

BESPOKE REQUIREMENTS

Revision 1
2023

Environmental testing

Test A4: De-fogging

1 Scope and object

This document outlines the details of the tests to be carried out in order to assess the ability of EchoVista's cleaning system to clean inner surface fog from the surface of a glass specimen.

The object of these tests is to determine the fog cleaning ability of a system under controlled conditions.

The tests are subdivided as follows:

Test	Title	Activation Time	Power Level	Comment
A4	De-fogging	T_1	$P_{av} \leq P_1$	Demonstrates ability to clear inner surface fog.
P_{av} : average power				

2 Test description

2.1 Test A4: De-fogging

2.1.1 Object

This procedure determines the ability of a system to clean surface fog from a specimen's inner surface.

2.1.2 General description

The specimen is mounted in the desired orientation in a testing space which is at ambient temperature. The specimen's inner surface is immersed in the water vapour generated by using a calibrated humidifier. The surface is imaged and processed in order to estimate fog density. the system is activated for T_1 with an average power of less than P_1 . The surface is imaged and processed again. The pre- and post-cleaning results constitute to a 'Cleanliness Score', this score determines the fog clearing ability of the specimen. Cleanliness Score must surpass 90%.

The test is carried out a multiple of times* to converge on an average score. The temperature of the specimen surface is confirmed to equal ambient temperature before repeating the procedure.

*Determined by application or customer

3 Test Procedure

3.1 Procedure

- a) Mount specimen in the test space, ensure the specimen surface is clean.
- b) Record ambient temperature readings and specimen surface temperature readings.
- c) Apply fog over the specimen's inner surface.
- d) Image and process the specimen surface.
- e) Activate system within 1 minute at an average power of less than P_L .
- f) Image and process the specimen surface.
- g) Clean the specimen surface.

Repeat task b) to g) until the desired test volume is reached.

3.2 Working Space

The working area must not exceed the ambient temperature range (15° to 25°). The test space should have limited airflow to minimise fog evaporation rate due to the external environment. Lights used for surface imaging should not lead to ambient or surface temperature readings exceeding the defined range.

3.3 Temperature Recording

The workspace temperature shall be logged throughout the testing period. The glass surface shall be monitored by an IR thermometer, the reading before any fog application must be within the acceptable range.

3.4 Fog Application

For test A4.1 an ultrasonic humidifier shall be used, calibrated for producing water vapour which produces a layer of fog on the specimen's inner surface in a defined time duration without forming droplets. The inner surface of the specimen is the surface the transducers are bonded to. This fog applicator shall be mounted in the test space and controlled via an external application to ensure repeatability. De-ionised water shall be used.

3.5 Surface Imaging and Processing

The specimen surface will be imaged via a high-resolution camera mounted in the test space. The lighting shall be adjusted to ensure visibility of the fog. The image shall be

recorded immediately after fog application. The image shall be processed and the fog density is determined and recorded (via calibration image on the other side of the glass). If the fog distribution and density are within the defined specification* then the test can proceed. Otherwise, the surface must be cleaned, and fog application shall be repeated. The elapsed time between the fog application and system activation should be no longer than 2 minutes.

After ultrasound cleaning has been carried out, another image of the specimen shall be captured and processed. The same metrics shall be calculated and recorded. The same procedure may be repeated multiple times to collect the averaged performance data. These results shall be used to determine the cleaning ability of EchoVista's cleaning system.

The processing script must output the same processed scores when the input image remains the same. The processing script must output similar processed scores (within +-2.5%) when the separate images are recorded of the same target surface (with slight changes in lighting and position).

The processing script will calculate the 'Cleanliness Score'. This is defined as the total area of contaminant post-cleaning as a percentage of the entire field of view. Cleanliness Score must surpass 90%.

$$\text{Cleanliness Score} = \left(1 - \frac{\sum A_n}{A_{fov}} \right) \times 100$$

A_n = individual contaminant area, A_{fov} = area of the field of view

The processing script will also calculate the 'Sensor Cleanliness Score'. This involves dividing the specimen field of view into a grid (at an appropriate resolution). The obstruction by the contaminant over the grid is calculated. An element will pass if the contaminant coverage is less than 1%.

$$\text{Sensor Cleanliness Score} = \left(\frac{\sum T_{pass}}{T_{total}} \right) \times 100$$

T_{pass} = passed tile, T_{total} = total number of tiles

*To be determined

3.6 System Activation

The cleaning system will be activated manually, the duration of activation shall be determined by the electronic controller. The power level of the system will be checked, the

average power consumption will be calculated. If the average power exceeds P_1 over the activation period the test will be discarded.