

Environment and Communications
Answers to questions on notice
Agriculture, Water and the Environment Portfolio

Question No: SQ22-000099
Hearing: Additional Estimates
Outcome: Agency
Division/Agency: Bureau of Meteorology
Topic: Senator Rennick written questions to the Bureau of Meteorology
Question Date: 22 February 2022
Question Type: Spoken

Senator Rennick asked:

1. In 1996, when the Bureau converted to custom-made electronic probes for temperature recording, rather than averaging temperatures over one to five minutes as is standard practice around the world from such equipment, did the Bureau start recording one second extrema resulting in a non-standard method of measuring (spot readings) from non-standard equipment (custom-built probes) making it impossible to establish the equivalence of recent temperatures with historical data?
2. How did the Bureau take into account the change in thermometers from mercury/alcohol to platinum resistance thermometers when homogenising data?
3. Could the Bureau provide specifications for the platinum resistance thermometers?
4. Why did the Bureau manipulate thermometers at Goulburn and Thredbo by putting a limit on how low the temperature can go?
5. Could the Bureau explain why putting a downside limit on temperature recordings isn't fraudulent?
6. Why should the Bureau be believed when it says there were the only two weather stations (Goulburn and Thredbo) out of 700 stations where downside limits were placed on thermometers?
7. Given these two stations were detected by external sources shouldn't the entire network be audited by an external auditor on a regular basis to ensure that there has been no further tampering of thermometers by the Bureau?
8. In 2011, the new Australian Climate Observation Reference Network – Surface Air Temperatures (ACORN-SAT) system for calculating the national average temperature removed 57 stations from its calculations, replacing them with 36 on-average hotter stations. Can the bureau confirm this had the effect of increasing the homogenised Australian average temperature by 0.42 degree Celsius, independently of any actual change in the weather?

Answer:

1. The Bureau of Meteorology's (The Bureau) automatic weather stations (AWS) record 1-minute air temperature data in accord with World Meteorological Organization recommendations. These 1-minute values are recorded as the temperature observed in the last second of each minute, not an extrema from the recordings taken throughout the minute.

Research undertaken by G.P. Ayres and J.O. Warne, published in the Journal of Southern Hemisphere Earth Systems Science [Response time of temperature measurements at automatic weather stations in Australia, 2020], addresses measurement intervals. This research demonstrates there is no significant difference in the method employed by the Bureau, and an averaged measurement taken over 1 minute.

This has been supported through parallel observations using manual and automatic instruments, which have demonstrated that there is no significant difference between temperatures recorded by manual and automatic equipment in the same environment (i.e. within the same Stevenson Screen). As such, data recorded using current AWS technology can confidently be compared with historical data from the same sites.

2. As outlined in the response to SQ22-000099-1, the change from manual to automatic observations, in itself, had no significant effect on temperature observations, as demonstrated by direct comparison or parallel observations taken in the same Stevenson Screen.

In cases where the change from manual to automatic instruments coincided with a site change, this had an impact on temperature observations. These impacts were dealt with through the normal comparison station and homogenisation process that is explained in great detail on the Bureau's website and is supported by peer-reviewed literature.

3. Construction specifications for the Bureau temperature sensors are included in the attached pdfs.

The sensing element used in the Bureau's thermometers meets international standard BS EN 60751-2008 [IEC 2008], band 5 (1/10 DIN) which have a $R_0=100\ \Omega$ and $\alpha = 0.003850\ \Omega/(\Omega.^{\circ}\text{C})$.

Each instrument is tested and calibrated across the full operational range prior to installation in the field in the Bureau of Meteorology's Standards and Metrology Laboratory.

4. Please refer to response to written Question on Notice number 176, portfolio question number 134 at the 2020-21 Budget Estimates, tabled on December 3 2020 which provides detail on these thermometers.

The Bureau has not manipulated thermometers at Goulburn and Thredbo.

As detailed in the Review of the Bureau of Meteorology's Automatic Weather Stations (2017), the AWS' at Goulburn and Thredbo were inadvertently fitted with a MSI1 hardware card during maintenance. The MSI1 card is unable to function at temperatures below -10.4°C . These installations occurred in November 2002 and May 2007 respectively.

The Bureau acknowledges that not adequately communicating the limitations of the MSI1 card to its field staff resulted in an error, and the AWS systems at Goulburn and Thredbo were not able to read temperatures below -10.4°C . Corrective action has been taken.

Bureau staff replaced the inappropriate MSI1 cards with the MSI2 alternative at both sites in July 2017.

5. The Bureau rejects the assertion that placing a downside limit on temperature measurement constitutes an attempt to deceive.

All sensor equipment has an effective operational range and therefore a 'downside limit' and an 'upside limit'. The Bureau makes every effort to ensure that sensor equipment employed in each location has appropriate operational limits.

The Bureau has performed an in-depth review of all 724 automatic weather stations, and can confirm that the technical specifications for each are fit-for-purpose for the climate of their installed location.

6. An extensive external review of the Bureau's automatic weather stations was undertaken in August 2017. The findings of this review are publicly available on the Bureau's website.

It was found that "the Bureau's data quality control processes work well, flag errors appropriately, and that the Bureau's practices are of a high standard, and are in line with accepted practice for meteorological services worldwide".

Furthermore, the Bureau can confirm that there were only two stations (Thredbo and Goulburn) where observations were affected by downside temperature limits. This was noted through the external AWS review.

7. The Bureau does not tamper with thermometers.

Irregularities in the data transmitted by the Thredbo and Goulburn automatic weather stations were identified by the Bureau through automated and manual quality control processes. It is through these reviews that the cause of the fault was determined and subsequently rectified. This is laid out in the report Review of the Bureau of Meteorology's Automatic Weather Stations, 2017 pages 48 and 50, available on the Bureau's website.

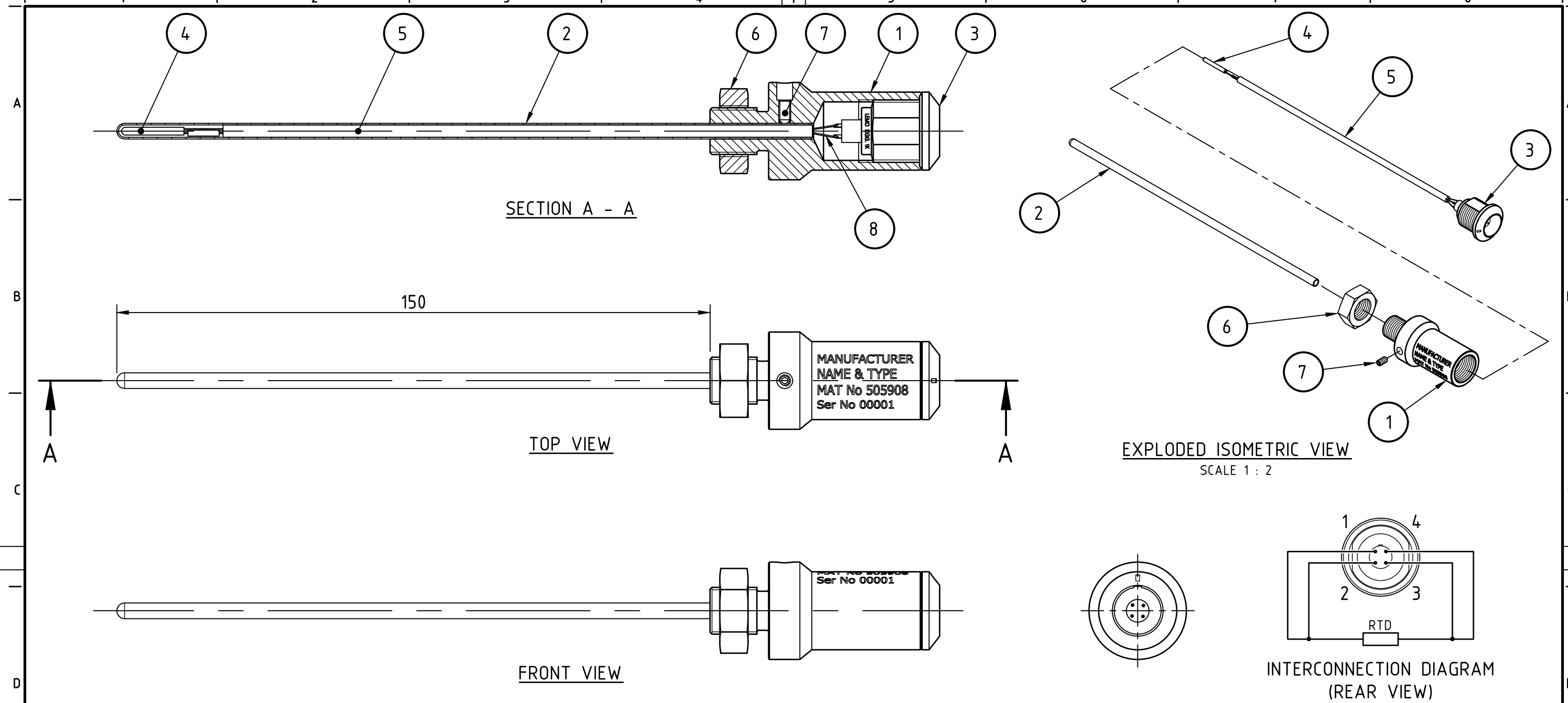
The Bureau's quality monitoring system is regarded by the World Meteorological Organization (WMO) as a best practice climate data management system. Further, the WMO standard for such systems is based on the Bureau's system.

The Bureau is accredited by the National Association of Testing Authorities for temperature and pressure calibration to the internationally recognised quality standard ISO17025.

Under this regime, the Bureau's temperature measurement and quality control systems and processes are subject to a surveillance audit every 18-months, with an in-depth reaccreditation audit every three years.

8. No; the change described had no effect on the expression of national average temperature.

In both ACORN-SAT and its predecessors, data from each station are expressed as a difference (anomaly) from the average for a standard reference period (currently 1961-1990). The station anomalies are then averaged into a national value. Since the anomaly for all stations, by definition, has an average of zero, changing the stations used makes no difference in itself to the national average. The reason why anomalies, rather than absolute values, are used is to prevent any bias that may arise from changes in the network, such as the opening of new stations in particularly hot or particularly cold areas.

**NOTES:**

- ALLOWABLE TEMPERATURE MEASUREMENT TOLERANCES :
± 0.08°C IN THE RANGE -30°C TO +60°C
± 0.05°C AT 0°C
- ELEMENT CERTIFICATE TO BE SUPPLIED WITH EACH BATCH.
- LOKTITE GRUB SCREW AFTER FINAL ASSEMBLY.

MATERIAL -
AS PER PARTS LIST

FINISH -

SCALE : 1 1

DRAFTING STANDARD AS1100

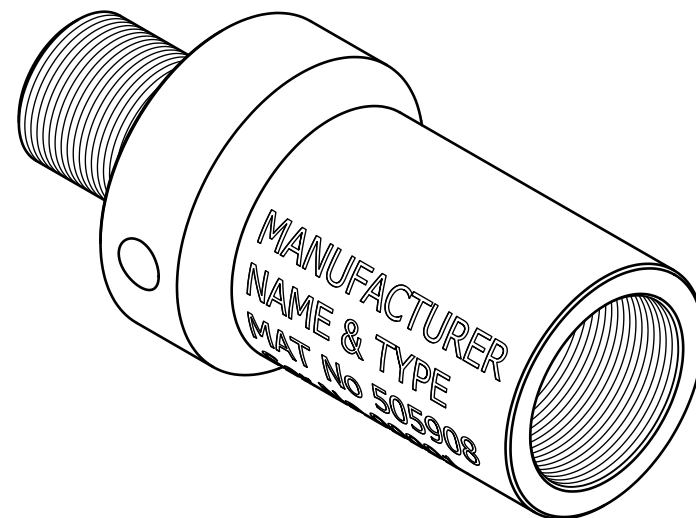
UNLESS STATED OTHERWISE
ALL DIMENSIONS IN MILLIMETRES
TOLERANCE ± 0.2
HOLES ± 0.2
DO NOT SCALE
EQUIPMENT SPEC.No. A3001
INSTALLATION SPEC.No.

8		WIRE, < > GAUGE, (TYPE)		1
7		SCREW, GRUB, CUP POINT, M3 x 0.5, 6 LONG, CRES STL, GR316		1
6		NUT, HEX, 1/4" BSP, CRES STL GR316		1
5		INSULATOR, MgO TO ASTM E1652-03 (OR ASSESSED TO BE THE EQUIVALENT)		1
4		ELEMENT, 100/15A, RTD (IEC 60751) (1/10 DIN) (BAND 5)		1
3		CONNECTOR, FIXED RECEPTACLE, NUT FIXING, "LEMO P/No EGG.1K.304.CLL" WITH VITON O-RING		1
2	MT-25-01 SHT 3	PROBE, DETAILS		1
1	MT-25-01 SHT 2	BODY, DETAILS		1

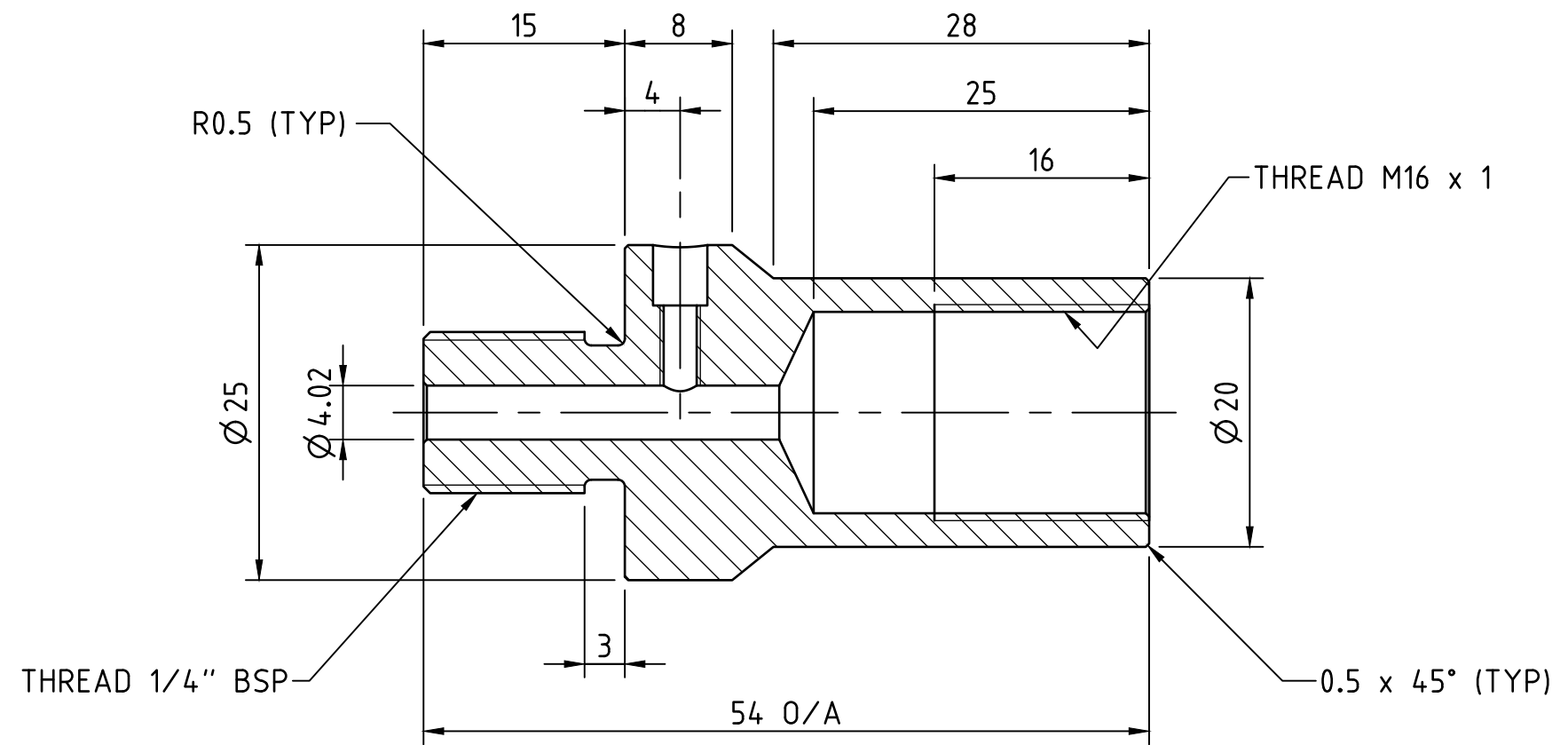
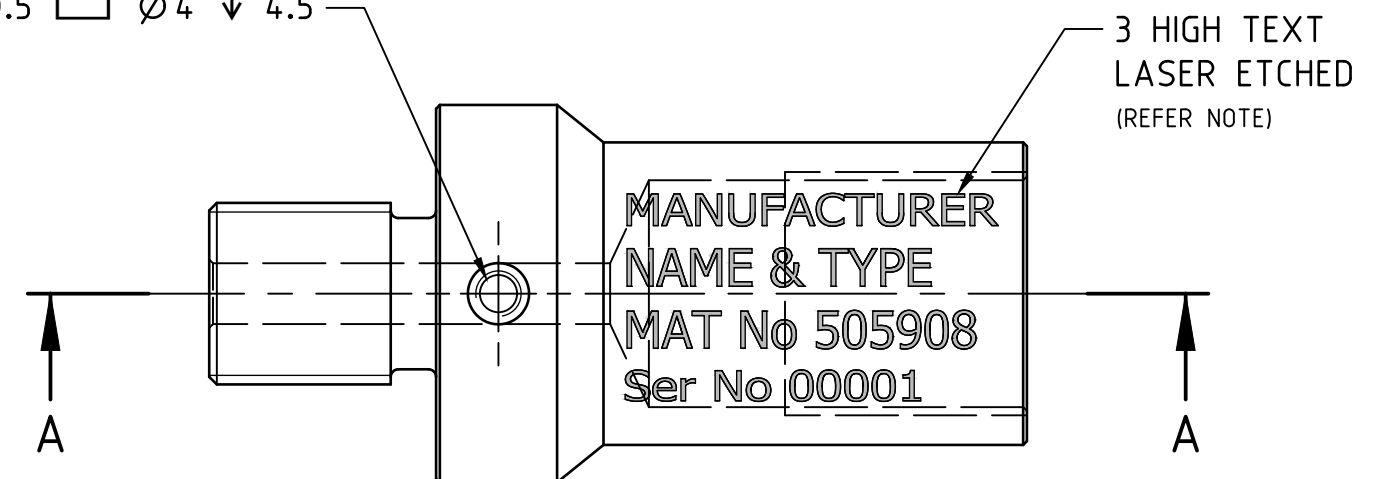
TEM	DRG No	DESCRIPTION	MAT No	QTY
PARTS LIST				

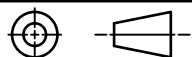
ORDER	DRN	CHKD	AMENDMENT	EXAM'D	APP'D	DATE	No	PROJECT: THERMOMETER, RESISTANCE, RTD	BUREAU OF METEOROLOGY	
25336	NGB	LAD		IDD	IDD	12/8/08	1	TITLE: AIR TEMPERATURE SENSOR		
30048	MRA	LAD	EQUIPMENT SPEC WAS A2538, TITLE	ZS	ID	5/4/16	2	MAT No 505908	DRG No MT-25-01 SHT 1	
30050	RMC	MRA	NOTE 1 TEMPERATURE RANGE CHANGED TO -30°	Benbow	Murphy	28/06/19	3	ASSEMBLY		

USED ON DRG No MT-25-01 SHT 1

ISOMETRIC VIEWNOTES:

MANUFACTURERS NAME & TYPE IS NOT LIMITED TO TWO LINES.
MAT NUMBER TO BE SAME FOR EACH THERMOMETER.
SERIAL NUMBER MUST BE UNIQUE FOR EACH THERMOMETER.

SECTION A - AM3 x 0.5  Ø4  4.5TOP VIEW

MATERIAL - Ø25 ROD, CRES STL, GR316	SCALE 2 : 1	DRAFTING STANDARD AS1100
	UNLESS STATED OTHERWISE ALL DIMENSIONS IN MILLIMETRES	
FINISH - REMOVE ALL BURRS & SHARP EDGES	TOLERANCE ± 0.1	DO NOT SCALE
	HOLES ± 0.2	EQUIPMENT SPEC.No. A3001 INSTALLATION SPEC.No.
SURFACE FINISH  ALL OVER		

ORDER	DRN	CHKD	AMENDMENT	EXAM'D	APP'D	DATE	No
25336	NGB	LAD		IDD	IDD	12/8/08	1
30048	MRA	LAD	EQUIPMENT SPEC WAS A2538, TITLE	ZS	ID	5/4/16	2

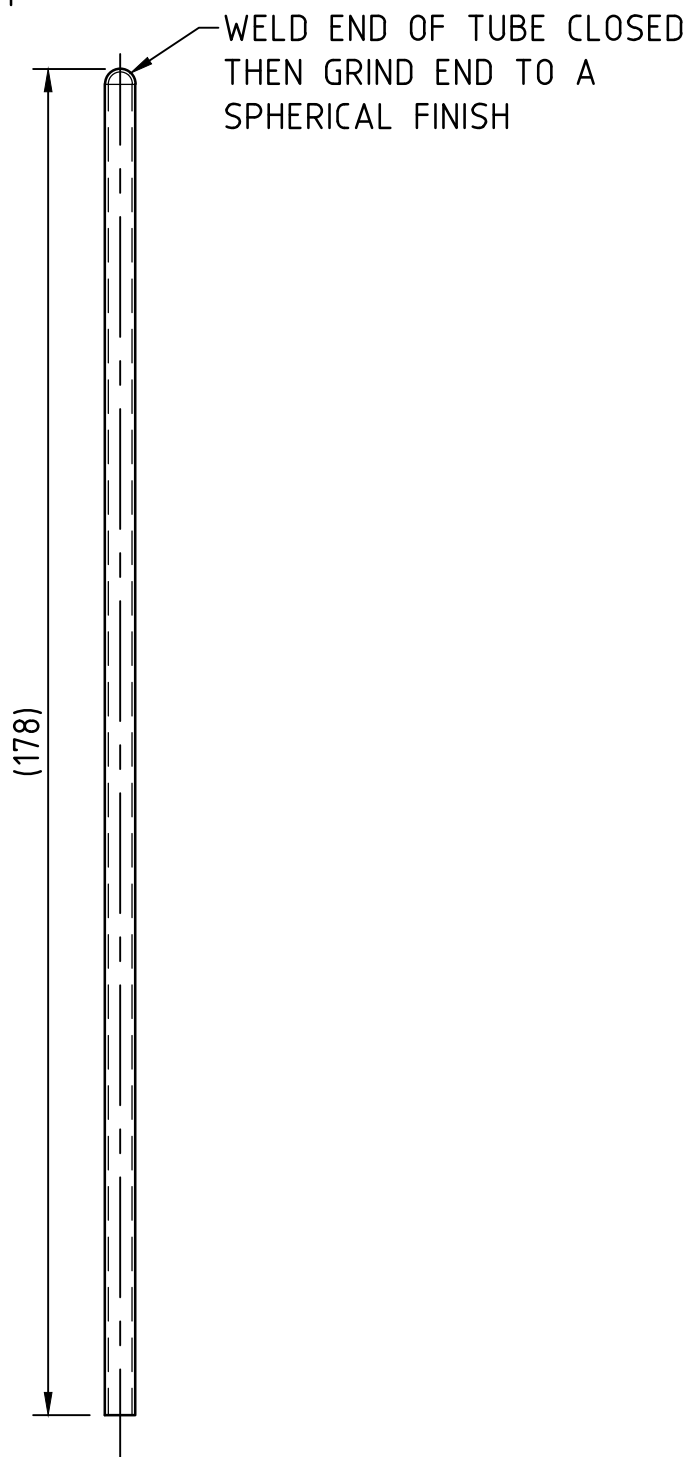
PROJECT: THERMOMETER, RESISTANCE, RTD

TITLE: AIR TEMPERATURE SENSOR
BODY
DETAILS

BUREAU OF
METEOROLOGY

DRG
No MT-25-01SHT
2

USED ON DRG No MT-25-01 SHT 1



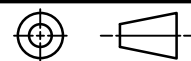
MATERIAL -
TUBE Ø4, 0.5 THIN WALL, CR STL GR316
OR APPROVED EQUIVALENT

FINISH -
REMOVE ALL BURRS & SHARP EDGES

SCALE 1 : 1

UNLESS STATED OTHERWISE
ALL DIMENSIONS IN MILLIMETRES
TOLERANCE ± 0.2
HOLES ± 0.2

DRAFTING STANDARD AS1100



DO NOT SCALE

EQUIPMENT SPEC.No. A3001
INSTALLATION SPEC.No.

ORDER	DRN	AMENDMENT	APP	DATE	No
25336	NGB		IDD	12/8/08	1
30048	MRA	EQUIP SPEC WAS A2538 TITLE	ID	5/4/16	2

PROJECT:
THERMOMETER, RESISTANCE, RTD

TITLE:
**AIR TEMPERATURE
SENSOR
PROBE**
DETAILS

**BUREAU
OF
METEOROLOGY**

DRG No
MT-25-01

SHT
3