1. **PURPOSE**

This procedure describes the equipment and techniques to be used to monitor the application conditions for heavy duty coatings applied over steel substrates.

1. **SCOPE**

This procedure applies to the monitoring of temperature and humidity conditions prior to application and during the initial phase of curing of heavy-duty coatings.

1. **REFERENCES**

AS1627.4, Metal finishing – Preparation and pre-treatment of surfaces – Abrasive blast cleaning

1. **DEFINITIONS**

For the purposes of this procedure, the following definitions apply:

Heavy-duty coating – Coatings applied to structural steel predominantly for corrosion protection.

Relative humidity – The ratio of the actual amount of water vapour in the air to the amount it could hold when saturated, expressed as a percentage

Dew Point – The temperature to which air must be cooled (at constant pressure and constant water vapour content) for saturation to occur.

1. **PROCEDURE TO BE FOLLOWED**

**5.1 Apparatus**

* Sling psychrometer fitted with liquid filled thermometers graduated to 0.5°C or better.
* Surface temperature thermometer, graduated to 0.1°C or better. This shall be an electronic digital thermometer fitted with a magnetic K-Type thermocouple.

 ***Note: Electronic relative humidity measurement devices shall not be used.***

**5.2 Background**

5.2.1 Relative Humidity

Relative humidity is a measure of the amount of water vapour in the air. The amount of water vapour the air can hold increases with temperature. Relative humidity therefore decreases with increasing temperature if the actual amount of water vapour stays the same.

The measurement of relative humidity is important as it may affect the curing of a coating and hence its performance. Some coatings require high humidity to cure, for example moisture cure urethanes, whilst others such as waterborne acrylics require low relative humidity.

Relative humidity is measured using a wet and dry bulb thermometer. The dry bulb measures the air temperature whilst the wet bulb measures the temperature depression resulting from evaporation of water from a wick. The dry bulb temperature and wet bulb depression are used to determine the relative humidity using a chart.

The Bureau of meteorology uses fixed thermometers mounted in a louvred box, (Stevenson’s Screen) designed to control natural air movement. The most accurate means of measuring relative humidity however requires air movement over the two thermometers, and this is accomplished using an aspirated or sling psychrometer. The aspirated psychrometer uses a battery or clockwork powered fan, whilst the sling psychrometer is spun by hand. Either device can be used within this procedure.

5.2.2 Dew Point

Dew point is calculated using the dry bulb temperature and wet bulb depression, and is the temperature at which the air becomes saturated with water vapour. Water will condense onto a surface where the surface temperature is at or below the dew point. The presence of moisture on a surface will compromise the performance of most heavy-duty coatings so knowing whether dew point conditions might occur is important.

5.2.3 Surface Temperature

Accurate measurement of substrate temperature allows application of paint close to dew point, and therefore provides operational advantages over conventional magnetic analogue devices. The 3°C differential between Dew Point and surface temperature is aimed at compensating for error in the 2 measurements and therefore accurate measurement will allow application of paint at less than a 3°C differential.

**5.3 Calibration and Checking**

All measurement devices require calibration and regular checks to ensure the ongoing accuracy and precision of measurements. The National Association of Testing Authorities (NATA) is the recognised body for accreditation of testing services in Australia, and provides guidance on the calibration and checking of test instruments.

NATA has developed Technical Note 19 which covers liquid-in-glass thermometers, such as those used in sling psychrometers, and the requirements are summarised in Table TP803-1.

Table TP803-

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| --- | --- | --- |
| **Type** | **Calibration** | **Checking** |
| **Frequency** | **Procedure** | **Frequency** | **Procedure** |
| **If the organisation has a reference thermometer** |
| Reference | Initial | External calibration, full scale | Before use | Check at ice point |
| 10 years |
| Working | Initial | Calibration against reference, full scale | 6 months | Check against reference at one point in working range |
| 5 years |
| **If the organisation does not have a reference thermometer** |
| Working | Initial | External calibration, full scale | 6 months | Check at ice-point |
| 5 years |

Technical Note 19 references the NATA Accreditation Requirements (NAR), which are incorporated into Table TP803-1.

Hygrometers, the collective name for Assmann and sling type psychrometers, are also covered in the NAR document. There is however an anomaly in the treatment of these devices which are essentially 2 thermometers in a frame. The requirement for checking is the comparison of the 2 thermometers, with the wick dry, at room temperature. This does not take account of error in either or both of the thermometers and is therefore not an acceptable checking process within the context of this procedure.

The NATA technical note states that the uncertainty of calibration of a reference thermometer should be 1/5th of the uncertainty of calibration required of the working thermometer. A reference thermometer readable to 0.1°C shall be used to determine the error and the correction required to ensure accuracy of the working thermometers to 0.5°C. Corrections must be marked on the thermometers to ensure that any correction required is applied at all times.

The wick shall be removed from the wet bulb thermometer before checking the ice-point, and shall be replaced at the conclusion of testing if it showing signs of wear or contamination. Note that the wick must not be touched with bare hands as this may impair its wicking properties.

Analogue and electronic surface temperature measurement devices shall be subject to the same calibration and checking regime as liquid-in-glass thermometers.

**5.4 Determination of Relative Humidity**

The procedure shall be as follows:

1. All measurements shall be carried out in the area of paint application.
2. Check the wick for wear or contamination, and replace if necessary. Note that the wick must not be touched with bare hands as this may impair its wicking properties.
3. Fill the water reservoir with distilled or deionised water, and allow at least 15 minutes for the water to saturate the wick.
4. Spin the psychrometer at a moderate speed for about 15 seconds, then take readings on both thermometers recording each to the nearest half of one graduation.
5. Make any corrections to the temperature values.
6. Subtract the wet bulb temperature from the dry bulb temperature to determine wet bulb depression.
7. Locate the wet bulb depression value across the top of the chart and read down the column until the dry bulb temperature is located. Record the relative humidity.

***Note: The relative humidity chart used shall be a recognised Australian Government reference document, such as that provided by the Bureau of Meteorology, and shall be specifically for ventilated thermometer instruments.***

**5.5 Measurement of Surface Temperature**

The procedure shall be as follows:

1. Locate a clean steel surface within the intended paint application area and attach the magnetic thermocouple to the surface, and plug the lead into the measuring device.
2. Allow 5 minutes for the reading to stabilise, and record.
3. Apply any temperature correction and record the final value.

**5.6 Dew Point**

1. The dry bulb and wet bulb depression values from 5.4 above are used to determine the dew point temperature.
2. Locate the wet bulb depression value across the top of the chart and read down the column until the dry bulb temperature is located. Record the dew point temperature.

***Note: The dew point chart used shall be a recognised Australian Government reference document, such as that provided by the Bureau of Meteorology, and shall be specifically for ventilated thermometer instruments.***

**5.7 Frequency of Testing**

The monitoring of application conditions is aimed at ensuring that paints are applied and cured within a suitable range of temperature and humidity conditions. These requirements will be paint type and brand specific.

The frequency of testing will be based on the specified requirements and the conditions likely to be encountered during application and cure. As a minimum, wet bulb, dry bulb, and surface temperature measurements shall be taken before commencement of painting and at the end of the day. The results shall be assessed against the requirements, and further interim monitoring shall be scheduled on the basis of the prevailing conditions.

If conditions are assessed to be improving, relative to the requirements, then no further testing would be required until the end of the day. If, however, the conditions are marginal and / or are likely to deteriorate relative to the requirements, then testing shall be carried out with sufficient frequency to ensure that all application is carried out within the specified conditions. All measurements shall be recorded.

**5.8 Interpretation of Results**

The measured relative humidity shall be checked against the manufacturer’s specified requirements to determine compliance. The first measurement of the day is important as it allows some judgement of whether the conditions are likely to remain complying or whether deterioration of conditions beyond the recommended limits is likely.

Similarly, the last measurement of the day will provide some indication of the expected conditions during overnight cure of an applied coating. Whilst little can be done to change these conditions, it is important that the necessary records are maintained should premature failure occur.

In terms of dew point, the measured surface temperature must not be less than 3°C above the calculated dew point temperature. This margin was introduced to allow for the combined temperature measurement and calculation errors and to ensure that condensation was avoided, at least during application and initial cure. This figure may be adjusted where the accuracy and precision of temperature and relative humidity is assured.

1. **PRECISION**

**6.1 Relative Humidity**

The uncertainty of measurement has been determined in accordance with the ISO Guide to Uncertainty of Measurement, and 95% confidence limits have been estimated as ± 6% relative humidity. Note that this uncertainty assumes the use of a hygrometer which utilises thermometers which are readable to 0.5°C, and which have been corrected for any error.

**6.2 Dew Point / Surface Temperature**

The uncertainty of measurement has been determined in accordance with the ISO Guide to Uncertainty of Measurement, and 95% confidence limits have been estimated as ± 1.5°C. Note that this uncertainty is based on the use of a hygrometer which utilises thermometers which are readable to 0.5°C, and which have been corrected for any error.

1. **DOCUMENTATION**

Records shall be maintained in a suitable format.