UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Manufacturing Engineering

EVOLUTION SENSOR AND DEVELOP THE STANDARD OPERATION PROCEDURE TEMPERATURE AND HUMIDITY CALIBRATION METHOD IN CALIBRATION LABORATORY

Liew Tye Leong

Master of Manufacturing Engineering
(Manufacturing System Engineering)

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LIEW TYE LLEONG

A thesis submitted
in fulfillment of the requirements for the degree of Master of Manufacturing Engineering (Manufacturing System Engineering)

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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SESI PENGAJIAN: 2016/2017

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Disahkan oleh:

Tyelong

Cop Rasmi: DR. MOHAMAD BIN MINHAT
Pensyarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

Alamat Tetap:
30 Lorong Bukit Juru 4
Taman Bukit Juru
14100 Simpang Ampat Pulau Pinang

Tarikh: 28 Julai 2017

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Universiti Teknikal Malaysia Melaka
Hang Tuah Jaya,
76100 Durian Tunggal,
Melaka, Malaysia.

Tel : +606 555 2000
Faks : +606 331 6247
www.utem.edu.my

FAKULTI KEJURUTERAAN PEMBUATAN
Tel : +606 331 6429/6019 | Faks : +606 331 6431/6411

Ruj. Kami (Our Ref.) :
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11 Jamadilawal 1438H
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DECLARATION

I declare that this thesis entitled "Evolution Sensor and Develop the Standard Operation Procedure Temperature and Humidity Calibration Method in Calibration Laboratory" is the result of my own research except as cited in the references. This thesis has not yet being accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : LIEW TYE LEONG

Date : 28 Julai 2017

APPROVAL

I hereby declare that I have read this thesis and it is sufficient in terms of the scope and quality to gain the award of Master of Manufacturing Engineering (Manufacturing System Engineering).

DR. MOHAMAD BIN MINHAT
Pensyarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

Signature : .....

Supervisor Name : .....DR. MOHAMAD BIN MINHAT.....

Date : .....28 JUL 2017.....

DEDICATION

To my beloved mother and father

ABSTRACT

The environmental control system for a laboratory must be maintained well. The laboratory shall not have any downtime. The environmental out-of-tolerance conditions and services may shut down the laboratory. Because of the requirement, the environmental controls sensors shall be calibrated regularly involves yearly calibration cost of USD 10,000. The objective of this project is to create a new process of a standard operating procedure to calibrate the laboratory temperature and humidity sensors. This project evaluates the accuracy of the recorder-sensors used in the laboratory. The project will also design the standard operating temperature and humidity calibration procedures (SOP) that consists of setting up instruments and collecting readings from instrumentation devises. In addition, the test and measurement methods are required as compliance criteria of the international standard requirements of ISO/IEC 17025:2005. This project is the successful develop and implement the operating temperature and humidity calibration procedures (SOP) in the calibration laboratory. This project has successfully developed and implemented the calibration of temperature and humidity standard operating procedure (SOP) in the calibration laboratory. A significant cost reduction for the annual operation cost for the laboratory which is 70% reduced compared to the previous cost is achieved. (one paragraph will do, don't so many paragraph)

ABSTRAK

Sistem kawalan persekitaran bagi makmal mesti diselengara dengan baik. Makmal ini hendaklah sentiasa beroperasi. Sekiranya persekitaran makmal berada di luar spesifikasi, aktiviti di dalam makmal akan diberhentikan. Oleh sebab demikian, pengesan yang digunakan untuk mengawal pesekitaran di dalam makmal perlu ditentukur secara berkala kerana kos penentukuran tahunan adalah sebanyak USD 10,000. Objektif projek ini adalah untuk mewujudkan satu proses baru untuk menentukur pengesan suhu dan kelembapan di dalam makmal. Projek ini akan menentukan ketepatan perakam yang digunakan di dalam makmal. Untuk projek ini, prosedur untuk pengesan suhu dan kelembapan akan dibuat dan prosedur ini mengandungi cara penyediaan peralatan dan cara mengumpul bacaan daripada peralatan.Di samping itu, ujian dan kaedah pengukuran dikehendaki sebagai kriteria mematuhi keperluan standard antarabangsa ISO / IEC 17025: 2005. Projek ini berjaya merangka dan melaksanakan prosedur operasi penentukuran suhu dan kelembapan (SOP) di dalam makmal. Dengan terlaksananya projek ini, pengurangan kos yang ketara untuk kos operasi tahunan makmal iaitu sebanyak 70% dapat dikurangkan berbanding dengan kos terdahulu.

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AC	Alternating current
CC	conversion coefficients
DC	Direct current
DMM	Digital multimeter
DUT	Device under test
ISO	International Organization for Standardization
GΩ	Gigaohm
GΩ	Teraohm
RH	Relative Humidity
PRT	Platinum resistance thermometers
SPRT	Standard Platinum resistance thermometers
TAR	Test Accuracy Ratio
TUR	Test Uncertainty Ratio

CHAPTER 1

INTRODUCTION

1.1 Overview

Calibration is a comparison between the output of a scale against a standard reading. Therefore, calibration determines the difference between a scale readout and the actual value of the platform to ensure accuracy. This statement was explained in detail in Jaworski, J.M., et al (2014). National Instruments Calibration Services Penang (NICSP) laboratory located in 8, Lebuh Batu Maung 1, Bayan Lepas, Pulau Pinang, Malaysia is an accredited calibration laboratory by American Association for Laboratory Accreditation. The calibration laboratory performs calibration procedures in the areas of AC or DC voltage and current, resistance, Resonance Frequency (RF), oscilloscope, time and frequency and capacitance.

The recommended temperature and humidity of the laboratory is required to operate within limits at 23 ± 1 ° C and 45 %, ± 10 % relative humidity (RH). The temperature and humidity operating limits is predefined to be in control within the specification to meet the calibration procedure of NI 4071 7½-Digit FlexDMM Calibration Procedure, National Instruments, April 2011 that specify the calibration to be performed in the predefined criteria. The calibration laboratory environmental control system is designed and setup by Precision Environments Inc. as shown in Figure 1.1. This system monitors the temperature and humidity changes of the laboratory room in order to prevent the effects that may lead to failure operation or damage of a system under testing.

This project introduces temperature sensor which is used to measure the temperature and humidity in the laboratory. Temperature sensors consist of two types, a contact sensor and a non-contact sensor. Contact temperature sensor requires a physical contact with an object detected. A non-contact sensor however, uses convection and energy methodology to

monitor the difference in temperature and cannot be touched during temperature measurement process.

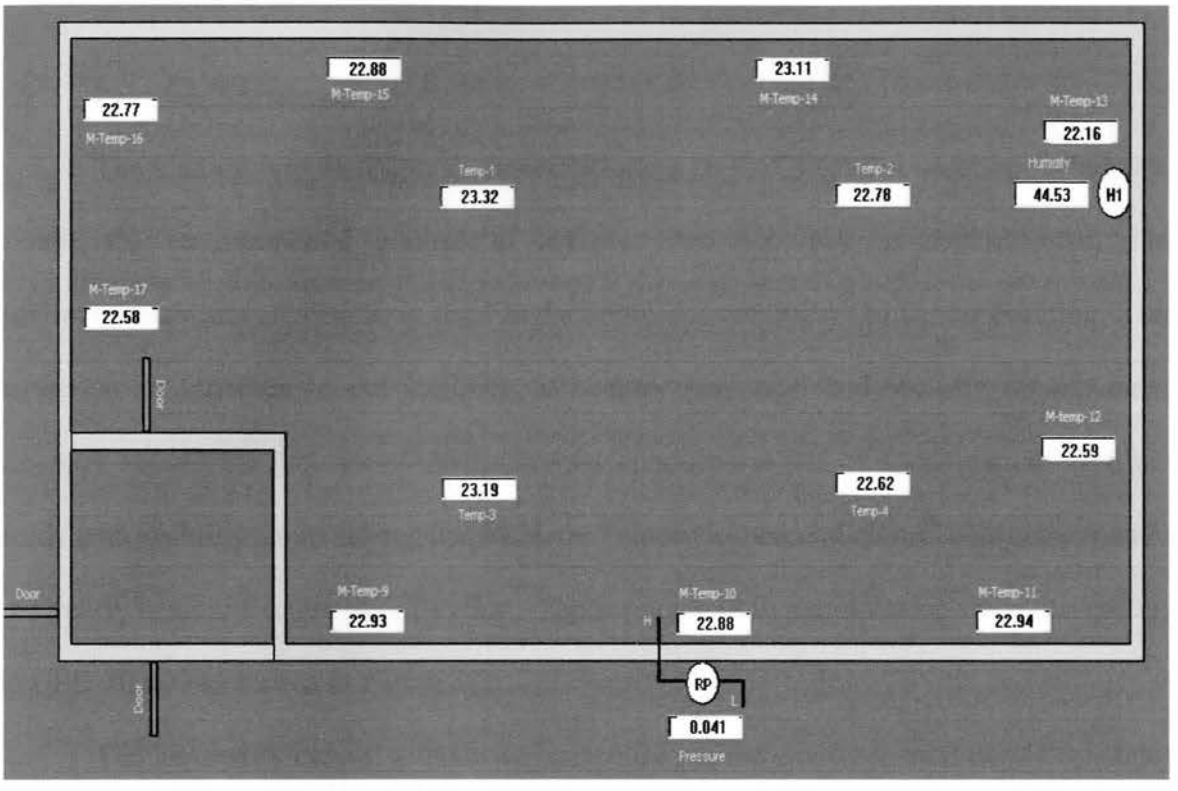

Figure 1. 1: NICSP Calibration Lab Layout

The sensor device also detects temperature and humidity data in real-time. Srbinovska, M., et al (2015) proposed a low cost wireless sensor to monitor key environmental parameters such as the temperature, humidity and illumination for vegetable greenhouse architecture. This sensor is capable to collect accurate data from the sensors. The few parameters that must be established during the sensor system setup is the specification and accuracy of the sensor, sensor operation and the locations of the sensor in the laboratory.

According to ISO/IEC 17025:2005 requirements, section 5.3; Accommodation and Environmental conditions, the laboratory facilities shall ensure that environment conditions do not invalidate results or adversely affect the required quality of measurement. The laboratory must establish a method in monitoring environmental factors such as temperature

and humidity. The sensors that are used in the laboratory requires to run a calibration exercise to ensure readings from the sensors are consistent with other measurements.

1.2 Problem Statement

The heating, ventilating and air-conditioning (HVAC) system must be installed to handle the environmental control to achieve high accuracy in measurement. The environmental control system is used to facilitate the control room in the building. This serves as an interface to the facilities, laboratory personnel and security organizations whereby should the laboratory environmental condition is out of specification, facilities holds responsibility for rectifying the problem. This environmental control sensors maintains at a yearly basis and requires calibration. The service cost in maintenance alone can cost up to USD 10,000 as shown in Figure 1.2.

The laboratory cannot tolerate downtime due to the environmental out-of-tolerance condition. This is because some of the products test conditions are required to be maintained at an ambient temperature of 23 ±1 °C. Test results may not meet published specification if the product is not tested in the specified environmental condition or it may lead to damaging of the device as shown in Figure 1.3.

YOUR AGREEMENT INVESTMENT

This Service Agreement will be for an original term of one (1) year, beginning on **January, 2016.** This Agreement will renew annually, unless either party changes the services covered, or the annual investment. **National Instruments'** annual investment in this program is shown below:

DESCRIPTION	PRICE	TERM
Annual Lab Recertification for **Calibration Lab** **Metrology Lab** **Work will be accomplished while we are already in Penang to avoid travel expense**	**$10,401.00**	**1 Year**

Payment terms will be thirty (30) days after Precision Environments date of invoice. Precision Environments reserves the right to discontinue its service any time payments have not been made as agreed. Failure to make payments when due or impairment of customer's credit shall relive Precision Environments of any and all obligations pertaining to work or performance of work.

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NICSP Lab yearly Temperature and Humidity re-certification

- the cost of service is USD 10.4K per year.

NATIONAL INSTRUMENTS

Figure 1. 2: Yearly Temperature and Humidity re-certification Calibration cost for NICSP laboratory

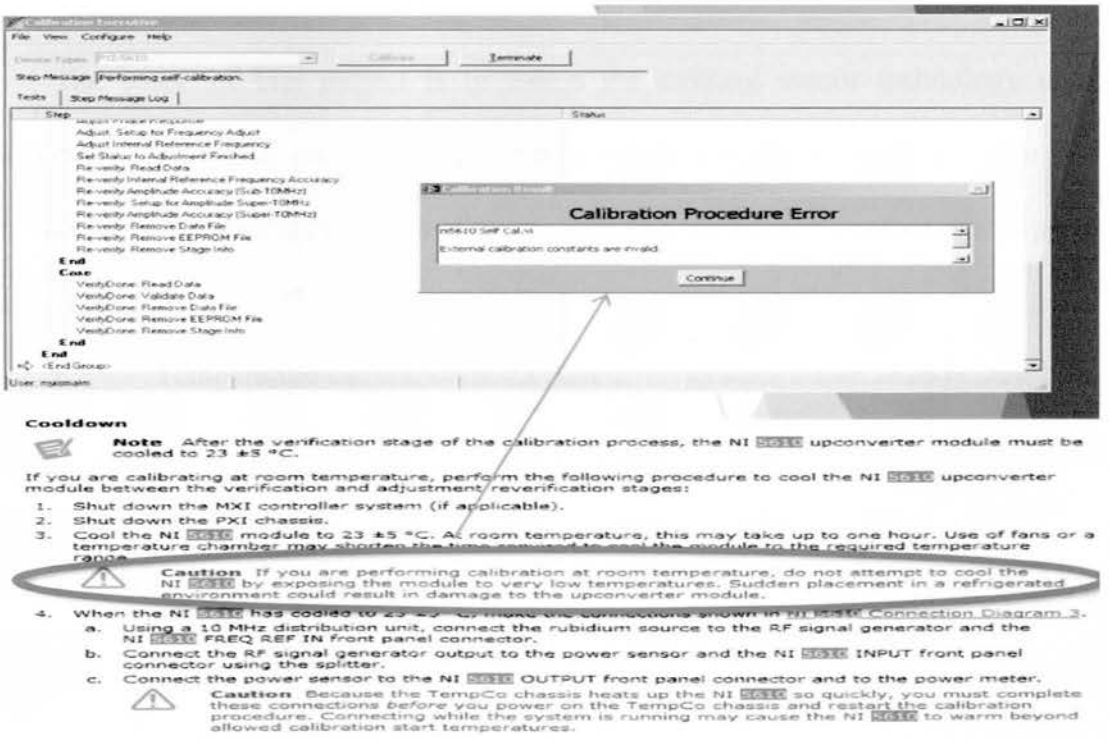

Figure 1. 3: A product can be damaged if the environmental condition is not within specification

1.3 Objectives

The goal of this project is to develop new process of standard operation procedure in terms of calibrating the laboratory and evaluate the temperature and humidity sensors. There are specific objectives to make the project a success.

The objectives are to:

- To Develop a temperature and humidity calibration standard operating procedure (SOP) in setting up instrumentation devices and data collection from the instruments.
- Evaluate the accuracy of the temperature and humidity calibration methods and introduce a unique SOP to calibrate temperature at 23°C and humidity 45 % RH.

1.4 Scope

The scope of this project is to assess the existing sensor technology and the measurement system as part of the practicability analysis for this project. The project identifies the benefits of the varieties of technology that can be used in other related projects. The technique are:

I. Temperature calibration at 23 °C ± 1 °C between Fluke 2626 H Dewk Prode, Extech Instrument temperature and humidity recorder and YSI 44000 series thermistor using propose calibration SOP.

II. Humidity calibration at 45%RH ± 10 %RH between Fluke 2626 H Dewk Prode, Extech Instrument temperature and humidity recorder and YSI 44000 series thermistor using propose calibration SOP.

III. Compare and conclusion of above sensor's result .

The project also reviews the humidity difference between some countries and the impact to the instruments. Calibration knowledge holds a significant part in accomplishing the objectives for the project. The instruments, calibration procedures and results collected from the calibration system must meet the requirement of the ISO standard ISO/IEC 17025:2005. parameter, stencil type and squeegee blade.

1.5 Expected Outcomes

The objective of the project is to develop a temperature and humidity calibration procedure to calibrate the sensors installed in the calibration laboratory. This process introduces a comparison method in which the sensor is calibrated by comparing a reference sensor or a standard sensor in the calibration laboratory.

This project will analyze the differences in practical measurement as compared to the theory learned in classroom. The goal is to have a standard operation procedure for the temperature and humidity calibration at the end of this project. The overall results from this project may introduce more future improvements to further improve the procedure.

1.6 Dissertation Organization

First chapter discusses the background, statement of problem, scope, objectives and expected outcomes. The main aim of this project is to gain knowledge about the temperature and humidity calibration with different sensors. It is also to gain more understanding on the operation of the different temperature and humidity sensors and their application.

The second chapter reviews the existing technology in for laboratory environment control, sensor and calibration for temperature and relative humidity. Advantages of different calibration systems developed by different vendors are compared to strengthen