlling indicators that have been defined, experiences and results obtained during the last years will also be shown.

## Introduction

The mission of the Spanish Met Office (AEMET), which has been established in their statutes, consist of “the development, establishment and support of the aerial navigation which are responsibilities of the Spanish State, and the public policies and private sector activities support; contributing to the security of people, sustainable development and social welfare “

“Providing with aerial navigation, needed to contribute to the safety, regularity and efficiency of the air traffic is the Spanish Met Office duty, which has been defined in its corporate plan 2012 – 2016. In addition to this, AEMET, in application of the Chicago international civil aviation commitment reached on December, 7th 1944 and confirmed on February, 21th 1947 and according to 7.a)

article of the 21/2003 7th July of Aerial Security, is the meteorological aerial authority". Moreover, "according to the Single European Sky regulation, AEMET is certified to supply supporting meteorological services to the aerial navigation since December, 2006 (BOE num 47, February, 23th 2007). State Secretary for the Environment, depending on the Ministry of Agriculture, Food and Nature who holds the ownership of the National Meteorological Supervision (ANSMET), according to the Royal Decree 401/2012, February 17th ".

The European Parliament regulations CE N° 549/2004 and the European Union Council, March, 10th 2004, generate the frame to the Single European Sky creation: "The main purpose of Single European Sky initiative consists of reinforce the current security rules and the global efficiency of the European air traffic, improving the capacity of response to the aerial space users and reducing to the minimum the delays.

With all this intentions in mind, it also exists the idea of creating an harmonised regulatory framework to generate a Single European Sky before December, 31th 2004."

The execution regulation n° 1035/2011 October , 17<sup>th</sup> 2011 of the European committee establishes common requirements in order to supply aerial navigation services. It appears in the Annex 1 a general requirement of competency, technological capability and operational capacity: "The aerial navigation suppliers must be able to provide with lasting, efficient, sustainable and secure services, adapted to a reasonable request in a specific aerial space. With this purpose in mind they will keep the experience and technological and operational competencies in a high level".

The European regulation N° 73/2010 of the January, 26th 2010 Committee establishes rules related to the quality of the aeronautic data and information. As indicated: "The current situation examination reveals the quality requirements related to the aeronautical data not always reach the integrity and accuracy EATMN requirements." (EATMN stands for European Air Traffic Management Network.)

The uncertainties required in the meteorological observations for the aeronautic purpose appear in the attached ICAO Annex 3 (ICAO stands for International Civil Aviation Organisation). Being more precise, it appears "The accuracy desirable in the observational process".

Due to all that have been said before, according to the aerial navigation support, the AEMET business plan establishes as one of the two priority strategies, the EA.1 strategy: Supplying high level products and services to the aerial navigation. The supply of aerial navigation services is certified according to the 9001:2008 ISO standard. As far as this strategy is concerned it is thought of an improvement in the aeronautical services that will be addressed to, among other things, "improving the quality of the data coming from the aeronautical observation systems in the

aerodromes.” Because of this reason it is put into practice metrology requirements in the checking process of the equipments located in the aerodromes. It exists different projects to reach the target value.

The activities that were done before 2004, regarding the metrology control and the maintenance of the equipments that were used in the meteorological observation process in the airports, when the framework Single Sky One regulation was set, were the following:

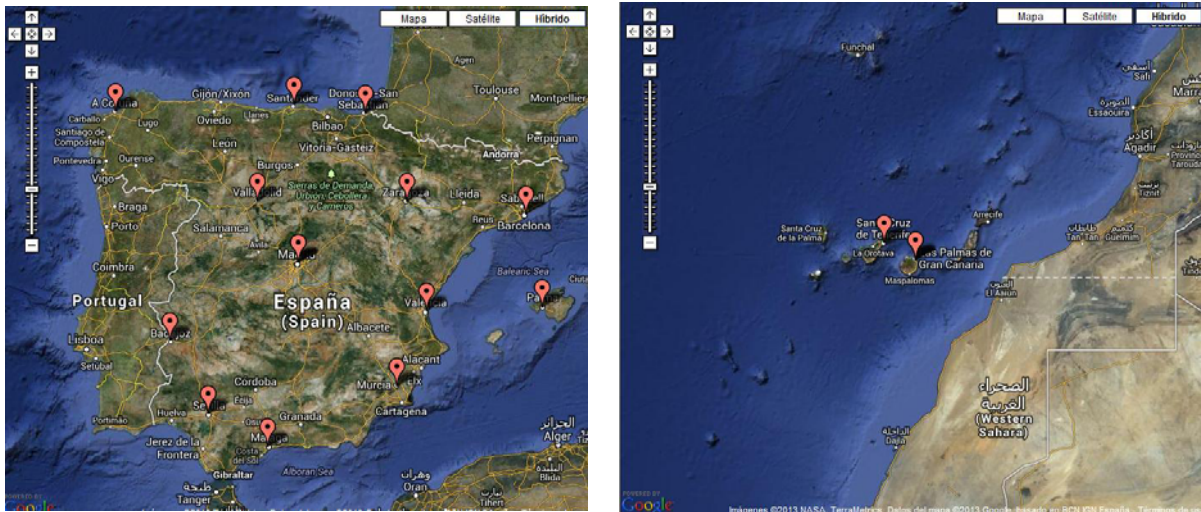
- Activities carried out by the outsourced company to keep updated the meteorological integrated system in the aerodromes to solve any problem (corrective maintenance) and the day-to-day preventive maintenance in two airports: Barcelona/El Prat and Madrid/Barajas.
- Checking the pressure transmitters comparing them with a pressure standard, both during the installation process and during the routine work, carried out by the AEMET staff.
- Routine calibration jobs of the pressure standards belonging to the 15 Regional Meteorological Centres carried out in the Calibration Laboratory of AEMET.

## **Description**

Due to the current situation, it is accepted that the control undertaken over the measuring instrument before 2004 it is not enough. There was an intention of improving the situation so that AEMET could obtain the accreditation to supply meteorological services to the aerial navigation.

First of all, it is necessary to explain briefly the AEMET structure, to show everybody the way it is faced up the maintenance and the metrology control of the measuring instruments in the airports. Inside the Production and Infrastructure Directorate it is found the Infrastructure and Systems Department, depending on the last one there are two Services: The Maintenance Management Centre, responsible for the contracts of maintenance, and the Calibration Laboratory, responsible for the calibration of both temperature and humidity probes and working standards of the Regional Meteorological Centres. Apart from the headquarters, located in Leonardo Prieto Castro street, number 8, and the Calibration Laboratory, placed in the Retiro Park, there are 15 Regional Meteorological Centres: Sevilla, Málaga, Zaragoza, Palma de Mallorca, Santa Cruz de Tenerife, Las Palmas de Gran Canaria, Santander, Valladolid, Barcelona, Badajoz, La Coruña, Madrid, Murcia , San Sebastián y Valencia. All of them posses a Section of Basic Systems (SSBB). The SSBB have a lot of tasks to be done. Among their responsibilities, they take metrology control over the measuring instruments under their ratio of influence. They check and adjust almost all the

instruments, if it is necessary. Apart from the SSBB staff there are more people available, at the airports and Military Bases, who help them. All together make the preventive maintenance and provide a first actuation in case of breakdown of the measuring instruments.



**Figure 1. AEMET Regional Meteorological Centers**

All the documents (procedures, instructions, formats...) connected to the control of the measuring instruments can be found inside the "Metrological Confirmation Manual".

It can be underlined the following expressions from this manual:

- Procedure: It gathers all the parts involved in the metrological confirmation process and it establishes the responsibilities.
- Program: It explains the different elements (measuring instruments, model, manufacturer), actions of the confirmation process that must be done, technical instructions to be followed, staff, confirmation intervals and metrological requirements that have been fixed for both equipments of the aeronautical network and the standards used in the verification process.
- Annual Plan: Planning of the activities that must be done over every single measuring instrument of every airport. SSBB staff along with the Calibration Laboratory perform this task.
- Technical instructions, addressed to the SSBB staff, with the intention of maintenance, adjust and field verification of the measuring instruments: pressure transmitters, temperature and humidity systems, interfaces, visibilimeters (scatterometers, transmissometers), ceilometers and wind sensors.
- Formats, from which it can be created registers, verification certificates of the measuring instruments.
- Controls between calibrations/verifications: temperature and humidity standard of the SSBB, pressure transmitter, wind (wind speed and direction).

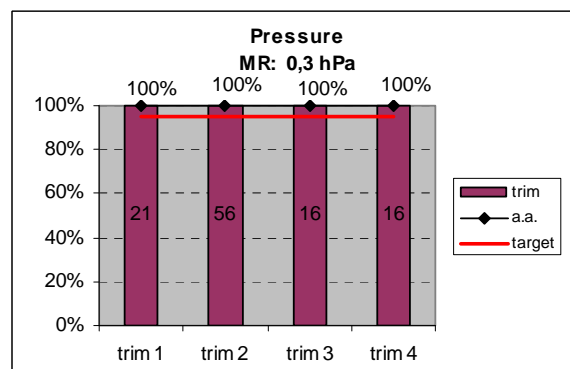
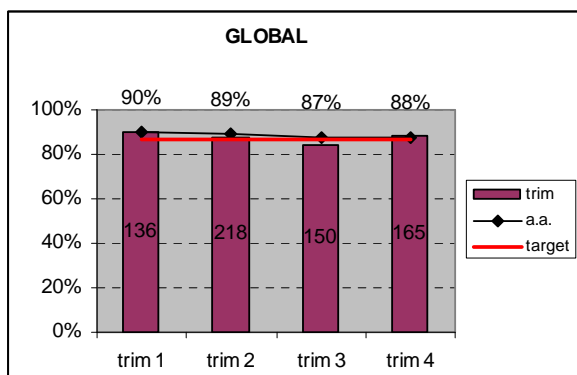
- Calibration procedures in the laboratory: standards of the SSBB (pressure, temperature and humidity, multimeters, multifunction tester calibrator) and humidity and temperature probes.
- Tracking instructions: verification and calibration of the instruments. Calculation of the fulfillment indicators of the metrological requirements (global, type of magnitude, manufacturer, and model) and the fulfilment of the annual plan of the SSBB and the Calibration Laboratory.

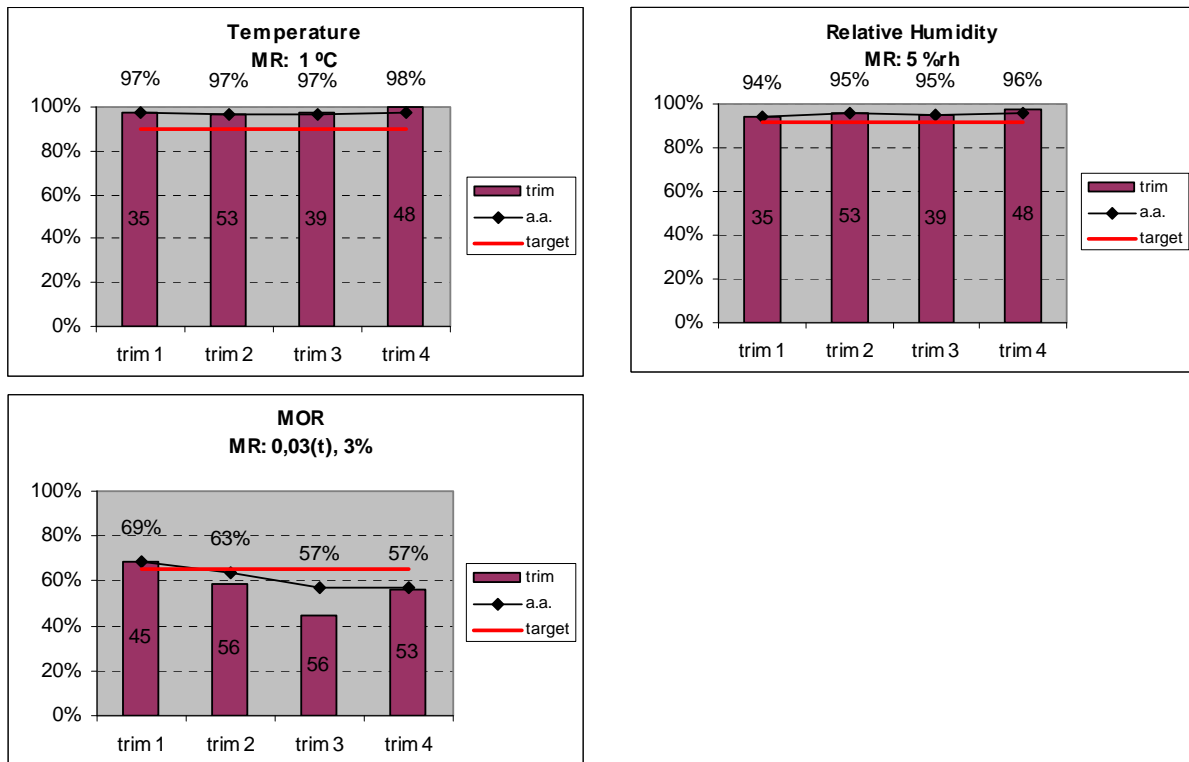
## Results and discussion

A summary of the work done and the results that have been obtained during the last year (2013) related to the aeronautical network is shown below:

- ✓ 109 field barotransmitter verifications.
- ✓ 175 field verifications of the measuring system of both humidity and temperature.
- ✓ 170 field temperature and humidity interfaces verifications.
- ✓ 270 visibilimeters verifications (scatterometers, transmissometers)
- ✓ 67 ceilometers adjustments.
- ✓ 24 humidity and temperature probes calibrations carried out in the laboratory.
- ✓ 15 pressure standards calibrations belonging to the SSBB carried out in the laboratory.
- ✓ 13 multifunction tester calibrator calibrations that belong to the SSBB carried out in the laboratory.
- ✓ 10 digital multimeter calibrations that belongs to the SSBB carried out in the laboratory .
- ✓ 44 controls between calibrations of the humidity and temperature standards belonging to the SSBB (checking the relative humidity with the help of CINA ,according to the Greenspan table).

The fulfilment percentage of the metrological requirements in field verifications are shown below:





**Figure 2. Metrological requirements indicators**

As the picture shows the indicator for the meteorological optical range (MOR) is worse than the others. Problems with the transmissometers have been found, in spite of the fact it must be taken into consideration it is placed above scatterometers in the traceability chain. Manufacturer of the transmissometer offers four points of calibration compared with the scatterometers with only one point. The most portion of transmissometers are Vaisala Mitras.

The main sources of problems are:

- The verification process is more complicated than in other instruments.
- In many cases the transmissometers are old-fashioned, when they breakdown they are not correctly treated. Spare parts and original accessories are very expensive in general.
- Restoration works are frequent at the airports. The dust deeply affects their proper operation.
- Depending on the filters used (AEMET or the outsourced company) the measuring instruments can be confirmed or not.

On the other hand, pressure indicator is perfect. Long term stability of the ancient models of Vaisala, PA21 and PTB220, which are mounted in the most part of airports, are really very good, better than 0.3 hpa/year. During the 2012 year there was a change in the verification period of time, from 6 months to 12 months. This change haven't brought about a deterioration in the pressure indicator results.

From 2012 onwards, there have been conducted controls between calibrations of the T/H standards that belongs to the SSBB, every three months, with the help of CINA saturated solutions. Taking as reference the value shown in the Greenspan table, when a deviation of more than 2.5% hr appears the T/H standard is send back to the laboratory for another recalibration process, even in the case the certification deadline is not reached.

Here are shown the results of those controls between calibrations:

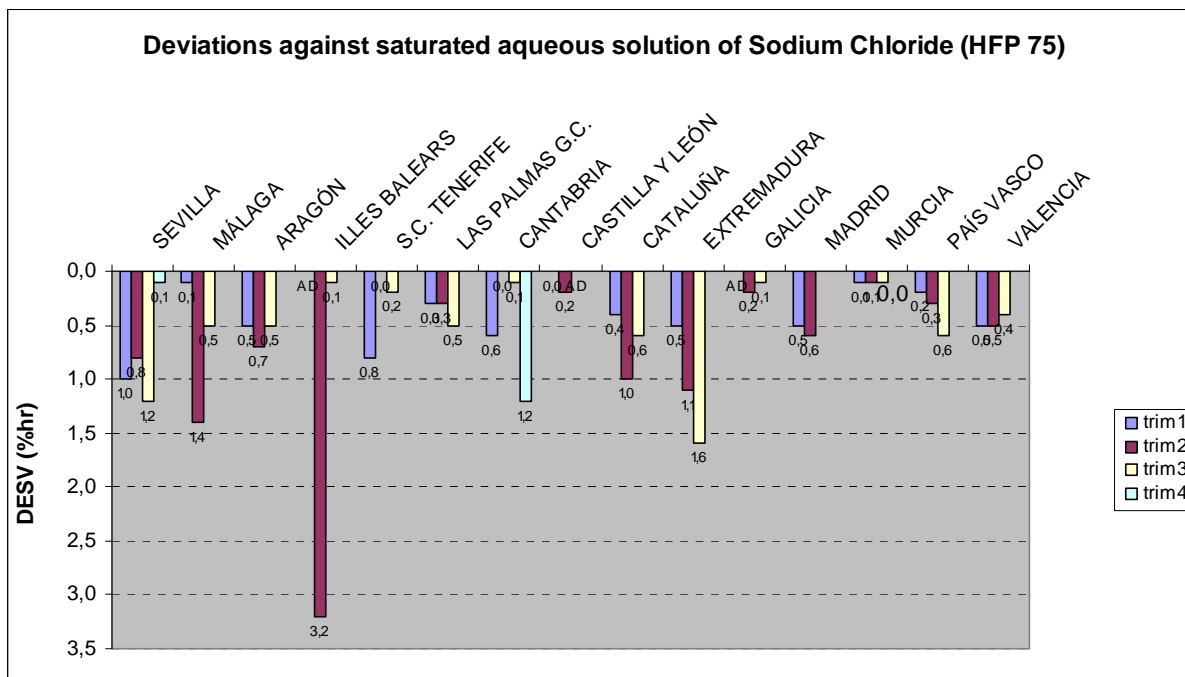


Figure 3. Deviations of working standards against saturated aqueous solution of Sodium Chloride (Greenspan)

There is an unusual case in which a temperature and humidity probe HMP35D Vaisala model n/s P4440019 is involved. This is the former probe regarding the aeronautical network and it was manufactured in 1995. It is usually placed at Madrid Barajas airport. This probe has got a Pt 100 resistance and an humidity output of 0-1 volts. It has been never adjusted. During the last two calibration process, carried out in 2010 and 2012, relative humidity corrections were less than 1 %rh at 23 °C. Temperature corrections were less than 0.10 °C. Long term stability for this probe is much better than in other HMP45D Vaisala probes calibrated in the laboratory. Vaisala does no longer manufacture this model of probe, being replaced for another model: HMP155D. During the last year, this probe has been progressively included in the aeronautical network. There are no enough data of this new model that enable us to conclude these probes are better than the special HMP35D one.

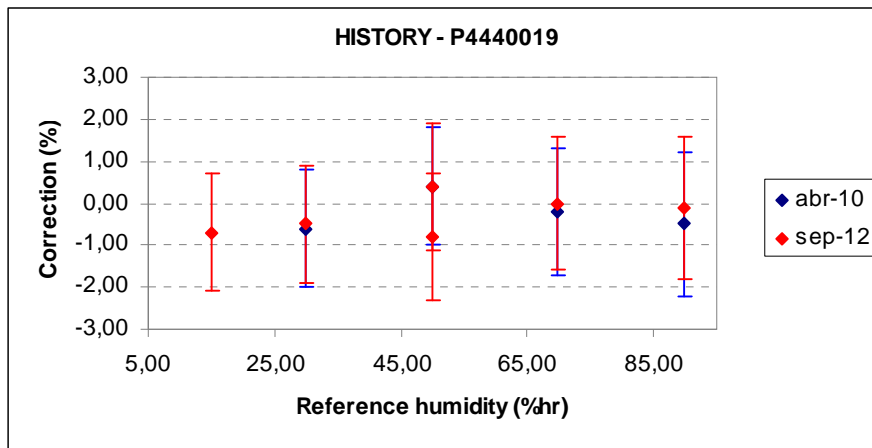


Figure 4. Humidity corrections and uncertainties

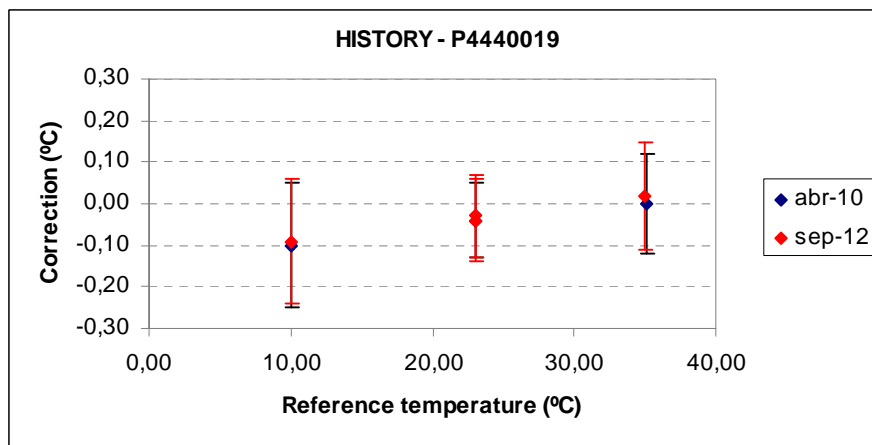


Figure 5. Temperature corrections and uncertainties

## Conclusions

Due to AEMET had to outsource the corrective maintenance at the airports, there was a lost in knowledge. Nowadays things have changed for the better. AEMET staff are retaking knowledge doing routine metrology in field verifications with the help of different working standards, and controlling those verifications. Metrology Confirmation Process has been the origin of that change, allowing AEMET staff taking part in the airports metrology activities.

Projects and works put into practice:

- ✓ Improving the fulfilment visibilimeter indicator: As a part of this project there is the aim of following a traceability chain until the national standard is achieved. In this case, the national standard comes from the “ Instituto de Óptica Daza y Valdés” of Consejo Superior de Investigaciones Científicas.



- ✓ Being able to create a traceability chain in the wind speed data, if not every sensor at least part of them, being calibrated in a certified MEASNET wind tunnel. METEOMET project of EURAMET gives the possibility of analysing the wind data to enable us undertake field calibrations.
- ✓ Revising the different instructions and procedures of the “Confirmation Metrology Manual” in the light of the results of the METEOMET project.
- ✓ Creating a procedure that includes the verification of the ceilometers, on the basis of TOPROF project, in which AEMET, Granada and Extremadura Universities take part.
- ✓ Widening the calibration range for the working standards and for the humidity and temperature probes calibrated in the laboratory, including negative temperatures.

Long-term objectives: Including more than 800 ground floor automatic stations in the metrology process, identifying the metrology requirements for every type of measurement in every observational network.

## References

1. Business AEMET plan 2012-2016.
2. Framework regulation to create the Single European Sky (CE) n° 549/2004.
3. Aerial navigation regulation UE n° 1035/2011.
4. Regulation that establish the aeronautical quality of the data to support the aerial navigation and their requirements, UE n°73/2010.
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6. Humidity fixed points of binary saturated aqueous solutions. Lewis Greenspan, National Bureau of Standards, October 22, 1976