COMMON FUND FOR COMMODITIES

TECHNICAL DEVELOPMENTS FOR INSTRUMENT TESTING

CHAPTER 8.4

ANNEX A: CLIMATE CONTROL

Project CFC/ICAC/33

Commercial Standardization of Instrument Testing of Cotton with particular consideration of Africa

Cotton Testing in Africa

CSITC - Project

This project is co-funded by the European Union and the Common Fund for Commodities

Activity D.1.3.: Development of a list of requirements and basic principle drawings for a simple and efficient integrated climate control system

Project CFC/ICAC/33

This project is co-funded by the European Union and the Common Fund for Commodities

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D.1.3. Development of a list of requirements and basic principle drawings for a simple and efficient integrated climate control system

Extract from project document:

"At each time we visit a lab, people are confident in the equipment they use for ambient air management while these equipments are not able to respect the basic rules/standards required for cotton testing. In fact, there are missing technical information describing what is and should be any laboratory system able to regulate both temperature and relative humidity in the air in the worldwide agreed tolerances.

This system is very complex while some traders can argue that they are able to make it easily, and at the final step, the laboratory is challenged for its results. To counter this, we wish to make a full description of the system with all its components including the regulations rules so that anyone will know what is necessary in his lab and know what to ask when a tender is launched for installing / improving a laboratory."

Bibliography: PAYET L., GOURLOT J-P., 2010, Rapport "D.1.3. Development of a list of requirements and basic principle drawings for a simple and efficient integrated climate control system", Project CFC/ICAC/33, 23 p.

Content

1 - Introduction

Expertise tours in the laboratories revealed some lack of hindsight when using their air management system. The basic standards required for cotton testing are sometimes not completely respected. Besides, the system is very complex and laboratories should be careful that their manufacturer does not miss any technical information about how to regulate both temperature and relative humidity of the air in approved tolerances.

The purpose of this activity is then to provide a full description of the system with all its components including the regulations rules to laboratories.

2 - Description of the technical objective

In this activity, we focus on drawing up a list of technical requirements and recommendations in order to help recognising the classing laboratories using SITC at the international level in terms of air management.

A list of specific requirements must be fulfilled to respect standards dealing with textiles testing. Additional experiments must be carried on by the laboratories to check that every requirement is effectively fulfilled for installing, improving or controlling the equipment. With this knowledge, laboratories should be able to prove their capacity for maintaining their climate control system within the worldwide agreed tolerances.

3 - Ambient Air Management System Requirements

3.1 - Reasons for working in standard conditions

Cotton properties are influenced by many factors and the most important is its hygroscopic capacities. Cotton can absorb or evaporate moisture from/to the environment. This will impact on some of the cotton properties, such as maturity, length and strength. Particularly, strength tends to increase with the increase in moisture content. A study conducted by Uster (Figure 1) shows that a change of 1% in moisture content causes a change in strength of 2 to 3 g/tex (unit equivalent to cN/tex).

Short Weak Cotton			Long Strong Cotton		
Moisture %	Length mm	Strength grams/ tex	Moisture %	Length mm	Strength grams/tex
6.5%	24.02	22.53	6.5%	32.42	34.76
7.5%	24.49	24.50	7.5%	33.05	37.80
8.5%	24.95	26.87	8.5%	33.67	40.84
9.5%	25.42	28.44	9.5%	34.30	43.88

Figure 1. Influence of moisture content on fibre length and strength measurements of SW an LS cottons

Source : USTER , Application Manuals v1.1 June 2006, 4. Basic Applications

In a laboratory, moisture content of cotton fibres will vary if the relative humidity level is not stable. *A change in relative humidity of 8 to 10% will change the moisture content of the HVI test specimen about 1%* and again, *a change in relative humidity of 3 to 5% will change HVI strength reading by 1 g/tex* (Sasser, 1990). It is important to bring cotton moisture content to equilibrium so that length and strength measurement variations and levels can be comparable intra- and inter-laboratories. Conventionnally, cotton samples moisture content (dry basis) should remain between 6.75% and 8.25% (for all cottons). To achieve this equilibrium moisture content range, cotton samples should be placed in approved atmospheric conditions within a specific tight range (ensuring conditions stability). Besides, it is recommended to start the conditioning from the dry side since absorption will process faster and will result at a more appropriate level compared to conditioning from the wet side (Figure 2).

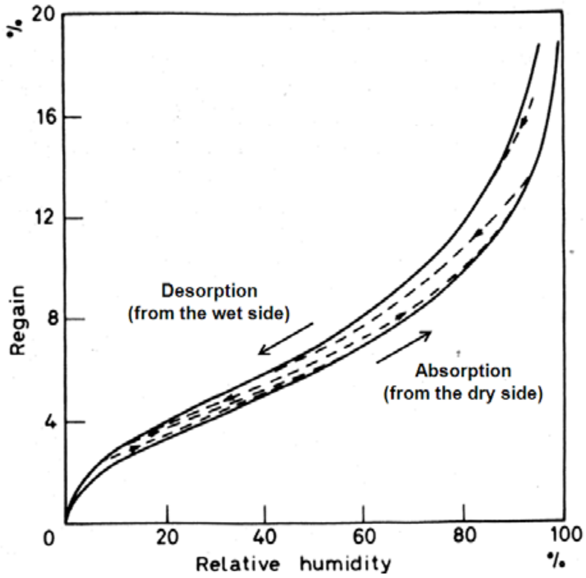


Figure 2. Equilibrium absorption of water for cotton fibres
Source: The physical properties of textile fibres, Morton and Hearle (figure obtained from Urquhart and Eckersall, JTI 21, 1930)

3.2 - Standard requirements and tolerances

In order to give reliable fibre characteristics results, laboratories must fulfil all standardised features for ambient air described in both standards ISO 139 and ASTM D1776. After pre-conditioning, the samples have to be conditioned and tested at standard atmospheres as shown in Table 1. These conditions have to be respected at any point of the laboratory where a test is realised by equipment totally independent from the regulation system. It is required to specify the reference of the standard used (e.g. ISO 139) being sure that it is the last version in use (e.g. ISO 139:2005).

<table>
<tr><th rowspan="2">Standard</th><th colspan="2">Temperature</th><th colspan="2">Relative Humidity</th></tr>
<tr><th>Standard</th><th>Tolerance</th><th>Standard</th><th>Tolerance</th></tr>
<tr><td>ISO 139:2005</td><td>20.0°C</td><td rowspan="2">± 2.0°C</td><td>65.0%</td><td rowspan="2">± 4%</td></tr>
<tr><td>ISO 139:2005 (alternative)</td><td>23.0°C</td><td>50.0%</td></tr>
<tr><td>ASTM D1776-08</td><td>70°F (21°C)</td><td>± 2°F (± 1°C)</td><td>65%</td><td>± 2%</td></tr>
</table>

Table 1. Requirements for standard atmospheres ISO 139:2005 and ASTM 1776-08.

Every possible source of error which could appear during measurement is taken into account within the tolerances:

- Precision of regulation equipment,
- Precision of regulation sensors of air conditioning system,
- Precision of independent sensors,
- Delay between ordering the modification of ambient air conditioning and its effective performing…

Besides, ordering and installing a stricter command system is necessary to respect both ISO 139 and ASTM D1776 standards at any point of the laboratory. The ASTM D1776-08 standard has the smallest tolerance zones, so this is the one retained to comply with both standards. Theoretically, it is physically impossible to reach the relative humidity tolerance required by the standard (± 2%) with the tolerance in temperature required by the same (± 1°C). Indeed at 21°C/65%, a tolerance zone of ±1°C in temperature would lead to an extended tolerance zone of ±4% in relative humidity. In order to reduce the tolerance zone to ± 2% for the same mass of water in the air (10.08g/kg), the temperature tolerance has to be restricted to ± 0.5°C, as referred to in Figure 3. The grey area is the tolerance zone for ASTM D1776-08 standard and the green area represents a restricted acceptable tolerance zone.

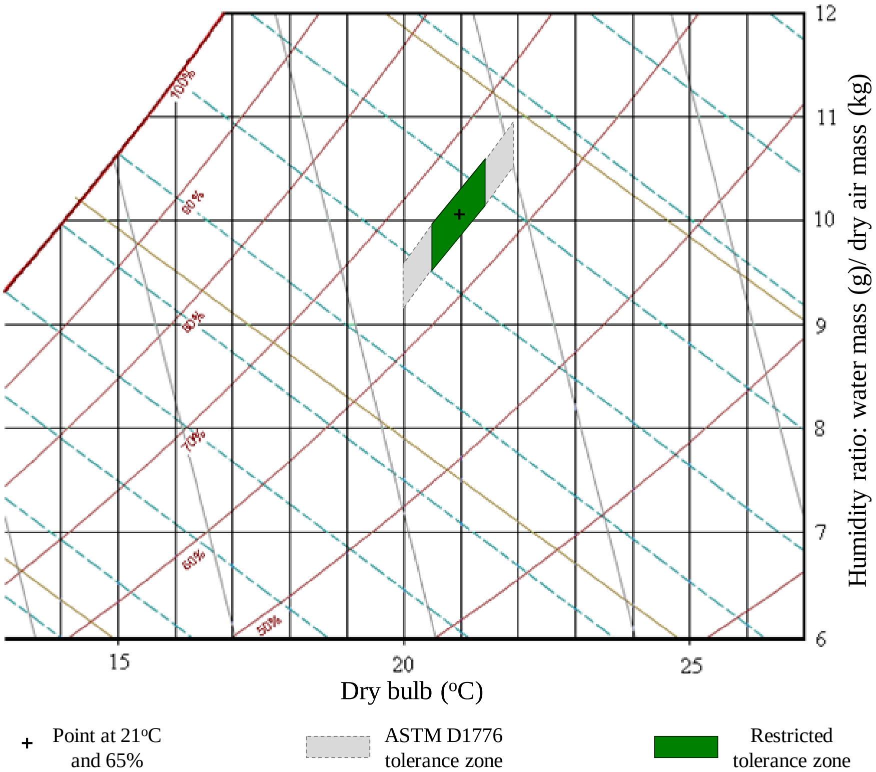


Figure 3. Psychrometric chart, focused on interest area (21°C, 65%)

Temperature		Relative Humidity	
Value	**Tolerance**	**Value**	**Tolerance**
21°C	± 0.5°C	65%	± 2%

Table 2. Summarized recommendations for command

3.3 - Laboratory specifications

3.3.1 - General specifications

When a company offers its services or replies to an invitation to tender for an AMS installation, it should probably ask a list of elements that would help it to choose to the best equipment that meets the laboratory requirements. Indeed, some elements are important for calculating calorific power and heat balance, for properly localizing the air vents, return air ducts… For instance, the list should include at least the following specifications:

- Dimensions, area and volume of the room,
- Insulation, sunshine, temperature on each wall/glass, roof information,
- Laboratory equipment, lighting and other equipment, number of people in the room, number of entrances and airlocks…

See Questionnaire in Annex as an example of what should an experimented company ask.

3.3.2 - <u>Influence of insulation</u>

Insulation of the laboratory is an important factor in air conditions stabilising and energy saving. Indeed, an efficient insulation system in the building will help abiding with the standardised atmospheres for conditioning and testing textiles.

Air conditioning system will be efficient only when specific requirements are fulfilled:

- The laboratory has to be in the middle of the building (in the absence thereof, at north of building in northern hemisphere or south in southern hemisphere), surrounded by corridors or office rooms so that external conditions could not affect the laboratory's. Failing this, the roof should be larger than the building to avoid its direct insulation, similarly to a penthouse.
- If the laboratory is in a warehouse, it is necessary to help the air circulating between the roof and the ceiling of the laboratory rooms. Be careful of nuisance, birds, rats…
- Walls, ceilings and floors of laboratory must be thermally insulated.
- Every door opening to the outside laboratory must be fitted out with an adapted airlock system, so that the two doors cannot open at the same time.
- Air conditioning system must insure a high pressure in analysing rooms so that external conditions cannot interfere with the laboratory.
- It is highly recommended to let the conditioning system running 24h per day and 7 days per week so that the room benefits of as stabilised conditions as possible. Thus, the conditioning and the complete testing of all the samples fulfil requirements of standard methods.
- Room layout is of utmost importance. Indeed, height and structure of ceiling, as well as room volume must be known for calculating air outputs, number and position of air vents (return/renewal air).

3.4 - Basic principles of Air Management System

3.4.1 - <u>Basics and drawing</u>

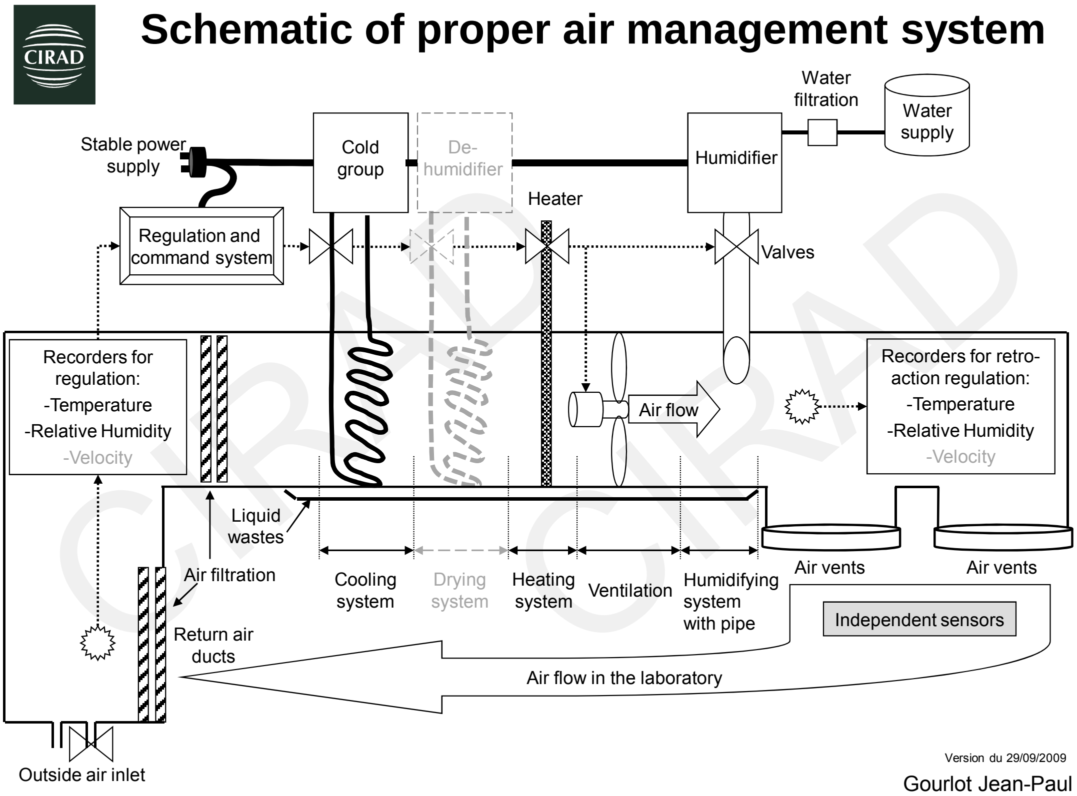
Maintaining characteristics of the ambient air in laboratory within given tolerances can be handled by an Air Management System (AMS).

The structure enables a percentage of outside air to come in through air inlet via an opening valve: the air is then distributed in a pipe with air filtration system (safety requirement).

A control/regulation system shall be in place, equipped with well-calibrated high sensitive temperature and relative humidity sensors. Measured ambient air characteristics are then compared to pre-set values. In order to bring the conditions to equilibrium, the regulation system gives commands to the operating system.

In a proper AMS compatible with fibre testing, the 3 to 4 major working components are the following: a cooling system, a heating system and a steam humidifying system which is to be fed with water supply provided with a water filtration system. A complementary drying system (de-humidifier) is optional; it is added in very humid atmosphere areas to help the system working better. These components are each provided with valves which have to be responsive to small changes demands within short delays. Depending on the requirements from the command system, adjusting more or less (gradually from 0 to 100% for opening setting) the different valves will change the air characteristics of the laboratory.

It is important to note that the regulating system shall command both cooling/heating systems and humidifying/optional de-humidifying systems in the same time so as to maintain the conditions stabilised properly. Indeed, independent regulation systems (see 3.4.3.1 - for explanation) would lead to very high instability in temperature and in relative humidity, since the two characteristics are linked to each other.



3.4.2 - Summarized descriptive equipment for AMS

Assuming the system is correctly power supplied according to recommendations in other chapter, next table sums up the main compulsory equipment for an AMS correctly working.

Control/regulation system	Operating system	Air flow
✓ Sensors for air temperature, relative humidity (and velocity) ✓ Calibration ✓ Comparator / Regulator ✓ Command	✓ Cooling system ✓ Heating system ✓ Steam humidifying system, water supply and filtration ✓ Drying system (optional)	✓ Pipes (air ducts) ✓ Air inlets ✓ Air filtration ✓ Ventilation+air vents ✓ Aspiration+return air ducts

Table 3. List of required equipment for a proper AMS

Particularly in the regulation system, the resolution of the measuring instruments should be of 0,1°C and 0,1% or better according to ISO 139:2005. The resolution must not be confused with the measuring accuracy of ± 0.5°C and ± 2.0% or better, knowing that the most powerful apparatus in the world allows a maximum precision of measurement of around ± 1%.

Standard	**Temperature**		**Relative Humidity**	
	Resolution	**Uncertainty**	**Resolution**	**Uncertainty**
ISO 139:2005	0.1°C or better	± 0.5°C or better	0.1% or better	± 2.0% or better
ASTM D 1776-08	N/A	N/A	N/A	N/A

Table 4. Accuracy requirements for regulation sensors, part of AMS equipment.

During expertise in laboratories, it was commonly observed that spray or fog humidifiers lead to incorrect water spreading out (water remains at specific locations only: just down the humidifier); a steam humidifier would help dispersion of humidity evenly in the room. Besides, velocity of the air must be controlled at air vents, so that the air distribution in the room is sufficient (fast enough but without disturbance). Air ducts with adjustable air vents were not often observed, but they do enable an even dispersion of the air flow in the room. Likewise, textile air ducts are not a good choice either: this type of membrane can certainly be porous enough to let the air spread out correctly, but in the humid conditions of fibre testing laboratory, fibres tend to clog the pores within time so the material become less and less porous, and the air sorely goes through it. Additionally, most of the cold groups (refrigerating machines) observed in laboratories used a gas as the refrigerant circulating in a single-stage vapour-compression refrigeration cycle. In this device, the four main components are: a compressor, a condenser, an expansion valve, and an evaporator. When warm air is sent on the evaporator to be cooled down, this type of device can cause material damage because of steam condensation on cooling coils (ice formation). For that reason, refrigerating machines using chilled water circulation in a complementary circuit are preferred, since the temperature deviation for cold generation is reduced with water compared to gas: around 8-12°C for water from a chiller against 4-50°C for a gas refrigerant.

To summarize, a proper AMS shall contain any single element listed in Table 3; from an existing system, some of them can easily be changed to fit the requirements (see Table 5). The following recommendations shall also be taken into consideration:

- equal distribution of the air: location of air vents and return air ducts must be adapted to each laboratory, depending on the areas of interest (to be defined),
- heating/cooling capacity: adding only power is not necessarily sufficient ; exchange surfaces on heating/cooling coils must also be adjusted.

Observed material	**Corresponding material for proper AMS**
Spray or fog humidification system	Steam humidification system
Air pipes without adjustable air vents	Air pipes with adjustable air vents (velocity control)
Cold group: single-stage vapour-compression refrigeration system (gas circulation)	Cold group: chilled water as a refrigerant (water circulation)
Independent regulation systems (thermostat, hygrostat)	Regulating system for both temperature and relative humidity (industrial PID regulators)
Binary system for valve opening command (0: close or 1: open)	Fine adjustment for valve opening command (gradually opened from 0 to 100%)

Table 5. Equipment observed during expertise and their corresponding for a proper AMS

3.4.3 - Comparison between independent and interrelated regulation systems

One of the most important components of the AMS is the regulation system. In this part, it is proposed to compare command systems that regulate independently the temperature and the humidity with interrelated regulation systems.

Difficulties of regulation come from the fact that temperature (T) and relative humidity (RH) are closely related. Indeed, there are 4 reactions that could be expected to modify the conditioning: T increasing, T decreasing, RH increasing and RH decreasing, associated to 3 (or 4) activators that command T and RH: heating system, cooling system, humidifying system (and de-humidifying system). The problem stands where:

- independent command in higher temperature by activating the heating system leads to higher temperature *and* lower relative humidity;
- independent command in lower temperature by activating the cooling system leads to lower temperature *and* higher relative humidity;
- independent command in higher relative humidity by activating the humidifying system leads to higher relative humidity *and* higher temperature;
- (independent command in lower relative humidity by activating the drying system leads to lower relative humidity and lower temperature).

3.4.3.1 - Independent regulation systems

Many of the command systems observed in air management systems in laboratories during expertise were independent. As described in Figure 4, temperature was indeed often regulated by a thermostat giving commands to the cold group and/or the heater valve to open (1) or close (0), while the humidifier valve was ordered to open/close by a hygrostat, regulating relative humidity. When regulation devices are separated, the risk of permanent fluctuation of the conditions is very high and more importantly with an open/close system.

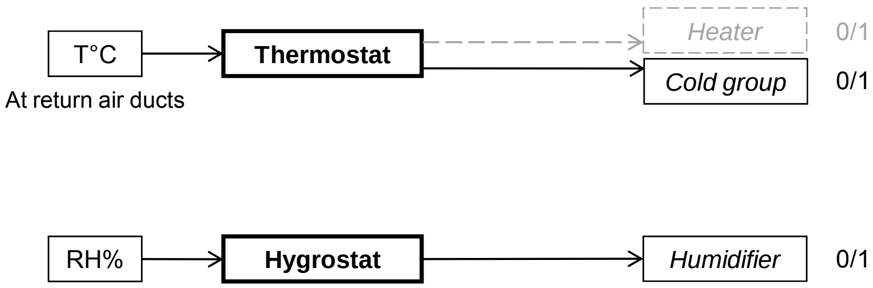


Figure 4. Independent command systems for temperature and relative humidity regulation

Set this way, the cold water valve will open when temperature is over 21°C and the humidifier valve is set to open below 65% (see Figure 5). A complex situation is for example when temperature is recorded at 24°C and relative humidity at 60%: both systems of regulation will react independently in the same time to cool down and humidify the room. As explained earlier and according to the psychrometric chart (Figure 3), the cooling down command will lead to lower temperature *and* higher humidity, while the humidifying command will lead to higher humidity *and* higher temperature. This situation brings about a humidified atmosphere but too much humid and still too warm. Such conditions could lead the system to react in the reverse direction to dry the room, beginning of the fluctuation issue.

Moreover, when a refrigerating machine with gas refrigerant is used, the cooling mechanism can be exposed to freezing conditions: ice can indeed be formed on cooling coils, since steam tend to condense on cold materials. The situation above is then much more complex than described.

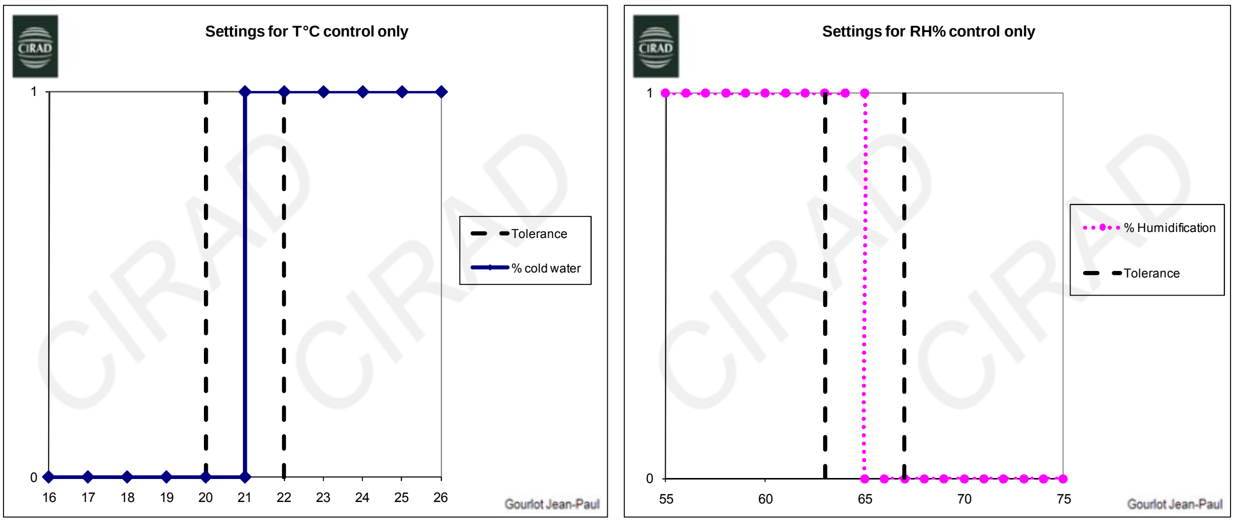


Figure 5. Settings for independent cold goup and humidifier regulations - Wrong regulation system

3.4.3.2 - Interrelated regulation systems

A correct regulation system is actually more complex than the previous described system. As shown in Figure 6, temperature and relative humidity are both regulated by a proportional–integral–derivative controller (PID Regulator), allowing a gradual opening of heating, cooling and humidifying systems from 0 to 100%. Ambient air characteristics, measured by T and RH sensors are first reported in regulators. They are then compared to pre-set T and RH couples of values associated with command orders.

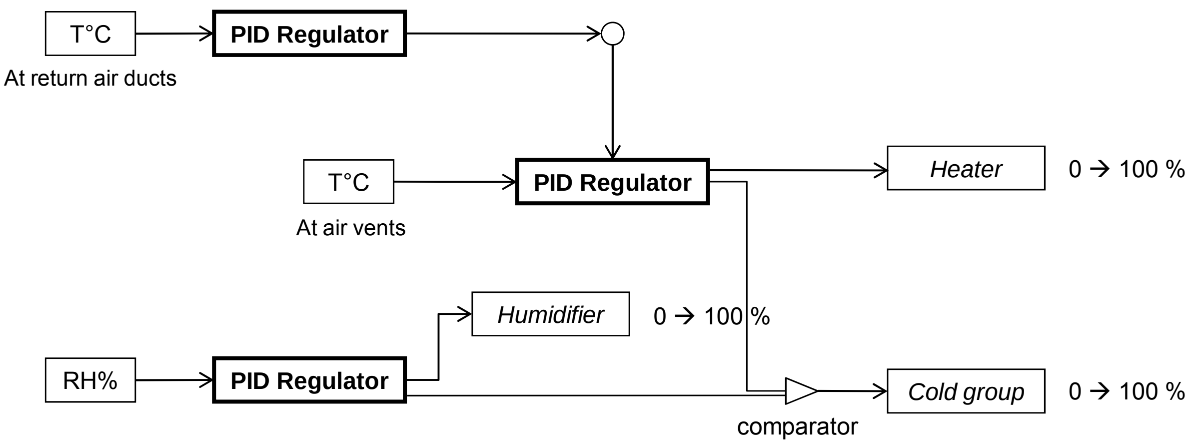


Figure 6. Interrelated regulation systems for temperature and relative humidity

Figures in the next charts (Figure 7) and explanations are given as an example. They depend of course on the precision, power and reactivity of the equipment. They also depend on general external conditions and capacity of insulation of building and equipment.

At equilibrium, the cold group and the humidifier are both set to provide continuously around 30% of their capacity via their own valve. When the regulation system detects a temperature (T) beyond the pre-set tolerances, it asks the cold group and/or the heater to react. For instance, if it is too warm in the room, the refrigerating machine alone will be asked to be effective (gradually opening depending on how warm over 21°C it is). In the other hand, if it is too cold, the heater will be asked to run on its own if temperature is below 18°C (heater valve gradually opening with decreasing temperature); whereas both heater and cold water will have to run if 18°C<T<21°C (heater valve gradually closing and cold water valve gradually opening with increasing temperature from 18 to 21°C). Moreover, when the regulation system detects that relative humidity (RH) is outside the pre-set tolerances, it asks the refrigerating machine, the humidifier and/or the heater to react. For instance, if the air of the room is too humid, the cold group and the heater are asked to be effective; the humidifier will also have to run additionally if 67%<RH<69%. In the other hand, if the air is too dry, the humidifier is very much in demand and refrigerating machine can also be asked to run (humidifier valve gradually opening and cold water valve gradually closing while decreasing relative humidity).

The two systems were described above individually for an easier representation but they are actually working with synergism. In the same complex example, with recorded temperature of 24°C and relative humidity of 60%, the regulation system will find a compromise between commanding the opening of the chiller and opening of the humidifier. This situation brings about an atmosphere getting closer to the expectations and stabilising conditions.

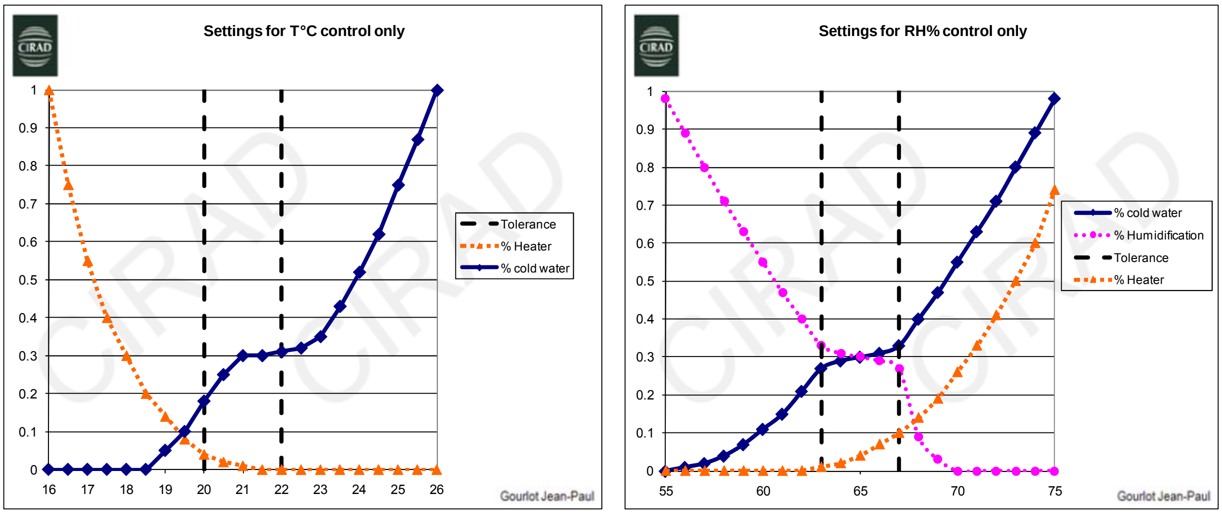


Figure 7. Settings for interrelated chiller, heater and humidifier regulation - Correct regulation system

4 - Method for controlling the AMS equipment

With the previous given requirements, textile testing laboratories could have the opportunity to maintain their climate control system within the worldwide agreed tolerances.

Moreover, additional experiments must be carried on with independent sensors from the AMS equipment, in order to check that the system is effectively working as required, especially for approving the installation or in a continuous improvement process.

Well controlling such an ambient air management system is somehow difficult. It is a real necessity to be aware of it. Despite all the efforts and investments that could be brought, variations are still likely to exist: short-time variations from conditioning system and long-time variations from external surroundings such as instrumental heating, heat conduction of the inner walls, people in the room, door opened for a limited time, evolution of temperature, relative humidity, wind speed and direction during the year… Therefore it is important to use continuous monitoring associated with routine procedures frequently in the year in order to be able to control the system and react consequently.

4.1 - Example of short-time variation due to system failure

Controlling the system by monitoring associated with alarm systems enables rapid reaction, collecting and visualising the conditions of the laboratory. Thus it is possible to be reactive and efficient.

Figure 8 is a recording of temperature and relative humidity of the air of a fibre testing room, which was obtained from electronic sensor readings. In this example, ambient conditions are disturbed by cutting down the water supply of humidifying system. It is important to notice the room "deconditioning", which occurs to be very fast. Once conditions are restored to conformity, a minimum delay of 24 hours is required before testing back again.

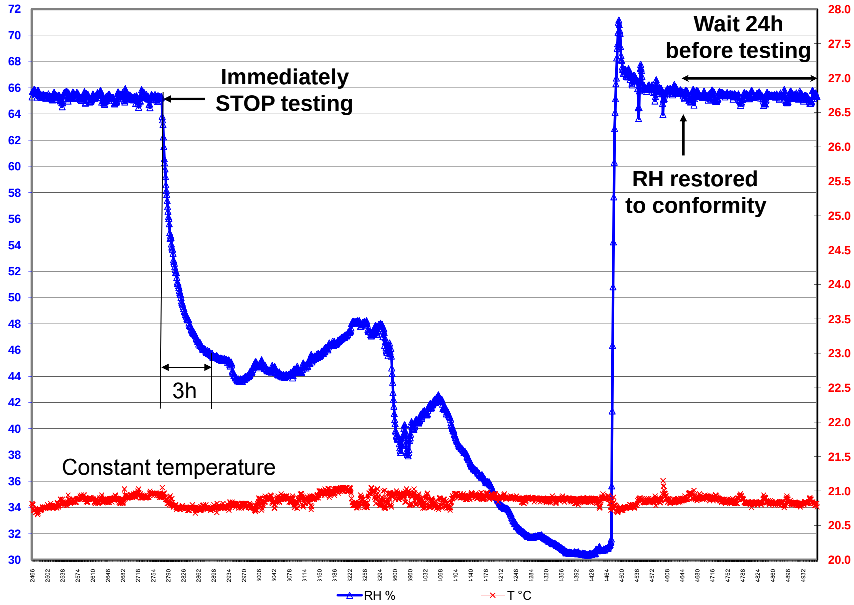


Figure 8. Recording of temperature and relative humidity of the air of a fibre testing room while perturbation in relative humidity.

4.2 - Example of a routine procedure proving the conformity of the laboratory to the international standards

4.2.1 - General information

Next important step is to prove whether or not that mean temperature and relative humidity are stable within the tolerances over any continuous 1h period as described in ISO 139:2005 Annex A, despite short-time and long-time heat variations in the laboratory. Measurements must be done at various locations in the testing room with sensors at a rate of minimum 1 per 50 m^3. These sensors shall be independent of regulation system sensors and very sensitive (resolution as mentioned in Table 4). Moreover, measurements shall be:

- carried out periodically (for instance every minute for digital or electronic measure equipment),
- recorded round-the-clock and printed on a graph to check the ability of the conditioning device to respect permanently the tolerances,
- stored and easily released for investigation in case of controversial laboratory results. All documents should be kept in storage in order to insure the traceability of sensor calibration and maintenance and the traceability of results.

4.2.2 - Checking the functioning

In order to check the ability of the system to adapt to the changes in the room, a previous experiment of heat changing shall be organised, for instance for approving a new installation. Figure 9 is an example of sequences of turning on and off automatically several instruments is planned for a long period of time, while no other condition is interfering with the system.

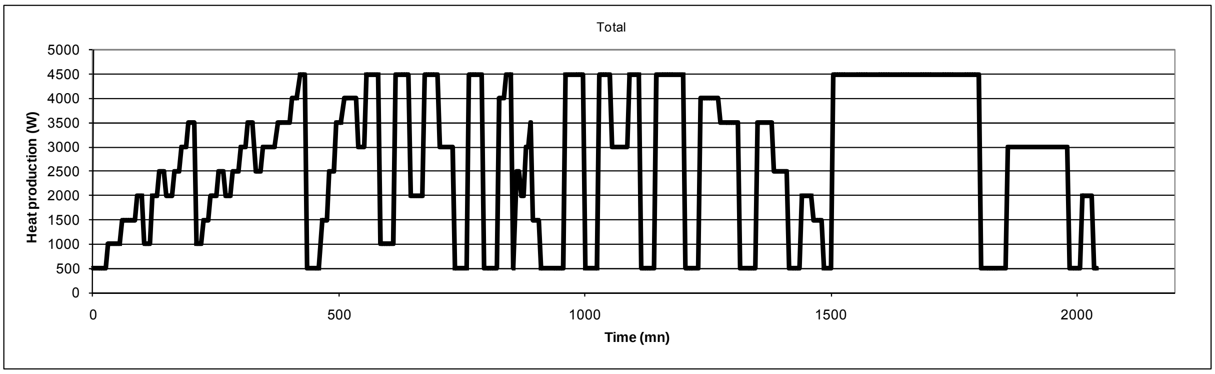


Figure 9. Heat production in the room changing with heat sources activating.

The intention is to observe the consequences of the changes on ambient air conditions by recording both temperature and relative humidity along the same time axis. This will help in concluding how to settle better regulation rules and settings depending on how the system is reacting.

4.2.3 - Description of an example of control procedure

The next following paragraph intends to explain how to control spatial variations of atmospheric conditions with an example of procedure. Leading experiments at various locations and several height levels will help representing a relative humidity (RH) and temperature (T) mapping of the laboratory such as represented in Figure 10.

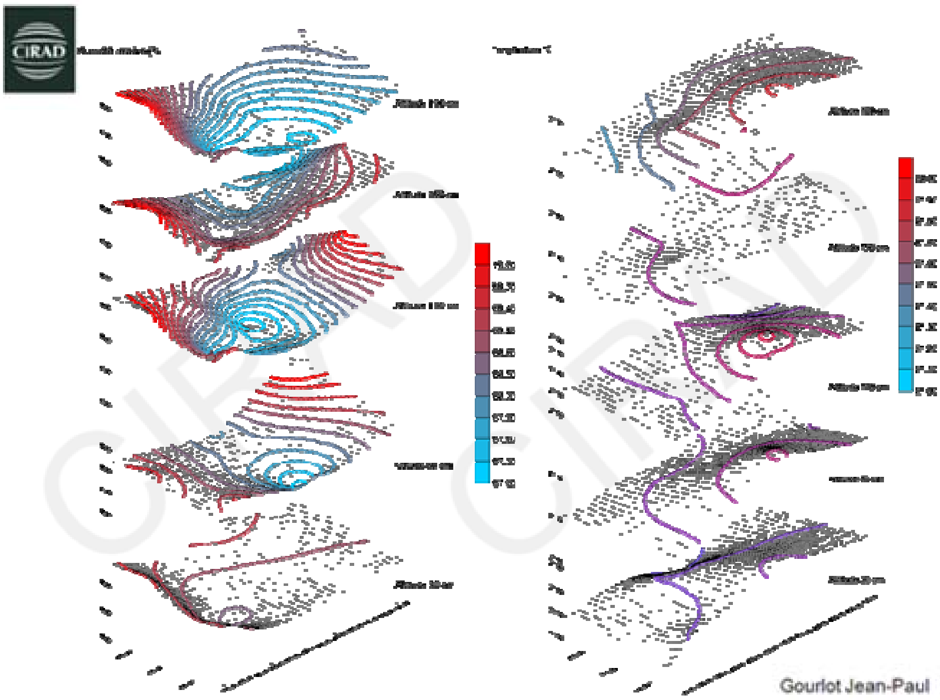


Figure 10. Example of cartography of RH and T of the laboratory (CIRAD, room #1)

The following procedure is organised into five steps:

- Step 1. Studying the impact of external surroundings on system reactivity
- Step 2. Checking that each independent T and RH sensor gives reliable results
- Step 3. Organising the volumetric measurements
- Step 4. Volumetric measuring
- Step 5. Data gathering and interpreting

- Step 1. Studying the impact of external surroundings on system reactivity is the first thing to be tested before starting the main study. We want to assure that the number of people in the room or doors opening do not modify the stability of the measurements, or not significantly. These assumptions have to be tested using an accredited T/RH probe, with and without such perturbation factors, at different height levels.

- Step 2. Since several independent T/RH sensors are going to be tested, it is necessary to ensure that all of them give reliable results. Thus, reading levels could not be blamed for any fluctuation in T or RH. It is then required to use directly accredited probes (e.g. Rotronic instruments); failing this, other probes can be used only if they were indirectly adjusted to an accredited instrument. A specific experiment needs to be devoted to check that all probes display common results: several instruments, including an accredited one, would measure atmospheric air conditions in the same time (as shown in Figure 11) and instruments offsets can be corrected if necessary. In our example, this operation was executed during 2 hours (every minute during 120 minutes) within 3 repetitions.

Figure 11. Three probes recording in the same time as an accredited probe

- Step 3. Volumetric measurements have to be organised depending on the dimensions of the laboratory. The first question is: where is it interesting to measure the air conditions? Specifying areas of interest AO (the sample storing and working areas) would inform on where to put the T/RH sensors and how many of them are needed. In the case of a $50m^3$ laboratory, 6 AO were specified, and 5 levels of height were also defined to complete the spatial volume. Ideally, all measurements should take place in the same time. Otherwise, randomisations can help figuring out how many series of measurements can be done, depending on the number of individual probes available.

- Step 4. After planning it, measuring can be proceed, ensuring that probes are recording and transferring T and RH data to data base automatically. In practical terms, 6 probes measured T and RH at 6 different AO at one particular height at a time. Each experiment of the whole process lasted 3 hours (recording every minute during 180 minutes) and was repeated 3 times.

- Step 5. Data gathering can be done by requesting the data base to obtain a total of 16200 lines of T and RH results (6x5x180x3). For each experiment, 180 minutes data give a possibility of averaging 120 times 60 min (1-61, 2-62, …, 120-180). It is important to understand that what is observed is the average on 1 hour measurement results, in opposite to every single measurement. As shown in Figure 12, it is easy to notice that the "moving" average is conform to tolerances, even if many single points are beyond the limits. Mean relative humidity was then stable within the tolerances over the 120 continuous 1hour-periods observed for this experiment (CIRAD, room #2, height 110cm, AO 3, repetition 3). This study has to be done for every experiment and for both T and RH conditions. For example, Figure 13 represents 1h-average temperatures for the 18 experiments at 110cm height (6AO, 3 repetitions).

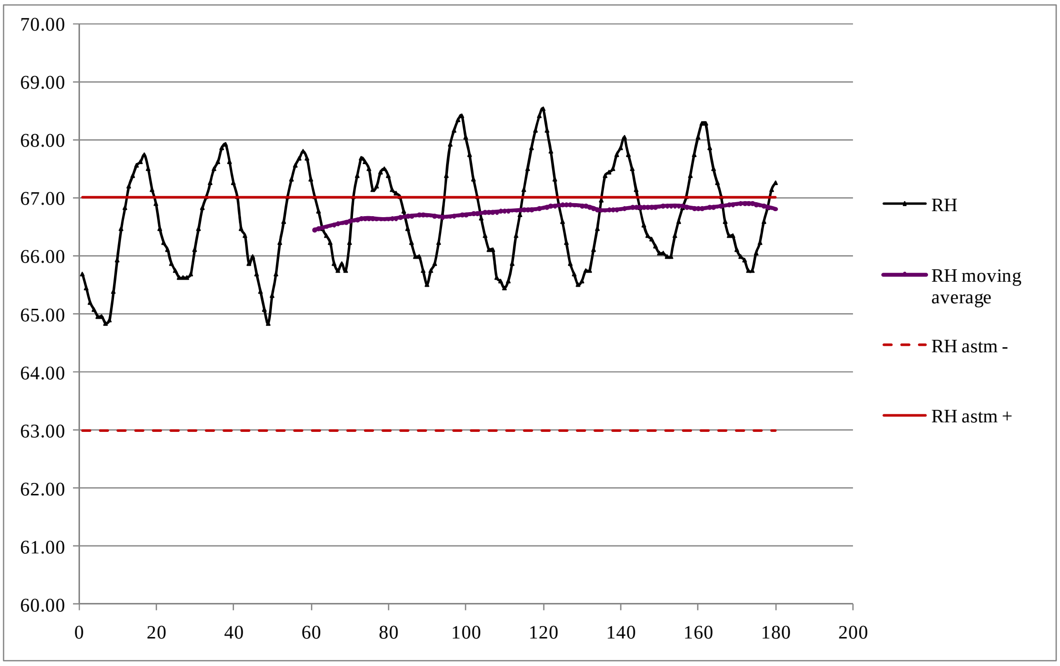


Figure 12. Relative Humidity recording during 180 minutes and moving average (CIRAD, room #2, height 110cm, AO 3, repetition 3)

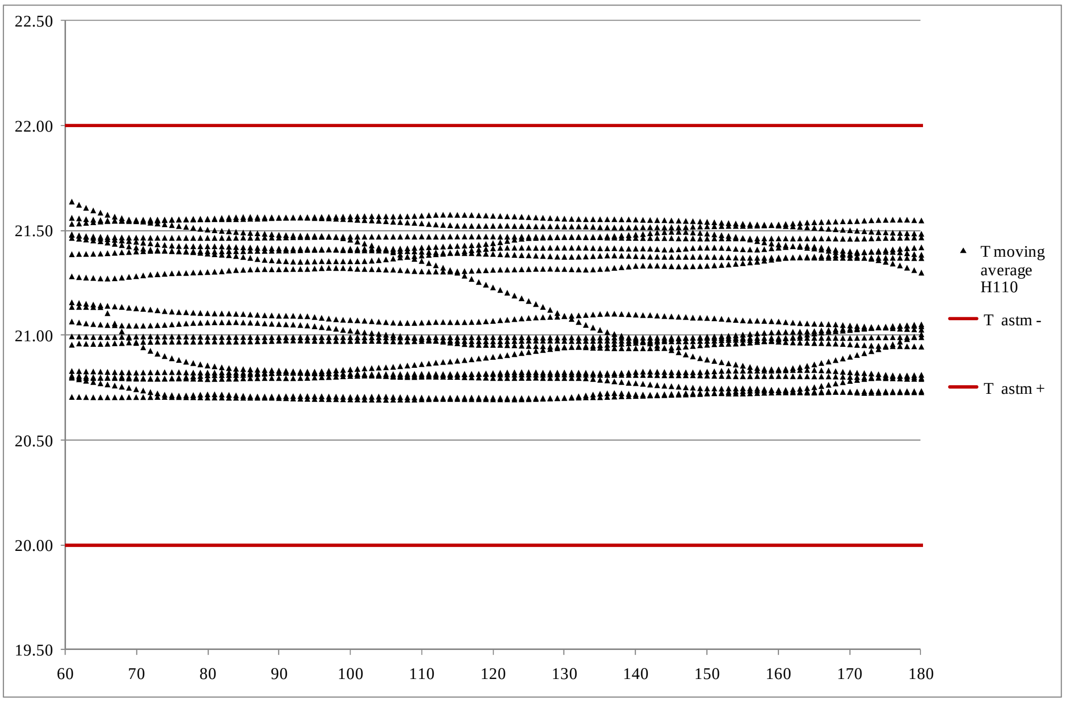


Figure 13. Moving average of Temperature, obtained from T recordings (CIRAD, room #2, height 110cm)

The atmospheric conditions need to fulfil the international standards at any point of the laboratory. When all the results are all in the tolerance zone, the conditioning of the laboratory can be considered as valid. However the same operation needs to be done several times a year in order to validate the capacity of controlling the Air Management System of the laboratory. When temperature or relative humidity is beyond the tolerances, a deeper analysis of the potential incriminated parameters must be done to understand and respond to the ongoing issue.

5 - <u>Conclusion</u>

For a complete satisfaction of the Air Management System, power supply must be correctly adapted upstream and maintenance shall be performed regularly. A full description of these two complementary requirements is covered in different chapters.

With the full description of the Air Management System in this part, providing technical requirements and recommendations, laboratories using SITC should now be able to:

- ✓ respect completely the basic standards required for cotton testing,
- ✓ evaluate the ability of a manufacturer/subcontractor willing to install new equipment to regulate both temperature and relative humidity of the air,
- ✓ modify their climate system if necessary,
- ✓ prove their ability to maintain atmospheric condition within the worldwide agreed tolerances whenever the equipment is newly installed or for a periodic verification.

Nevertheless, if the laboratory needs to improve its AMS, it is highly recommended that a fully detailed diagnosis is realized by a specialist in air conditioning engineering, with expertise in cotton classing conditioned laboratories.

Annex
Questionnaire for HVAC (AMS) of laboratory
Questionnaire on laboratory rooms

QUESTIONNAIRE FOR HVAC OF LABORATORY

1). **NAME AND GEOGRAPHICAL LOCATION**

Company name: ……………………… Contact name: ………………....
Address: ……………………………….. Tel.: ……………….…………
Address: ……………………………….. Fax: ………………………………
City: ……………………..……….……… E-mail: ……………………………
Country: ………………………….……..
Altitude above sea level (in m): ……… Date: ……………………………..

Please specify maximum and minimum outside design dry and wet bulb temperatures if known.

	dry bulb °C
maximum:	
minimum:	

	wet bulb °C
maximum:	
minimum:	

[The dry bulb temperatures are simply thermometer readings of outside air in the shade as e.g. given by the weather forecasts. If you do not know the wet bulb values, please fill in the following table.]

Alternatively to wet bulb values specify extremes at your location (whole year's course):

max. / min. temp. at 100 % rel. humidity (most humid conditions)

rel. humidity	temperature °C
100 % @	max.:
100 % @	min.:

minimal humidity at cold / hot conditions (most dry conditions)

rel. humidity	at extreme temp. of °C
min.: % @	min.:
min.: % @	max.:

Please also attach a table with monthly averages of temperature and relative humidity of your area. If available please attach a graph with minimum and maximum temperatures and relative humidity / wet bulb temperature / dew point temperature for the year. Such a graph may be obtained from the national weather bureau or the meteorological station of the nearest airport.

2). **DESCRIPTION OF LABORATORY**

Please specify the number of rooms and their purpose. Please also flip over this page and draw a floor plan of the laboratory rooms (mark the rooms by their numbers and add an arrow pointing northwards to your drawing). You can also attach an existing floor plan.

Number of rooms:

Purpose of Room 1:	
Purpose of Room 2:	
Purpose of Room 3:	

Please fill in a separate form (Annex 1) for each laboratory room that needs air conditioning.

2a). **FLOOR PLAN**

ANNEX 1: QUESTIONNAIRE ON LABORATORY ROOMS

(Please fill in a separate annex questionnaire for each room of the lab)

Room Number (as specified on main page): ……………..

1). **DIMENSIONS OF ROOM**

-Length of room (in m) : ……..….

-Width of room (in m) : ……..….

-Height of room (in m) : ………..

2). **CONSTRUCTION OF WALLS**

Specify thickness and material of wall. (Example: 250mm thick brick wall or 75mm dry wall partitioning). If available provide value of thermal conductivity of walls (value + measurement indicator e.g. α = …..W/m²K, thermal diffusivity).

-East - Wall: ……………………………………………………………………

-North - Wall: ……………………………………………………………………

-West - Wall: ……………………………………………………………………

-South - Wall: …………………………………………………………………

3). **CONSTRUCTION OF ROOF**

Please describe the roof construction and the roof's insulation (Please note that the roof should have at least 25mm thick insulation, preferably 50mm in order to reduce the running cost of the HVAC System). (Example: IBR Sheeting with 25mm thick insulation and suspended ceiling)

Roof construction: ……………………………………………………………

…………………………………………………………………………………

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4). **INTERNAL OR EXTERNAL WALL**

Please mark the appropriate property. If it is an external wall please indicate shading/sun (hours of per day). If it is an internal wall, then please indicate the temperature in the adjacent room.

- E - Wall: External* (…….. hours sun, …….. hours shade)
  Internal* (temperature of adjacent room: …….^{0}C)
- N - Wall: External* (…….. hours sun, …….. hours shade)
  Internal* (temperature of adjacent room: …….^{0}C)
- W - Wall: External* (…….. hours sun, …….. hours shade)
  Internal* (temperature of adjacent room: …….^{0}C)
- S - Wall: External* (…….. hours sun, …….. hours shade)
  Internal* (temperature of adjacent room: …….^{0}C)

5). **WINDOWS**

Please mark if applicable: internal / external. Please indicate the size of windows, the type of glass (simple or insulation glass / no. of layers), air tightness (of glass/frame: tight – untight) and sun blinds (none – inside – outside).

- E - Wall: Internal / External Size of window : …….. cm x ………. cm
  glass: ………/….. tightness: ………… sun blinds: …......
- N - Wall: Internal / External Size of window : …….. cm x ………. cm
  glass: ………/….. tightness: ………… sun blinds: ……...
- W - Wall: Internal / External Size of window : …….. cm x ………. cm
  glass: ………/….. tightness: ………… sun blinds: ……...
- S - Wall: Internal / External Size of window : …….. cm x ………. cm
  glass: ………/….. tightness: ………… sun blinds: ……...

6). **PEOPLE**

How many people will be working in the Laboratory:

Normally ………. People, maximally .... People.

7). **EXTRACTION SYSTEMS**

There should not be any extract fans installed in the Laboratory, but if there is an extraction system installed, then please specify the extraction air volume in

m^3/h: ……….

8). **LIGHTS**

Please specify the type and number of lights and their rating in Watts:

Type(s): ……….….Number(s): ………….. Rating (sum of all): …………W

If this is not yet known then a lighting load of $25W/m^2$ will be assumed.

9). **LABORATORY EQUIPMENT**

Please specify the installed power in Watts of all test equipment that is located in the room:

Device 1: Type: …………………, Power: ………… W

Device 2: Type: …………………, Power: ………… W

Device 3: Type: …………………, Power: ………… W

Device 4: Type: …………………, Power: ………… W

Device 5: Type: …………………, Power: ………… W

Device 6: Type: …………………, Power: ………… W

10). **ENTRANCES / AIRLOCK.**

All entrances to the Laboratory should have an airlock. Please indicate below the number of entrances, mark if the respective entrance is internal/external and confirm that it has an airlock. Please also name entrances for goods (if they are not covered under the windows field).

Number of entrances: ……….

Entrance 1: internal / external airlock YES / NO

Entrance 2: internal / external airlock YES / NO

Entrance 3: internal / external airlock YES / NO

Entrance 4: internal / external airlock YES / NO

Entrance 5: internal / external airlock YES / NO

11). **ADDITIONAL REMARKS.**

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