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Course: HNC Instrumentation Engineering Year 1
Module Code: **PCEE4002/PCP04002**
Module Name: Research Study and Presentation Skills
Element 1: A Literature Review

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Introduction

The following literature review aims to evaluate and compare three given articles from the Institution of Occupational Health and Safety (IOSH) monthly magazine. Namely:-

Crisis response: Good in a storm,

Human error: Error on trial,

Piper Alpha: Regime change.

These informative articles are aimed at a wide audience of the population from those in higher management aiming to benefit their organization to those aiming to gain a better understanding of human behavior when accidents occur. They also highlight how lessons can be learnt from different scenarios.

Article 1 – ‘Good in a storm’ focuses on the psychology behind persons behavioral responses to a crisis. It explains how responses determine survival, yet do not always respond in a way that makes survival more likely. It explores why these thought processes occur and what can be done to overcome this resulting in fewer fatalities from accidents.

Article 2 – ‘Error on trial’ explores different behavior-based safety approaches towards human errors. Be the focus on the end user or organizational faults.

Article 3 – ‘Regime change’ reviews the Piper Alpha Oil Platform Disaster of July 1988. It outlines the failings which resulted in this disaster leading to a change in safety regulation and practice. There have been no further safety failures in the North Sea oil industry since then (excluding air accidents).

Literature Review

The theories discussed in the two articles 'Crisis response: Good in a storm' (Leach, 2018) and 'Human error: Error on trial' (Leathley, 2017) are perfectly highlighted in the third article 'Piper Alpha: Regime change' (Wustemann, 2018).

The Piper Alpha article reports how the errors made, both by management and end-user, contributed towards the disaster and how people's reactions to the disaster hampered or assisted their survival.

On July 6th 1988, 165 crew of the above named oil platform, lost their lives as a result of a series of explosions and arguably a series of human errors. The literature suggests that the cause of these explosions could have been avoided should communication during a shift change have been efficient.

Despite the US firefighter Red Adair being drafted in to direct the firefighters, the blaze was unable to be contained and only 61 of the 226 people on the rig were rescued (Wustemann, 2018). Between the first and second explosions most of the survivors jumped into the water from the lower decks. The vast majority of bodies recovered were from the accommodation module where the crew were believed to be seeking sanctuary and where smoke inhalation was the most common cause of death.

The above observations support Leach's findings detailing how common responses to a disaster can decrease the likelihood of survival. It may appear that the individuals who sought sanctuary within the platform were experiencing a loss of initiative and did not actively seek to save their lives through different actions. Some, possibly those who were in the accommodation module when the first explosion occurred, may have experienced 'hypoactivity' or 'cognitive paralysis' (Leach, 2018) and simply not responded to the situation unfolding around them. Those who survived appeared to be the individuals who were able to formulate a plan of action to evacuate from the platform. This suggests they were able to make use of the 'Supervisory System' (Leach, 2018) to generate a plan and be able to focus their attention on this despite the disaster unfolding around them. These survivors may have used previous knowledge to draw on their memory stores to generate a plan. However, it is important to note that this system would have been affected by the seriousness of the situation, this combined with an increase of catecholamines which would

have affected the response of different brain regions (Leach, 2018). However, it could be argued that this rush of catecholamines may have worked to the advantage of the individual having to react quickly to a situation being on fire and instinctively dropping to the floor and rolling.

The evidence from 'Good in a storm' (Leach, 2018) suggests that providing individuals with a response to an emergency would increase their likelihood to survive. Having this response, or variety of appropriate responses, stored in their memory would mean that they would not have to rely on the flawed systems outlined above which rely on the pre-frontal cortex but instead utilise the subcostal reactive functions which is where these learned responses can be accessed from. An excess of catecholamines actually enhances the function of this region of the brain. Training individuals to respond appropriately to specific dangers is also less likely to result in 'hypoactivity', 'hyperactivity' and 'cognitive paralysis' (Leach, 2018). Being better prepared for a disaster also allows personnel to be calmer during the incident and therefore lessen the amount of catecholamines released by the brain and therefore lessens the adverse effect they may have on them.

Evidence drawn from the article 'Error on trial' (Leathley, 2017) shows how human error affected the 1988 Piper Alpha disaster. It discusses whether accidents can be attributed to individual failings or errors are simply unavoidable in human life.

The most common cause of death on the Piper Alpha oil platform was found to be smoke inhalation. This raises the question of should personal protective equipment, i.e. breathing apparatus, have been provided by higher management, and utilised by crew. Could this have impacted on the survival rate? Behaviour – based safety approaches would support this view.

The "Swiss cheese" model (Reason, 2016) explains how failings at the managerial level has a trickling effect through further "slices" working its way down to the end user and resulting in an accident. This model can be applied to various contributors to the Piper Alpha disaster but primarily to the initial error which resulted in the first explosion. There was a lack of communication between the first and second shift change regarding the two compression pumps operating on the rig. During the first shift engineers working on valve completed a form stating it was out of commission pending a valve refit. The second shift was not aware of this decision and whilst working on the second pump a fault occurred. This led them to complete a permit of work to restart the first pump resulting in a gas leak which ignited causing several explosions. This leads to the question of why this vital information was not

made available during the shift changeover? Were protocols in place, by higher management, to ensure information filtered down to the end user? At which point did this communication fail? The view of deflecting the fault from the individual (end user) to view it as “a symptom of the problems in the organisation” would appear to support this finding (Decker, 2014).

Similarly the majority of findings from the Cullen Enquiry point towards a failure in management systems which had a catastrophic effect. The Department of Energy Inspectorate could also be seen to play a role as they had conducted earlier in 1988 an investigation which was perceived that its enforcement role was at odds with Occidental’s desire to maximise oil and gas production. This also raises the question of whether the decision to continue production during the maintenance period was influenced by this desire.

However, despite best efforts to understand the chains of errors that allow accidents to occur, disasters will still happen (Turner, 1997). However, it must be noted that no major incident has occurred in the North Sea for the last 30 years suggesting that lessons have been learned from this disaster.

An alternative way to understand behaviour which is termed “human error” is defined by attempts to redefine safety stating that old safety (Safety I) as “a condition where the number of things that go wrong is acceptably small” (Hollnagel, 2014). He believes that this model leads to a focus on errors only. However, by contrast Safety II encourages the focus to be on the desired outcome rather than the error. It believes that variability in human behaviour is necessary and unable to be eliminated. “Human variability is an important ingredient in adaptation and learning, and the ability to adapt to peculiarities in system performance and optimise interaction is the very reason for having people in a system” (Rasmussen, 1982) supports Hollnagel’s observations. Unfortunately, the complex nature of an oil rig does not allow for error so providing people with trial and error opportunities is not possible. There are safe ways of training workers in potentially highly dangerous roles to deal with errors. Experiments can be conducted in simulators without risk. Training workers to respond effectively to such a disaster, possibly using simulators, may have lessened the severity of the disaster and have a positive influence on the survival rate. There were a number of factors which would have prevented the workers accessing the control room to attempt to carry out some of the skills taught through training. The main factor being that the control room was

situated too close to the hazardous areas despite this being a known safety principle when the rig was converted from oil only production to oil and gas production.

Conclusion

All three articles are entwined by the commonality of health and safety. Reading the article 'Piper Alpha: Regime changer' (Wustemann, 2018) links can be made to the other two articles. 'Crisis Response: Good in a storm' (Leach, 2018) helps us to explain the behaviour and response of the workers, who survived and those who perished. 'Human Error: Error on trial' (Leathley, 2017) helps understand why and how errors, leading to such a disaster, occurred and if these could possibly be controlled or even eliminated.

What appears to have begun as one potentially avoidable human error, lack of communication between shift change, led to a catastrophic disaster. However, a closer look reveals a series of errors playing their part in a high mortality rate. The workers response to this situation determined their survival or demise. It must also be noted that the effects of this disaster have had a life-long effect (for example, Post Traumatic Stress Disorder) on many of those who survived, as reported in the Piper Alpha YouTube documentary (Arifin, 2014).

The fact that no major disaster has occurred in the North Sea since this occasion strongly suggests that lessons have been learnt. Possibly, one of the main reasons for this success was the removal of regulatory responsibility from The Department of Energy to The Health and Safety Executive. It could be argued that The Department of Energy's conclusions could have been clouded by its desire to continue to maximise production whereas The Health and Safety Executive was able to provide an unbiased view on the events.

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Soil Temperature Measuring Device

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Course: HNC Instrumentation Engineering Year 1

Module Code: **PCEE4002/PCP04002**

Module Name: Research Study and Presentation Skills

Element 2: Technical Report

Soil Temperature Measuring Device

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Summary:

Development of a method to record soil temperature at regular timed intervals which is linked to the Natural Resources Wales Telemetry System.

Introduction:

The Hydrometry and Telemetry Team of Natural Resources Wales were jointly approached by Natural Resources Wales and Farming Connect to develop a monitoring process in the growing of maize. Farmers were either losing crop or were not maximising crop yield due to planting at the wrong time of year based on soil temperature. Maize has an optimum sprouting/growing temperature range of 7-10°C. The task required the design and installation of a process to enable farmers monitor soil temperature at the depth of 6 inches where maize is planted.



Technical Report:

The basic technical elements of a temperature measuring device and a brief overview of the instruments selected for the project are described below.

The basic elements of a typical measuring device are:-

- (a) Parameter – The physical quantity to be measured.
- (b) Sensor – A device which responds directly in some way to changes in the parameter. This is sometimes referred to as a transducer which produces a signal related to the input quantity measured.
- (c) Signal Conditioner (Amplifier) – Changes the transducer signal to an appropriate form by amplifying the signal.
- (d) Display Unit – Measures and displays the output.

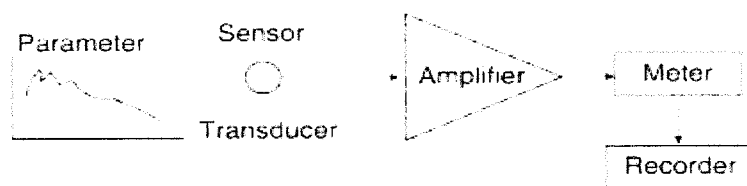


Figure 1 Elements of a typical instrument or measuring system intended to measure variations in the parameter (soil temperature) to be sensed.

(Harrison, 2015)

(a) **Parameter** - in this case the soil temperature.

(b) **Sensor** - The sensor selected for the project was the Platinum resistance thermocouple probe (PT100), the 100 refers to the base resistance of 100 Ω at 0° C (Harrison, 2015).

Soil Temperature Measuring Device

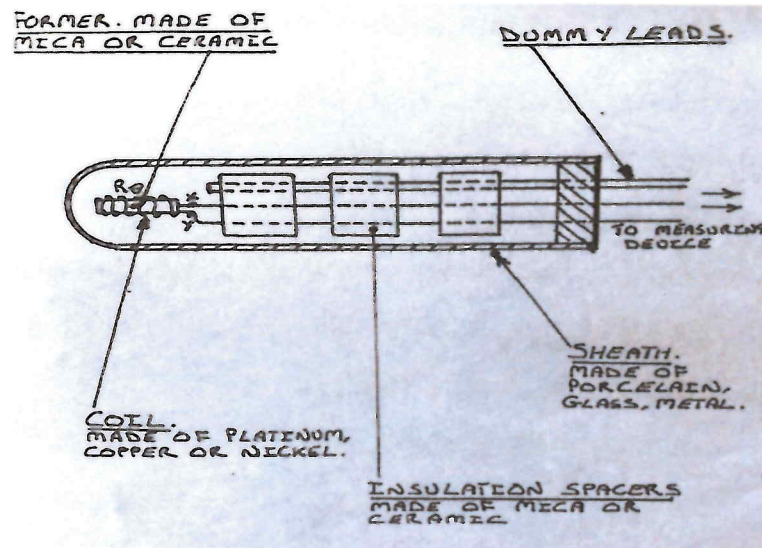


Figure 2 Construction details of a PT100 temperature probe

Principle of operation: -

- Based on the principle that the electrical resistance of a wire increases with temperature.
- The resistance coil measures the temperature.
- Resistance coil made of platinum because more stable, good accuracy, resists corrosion and oxidation.
- Since platinum is expensive copper wire is used to connect the thermometer to the measuring unit.
- Coil is connected to the copper wire at points X and Y (sometimes located outside the sheath).
- Because contacts X and Y are close together errors in measurement result. This is eliminated by using dummy leads which experience the same temperature change as the extension leads.
- The probe is based on the Wheatstone bridge circuit and forms part of this circuit.

(Jefferies, 2006)

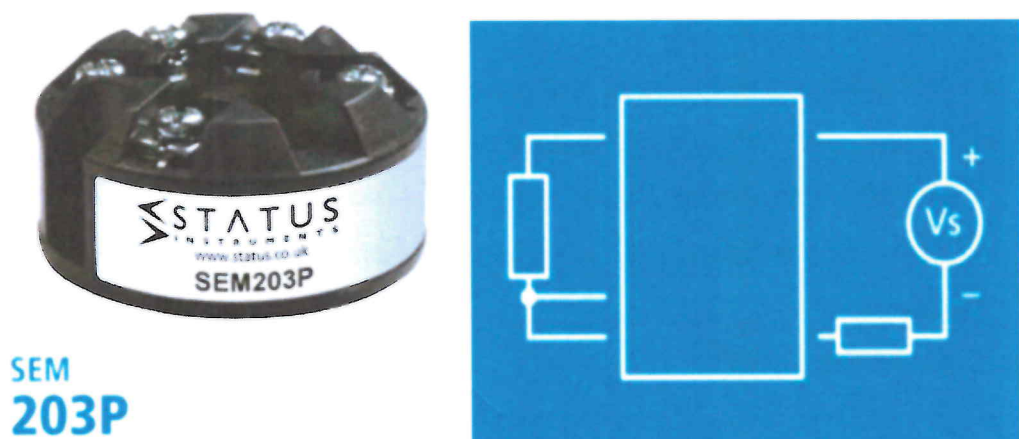
Advantages of PT100 temperature probe:-

- Compact
- Simple construction
- Very stable and reliable
- Platinum coil resistor has good electrical properties which gives high accuracy
- Platinum coil is chemically inert – resists corrosion and oxidation
- Good temperature range (-150°C to 1000°C)
- Use of dummy leads eliminate errors

(c) **Signal Conditioner.** This signal device (often called the signal transmitter or converter) improves the quality of the reading or signal output of a measurement system (Harrison, 2015).

It is used to convert the linearised temperature transmitted by the PT100 probe (sensor) to an electrical signal which is amplified and then transmitted to the display/recording unit to analyse the data.

Research showed the best suited signal transmitter to convert and amplify the signal was the device manufactured by Status Instruments. It converts the resistance controlled by temperature change to an electrical signal ranging between 4mA and 20mA. The device together with its specifications and advantages is shown below: -



Status Instruments <https://www.status.co.uk/product-categories>

Figure 3 Signal conditioner used for the project along with its schematic diagram - Status SEM203P

Advantages of this device

- High stability, has a wide operating temperature range (input range -200 to 1000°C)
- Input accuracy of $\pm 0.1^\circ\text{C}$
- Output accuracy of $\pm 5\mu\text{A}$
- Good working ambient temperature of -40°C to 85°C
- Low power supply to 10V DC
- Circuits housed in good casing- protects from moisture, dust and corrosive atmosphere.
- Compact and allows for space
(Jefferies, 2006)

The circuits used in this signal conditioner consist of a Wheatstone Bridge circuit and Operational Amplifier circuit

Bridge circuits are used commonly as a variable conversion element in measurement systems and produce an output in the form of a voltage level that changes as the measured physical quantity changes (Morris, 2006).

Operational amplifier circuits are used when the typical signal output level of a measurement transducer is too low. Amplification by analogue means is carried out by an operational amplifier (Morris, 2006).

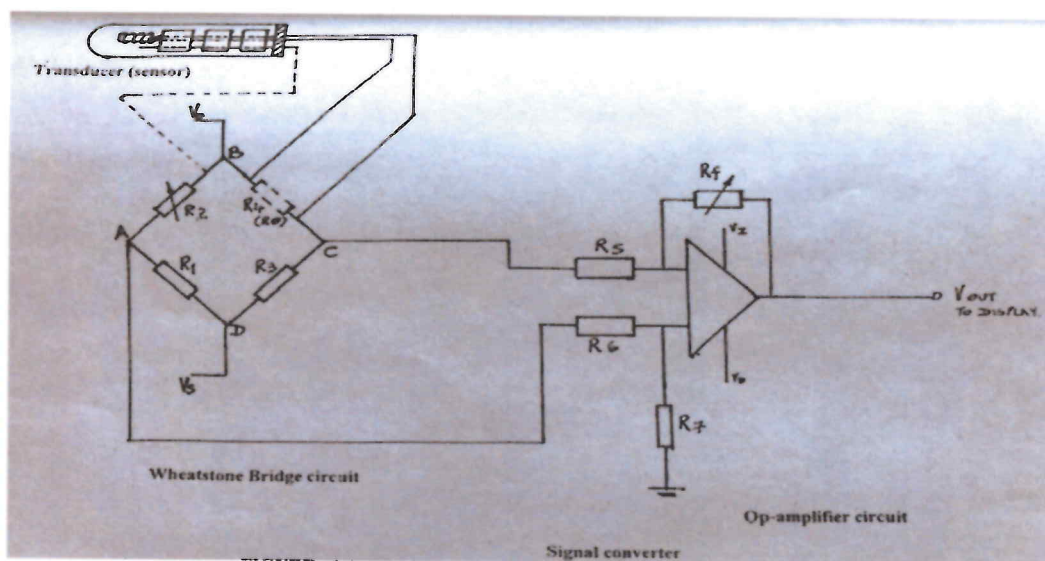


Figure 4 Schematic diagram showing the PT100 probe and the Status SEM203P signal conditioner

(d) Display Unit

The display unit used is a Dynamic Logic Remote Telemetry Unit which has a digital display screen at the front. Within the unit is an analogue to digital converter converting the 4mA to 20mA analogue signal from the signal conditioner SEM203P to display a digital signal. The unit records, stores and transmits the data by mobile means (GSM) or by telephone line (PSTN) comms to the Natural Resources Wales Telemetry System.

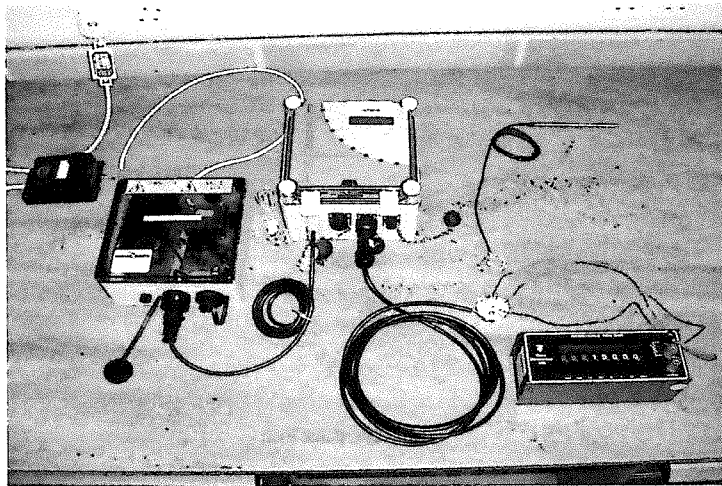


Figure 5 Photograph showing the components used and calibration decade box before transferring to the field

Calibration of signal conditioner within workshop

- The equipment is connected as shown in the photograph prior to installation within the field.
- The telemetry display unit analogue to digital converter was calibrated using an analogue injector to accept the range of 4mA to 20mA at intervals of temperature in range of 0°C to 30°C.
- The temperature probe was disconnected and replaced by the decade box (this was set at 100Ω which resulted in a reading of 0°C on the telemetry display unit).
- The setting on the decade box was changed from 100Ω in steps of 3Ω to 112Ω and the corresponding displays on the telemetry display unit were noted to change in steps of 7.5°C in a range of 0°C to 30°C.
- The equipment was then transferred to the field to start recording the soil temperature.

Equipment set up within field



Figure 6 Photograph showing the components within the field

Conclusion

The task of recording soil temperature in the project enabled farmers to gather real time data allowing them to plant maize at a favourable time of the year and thus yield higher profits and minimise soil erosion.

The report demonstrates my ability to understand the principles of soil measurement instrumentation and to construct and deploy the devices within the field providing a solution to the task.

The project has successfully assisted farmers at the trial site in Newcastle Emlyn, West Wales and, as a result, a further ten sites have been set up across Wales. The data is accessible through the Farming Connect website.



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Appendix

Status SEM203P data sheet

PT100 probe data sheet

PT100 resistance to temperature values table

SEM203P IN HEAD PT100 TEMPERATURE TRANSMITTER

➤ SUITABLE FOR PT100 TEMPERATURE SENSORS

➤ (4 to 20) mA OUTPUT

➤ PUSH BUTTON PROGRAMMABLE

➤ HIGH STABILITY

➤ OUTPUT CURRENT TRIM

➤ INTRODUCTION

The SEM203P is a push button configurable in-head transmitter that accepts PT100 temperature sensors and converts sensor output over a configured range to a standard industrial (4 to 20) mA transmission signal.

A simple push button operation allows the user to not only select the desired range and burnout direction but also perform user trim at both (4 and 20) mA points.

If required, the desired range can be specified at the time of order, removing the need for user configuration. If the range is not specified, then the transmitter will be shipped with the default range of (0 to 100) °C.

➤ FEATURE HIGHLIGHTS

PUSH BUTTON CONFIGURATION

The SEM203P can be ranged against a probe held at high and low range values or by using a resistive representation of the required temperature using a simple “teach” method. Burnout direction can also be set using the same push button.

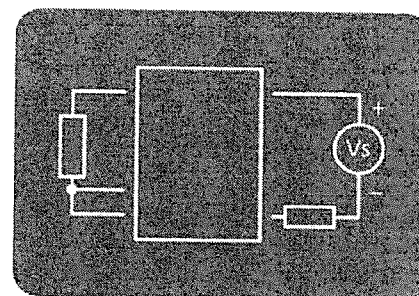
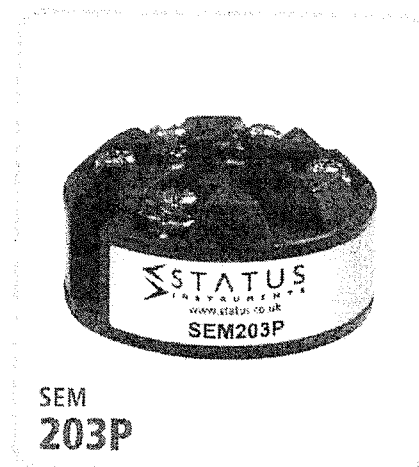
A zero and span trim function is also incorporated into the SEM203P to give maximum flexibility.

SENSOR BURN OUT DETECTION

If a sensor wire is broken or becomes disconnected the SEM203P output will automatically go to its user defined level upscale or downscale and the LED illuminates.

STABILITY

The SEM203P in head transmitter incorporates the latest digital technology to ensure accurate, low drift performance.



SEM203P IN HEAD PT100 TEMPERATURE TRANSMITTER

INPUT		SPECIFICATIONS @ 20 °C
Type / Function	Range / Description	Accuracy/ Stability
PT100 2 or 3 wire	(-200 to 850) °C	± 0.2 °C ± 0.05 % of reading *2
Thermal drift	Zero at 20 °C	±0.02 °C / °C
Minimum span	25 °C *1	
Linearization	BS EN 60751 (IEC 751) standard / JISC 1604	
Excitation current	Approximately	1 mA
Lead resistance effect	0.002 °C / Ohms	
Maximum lead resistance	20 Ohms per leg	
*1 Any span may be used; full accuracy is only guaranteed for spans greater than the minimum recommended		
*2 Basic measurement accuracy includes the effects of calibration, linearization and repeatability		

OUTPUT		SPECIFICATIONS @ 20 °C
Type / Function	Range / Description	Accuracy/ Stability/ Notes
Two wire current	(4 to 20) mA	(mA output / 2000) or 5 uA (Whichever is the greater)
Thermal drift	Zero at 20 °C	2 uA / °C
Maximum output current	21.5 mA	In high burnout condition
Minimum output current	< 3.9 mA	In low burnout condition
Loop voltage effect	0.2 uA / V	
Maximum output load	[(V supply - 10) / 20] KΩ	700 Ω @ 24 V DC
Loop supply	(10 to 30) V DC	SELV

PUSH BUTTON USER INTERFACE		
Type/ Function	Range/ Description	Notes
Sensor configuration	Temperature range for (4 to 20) mA retransmission Burnout current Trim output current	°C or °F against probe or resistance Upscale or downscale At 4.0 mA and 20.0 mA

GENERAL	
Function	Description
Update time	500 ms
Response time	1 s
Start-up time	4 s (mA out < 4 mA during start up)
Warm up time	60 s to full accuracy
Default configuration	PT100 (0 to 100) °C upscale burnout

ENVIRONMENTAL	
Function	Description
Ambient temperature	Operating/ Storage (-40 to 85) °C Full accuracy only between (-30 to 75) °C
Ambient Humidity	Operating/Storage (10 to 90) %RH non-condensing
Protection requirement	>= IP65 recommended
Configuration ambient	20 °C to maintain specification

SEM203P IN HEAD PT100 TEMPERATURE TRANSMITTER

MECHANICAL

Function	Description
Dimensions	43 mm diameter; 21 mm height
Fixing centres	2 x 5 mm holes on 33 mm centres
Centre hole	4.5 mm hole for wiring aid
Weight	31 g (encapsulated)

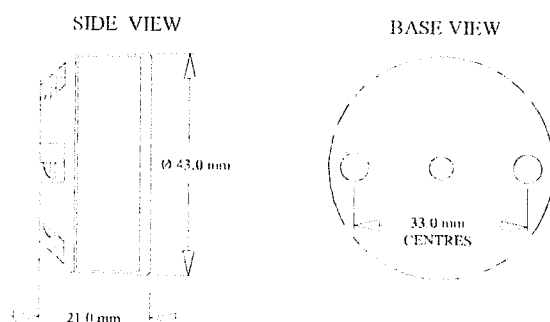
APPROVALS

EMC	BS EN 61326: Note - Sensor input wires to be less than 3.0 m to comply
Ingress protection	BS EN 60529
RoHS	Directive 2011/65/EU
EAC	Please refer to www.statinst.com
DNV	Please refer to www.statinst.com

ORDER CODE

SEM203P

MECHANICAL

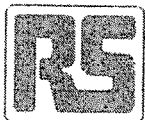


Fixing holes 2 x Ø5.5 mm, Centre hole Ø4.5 mm

ACCESSORIES

Head options	Please refer to www.statinst.com
Probe options	Please refer to www.statinst.com

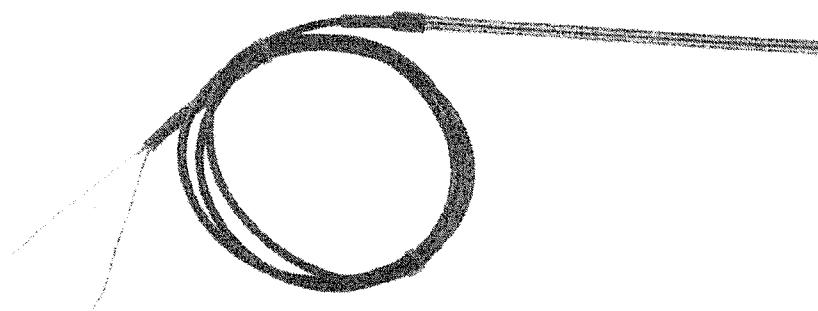
To maintain full accuracy annual calibration is required contact sales@statinst.com for details
The data in this document is subject to change. Status Instruments assumes no responsibility for errors



Data sheet

Precision Pt100 Probe

High accuracy platinum resistance thermometer probe, 6mm diameter x 250mm



Precision Pt100 sensor offering high accuracy over the range -50 to 250°C. Ideal for use as a reference probe for comparison calibration of industrial sensors in temperature calibration baths, or for those looking for a high accuracy probe better than the usually offered class A or B types

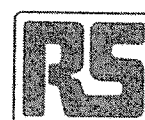
- High accuracy, $\pm 0.06^{\circ}\text{C}$ at 0°C^*
- Pt100 1/5th Din, 4 wire configuration
- 316 stainless steel sheath, 6mm x 250mm
- 2 metres 7/0.2mm PTFE insulated screened lead
- Sensor temperature range -50 to 250°C
- In accordance with IEC 751
- Supplied uncalibrated for custom calibration by the user (if required)

*the probe is manufactured using a close tolerance PT100 resistance bulb including the finest materials and methods of manufacture and is offered with an accuracy of 0.06°C . It is not supplied certified by an independent calibration house i.e. UKAS accredited or otherwise, therefore actual errors will not be known until carried out separately by the user

Specifications

Sensor type:	Pt100 (100 Ohms @ 0°C), 4 wire configuration 1/5 din in relation to IEC 751, $\pm 0.06^{\circ}\text{C}$ at 0°C^*
Probe construction:	6.0mm diameter, 316 stainless steel sheath.
Probe temperature range:	-50°C to +250°C
Extension cable:	7/0.2mm PTFE insulated with silver plated copper screen
Termination:	4-wire tails

Probe Diameter	Probe Length	Cable Length	RS Order Number
6mm	250mm	2 metres	236-4299



Platinum resistance temperature sensor Pt100 (Pt1000)

Relation Temperature According to IEC751

°C ITS-90	0	1	2	3	4	
-200	18.52					
-190	22.53	22.40	21.97	21.54	21.11	2
-180	27.10	26.67	26.24	25.82	25.39	3
-170	31.34	30.91	30.49	30.07	29.64	4
-160	35.54	35.12	34.70	34.28	33.86	5
-150	39.72	39.31	38.89	38.47	38.05	6
-140	43.88	43.46	43.05	42.63	42.22	7
-130	48.00	47.59	47.18	46.77	46.36	8
-120	52.11	51.70	51.29	50.88	50.47	9
-110	56.19	55.79	55.38	54.97	54.56	10
-100	60.26	59.86	59.44	59.04	58.63	11
-90	64.30	63.90	63.49	63.09	62.68	12
-80	68.33	67.92	67.52	67.12	66.72	13
-70	72.35	71.95	71.55	71.15	70.75	14
-60	76.33	75.93	75.53	75.13	74.73	15
-50	80.31	79.91	79.51	79.11	78.72	16
-40	84.27	83.87	83.48	83.08	82.69	17
-30	88.22	87.83	87.43	87.04	86.64	18
-20	92.16	91.77	91.37	90.98	90.59	19
-10	96.09	95.69	95.30	94.91	94.52	20
0	100.00	99.61	99.22	98.83	98.44	21
10	100.00	100.39	100.79	101.17	101.56	22
20	103.90	104.29	104.68	105.07	105.46	23
30	107.79	108.18	108.57	108.96	109.35	24
40	111.67	112.06	112.45	112.83	113.22	25
50	115.54	115.93	116.31	116.70	117.08	26
60	119.40	119.78	120.17	120.55	120.94	27
70	123.24	123.63	124.01	124.39	124.78	28
80	127.08	127.46	127.84	128.22	128.61	29
90	130.90	131.28	131.66	132.04	132.42	30
100	134.71	135.09	135.47	135.85	136.23	31
110	138.51	138.88	139.26	139.64	140.02	32
120	142.29	142.67	143.05	143.43	143.80	33
130	146.07	146.44	146.82	147.20	147.57	34
140	149.83	150.21	150.58	150.96	151.33	35
150	153.58	153.96	154.33	154.71	155.08	36
160	157.31	157.70	158.07	158.45	158.82	37
170	161.05	161.43	161.80	162.17	162.54	38
180	164.77	165.14	165.51	165.89	166.26	39
190	168.49	168.85	169.22	169.59	169.96	40
200	172.17	172.54	172.91	173.28	173.65	41

Pt1000 = Pt100 x 10

Learner Name: Gareth Wyn Thomas

Course: HNC Instrumentation Engineering Year 1

Module Code: **PCEE4002/PCP04002**

Module Name: Research Study and Presentation Skills

Element 3: PowerPoint Presentation and Handout

Cyfoeth
Naturiol
Cymru
Natural
Resources
Wales

Gareth Thomas
Natural Resources Wales
Hydrometry/Telemetry

Soil Temperature Measuring Device



1812 2019 Soil Measuring Device H&T

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Introduction

Natural Resources Wales

- Natural Resources Wales is a Welsh Government sponsored body responsible for the environment in Wales.
- Hydrometry and Telemetry team are a service provider, carrying out work on behalf of our Customers (WR, FCRM, Fisheries etc.).
- I have selected a project I worked on in collaboration with another Welsh Government sponsored body – Farming Connect Wales.

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Soil Temperature - Background

- H&T were approached by a joint NRW and Farming Connect project to provide a monitoring solution to an issue where farmers were either losing crop or were not yielding as much crop as they could due to planting at the wrong time of year based on soil temperature.
- Maize has an optimum sprouting/growing temperature range of 7-10° and we were challenged with designing and installing a solution that would enable farmers to monitor soil temperature at the depth where maize is planted.

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Elements of a typical measuring device



- Parameter – The physical quantity to be measured, in this case the soil temperature
- Sensor – A device which responds directly in some way to changes in the parameter. This is sometimes referred to as a transducer which produces a signal related to the input quantity measured
- Signal Conditioner (Amplifier) – Changes the transducer signal to an appropriate form by amplifying (magnifying) the signal
- Display Unit – Measures and displays the output.



Selected Instruments

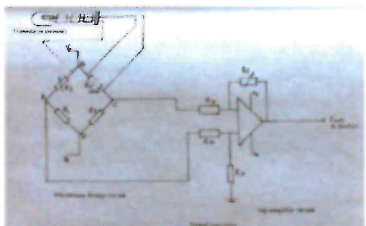
The selected sensor for the project was the Platinum resistance thermocouple probe (PT100).

The best suited signal transmitter to convert and amplify the signal was the device manufactured by Status Instruments. SEM 203P.

The display unit used with this project was a Dynamic Logic Remote Telemetry Unit. D7151.



Schematic Diagram of Instruments



The two circuits used in this signal conditioner consists of a Wheatstone bridge circuit and Operational amplifier circuit.

Calibration of signal conditioner within workshop

- The equipment was connected as shown in the photograph prior to installation within the field
- The telemetry display analogue to digital converter was calibrated using an analogue injector to accept the range of 4mA to 20mA at intervals of temperature of 0°C to 30°C
- The temperature probe was disconnected and replaced by the decade box (this was set at 100Ω which resulted in a reading of 0°C on the telemetry display unit)
- The setting on the decade box was changed from 100Ω in steps of 3Ω to 112Ω and the corresponding displays on the telemetry display unit were noted to change in steps of 10°C in a range of 0°C to 30°C
- The equipment was then transferred to the field to start recording the soil temperature

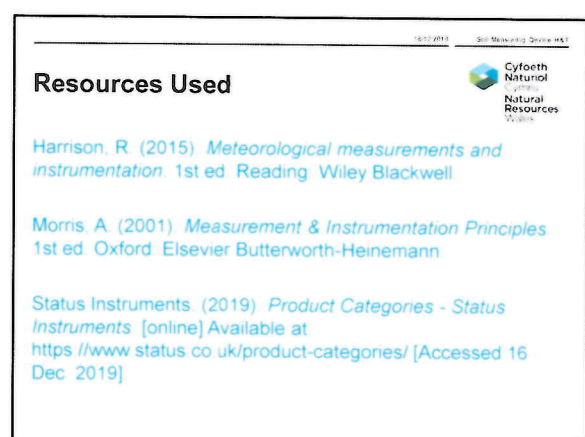
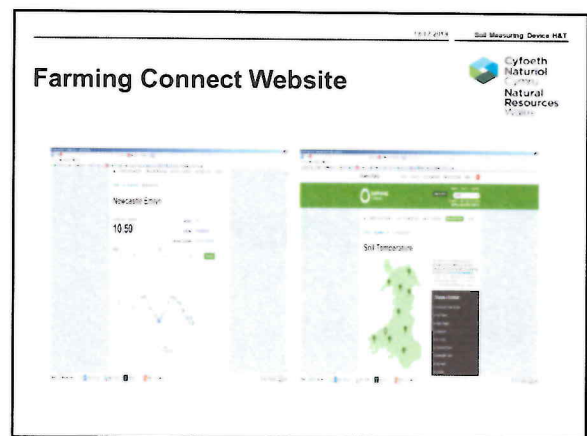
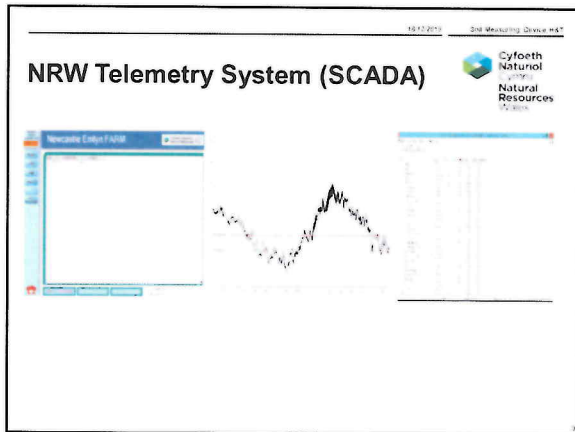


Temp°C	Resistance Ω
0	100
10	103.9
20	107.7
30	111.6

Selection of trial site

- In collaboration with Farming Connect and the wider farming community, the selected trial site was Ddol farm, Newcastle Emlyn.
- This is an area where maize is cultivated widely.
- Farmers were not yielding enough profit as they should have been.
- Problem with runoff to rivers, polluting them.





Soil Temperature Measuring Device

Gareth Wyn Thomas. Hydrometry/Telemetry, Natural Resources Wales

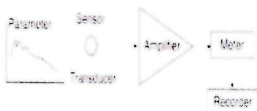
Introduction

The Hydrometry and Telemetry Team of Natural Resources Wales were jointly approached by Natural Resources Wales and Farming Connect to develop a monitoring process in the growing of maize. Farmers were either losing crop or were not maximizing crop yield due to planting at the wrong time of year based on soil temperature. Maize has an optimum sprouting/growing temperature range of 7-10 deg C. The task required the design and installation of a process to enable farmers monitor soil temperature.

Method

The elements of a temperature measuring device are:-

- Parameter
- Sensor
- Signal conditioner
- Display Unit



Instruments used in the project

- Sensor - Platinum resistance thermocouple probe (PT100).
- Signal Conditioner – Status Instruments SEM203P.
- Display unit – Dynamic Logic D7151.

Calibration of Signal conditioner

- The equipment is connected as shown in the photograph prior to installation within the field.
- The telemetry display unit analogue to digital converter was calibrated using an analogue injector to accept the range of 4mA to 20mA at intervals of temperature in range of 0°C to 30°C.
- The temperature probe was disconnected and replaced by the decade box (this was set at 100Ω which resulted in a reading of 0°C on the telemetry display unit).
- The setting on the decade box was changed from 100Ω in steps of 3Ω to 112Ω and the corresponding displays on the telemetry display unit were noted to change in steps of 10°C in a range of 0°C to 30°C.
- The equipment was then transferred to the field to start recording the soil temperature.



Conclusions

The task of recording soil temperature in the project enabled farmers to gather real time data allowing them to plant maize at a favorable time of the year and thus yield higher profits and minimise soil erosion.

The report demonstrates my ability to understand the principles of soil measurement instrumentation and to construct and deploy the devices within the field providing a solution to the task.

The project has successfully assisted farmers at the trial site in Newcastle Emlyn, West Wales and, as a result, a further ten sites have been set up across Wales. The data is accessible through the Farming Connect website.



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Acknowledgments

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