



# TEST REPORT



Report No. : KES-RE240315

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**KES Co., Ltd.**

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## 1. Client

- ☐ Name : Hanwha Vision Co., Ltd.
- ☐ Address : 6, Pangyo-ro 319Beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea

## 2. Sample Description

- ☐ Product item : NETWORK CAMERA
- ☐ Model name : XNV-6022RM
- ☐ Variant Model : -
- ☐ Manufacturer 1 etc. : HANWHA VISION VIETNAM COMPANY LIMITED / Vietnam
- ☐ Manufacturer 2 etc. : D-TECH CO., LTD. / Republic of Korea

**3. Date of test** : Aug. 02, 2024 to Aug. 13, 2024

**4. Test method used** : EN 50155:2021 Railway applications – Rolling stock - Electronic equipment

**5. Test result** : Test result reference

**6. Test Report Purpose** : For quality management

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|             |                                 |                                 |
|-------------|---------------------------------|---------------------------------|
| Affirmation | Tested by                       | Technical manager               |
|             | Name : Sungwoo, Lee (Signature) | Name : Kangsun, Lee (Signature) |

**August 21, 2024**

**KES Co., Ltd.**



## REPORT REVISION HISTORY

| Date          | Test Report No. | Revision History |
|---------------|-----------------|------------------|
| Aug. 21, 2024 | KES-RE240302    | Issued           |
|               |                 |                  |
|               |                 |                  |

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## 1. General information

### 1.1 Introduction

|                                |                                                                                                              |
|--------------------------------|--------------------------------------------------------------------------------------------------------------|
| <b>Company Name</b>            | KES Co., Ltd.                                                                                                |
| <b>Name of President / CEO</b> | Young, Kim                                                                                                   |
| <b>Address</b>                 | #3002, #3503, #3701, 40, Simin-daero365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Republic of Korea |
| <b>Tel</b>                     | +82-31-425-6200                                                                                              |
| <b>Fax</b>                     | +82-31-424-0450                                                                                              |
| <b>E-mail</b>                  | kes@kes.co.kr                                                                                                |

### 1.2 Laboratory

|                |                                                                                                                                                                                       |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Address</b> | #3002, #3503, #3701, 40, Simin-daero365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Republic of Korea<br><br>473-21, Gayeo-ro, Yeosu-si, Gyeonggi-do, 12658, Republic of Korea |
| <b>Tel</b>     | +82-31-425-6200                                                                                                                                                                       |
| <b>Fax</b>     | +82-31-424-0450                                                                                                                                                                       |

**2. Information of E.U.T.**

|  |            |  |                     |
|-----------------------------------------------------------------------------------|------------|------------------------------------------------------------------------------------|---------------------|
| Product                                                                           | Model      | S/N                                                                                | Remark              |
| NETWORK CAMERA                                                                    | XNV-6022RM | ZKQM6V4TB0001FV                                                                    | PoE<br>(DC 37-57 V) |

**3. Visual inspection : EN 50155:2021 (clause 13.4.1)****3.1 General**

The Visual inspection test verifies the mechanical and appearance conformance of the electronic equipment. The Visual inspection shall be carried out before and after tests to check whether any damage or deterioration has occurred resulting from the tests.

**3.2 Mechanical and appearance**

| Test Items                | Test standard                                                                                         | Test result                                                                     | Remarks |
|---------------------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------|
| Mechanical and appearance | No mechanical damage or deterioration has occurred resulting from the tests, loosening of screw, etc. | Positive results<br>(refer to the test result and/or the remarks of each tests) | -       |

**4. Performance test : EN 50155:2021 (clause 13.4.2)****4.1 General**

The performance test is carried out according to the Performance test specification and Performance test procedure written by the supplier. (E.U.T. shall continue to operate as intended during and after the test.)

**4.2 Test result**

| Test Items       | Test standard                                  | Test result                                                                     | Remarks |
|------------------|------------------------------------------------|---------------------------------------------------------------------------------|---------|
| Performance test | Boot and video output shall operating normally | Positive results<br>(refer to the test result and/or the remarks of each tests) | -       |



## 5. Insulation test : EN 50155:2021 (clause 13.4.7)

### 5.1 General

The aim of this test (insulation resistance test and voltage withstand test) is to ensure that the mounted components, their metal connections and enclosures, and the routing of printed circuit board tracks and wires (if any), are not located too close to surrounding metal parts or fixings.

The test verifies that the design of circuits meets the requirements for galvanic isolation.

The test shall be carried out on fully assembled parts of equipment, and/or complete equipment dependent upon the scope of supply. For this test no alteration of the original equipment is permitted (e.g. component removal).

After the insulation test the equipment shall work as intended and within its specified limits. All measured values shall be recorded in the test report.

Each equipotential area shall be defined and tested against functional earth and against all adjacent equipotential areas.

An equipotential area can be formed by ELV circuits that have internal electronic earth potential (0 V) electrically connected to the functional earth. In this case, insulation test against functional earth is not required.

The voltage withstand test procedure shall be arranged such that equipotential areas are subjected to the minimum number of applications of the dielectric test voltage.

The earth continuity shall be ensured for subracks and PBAs with exposed metal parts which can be touched.

### 5.2 Insulation measurement test

The insulation resistance test shall be carried out at DC 500 V and the resistance values shall be recorded for all the equipotential areas defined for the insulation test. During the test, the equipment shall not be powered on.

#### Test acceptance requirements:

For a single equipotential area on a fully assembled part of equipment (e.g. on a single PBA), the minimum value of the insulation resistance after the voltage withstand test shall be higher than 20 MΩ.

For assembled equipment (e.g. control electronics in traction converter), the minimum value of the insulation resistance of equipotential areas depends on the extent of the complete circuit. The insulation resistance at the interfaces to the vehicle shall be agreed between the involved parties.

In the case of high-impedance bleeder resistors between adjacent equipotential areas or between an equipotential area and functional earth, the effect of these resistors shall be deducted.



### 5.3 Voltage withstand test

(e.g. when EMC filter capacitors are mounted between active signals and functional earth) DC test voltage according to the same table shall be used.

Each equipotential area shall be defined and tested against functional earth and against all surrounding equipotential areas.

The test voltage shall be applied by gradually increasing the voltage amplitude to the test voltage (i.e. in more than 1 s), and maintained at the specified level for:

- Type test: 1 min;
- Routine test: 10 s.

For type test always the initial test voltage shall be applied.

For routine test, in case of repetition of the voltage withstand test during the life cycle of the same equipment, the test voltage may be reduced to 80 % of the initial test voltage to avoid pre-damages by partial discharges. For the same reason, if the same electronic equipment integrated into a subsystem is used, it may be disconnected or removed from the subsystem during the voltage withstand routine test or type test carried on this subsystem.

During the test, the equipment shall not be powered on.

An insulation resistance test shall be carried out before and after the voltage withstand test. Significant differences in the results shall be analysed and justified in the test report.

The nominal battery voltage and/or I/O voltage of each equipotential area define the test voltage according to Table 13.

The test shall be applied to all insulated ports including power supply, I/O-ports and communication ports.

**Table 13 — Test voltages of voltage withstand test**

| Nominal battery voltage and/or I/O voltage                             | Test voltage             |
|------------------------------------------------------------------------|--------------------------|
| < DC 72 V<br>or AC 50 V <sub>RMS</sub>                                 | AC 500 V or DC 750 V     |
| DC 72 V ≤ DC V < DC 125 V<br>or from AC 50 to 90 V <sub>RMS</sub>      | AC 1 000 V or DC 1 500 V |
| DC 125 V ≤ DC V DC < DC 315 V<br>or from AC 90 to 225 V <sub>RMS</sub> | AC 1 500 V or DC 2 200 V |

**5.4 Insulation measurement test results**

| Test Items                  | Test standard                                                                                         | Test result    | Remarks                   |
|-----------------------------|-------------------------------------------------------------------------------------------------------|----------------|---------------------------|
| Insulation measurement test | Carried out at DC 500 V,<br>There shall be no fundamental deterioration from the initial measurement. | Not applicable | ELV part<br>(Input : PoE) |

**5.5 Voltage withstand test results**

| Test Items             | Test standard                                                                      | Test result    | Remarks                   |
|------------------------|------------------------------------------------------------------------------------|----------------|---------------------------|
| Voltage withstand test | AC 500 V, 60 Hz, 1 min,<br>Neither disruptive discharge nor flashover shall occur. | Not applicable | ELV part<br>(Input : PoE) |

**6. Low temperature test : EN 50155:2021 (clause 13.4.4)**

- Carried out in accordance with EN 60068-2-1:2007 (test Ad)

**6.1 Test description and symbol**

| Standard     | Terms | Test description                                                                                                                |
|--------------|-------|---------------------------------------------------------------------------------------------------------------------------------|
| EN 60068-2-1 | Ab    | Cold for non heat-dissipating specimens with gradual change of temperature                                                      |
|              | Ad    | Cold for heat-dissipating specimens with gradual change of temperature that are powered after initial temperature stabilization |
|              | Ae    | Cold for heat-dissipating specimens with gradual change of temperature that are required to be powered throughout the test      |

**6.2 Table 1 – Operating temperature classes**

| Class | Operating temperature range (°C) | Class | Operating temperature range (°C) |
|-------|----------------------------------|-------|----------------------------------|
| OT1   | -25 to +55                       | OT4   | -40 to +70                       |
| OT2   | -40 to +55                       | OT5   | -25 to +85                       |
| OT3   | -25 to +70                       | OT6   | -40 to +85                       |

**6.3 Test instrument performance**

|                                         |                                          |
|-----------------------------------------|------------------------------------------|
| Set point temperature control method    | Temperature sensor detection and control |
| Applied temperature change rate (slope) | ≤ 1 K/min                                |

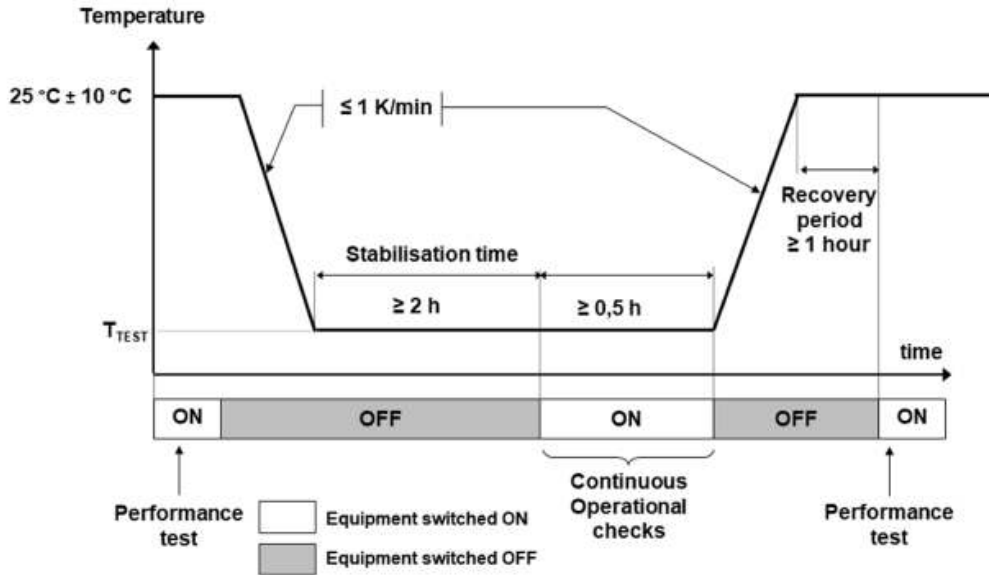


## 6.4 Test conditions

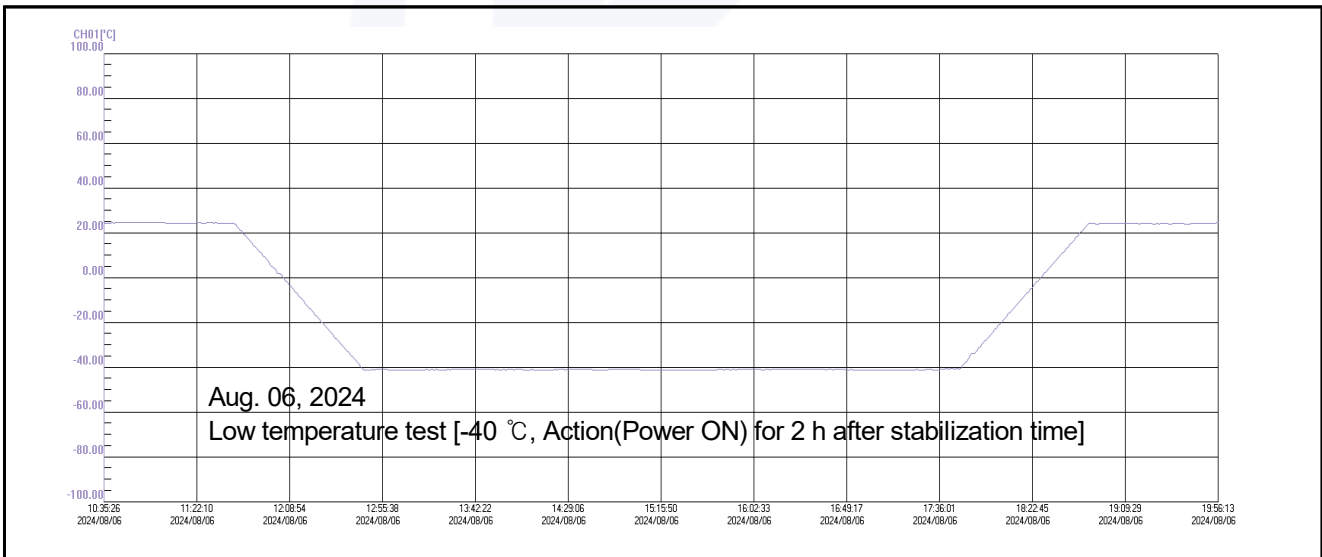
| Item                          |                   | Detailed description                                                                                                                                                                                                                                                                                                                           | Remarks                                          |
|-------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Test date                     |                   | Aug. 06, 2024                                                                                                                                                                                                                                                                                                                                  | -                                                |
| Atmospheric condition         |                   | (25.0 ± 10.0) °C, (50 ± 25) % R.H.                                                                                                                                                                                                                                                                                                             | -                                                |
| Power state                   |                   | <input checked="" type="checkbox"/> Store (Power OFF) <input checked="" type="checkbox"/> Action (Power ON)                                                                                                                                                                                                                                    | Reference of 6.5 Profile of Low temperature test |
| Operating temperature classes |                   | <input type="checkbox"/> OT1 <input checked="" type="checkbox"/> OT2 <input type="checkbox"/> OT3<br><input type="checkbox"/> OT4 <input type="checkbox"/> OT5 <input type="checkbox"/> OT6                                                                                                                                                    | -40 °C                                           |
| Specimen classification       |                   | <input type="checkbox"/> Non heat-dissipating specimens<br><input checked="" type="checkbox"/> heat-dissipating specimens                                                                                                                                                                                                                      | -                                                |
| Application testing           |                   | <input type="checkbox"/> Test Ab <input checked="" type="checkbox"/> Test Ad <input type="checkbox"/> Test Ae                                                                                                                                                                                                                                  | EN 50155:2021                                    |
| Severity                      | Temperature       | <input type="checkbox"/> -65 °C <input type="checkbox"/> -55 °C <input type="checkbox"/> -50 °C <input checked="" type="checkbox"/> -40 °C<br><input type="checkbox"/> -33 °C <input type="checkbox"/> -25 °C <input type="checkbox"/> -20 °C <input type="checkbox"/> -10 °C<br><input type="checkbox"/> -5 °C <input type="checkbox"/> +5 °C | -                                                |
|                               | Duration          | <input checked="" type="checkbox"/> 2 h <input type="checkbox"/> 16 h <input type="checkbox"/> 72 h <input type="checkbox"/> 96 h <input type="checkbox"/> Etc                                                                                                                                                                                 | EN 50155:2021, EN 60068-2-1: 2007                |
| Pre conditioning              | Applicability     | <input checked="" type="checkbox"/> No Regulations <input type="checkbox"/> Regulations                                                                                                                                                                                                                                                        | -                                                |
|                               | Contents          | -                                                                                                                                                                                                                                                                                                                                              | -                                                |
| Initial measurements          | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                                                                                                                                                    | -                                                |
|                               | Performance test  | Normal operation check                                                                                                                                                                                                                                                                                                                         | -                                                |
| Intermediate measurements     | Visual inspection | Not applicable                                                                                                                                                                                                                                                                                                                                 | -                                                |
|                               | Performance test  | Normal operation check                                                                                                                                                                                                                                                                                                                         | -                                                |
| Recovery                      | Applicability     | <input type="checkbox"/> No Regulations <input checked="" type="checkbox"/> Regulations                                                                                                                                                                                                                                                        | -                                                |
|                               | Condition         | <input checked="" type="checkbox"/> Recovery from standard atmospheric conditions<br><input type="checkbox"/> Etc :                                                                                                                                                                                                                            | Minimum 1 h                                      |
| Final measurements            | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                                                                                                                                                    | -                                                |
|                               | Performance test  | Normal operation check                                                                                                                                                                                                                                                                                                                         | -                                                |



### 6.5 Profile of Low temperature test



### 6.6 Graph of Low temperature test

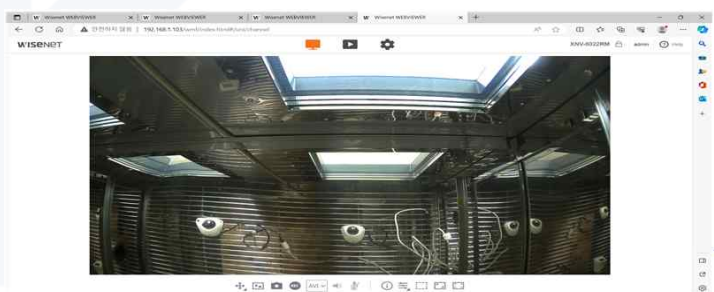
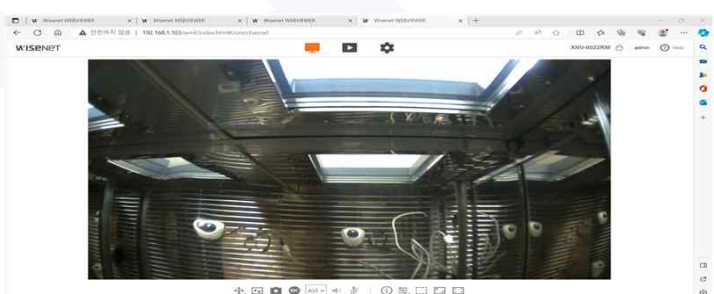
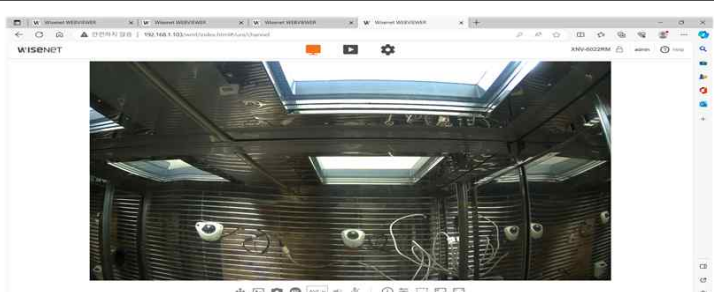


### 6.7 Test result

| Test Items           | Test standard                                                                                                                                                                                                                                                   | Test result                                                                                                                | Remarks |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------|
| Low temperature test | Low temperature test of EN 50155:2021, duration at $-40^{\circ}\text{C}$ for 2 h after stabilization time. No abnormalities and no mechanical defects when the performance tests are confirmed at the initial, intermediate and final measurements of the test. | In the initial, intermediate and final measurements of the test, no problem when performance test and no mechanical fault. | -       |



## 6.8 Photos & Normal operation check of Low temperature test

|                                                    |                              |              |                                                                                      |
|----------------------------------------------------|------------------------------|--------------|--------------------------------------------------------------------------------------|
| Low<br>temperature<br>test of<br>EN 50155:<br>2021 | Internal<br>chamber          |              |    |
|                                                    | During<br>the test           |              |   |
|                                                    | Normal<br>operation<br>check | Initial      |  |
|                                                    |                              | Intermediate |  |
|                                                    |                              | Final        |  |

**7. Dry heat test : EN 50155:2021 (clause 13.4.5)**

- Carried out in accordance with EN 60068-2-1:2007 (test Bd)

**7.1 Test description and symbol**

| Standard     | Terms | Test description                                                                                                               |
|--------------|-------|--------------------------------------------------------------------------------------------------------------------------------|
| EN 60068-2-2 | Bb    | Dry heat for non heat-dissipating specimens with gradual change of temperature                                                 |
|              | Bd    | Dry heat for heat-dissipating specimens with gradual change of temperature that are not powered during the conditioning period |
|              | Be    | Dry heat for heat-dissipating specimens with gradual change of temperature that are required to be powered throughout the test |

**7.2 Table 1 – Operating temperature classes**

| Class | Operating temperature range (°C) | Class | Operating temperature range (°C) |
|-------|----------------------------------|-------|----------------------------------|
| OT1   | -25 to +55                       | OT4   | -40 to +70                       |
| OT2   | -40 to +55                       | OT5   | -25 to +85                       |
| OT3   | -25 to +70                       | OT6   | -40 to +85                       |

**7.3 Table 2 – Classes for increased operating temperature at switch-on**

| Class | Increased operating temperature at switch-on | Thermal test cycle |
|-------|----------------------------------------------|--------------------|
| ST0   | OTx (no increased temperature)               | Test cycle A       |
| ST1   | OTx + 15 °C                                  | Test cycle B       |
| ST2   | OTx + 15 °C                                  | Test cycle C       |

Note) Class ST1 and ST2 do not apply to classes OT5 and OT6.

**7.4 Test instrument performance**

|                                         |                                          |
|-----------------------------------------|------------------------------------------|
| Set point temperature control method    | Temperature sensor detection and control |
| Applied temperature change rate (slope) | ≤ 1 K/min                                |

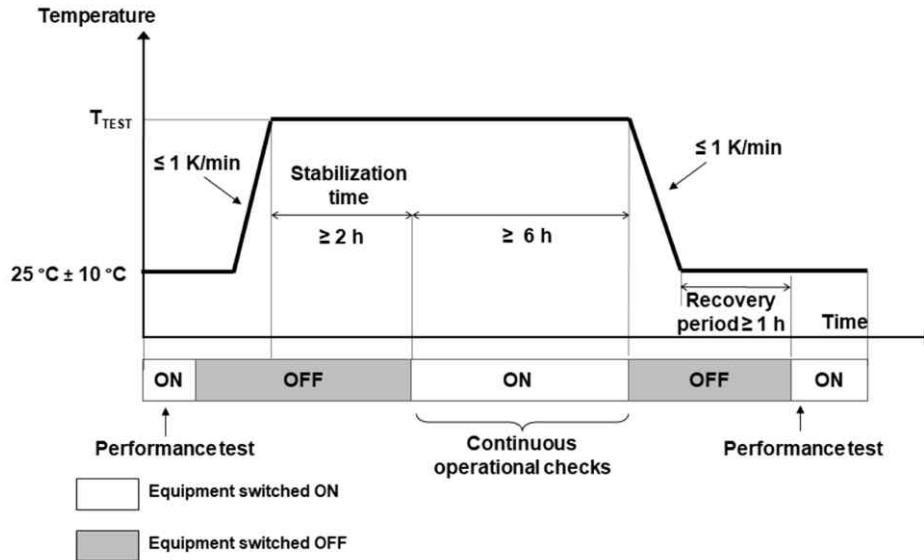


## 7.5 Test conditions

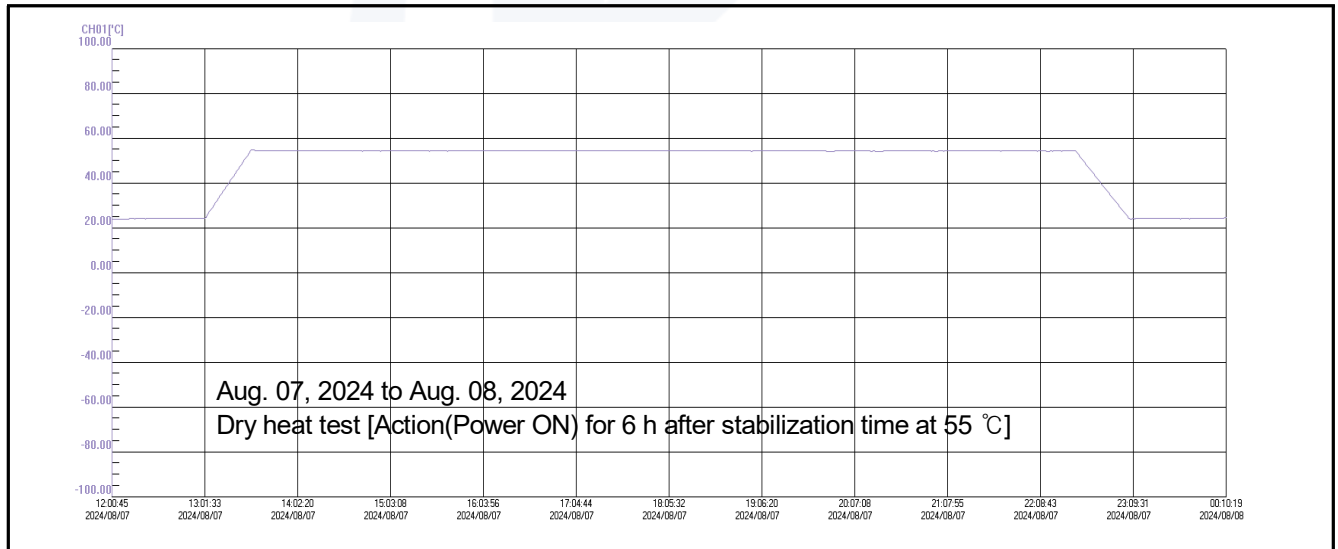
| Item                                                     |                   | Detailed description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Remarks                                                  |
|----------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| Test date                                                |                   | Aug. 07, 2024 to Aug. 08, 2024                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -                                                        |
| Atmospheric condition                                    |                   | (25.0 ± 10.0) °C, (50 ± 25) % R.H.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | -                                                        |
| Power state                                              |                   | <input checked="" type="checkbox"/> Store (Power OFF) <input checked="" type="checkbox"/> Action (Power ON)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Reference of 7.6 Profile of Dry heat test (Test cycle A) |
| Operating temperature classes                            |                   | <input type="checkbox"/> OT1 <input checked="" type="checkbox"/> OT2 <input type="checkbox"/> OT3<br><input type="checkbox"/> OT4 <input type="checkbox"/> OT5 <input type="checkbox"/> OT6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 55 °C                                                    |
| Classes for increased operating temperature at switch-on |                   | <input checked="" type="checkbox"/> ST0 <input type="checkbox"/> ST1 <input type="checkbox"/> ST2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Test cycle A                                             |
| Specimen classification                                  |                   | <input type="checkbox"/> Non heat-dissipating specimens<br><input checked="" type="checkbox"/> heat-dissipating specimens                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -                                                        |
| Application testing                                      |                   | <input type="checkbox"/> Test Bb <input checked="" type="checkbox"/> Test Bd <input type="checkbox"/> Test Be                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | EN 50155:2021                                            |
| Severity                                                 | Temperature       | <input type="checkbox"/> 1 000 °C <input type="checkbox"/> 800 °C <input type="checkbox"/> 630 °C <input type="checkbox"/> 500 °C<br><input type="checkbox"/> 400 °C <input type="checkbox"/> 315 °C <input type="checkbox"/> 250 °C <input type="checkbox"/> 175 °C<br><input type="checkbox"/> 155 °C <input type="checkbox"/> 125 °C <input type="checkbox"/> 100 °C <input type="checkbox"/> 85 °C<br><input type="checkbox"/> 70 °C <input type="checkbox"/> 65 °C <input type="checkbox"/> 60 °C <input checked="" type="checkbox"/> 55 °C<br><input type="checkbox"/> 50 °C <input type="checkbox"/> 45 °C <input type="checkbox"/> 40 °C <input type="checkbox"/> 35 °C <input type="checkbox"/> 30 °C | -                                                        |
|                                                          | Duration          | <input type="checkbox"/> 2 h <input type="checkbox"/> 16 h <input type="checkbox"/> 72 h <input type="checkbox"/> 96 h<br><input type="checkbox"/> 168 h <input type="checkbox"/> 240 h <input type="checkbox"/> 336 h <input type="checkbox"/> 1 000 h<br><input checked="" type="checkbox"/> Etc : 6 h (after stabilization time at 55 °C)                                                                                                                                                                                                                                                                                                                                                                   | EN 50155:2021                                            |
| Initial measurements                                     | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -                                                        |
|                                                          | Performance test  | Normal operation check                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -                                                        |
| Intermediate measurements                                | Visual inspection | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -                                                        |
|                                                          | Performance test  | Normal operation check                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -                                                        |
| Recovery                                                 | Applicability     | <input type="checkbox"/> No Regulations <input checked="" type="checkbox"/> Regulations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -                                                        |
|                                                          | Condition         | <input checked="" type="checkbox"/> Recovery from standard atmospheric conditions<br><input type="checkbox"/> Etc :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Minimum 1 h                                              |
| Final measurements                                       | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -                                                        |
|                                                          | Performance test  | Normal operation check                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -                                                        |



## 7.6 Profile of Dry heat test (Test cycle A)



## 7.7 Graph of Dry heat test (Test cycle A)

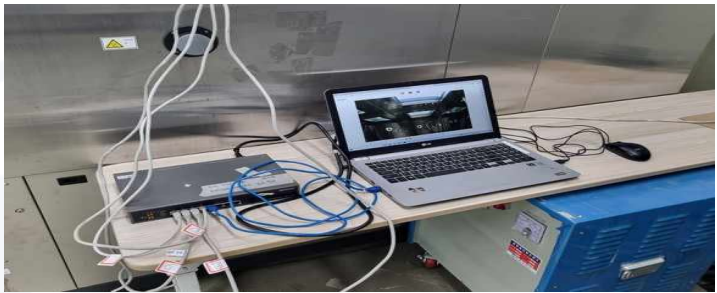
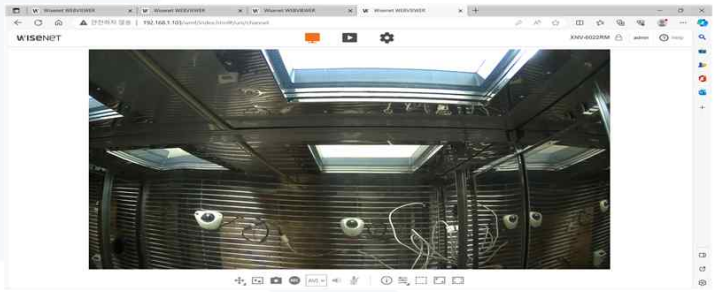
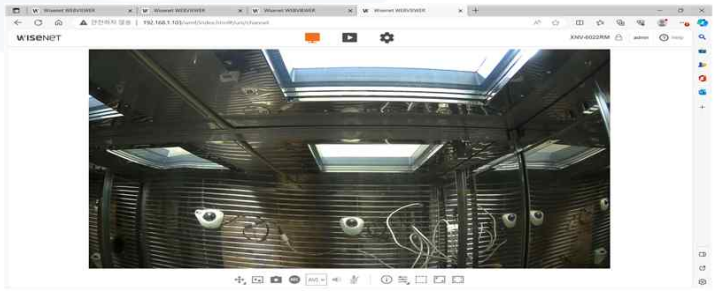
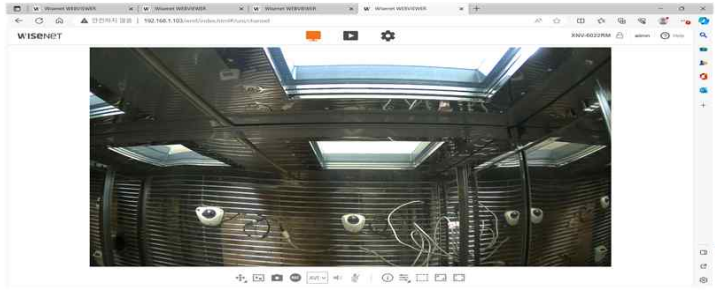


## 7.8 Test result

| Test Items    | Test standard                                                                                                                                                                                                                                           | Test result                                                                                                                                  | Remarks |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Dry heat test | Dry heat test of EN 50155:2021,<br>duration at 55 °C for 6 h after stabilization time.<br>No abnormalities and no mechanical defects<br>when the performance tests are confirmed at<br>the initial, intermediate and final<br>measurements of the test. | In the initial,<br>intermediate and<br>final measurements<br>of the test,<br>no problem when<br>performance test and<br>no mechanical fault. | -       |



## 7.9 Photos & Normal operation check of Dry heat test

|                                          |                              |              |                                                                                      |
|------------------------------------------|------------------------------|--------------|--------------------------------------------------------------------------------------|
| Dry heat test<br>of<br>EN 50155:<br>2021 | Internal<br>chamber          |              |    |
|                                          | During<br>the test           |              |   |
|                                          | Normal<br>operation<br>check | Initial      |  |
|                                          |                              | Intermediate |  |
|                                          |                              | Final        |  |

**8. Cyclic damp heat test : EN 50155:2021 (clause 13.4.8)**

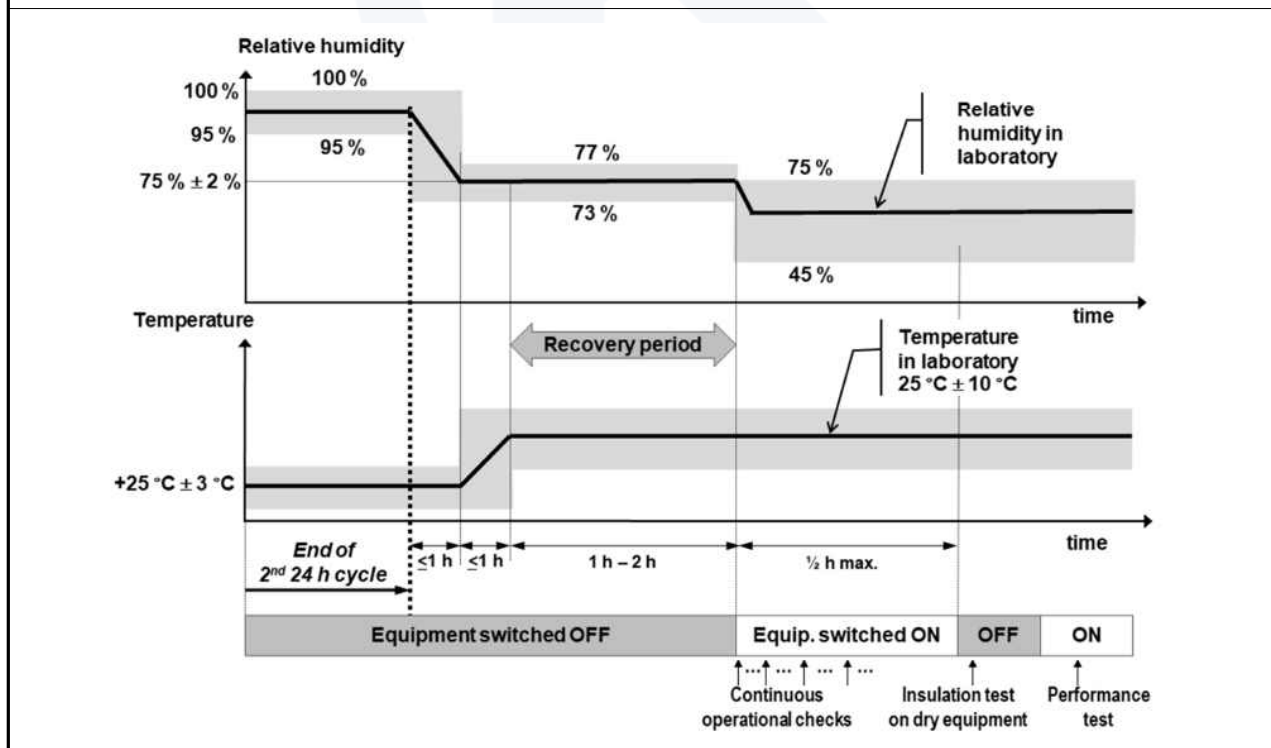
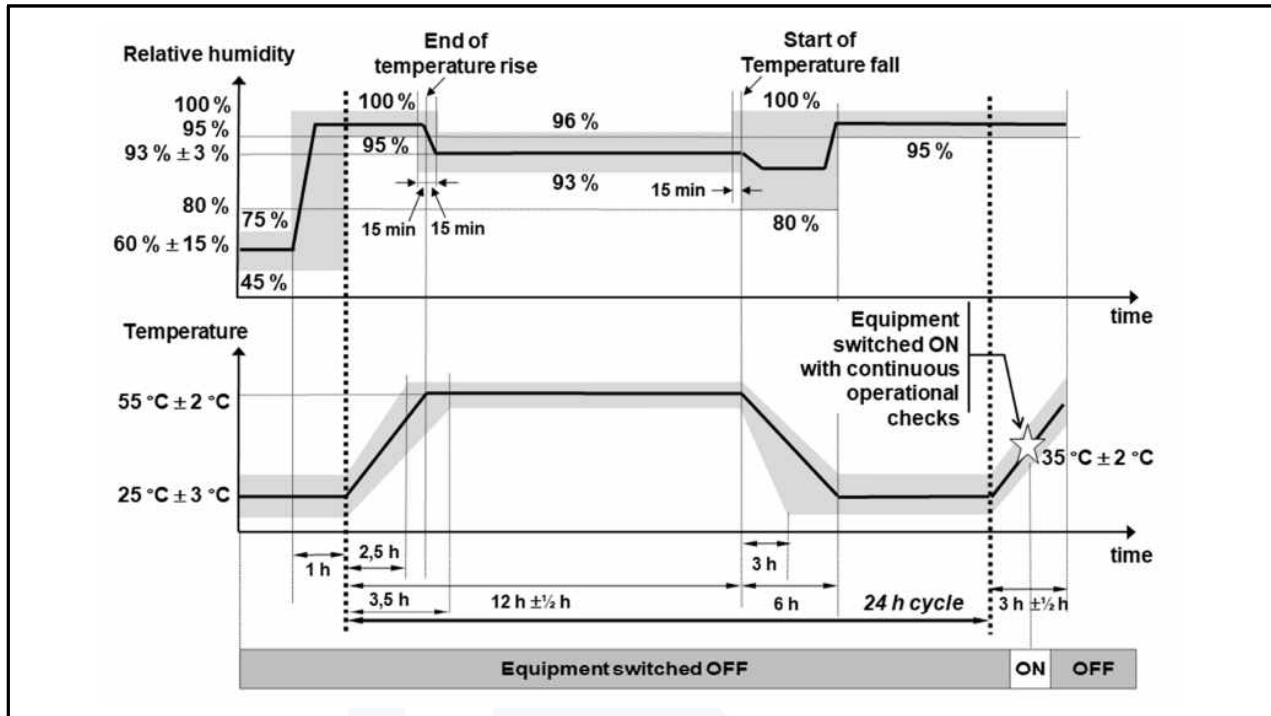
- Carried out in accordance with EN 60068-2-30:2005 (test Db variant 2)

**8.1 Test conditions**

| Item                                                           |                   | Detailed description                                                                                                                                                            | Remarks                                               |
|----------------------------------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| Test date                                                      |                   | Aug. 03, 2024 to Aug. 05, 2024                                                                                                                                                  | -                                                     |
| Atmospheric condition                                          |                   | (25.0 ± 10.0) °C, (50 ± 25) % R.H.                                                                                                                                              | -                                                     |
| Power state                                                    |                   | <input checked="" type="checkbox"/> Store (Power OFF) <input type="checkbox"/> Action (Power ON)                                                                                | EN 50155:2021                                         |
| Severities of test                                             |                   | <input type="checkbox"/> a) upper temperature: 40 °C<br><input checked="" type="checkbox"/> b) upper temperature: 55 °C                                                         | EN 50155:2021                                         |
| Selection of variant                                           |                   | <input type="checkbox"/> Variant 1 <input checked="" type="checkbox"/> Variant 2                                                                                                | EN 50155:2021                                         |
| Number of cycles                                               |                   | <input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 6 <input type="checkbox"/> 12 <input type="checkbox"/> 21 <input type="checkbox"/> 56 | EN 50155:2021                                         |
| Pre treatment condition                                        | Applicability     | <input checked="" type="checkbox"/> No Regulations <input type="checkbox"/> Regulations                                                                                         | -                                                     |
|                                                                | Contents          | -                                                                                                                                                                               | -                                                     |
| Initial measurements                                           | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                     | -                                                     |
|                                                                | Performance test  | Normal operation check                                                                                                                                                          | -                                                     |
| Intermediate measurements                                      | Visual inspection | Not applicable                                                                                                                                                                  | -                                                     |
|                                                                | Performance test  | Normal operation check<br>(During the operational check at the beginning of the 2 <sup>nd</sup> cycle)                                                                          | See Figure 1 of 8.2 Profiles of Cyclic damp heat test |
| Recovery                                                       | Applicability     | <input type="checkbox"/> No Regulations <input checked="" type="checkbox"/> Regulations                                                                                         | EN 50155:2021                                         |
|                                                                | Condition         | <input type="checkbox"/> Standard atmospheric conditions<br><input checked="" type="checkbox"/> Controlled recovery condition                                                   | See Figure 2 of 8.2 Profiles of Cyclic damp heat test |
| Final measurements                                             | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                     | -                                                     |
|                                                                | Performance test  | Normal operation check                                                                                                                                                          | See Figure 2 of 8.2 Profiles of Cyclic damp heat test |
| Special precautions to be taken when removing surface moisture |                   | <input checked="" type="checkbox"/> No special precautions <input type="checkbox"/> special precautions                                                                         | -                                                     |

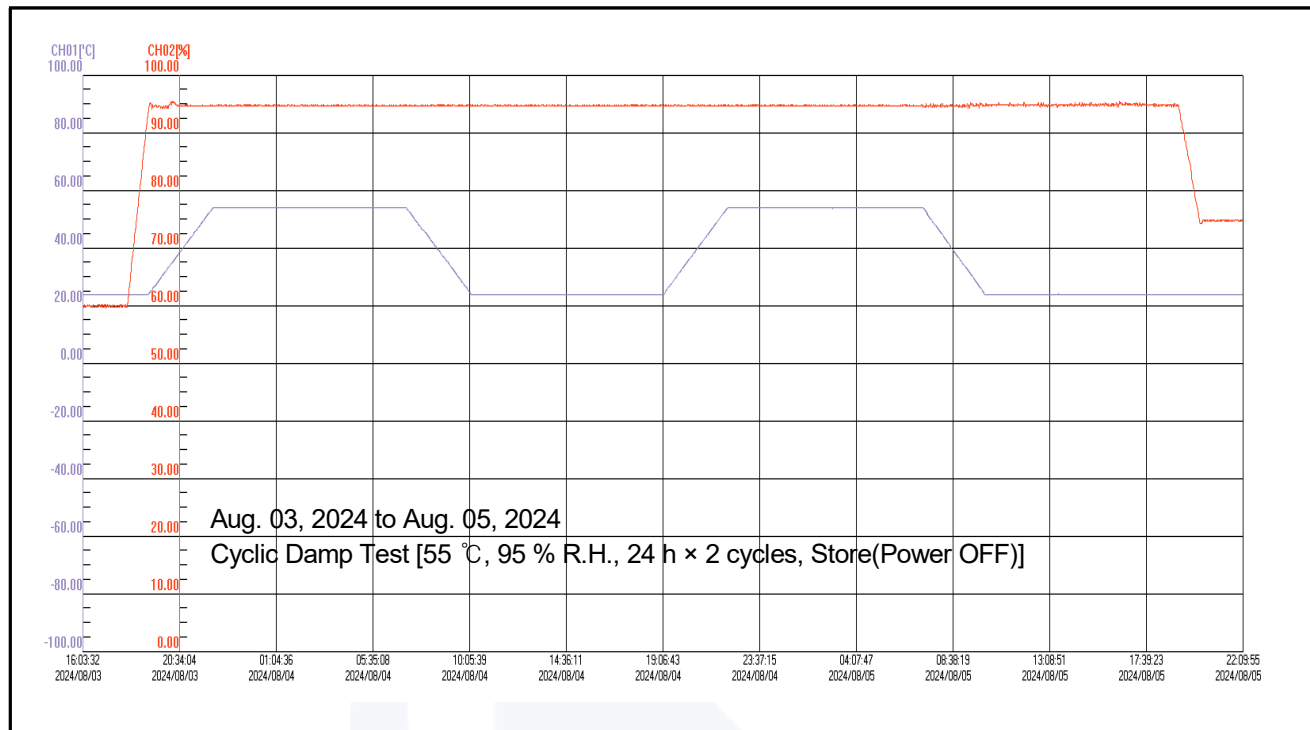


## 8.2 Profiles of Cyclic damp heat test





### 8.3 Graph of Cyclic damp heat test

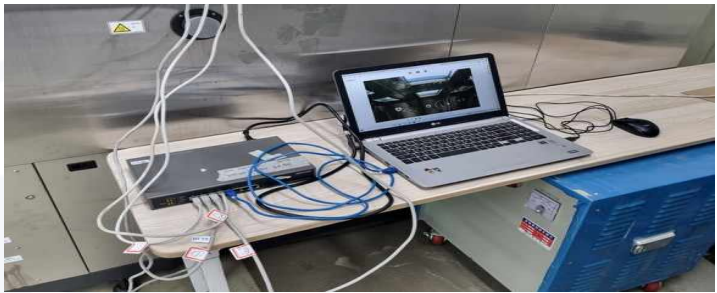
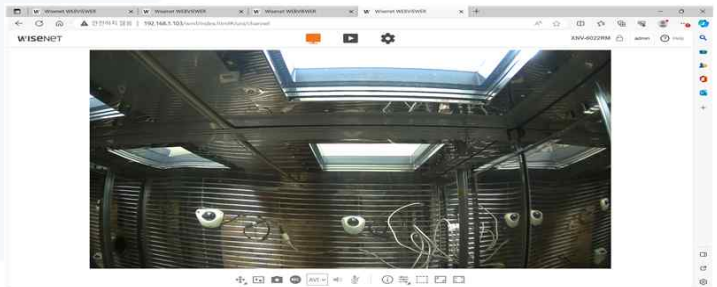
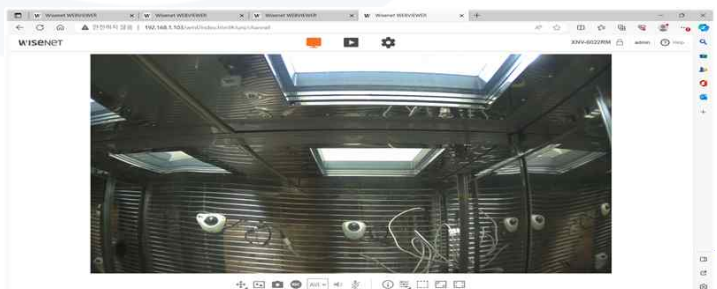
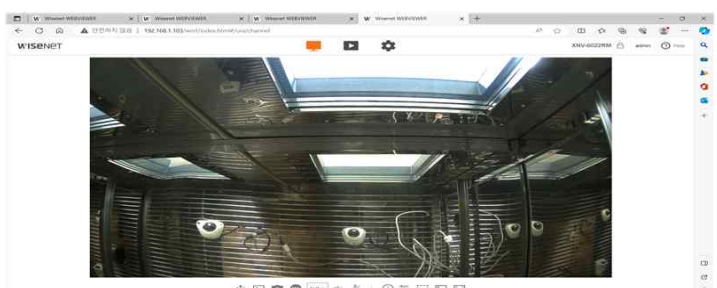


### 8.4 Test result

| Test Items            | Test standard                                                                                                                                                                                                                                        | Test result                                                                                                                | Remarks |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------|
| Cyclic damp heat test | Cyclic damp heat test of EN 50155:2021, upper temperature 55 °C, 95 % R.H., 24 h × 2 cycles.<br>No abnormalities and no mechanical defects when the performance tests are confirmed at the initial, intermediate and final measurements of the test. | In the initial, intermediate and final measurements of the test, no problem when performance test and no mechanical fault. | -       |



### 8.5 Photos & Normal operation check of Cyclic damp heat test

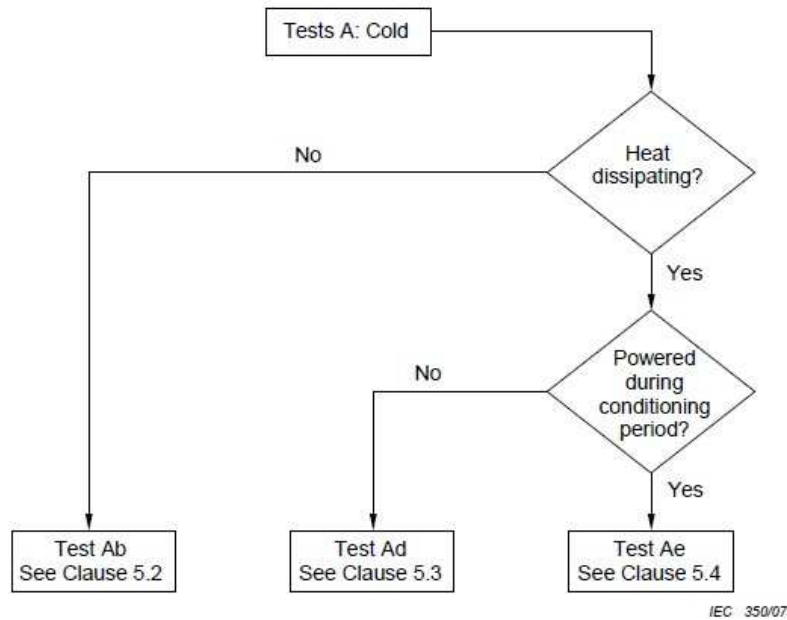
|                                         |                        |              |                                                                                      |
|-----------------------------------------|------------------------|--------------|--------------------------------------------------------------------------------------|
| Cyclic damp heat test of EN 50155: 2021 | Internal chamber       |              |    |
|                                         | During the test        |              |   |
|                                         | Normal operation check | Initial      |  |
|                                         |                        | Intermediate |  |
|                                         |                        | Final        |  |



## 9. Low temperature storage test : EN 50155:2021 (clause 13.4.6)

- Carried out in accordance with EN 60068-2-1:2007 (test Ab)

### 9.1 Test description



| Terms   | Test description                                                                                                                |
|---------|---------------------------------------------------------------------------------------------------------------------------------|
| Test Ab | Cold for non heat-dissipating specimens with gradual change of temperature                                                      |
| Test Ad | Cold for heat-dissipating specimens with gradual change of temperature that are powered after initial temperature stabilization |
| Test Ae | Cold for heat-dissipating specimens with gradual change of temperature that are required to be powered throughout the test      |

### 9.2 Test instrument performance

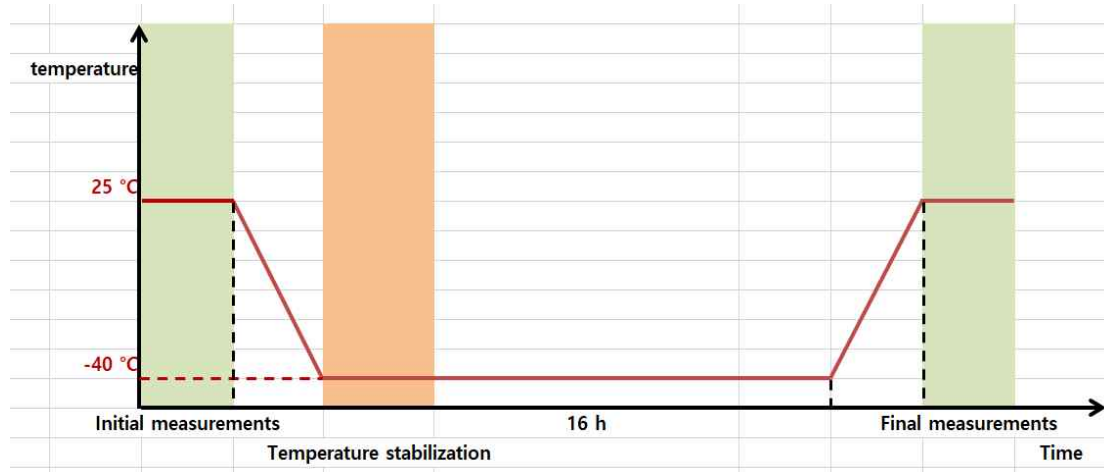
|                                         |                                          |
|-----------------------------------------|------------------------------------------|
| Set point temperature control method    | Temperature sensor detection and control |
| Applied temperature change rate (slope) | $\leq 1$ K/min                           |

**9.3 Test condition**

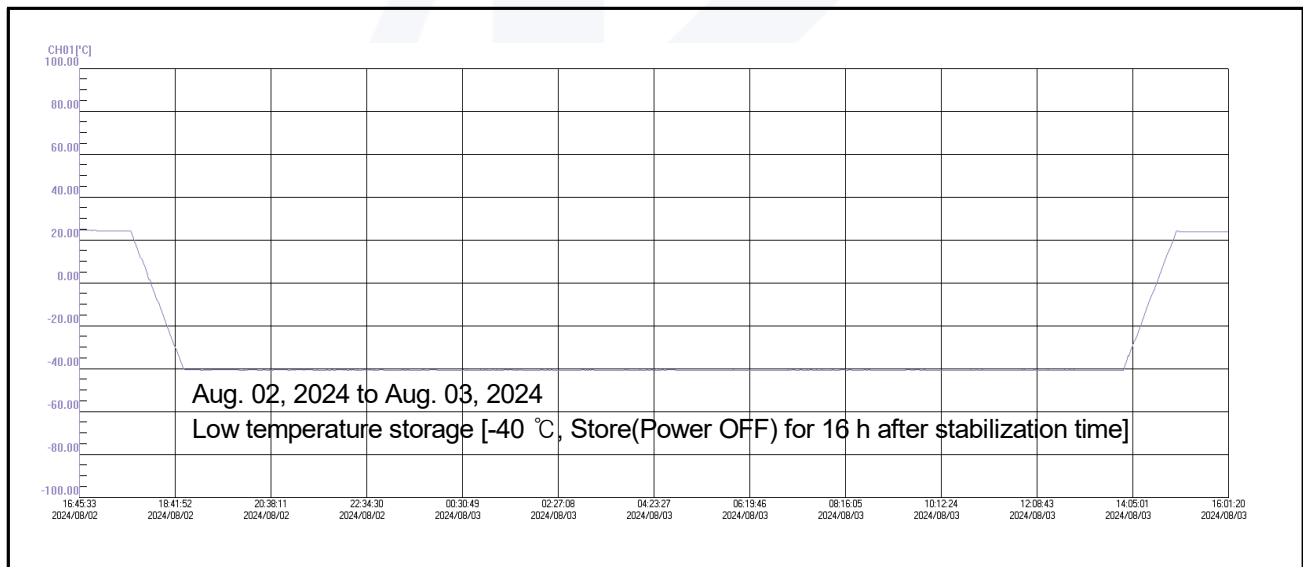
| Item                      |                   | Detailed description                                                                                                                                                                                                                                                                                                                                                        | Remarks       |
|---------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Test date                 |                   | Aug. 02, 2024 to Aug. 03, 2024                                                                                                                                                                                                                                                                                                                                              | -             |
| Atmospheric condition     |                   | (25.0 ± 10.0) °C, (50 ± 25) % R.H.                                                                                                                                                                                                                                                                                                                                          | -             |
| Power state               |                   | <input checked="" type="checkbox"/> Store (Power OFF) <input type="checkbox"/> Action (Power ON)                                                                                                                                                                                                                                                                            | EN 50155:2021 |
| Additional condition      |                   | Equipment without transportation packaging is placed                                                                                                                                                                                                                                                                                                                        | -             |
| Specimen classification   |                   | <input checked="" type="checkbox"/> Non heat-dissipating specimens<br><input type="checkbox"/> heat-dissipating specimens                                                                                                                                                                                                                                                   | -             |
| Type of test              |                   | <input checked="" type="checkbox"/> Test Ab <input type="checkbox"/> Test Ad <input type="checkbox"/> Test Ae                                                                                                                                                                                                                                                               | EN 50155:2021 |
| Severity                  | Temperature       | <input type="checkbox"/> -65 °C <input type="checkbox"/> -55 °C <input type="checkbox"/> -50 °C <input checked="" type="checkbox"/> -40 °C<br><input type="checkbox"/> -33 °C <input type="checkbox"/> -25 °C <input type="checkbox"/> -20 °C <input type="checkbox"/> -10 °C<br><input type="checkbox"/> -5 °C <input type="checkbox"/> +5 °C <input type="checkbox"/> Etc | EN 50155:2021 |
|                           | Duration          | <input type="checkbox"/> 2 h <input checked="" type="checkbox"/> 16 h <input type="checkbox"/> 72 h <input type="checkbox"/> 96 h <input type="checkbox"/> Etc.                                                                                                                                                                                                             | EN 50155:2021 |
| Pretreatment condition    | Applicability     | <input checked="" type="checkbox"/> No Regulations <input type="checkbox"/> Regulations                                                                                                                                                                                                                                                                                     | -             |
|                           | Contents          | -                                                                                                                                                                                                                                                                                                                                                                           | -             |
| Initial measurements      | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                                                                                                                                                                                 | -             |
|                           | Functional test   | Normal operation check                                                                                                                                                                                                                                                                                                                                                      | -             |
| Intermediate measurements | Visual inspection | Not applicable                                                                                                                                                                                                                                                                                                                                                              | -             |
|                           | Functional test   | Not applicable                                                                                                                                                                                                                                                                                                                                                              | -             |
| Recovery                  | Applicability     | <input type="checkbox"/> No Regulations <input checked="" type="checkbox"/> Regulations                                                                                                                                                                                                                                                                                     | -             |
|                           | Condition         | <input checked="" type="checkbox"/> Recovery from standard atmospheric conditions<br><input type="checkbox"/> Etc :                                                                                                                                                                                                                                                         | Minimum 1 h   |
| Final measurements        | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                                                                                                                                                                                 | -             |
|                           | Functional test   | Normal operation check                                                                                                                                                                                                                                                                                                                                                      | -             |



#### 9.4 Profile of Low temperature storage test



#### 9.5 Graph of Low temperature storage test

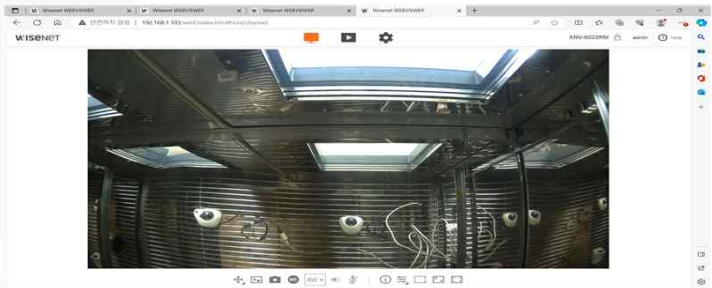
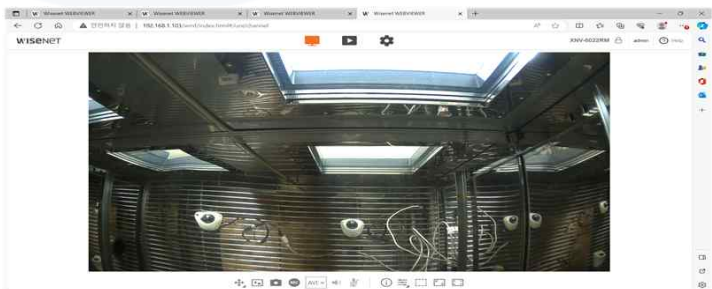


#### 9.6 Test result

| Test Items                   | Test standard                                                                                                                                                                                                                                  | Test result                                                                                                  | Remarks |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|---------|
| Low temperature storage test | Low temperature storage test of EN 50155:2021, duration at -40 °C for 16 h after stabilization time.<br>No abnormalities and no mechanical defects when the performance tests are confirmed at the initial and final measurements of the test. | In the initial and final measurements of the test, no problem when performance test and no mechanical fault. | -       |



### 9.7 Photos & Normal operation check of Low temperature storage test

|                                                |                        |         |                                                                                      |
|------------------------------------------------|------------------------|---------|--------------------------------------------------------------------------------------|
| Low temperature storage test of EN 50155: 2021 | Internal chamber       |         |    |
|                                                | During the test        |         |   |
|                                                | Normal operation check | Initial |  |
|                                                |                        | Final   |  |

**10. Shock and vibration tests : EN 50155:2021 (clause 13.4.10)**

- Carried out in accordance with EN 61373:2010

**10.1 Scope**

This International Standard specifies the requirements for testing items of equipment intended for use on railway vehicles which are subsequently subjected to vibrations and shock owing to the nature of railway operational environment. To gain assurance that the quality of the equipment is acceptable, it has to withstand tests of reasonable duration that simulate the service conditions seen throughout its expected life.

Simulated long-life testing can be achieved in a number of ways each having their associated advantages and disadvantages, the following being the most common:

- a) amplification: where the amplitudes are increased and the time base decreased;
- b) time compression: where the amplitude history is retained and the time base is decreased (increase of the frequency);
- c) decimation: where time slices of the historical data are removed when the amplitudes are below a specified threshold value.

**10.2 Purpose and choice of the tests**

| Terms                                           | Test description                                                                                                                                                                                                                          |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Category 1</b><br><b><u>Body mounted</u></b> | Class A Cubicles, subassemblies, equipment and components mounted directly on<br>or<br>under the car body.                                                                                                                                |
|                                                 | <b><u>Class B Anything mounted inside an equipment case which is in turn mounted<br/>directly on or under the car body.</u></b><br><b><u>NOTE 1 Class B should be used when it is not clear where the equipment is to be located.</u></b> |
| Category 2<br>Bogie mounted                     | Cubicles, subassemblies, equipment and components which are to be mounted<br>on the bogie of a railway vehicle                                                                                                                            |
| Category 3<br>Axle mounted                      | Subassemblies, equipment and components or assemblies which are to be mounted<br>on the wheelset assembly of a railway vehicle.                                                                                                           |

**10.3 General**

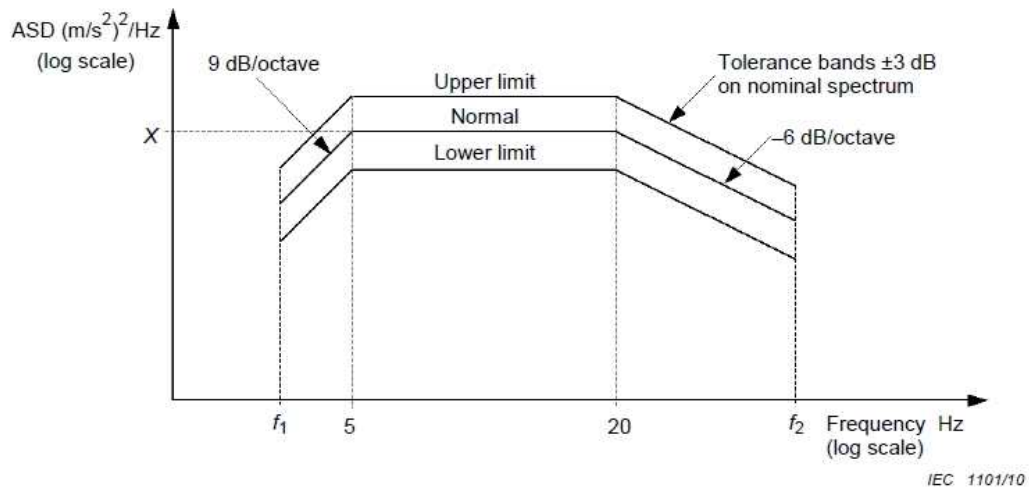
This standard is intended to highlight any weakness/error which may result in problems as a consequence of operation under environments where vibration and shock are known to occur in service on a railway vehicle. This is not intended to represent a full life test. However, the test conditions are sufficient to provide some reasonable degree of confidence that the equipment will survive the specified life under service conditions.

**10.4 Simulated long-life testing****10.4.1 Test Conditions**

| Item                                        |                      | Detailed description                                                                                                                                                                                       |                                                                                             |                                                     |                                                     | Remarks                                                |
|---------------------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|--------------------------------------------------------|
| Test date                                   |                      | Aug. 11, 2024 to Aug. 13, 2024                                                                                                                                                                             |                                                                                             |                                                     |                                                     | -                                                      |
| Atmospheric condition                       |                      | (25.0 ± 10.0) °C, (50 ± 25) % R.H.                                                                                                                                                                         |                                                                                             |                                                     |                                                     | -                                                      |
| Power State                                 |                      | <input checked="" type="checkbox"/> Store (Power OFF) <input type="checkbox"/> Action (Power ON)                                                                                                           |                                                                                             |                                                     |                                                     | -                                                      |
| Examination                                 |                      | <input checked="" type="checkbox"/> Category 1 ( <input type="checkbox"/> Class A <input checked="" type="checkbox"/> Class B )<br><input type="checkbox"/> Category 2 <input type="checkbox"/> Category 3 |                                                                                             |                                                     |                                                     | Client requirements                                    |
| when mass                                   |                      | <input checked="" type="checkbox"/> ≤ 500 kg <input type="checkbox"/> > 500 kg, ≤ 1 250 kg <input type="checkbox"/> > 1 250 kg                                                                             |                                                                                             |                                                     |                                                     |                                                        |
| Direction time<br><br>and<br><br>test level | Axis                 |                                                                                                                                                                                                            | Vertical (5 h)                                                                              | Transverse (5 h)                                    | Longitudinal (5 h)                                  |                                                        |
|                                             | Frequency [ Hz ]     |                                                                                                                                                                                                            | ASD Levels [ (m/s <sup>2</sup> ) <sup>2</sup> /Hz ]                                         | ASD Levels [ (m/s <sup>2</sup> ) <sup>2</sup> /Hz ] | ASD Levels [ (m/s <sup>2</sup> ) <sup>2</sup> /Hz ] |                                                        |
|                                             | f <sub>1</sub> to 5  |                                                                                                                                                                                                            | 9 dB/oct                                                                                    | 9 dB/oct                                            | 9 dB/oct                                            |                                                        |
|                                             | 5 to 20              |                                                                                                                                                                                                            | 0.964                                                                                       | 0.192                                               | 0.461                                               |                                                        |
|                                             | 20 to f <sub>2</sub> |                                                                                                                                                                                                            | -6 dB/oct                                                                                   | -6 dB/oct                                           | -6 dB/oct                                           |                                                        |
|                                             | RMS value            |                                                                                                                                                                                                            | 5.72 m/s <sup>2</sup>                                                                       | 2.55 m/s <sup>2</sup>                               | 3.96 m/s <sup>2</sup>                               |                                                        |
|                                             | ASD spectrum         |                                                                                                                                                                                                            | Category 1 ( <input type="checkbox"/> Class A <input checked="" type="checkbox"/> Class B ) |                                                     |                                                     | Reference of 10.4.2 Category 1 – Class B, ASD spectrum |
| Initial measurements                        | Visual inspection    | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                                                                                             |                                                     |                                                     | -                                                      |
|                                             | Functional test      | Normal operation check                                                                                                                                                                                     |                                                                                             |                                                     |                                                     | -                                                      |
| Intermediate measurements                   | Visual inspection    | Not applicable                                                                                                                                                                                             |                                                                                             |                                                     |                                                     | -                                                      |
|                                             | Functional test      | Not applicable                                                                                                                                                                                             |                                                                                             |                                                     |                                                     | -                                                      |
| Final measurements                          | Visual inspection    | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                                                                                             |                                                     |                                                     | -                                                      |
|                                             | Functional test      | Normal operation check                                                                                                                                                                                     |                                                                                             |                                                     |                                                     | -                                                      |



#### 10.4.2 Category 1 – Class B, ASD spectrum



when mass  $\leq 500$  kg:  $f_1 = 5$  Hz  $f_2 = 150$  Hz

when mass  $> 500$  kg  $\leq 1\,250$  kg:  $f_1 = \frac{1\,250}{\text{mass}} \times 2$  Hz  $f_2 = \frac{1\,250}{\text{mass}} \times 60$  Hz

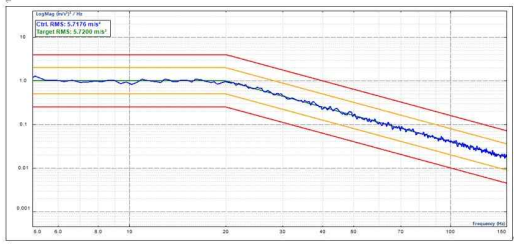
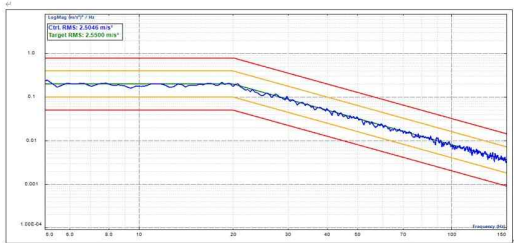
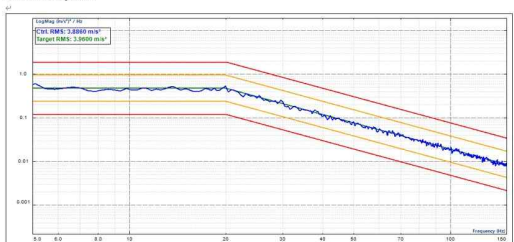
when mass  $> 1\,250$  kg:  $f_1 = 2$  Hz  $f_2 = 60$  Hz

#### 10.4.3 Test result

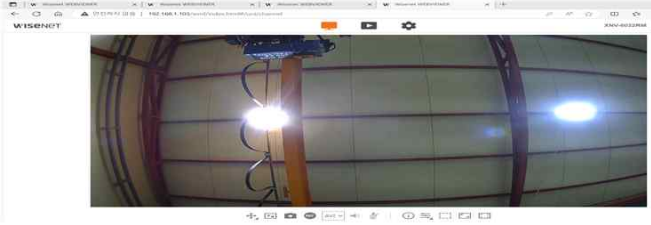
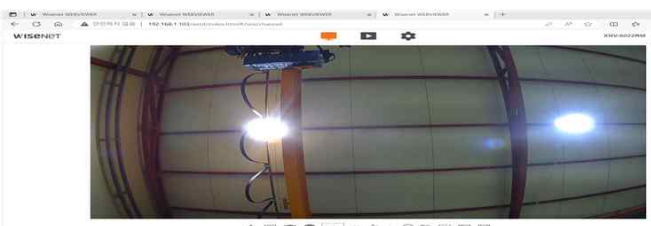
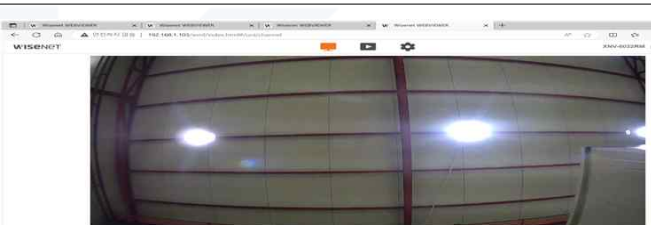
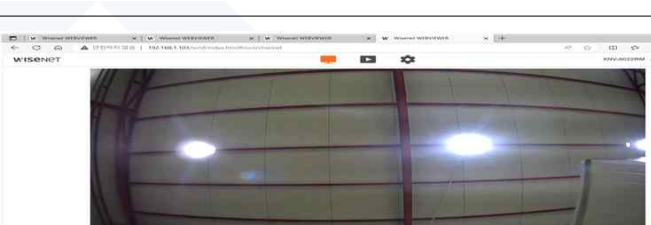
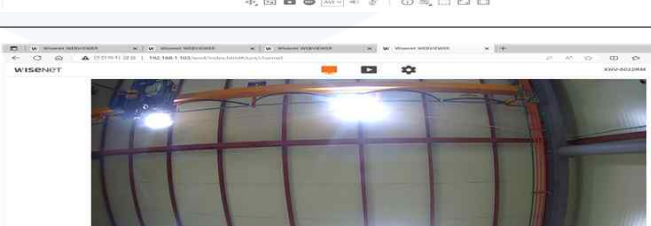
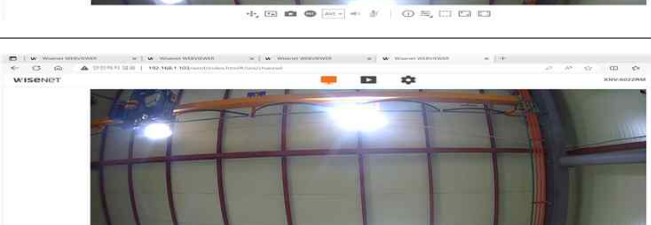
| Test Items                  | Test standard                                                                                                                                                                                                                                                                  | Test result                                                                                                  | Remarks |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|---------|
| Simulated long-life testing | Simulated long-life testing of EN 50155:2021, carried out in accordance with EN 61373:2010, Clause 9 - Category 1, Class B test method. No abnormalities and no mechanical defects when the performance tests are confirmed at the initial and final measurements of the test. | In the initial and final measurements of the test, no problem when performance test and no mechanical fault. | -       |



#### 10.4.4 Test photos & graphs

|                  |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vertical         |    | <p>2024. 08. 13. / 10:12:21</p> <p><b>Test Report</b></p> <p>Testing time: Remaining Time: 00:00:00<br/>Run Start Time: Aug-13-2024 10:12:21</p> <p>Total elapsed time: 05:01:02<br/>Full level elapsed time: 05:00:00</p> <p>Test parameters: Lines: 400<br/>Average: 64</p> <p>DOP: 64</p> <p>Frequency range (fa): Calculated by profile</p> <p>* Control Composite</p>    |
| Trans<br>verse   |   | <p>2024. 08. 11. / 09:24:50</p> <p><b>Test Report</b></p> <p>Testing time: Remaining Time: 00:00:00<br/>Run Start Time: Aug-11-2024 09:24:50</p> <p>Total elapsed time: 05:01:02<br/>Full level elapsed time: 05:00:00</p> <p>Test parameters: Lines: 400<br/>Average: 64</p> <p>DOP: 64</p> <p>Frequency range (fa): Calculated by profile</p> <p>* Control Composite</p>  |
| Longitu<br>dinal |  | <p>2024. 08. 12. / 09:37:14</p> <p><b>Test Report</b></p> <p>Testing time: Remaining Time: 00:00:00<br/>Run Start Time: Aug-12-2024 09:37:14</p> <p>Total elapsed time: 05:01:01<br/>Full level elapsed time: 05:00:00</p> <p>Test parameters: Lines: 400<br/>Average: 64</p> <p>DOP: 64</p> <p>Frequency range (fa): Calculated by profile</p> <p>* Control Composite</p>  |

**10.4.5 Normal operation check of Simulated long-life testing**

|                                                                         |                  |         |                                                                                      |
|-------------------------------------------------------------------------|------------------|---------|--------------------------------------------------------------------------------------|
| Normal<br>operation<br>check<br>of<br>Simulated<br>long-life<br>testing | Vertical         | Initial |    |
|                                                                         |                  | Final   |    |
|                                                                         | Trans<br>verse   | Initial |   |
|                                                                         |                  | Final   |  |
|                                                                         | Longitu<br>dinal | Initial |  |
|                                                                         |                  | Final   |  |



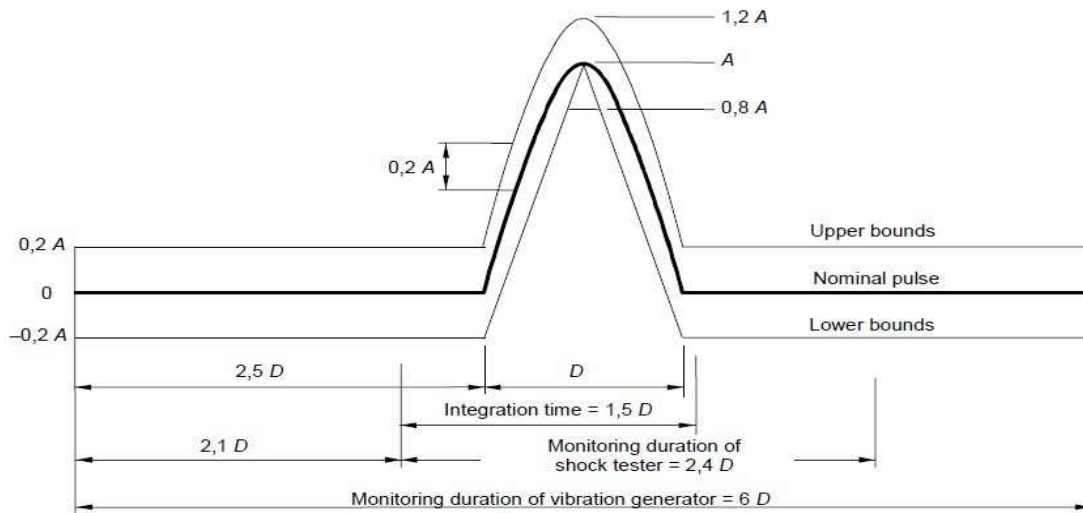
## 10.5 Shock testing

### 10.5.1 Test conditions

| Item                                        |                                            | Detailed description                                                                                                                                                                                       |                 |                 | Remarks                                                      |
|---------------------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|--------------------------------------------------------------|
| Test date                                   |                                            | Aug. 11, 2024 to Aug. 13, 2024                                                                                                                                                                             |                 |                 | -                                                            |
| Atmospheric condition                       |                                            | (25.0 ± 10.0) °C, (50 ± 25) % R.H..                                                                                                                                                                        |                 |                 | -                                                            |
| Power State                                 |                                            | <input type="checkbox"/> Store (Power OFF) <input checked="" type="checkbox"/> Action (Power ON)                                                                                                           |                 |                 | -                                                            |
| Examination                                 |                                            | <input checked="" type="checkbox"/> Category 1 ( <input type="checkbox"/> Class A <input checked="" type="checkbox"/> Class B )<br><input type="checkbox"/> Category 2 <input type="checkbox"/> Category 3 |                 |                 | Client requirements                                          |
| when mass                                   |                                            | <input checked="" type="checkbox"/> ≤ 500 kg <input type="checkbox"/> > 500 kg, ≤ 1 250 kg <input type="checkbox"/> > 1 250 kg                                                                             |                 |                 |                                                              |
| Direction time<br><br>and<br><br>test level |                                            |                                                                                                                                                                                                            | Vertical        | Transverse      | Longitudinal                                                 |
|                                             | Peak acceleration A<br>(m/s <sup>2</sup> ) |                                                                                                                                                                                                            | 30              | 30              | 50                                                           |
|                                             | Nominal duration D<br>(ms)                 |                                                                                                                                                                                                            | 30              | 30              | 30                                                           |
|                                             | Number of repetitions<br>(+, -)            |                                                                                                                                                                                                            | 3 / 3           | 3 / 3           | 3 / 3                                                        |
|                                             | Pulse shape                                |                                                                                                                                                                                                            | Half-sine pulse | Half-sine pulse | Half-sine pulse                                              |
| Allowable width of<br>half-sine pulse       |                                            | Category 1 ( <input type="checkbox"/> Class A <input checked="" type="checkbox"/> Class B )                                                                                                                |                 |                 | Reference of 10.5.2<br>Allowable width of<br>half-sine pulse |
| Initial<br>measurements                     | Visual<br>inspection                       | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                 |                 | -                                                            |
|                                             | Functional<br>test                         | Normal operation check                                                                                                                                                                                     |                 |                 | -                                                            |
| Intermediate<br>measurements                | Visual<br>inspection                       | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                 |                 | -                                                            |
|                                             | Functional<br>test                         | Normal operation check                                                                                                                                                                                     |                 |                 | -                                                            |
| Final<br>measurements                       | Visual<br>inspection                       | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                 |                 | -                                                            |
|                                             | Functional<br>test                         | Normal operation check                                                                                                                                                                                     |                 |                 | -                                                            |



### 10.5.2 Allowable width of half-sine pulse

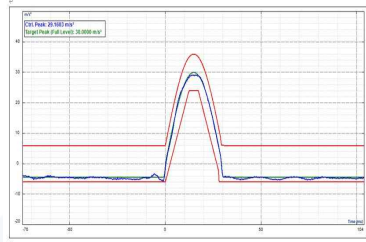
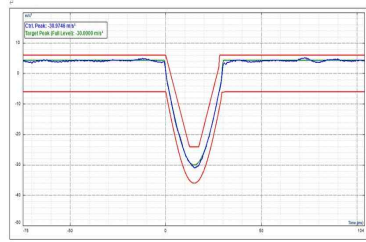
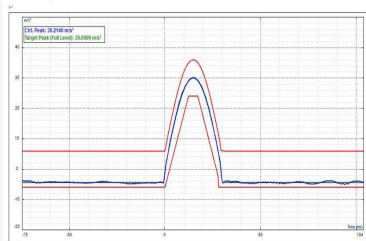
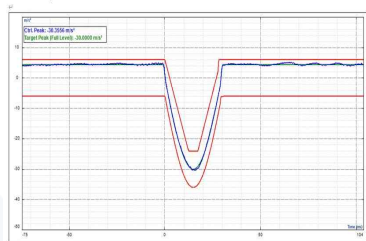
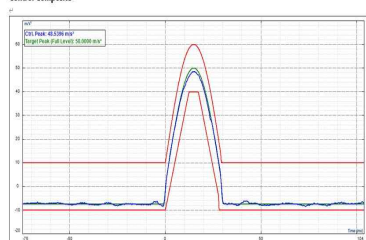
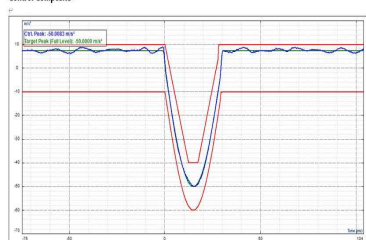
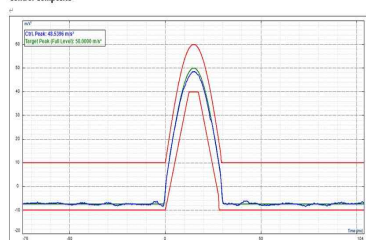
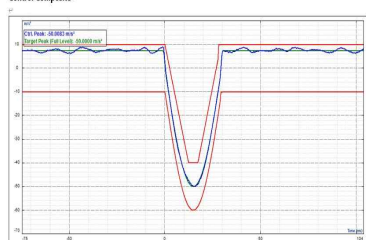
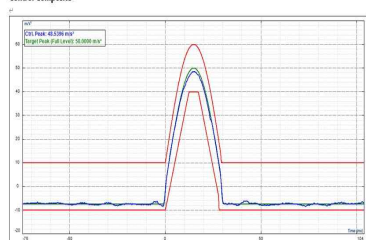
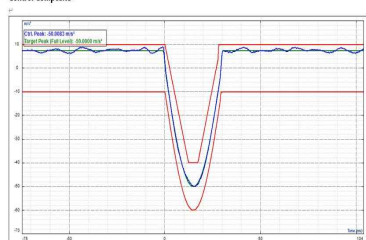
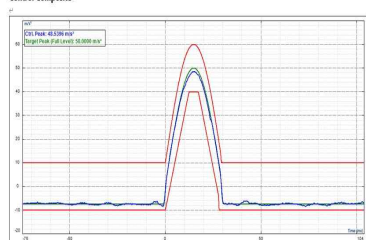
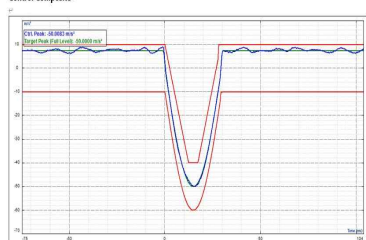


### 10.5.3 Test result

| Test Items    | Test standard                                                                                                                                                                                                                                                                      | Test result                                                                                                                | Remarks |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------|
| Shock testing | Shock testing of EN 50155:2021, carried out in accordance with EN 61373:2010, Clause 10 - Category 1, Class B test method.<br>No abnormalities and no mechanical defects when the performance tests are confirmed at the initial, intermediate and final measurements of the test. | In the initial, intermediate and final measurements of the test, no problem when performance test and no mechanical fault. | -       |

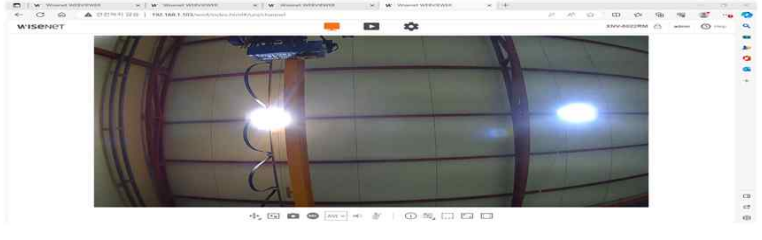
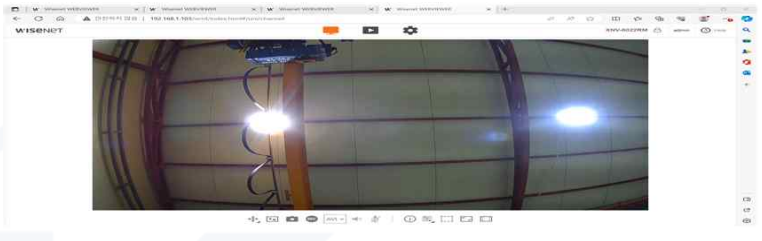
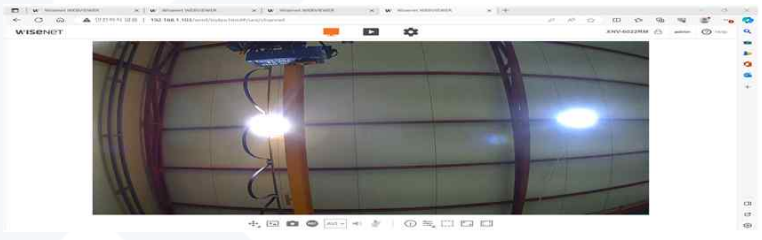
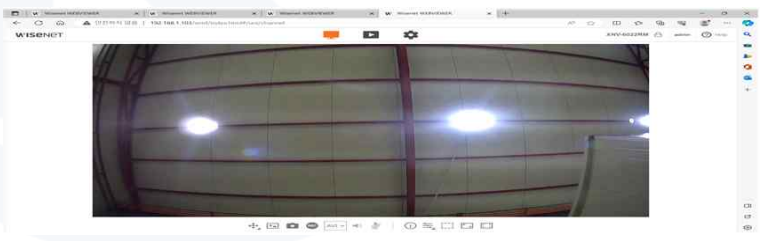
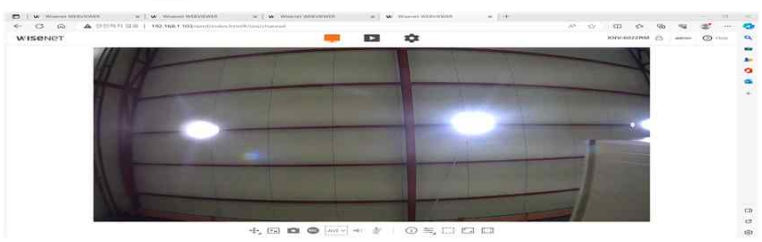


### 10.5.4 Test photos & graphs

|              |                                                                                     |                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------|-------------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vertical     |    | 2024. 08. 13. / 15:19:43 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-13-2024 15:19:43</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div>   | 2024. 08. 13. / 15:23:04 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-13-2024 15:23:04</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div>   |
|              |                                                                                     | 2024. 08. 11. / 14:28:25 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-11-2024 14:28:25</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> | 2024. 08. 11. / 14:29:52 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-11-2024 14:29:52</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> |
| Transverse   |   | 2024. 08. 12. / 14:43:37 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:43:37</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> | 2024. 08. 12. / 14:45:46 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:45:46</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> |
|              |                                                                                     | 2024. 08. 12. / 14:43:37 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:43:37</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> | 2024. 08. 12. / 14:45:46 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:45:46</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> |
| Longitudinal |  | 2024. 08. 12. / 14:43:37 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:43:37</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> | 2024. 08. 12. / 14:45:46 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:45:46</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> |
|              |                                                                                     | 2024. 08. 12. / 14:43:37 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:43:37</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> | 2024. 08. 12. / 14:45:46 | <div>Test Report</div> <div>Testing time: 00:00<br/>Remaining pulse: 0.0<br/>Run Start Time: Aug-12-2024 14:45:46</div> <div>Total elapsed: 15.0<br/>Full level elapsed: 3.0</div> <div>Test parameters<br/>Sampling Rate (Hz): 2560.00 Hz<br/>Frequency range (Hz): 1000.00 Hz<br/>Block Size: 2048<br/>Block Time: 0.0 s</div> <div>* Control Composite *</div> <div></div> |

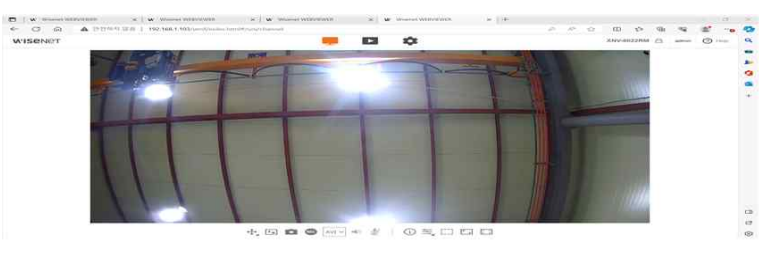
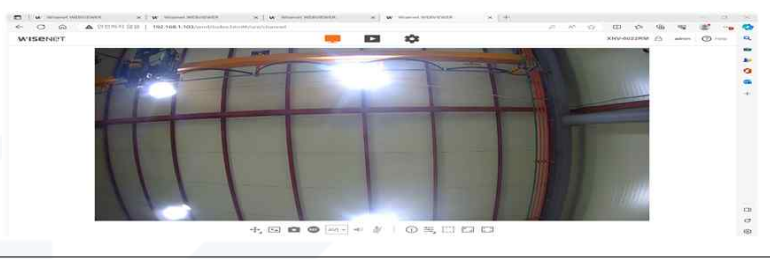
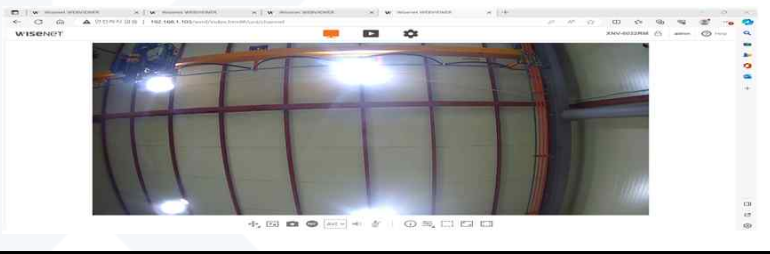


### 10.5.5 Normal operation check of Shock testing

|                                                        |                |              |                                                                                      |
|--------------------------------------------------------|----------------|--------------|--------------------------------------------------------------------------------------|
| Normal<br>operation<br>check<br>of<br>Shock<br>testing | Vertical       | Initial      |    |
|                                                        |                | Intermediate |    |
|                                                        |                | Final        |   |
|                                                        | Trans<br>verse | Initial      |  |
|                                                        |                | Intermediate |  |
|                                                        |                | Final        |  |



10.5.5 Normal operation check of Shock testing (continued)

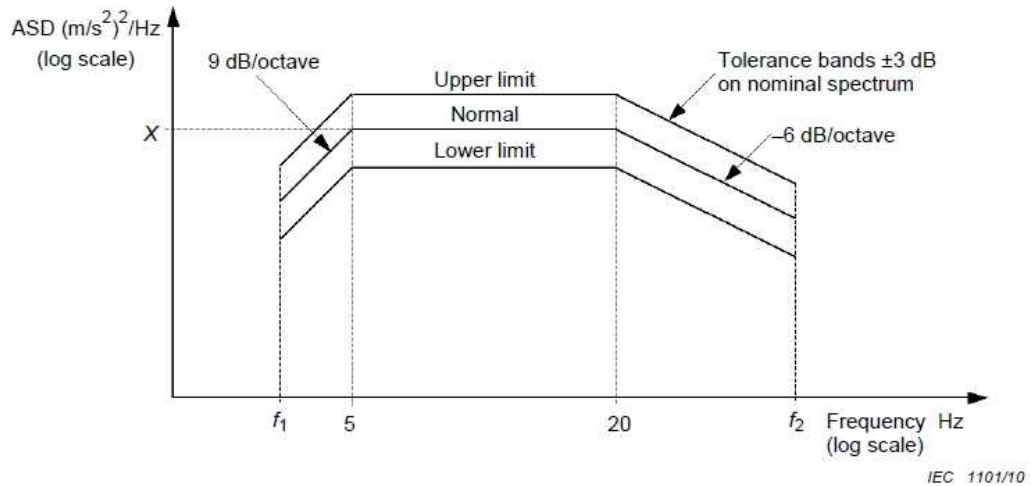
|                                         |              |              |                                                                                     |
|-----------------------------------------|--------------|--------------|-------------------------------------------------------------------------------------|
| Normal operation check of Shock testing | Longitudinal | Initial      |   |
|                                         |              | Intermediate |   |
|                                         |              | Final        |  |

**10.6 Functional random vibration test****10.6.1 Test conditions**

| Item                          |                   | Detailed description                                                                                                                                                                                       |                                                                                             |                                                     |                                                     | Remarks                                                |
|-------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|--------------------------------------------------------|
| Test date                     |                   | Aug. 11, 2024 to Aug. 13, 2024                                                                                                                                                                             |                                                                                             |                                                     |                                                     | -                                                      |
| Atmospheric condition         |                   | (25.0 ± 10.0) °C, (50 ± 25) % R.H.                                                                                                                                                                         |                                                                                             |                                                     |                                                     | -                                                      |
| Power State                   |                   | <input type="checkbox"/> Store (Power OFF) <input checked="" type="checkbox"/> Action (Power ON)                                                                                                           |                                                                                             |                                                     |                                                     | -                                                      |
| Examination                   |                   | <input checked="" type="checkbox"/> Category 1 ( <input type="checkbox"/> Class A <input checked="" type="checkbox"/> Class B )<br><input type="checkbox"/> Category 2 <input type="checkbox"/> Category 3 |                                                                                             |                                                     |                                                     | Client requirements                                    |
| when mass                     |                   | <input checked="" type="checkbox"/> ≤ 500 kg <input type="checkbox"/> > 500 kg, ≤ 1 250 kg <input type="checkbox"/> > 1 250 kg                                                                             |                                                                                             |                                                     |                                                     |                                                        |
| Direction time and test level |                   | Axis                                                                                                                                                                                                       |                                                                                             | Vertical (15 min)                                   | Transverse (15 min)                                 | Longitudinal (15 min)                                  |
|                               |                   | Frequency [ Hz ]                                                                                                                                                                                           |                                                                                             | ASD Levels [ (m/s <sup>2</sup> ) <sup>2</sup> /Hz ] | ASD Levels [ (m/s <sup>2</sup> ) <sup>2</sup> /Hz ] | ASD Levels [ (m/s <sup>2</sup> ) <sup>2</sup> /Hz ]    |
|                               |                   | f <sub>1</sub> to 5                                                                                                                                                                                        |                                                                                             | 9 dB/oct                                            | 9 dB/oct                                            | 9 dB/oct                                               |
|                               |                   | 5 to 20                                                                                                                                                                                                    |                                                                                             | 0.030 1                                             | 0.006 0                                             | 0.014 4                                                |
|                               |                   | 20 to f <sub>2</sub>                                                                                                                                                                                       |                                                                                             | -6 dB/oct                                           | -6 dB/oct                                           | -6 dB/oct                                              |
|                               |                   | RMS value                                                                                                                                                                                                  |                                                                                             | 1.01 m/s <sup>2</sup>                               | 0.450 m/s <sup>2</sup>                              | 0.700 m/s <sup>2</sup>                                 |
| ASD spectrum                  |                   |                                                                                                                                                                                                            | Category 1 ( <input type="checkbox"/> Class A <input checked="" type="checkbox"/> Class B ) |                                                     |                                                     | Reference of 10.6.2 Category 1 – Class B, ASD spectrum |
| Initial measurements          | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                                                                                             |                                                     |                                                     | -                                                      |
|                               | Functional test   | Normal operation check                                                                                                                                                                                     |                                                                                             |                                                     |                                                     | -                                                      |
| Intermediate measurements     | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                                                                                             |                                                     |                                                     | -                                                      |
|                               | Functional test   | Normal operation check                                                                                                                                                                                     |                                                                                             |                                                     |                                                     | -                                                      |
| Final measurements            | Visual inspection | Mechanical damage, loosening of screw, etc.                                                                                                                                                                |                                                                                             |                                                     |                                                     | -                                                      |
|                               | Functional test   | Normal operation check                                                                                                                                                                                     |                                                                                             |                                                     |                                                     | -                                                      |



### 10.6.2 Category 1 – Class B, ASD spectrum



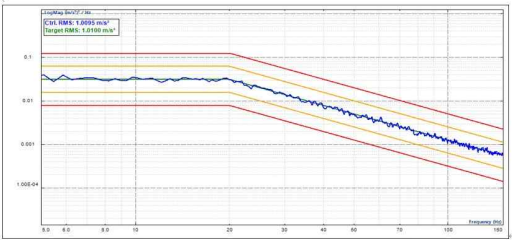
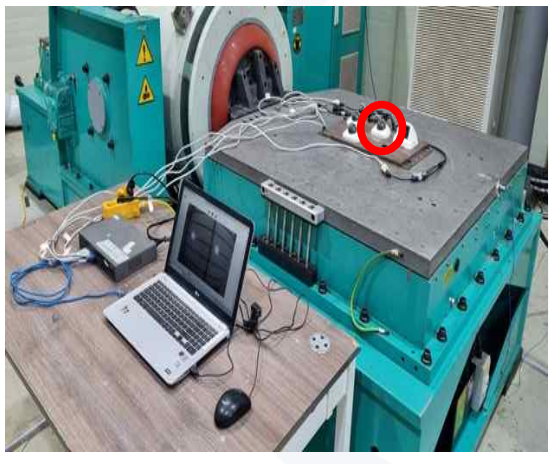
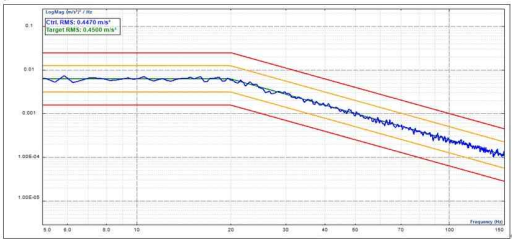
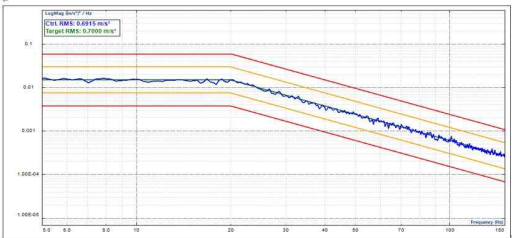
|           |                              |                                                |                                                 |
|-----------|------------------------------|------------------------------------------------|-------------------------------------------------|
| when mass | $\leq 500$ kg:               | $f_1 = 5$ Hz                                   | $f_2 = 150$ Hz                                  |
| when mass | $> 500$ kg $\leq 1\,250$ kg: | $f_1 = \frac{1\,250}{\text{mass}} \times 2$ Hz | $f_2 = \frac{1\,250}{\text{mass}} \times 60$ Hz |
| when mass | $> 1\,250$ kg:               | $f_1 = 2$ Hz                                   | $f_2 = 60$ Hz                                   |

### 10.6.3 Test result

| Test Items                       | Test standard                                                                                                                                                                                                                                                                                        | Test result                                                                                                                | Remarks |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------|
| Functional random vibration test | Functional random vibration test of EN 50155:2021, carried out in accordance with EN 61373:2010, Clause 8 - Category 1, Class B test method.<br>No abnormalities and no mechanical defects when the performance tests are confirmed at the initial, intermediate and final measurements of the test. | In the initial, intermediate and final measurements of the test, no problem when performance test and no mechanical fault. | -       |

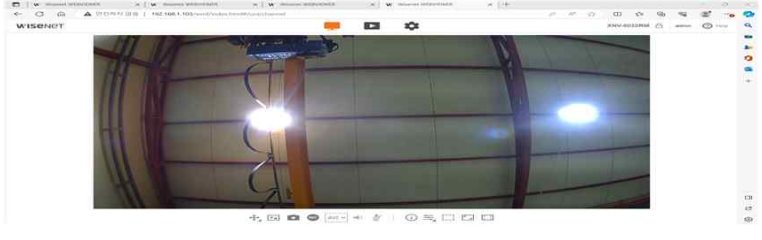
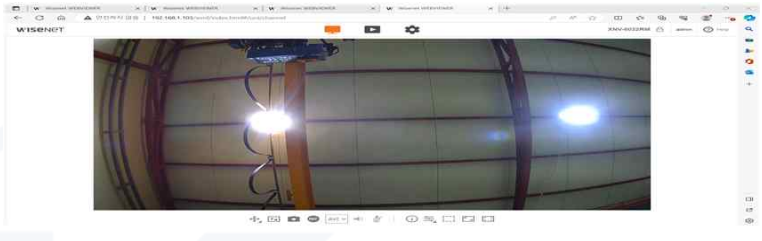
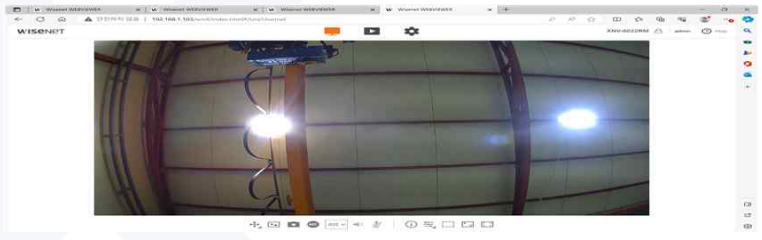
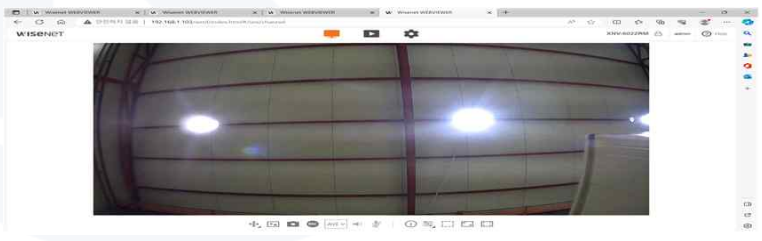
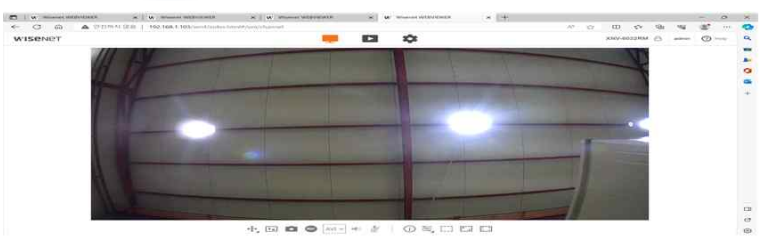
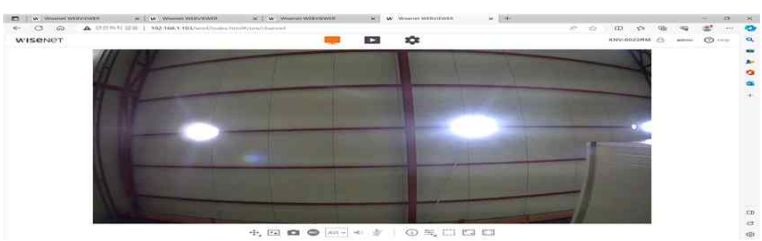


#### 10.6.4 Test photos & graphs

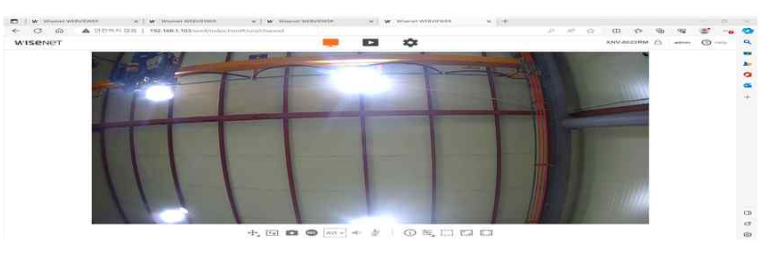
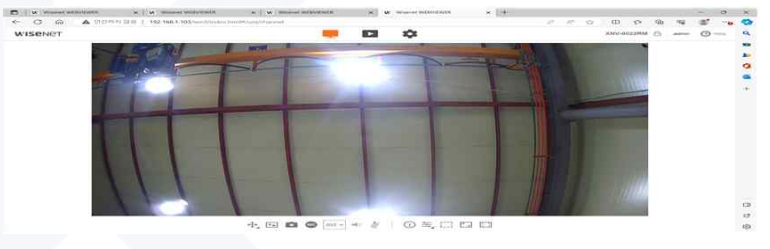
|                  |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vertical         |    | <p>2024. 08. 13. / 15:27:11</p> <p><b>Test Report</b></p> <p>Testing time: Remaining Time: 00:00:00<br/>Run Start Time: Aug-13-2024 15:27:11</p> <p>Total elapsed time: 00:15:53<br/>Full level elapsed time: 00:15:00</p> <p>Test parameters:<br/>Lines: 400<br/>Average: 64</p> <p>DOF: 64<br/>Frequency range (f<sub>0</sub>): Calculated by profile</p> <p>* Control Composite</p>    |
| Trans<br>verse   |   | <p>2024. 08. 11. / 14:34:06</p> <p><b>Test Report</b></p> <p>Testing time: Remaining Time: 00:00:00<br/>Run Start Time: Aug-11-2024 14:34:06</p> <p>Total elapsed time: 00:16:02<br/>Full level elapsed time: 00:15:00</p> <p>Test parameters:<br/>Lines: 400<br/>Average: 64</p> <p>DOF: 64<br/>Frequency range (f<sub>0</sub>): Calculated by profile</p> <p>* Control Composite</p>  |
| Longitu<br>dinal |  | <p>2024. 08. 12. / 14:51:33</p> <p><b>Test Report</b></p> <p>Testing time: Remaining time: 00:00:00<br/>Run Start Time: Aug-12-2024 14:51:33</p> <p>Total elapsed time: 00:16:02<br/>Full level elapsed time: 00:15:00</p> <p>Test parameters:<br/>Lines: 400<br/>Average: 64</p> <p>DOF: 64<br/>Frequency range (f<sub>0</sub>): Calculated by profile</p> <p>* Control Composite</p>  |



### 10.6.5 Normal operation check of Functional random vibration test

|                                                            |             |              |                                                                                      |
|------------------------------------------------------------|-------------|--------------|--------------------------------------------------------------------------------------|
| Normal operation check of Functional random vibration test | Vertical    | Initial      |    |
|                                                            |             | Intermediate |    |
|                                                            |             | Final        |   |
|                                                            | Trans verse | Initial      |  |
|                                                            |             | Intermediate |  |
|                                                            |             | Final        |  |

**10.6.5 Normal operation check of Functional random vibration test (continued)**

|                                                            |              |              |                                                                                     |
|------------------------------------------------------------|--------------|--------------|-------------------------------------------------------------------------------------|
| Normal operation check of Functional random vibration test | Longitudinal | Initial      |   |
|                                                            |              | Intermediate |   |
|                                                            |              | Final        |  |

**11. Used instrument list**

| No. | KES Management Number | Instrument Name             | Mfr.           | Model       | Serial #          | Date of Calibration | Next Calibration Date | Calibration Cycle | Remark |
|-----|-----------------------|-----------------------------|----------------|-------------|-------------------|---------------------|-----------------------|-------------------|--------|
| 1   | KES-RE-107            | Electronic Vibration tester | JINN Co., Ltd. | S701LS4-450 | S1611032          | May 02, 2024        | May 02, 2025          | 1 year            | -      |
|     |                       | Accelerometer               | PCB            | 353B31      | 207355            | Apr. 08, 2024       | Apr. 08, 2025         | 1 year            | -      |
| 2   | KES-RE-109            | Temp. & Humid. Chamber      | SJ SCIENCE CO  | SJ-TH-S150  | SJ-TH-S150-171205 | Dec. 27, 2023       | Dec. 27, 2024         | 1 year            | -      |

- The end of test report -