



TEST REPORT



Report No. : KES-RE240316

Page 1 / 39

KES Co., Ltd.

#3002, #3503, #3701,

40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si,

Gyeonggi-do, 14057, Republic of Korea

Tel: +82-31-425-6200, Fax: +82-31-341-3838

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 : QNV-6024RM
- ☐ 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

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This report shall not be reproduced except in full, without the written approval of KES Co., Ltd.
This report is prohibited from being used other than for use of report.
This test report is not related to KOLAS accreditation.

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-RE240316	Issued

This report shall not be reproduced except in full, without the written approval of KES Co., Ltd. This document may be altered or revised by KES Co., Ltd. personnel only, and shall be noted in the revision section of the document. Any alteration of this document not carried out by KES Co., Ltd. will constitute fraud and shall nullify the document.

TABLE OF CONTENTS

1. General information	3
2. Information of E.U.T.	4
3. Visual inspection	5
4. Performance test	5
5. Insulation test	6
6. Low temperature test	9
7. Dry heat test	13
8. Cyclic damp heat test	17
9. Low temperature storage test	21
10. Shock and vibration tests	25
11. Used instrument list	39



1. General information

1.1 Introduction

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

1.2 Laboratory

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

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

			
Product	Model	S/N	Remark
NETWORK CAMERA	QNV-6024RM	ZNT96V4W90001AK	PoE (DC 48 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 (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 (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 or AC 50 V _{RMS}	AC 500 V or DC 750 V
DC 72 V ≤ DC V < DC 125 V or from AC 50 to 90 V _{RMS}	AC 1 000 V or DC 1 500 V
DC 125 V ≤ DC V DC < DC 315 V or from AC 90 to 225 V _{RMS}	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, There shall be no fundamental deterioration from the initial measurement.	Not applicable	ELV part (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, Neither disruptive discharge nor flashover shall occur.	Not applicable	ELV part (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

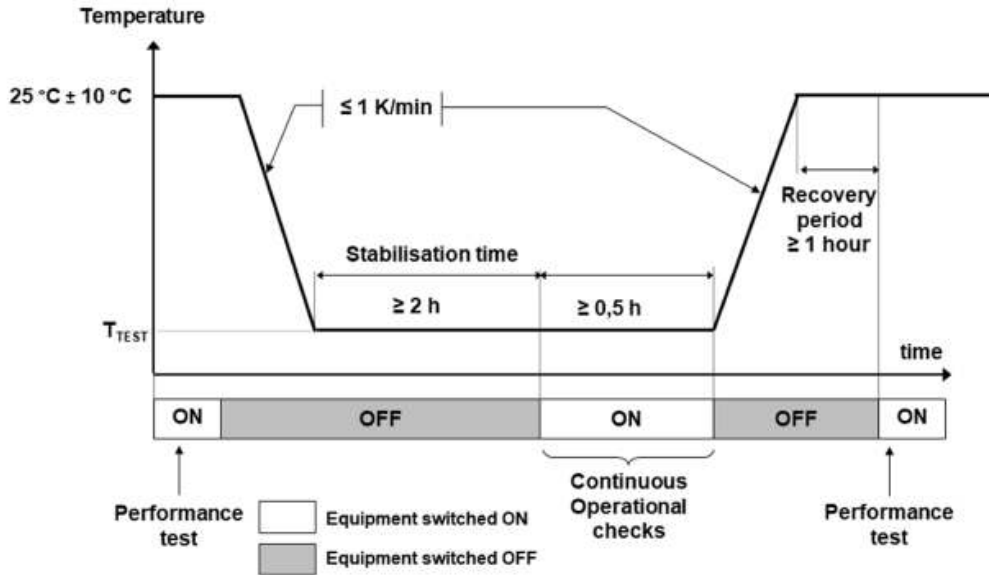


6.4 Test conditions

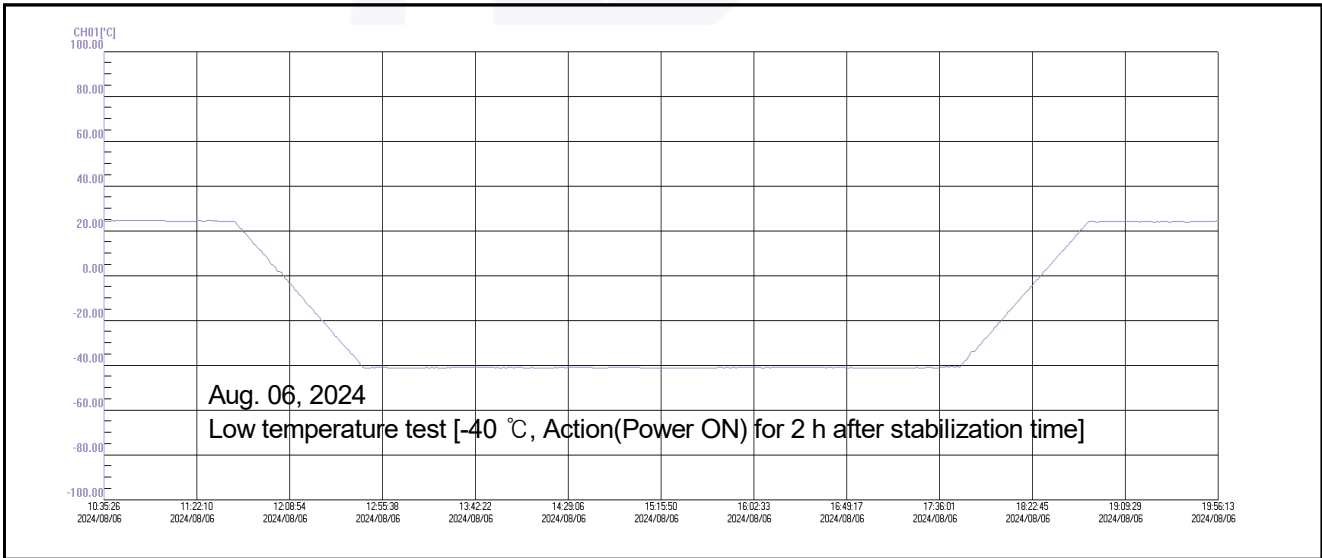
Item		Detailed description	Remarks
Test date		Aug. 06, 2024	-
Atmospheric condition		(25.0 ± 10.0) °C, (50 ± 25) % R.H.	-
Power state		☒ Store (Power OFF) ☒ Action (Power ON)	Reference of 6.5 Profile of Low temperature test
Operating temperature classes		☐ OT1 ☒ OT2 ☐ OT3 ☐ OT4 ☐ OT5 ☐ OT6	-40 °C
Specimen classification		☐ Non heat-dissipating specimens ☒ heat-dissipating specimens	-
Application testing		☐ Test Ab ☒ Test Ad ☐ Test Ae	EN 50155:2021
Severity	Temperature	☐ -65 °C ☐ -55 °C ☐ -50 °C ☒ -40 °C ☐ -33 °C ☐ -25 °C ☐ -20 °C ☐ -10 °C ☐ -5 °C ☐ +5 °C	-
	Duration	☒ 2 h ☐ 16 h ☐ 72 h ☐ 96 h ☐ Etc	EN 50155:2021, EN 60068-2-1: 2007
Pre conditioning	Applicability	☒ No Regulations ☐ 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	☐ No Regulations ☒ Regulations	-
	Condition	☒ Recovery from standard atmospheric conditions ☐ 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

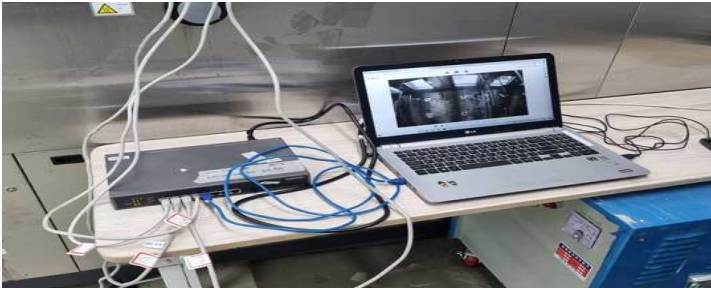
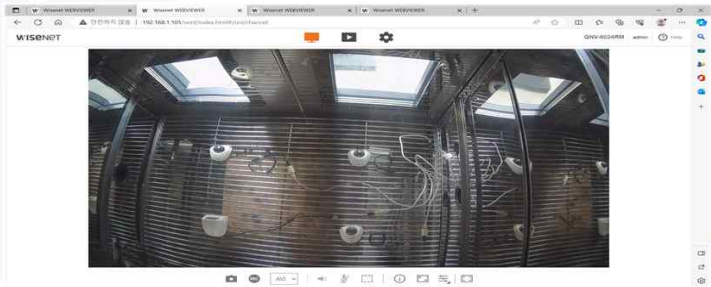
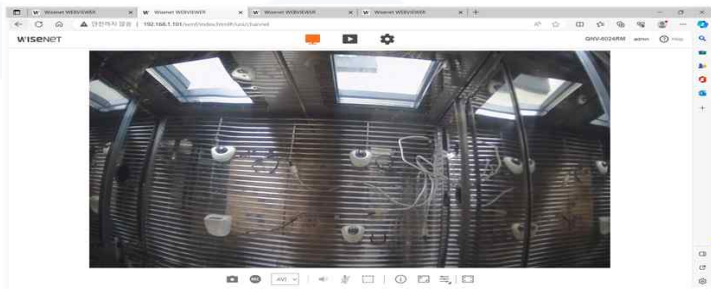
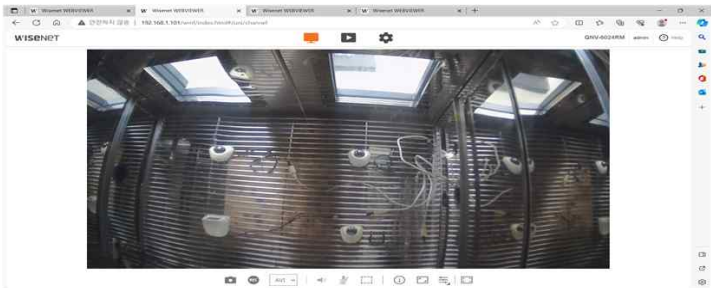


6.7 Test result

Test Items	Test standard	Test result	Remarks
Low temperature test	Low temperature test of EN 50155:2021, duration at -40°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 temperature test of EN 50155: 2021	Internal chamber		
	During the test		
	Normal operation 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

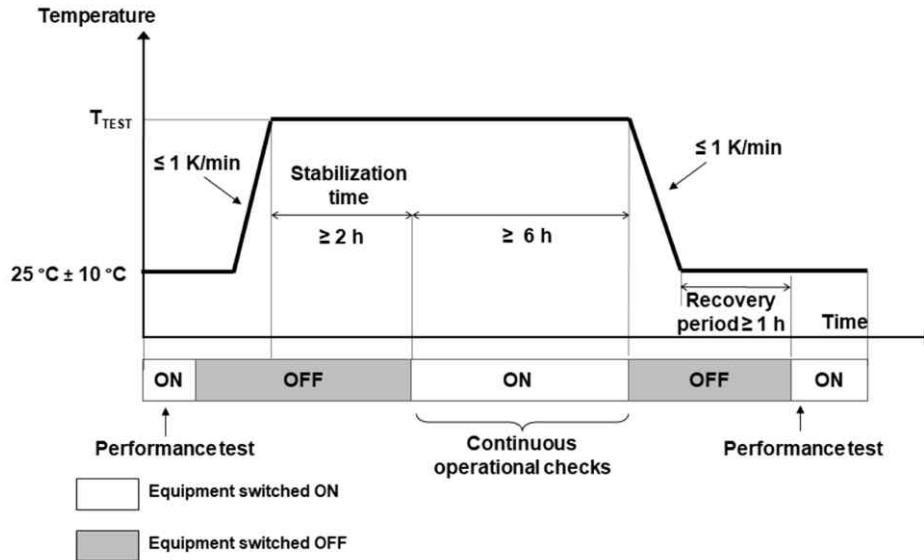


7.5 Test conditions

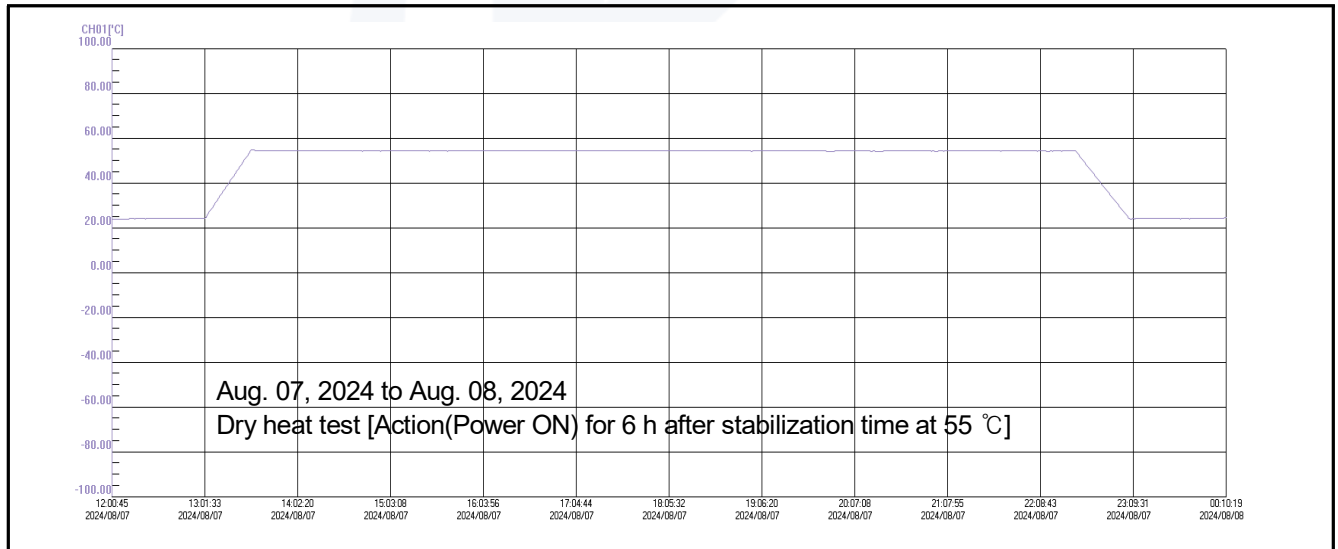
Item		Detailed description	Remarks
Test date		Aug. 07, 2024 to Aug. 08, 2024	-
Atmospheric condition		(25.0 ± 10.0) °C, (50 ± 25) % R.H.	-
Power state		☒ Store (Power OFF) ☒ Action (Power ON)	Reference of 7.6 Profile of Dry heat test (Test cycle A)
Operating temperature classes		☐ OT1 ☒ OT2 ☐ OT3 ☐ OT4 ☐ OT5 ☐ OT6	55 °C
Classes for increased operating temperature at switch-on		☒ ST0 ☐ ST1 ☐ ST2	Test cycle A
Specimen classification		☐ Non heat-dissipating specimens ☒ heat-dissipating specimens	-
Application testing		☐ Test Bb ☒ Test Bd ☐ Test Be	EN 50155:2021
Severity	Temperature	☐ 1 000 °C ☐ 800 °C ☐ 630 °C ☐ 500 °C ☐ 400 °C ☐ 315 °C ☐ 250 °C ☐ 175 °C ☐ 155 °C ☐ 125 °C ☐ 100 °C ☐ 85 °C ☐ 70 °C ☐ 65 °C ☐ 60 °C ☒ 55 °C ☐ 50 °C ☐ 45 °C ☐ 40 °C ☐ 35 °C ☐ 30 °C	-
	Duration	☐ 2 h ☐ 16 h ☐ 72 h ☐ 96 h ☐ 168 h ☐ 240 h ☐ 336 h ☐ 1 000 h ☒ 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	☐ No Regulations ☒ Regulations	-
	Condition	☒ Recovery from standard atmospheric conditions ☐ 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)

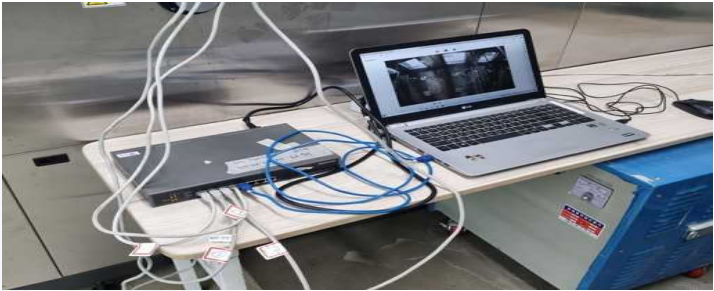
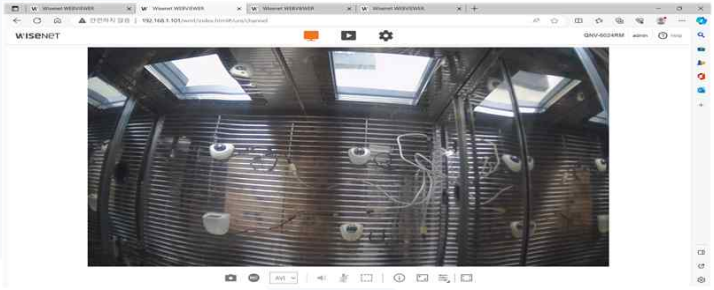
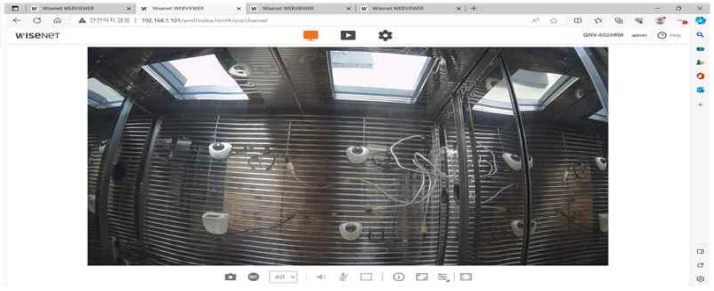
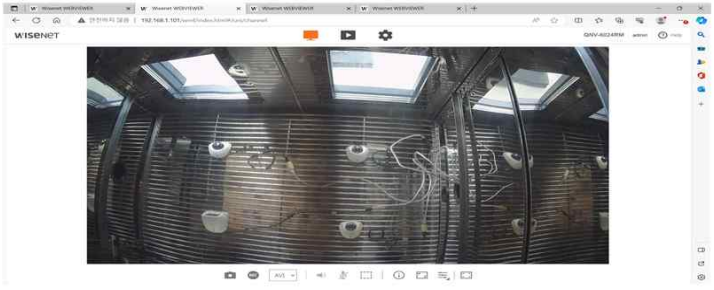


7.8 Test result

Test Items	Test standard	Test result	Remarks
Dry heat test	Dry heat test of EN 50155:2021, duration at 55 °C for 6 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.	-



7.9 Photos & Normal operation check of Dry heat test

Dry heat test of EN 50155: 2021	Internal chamber		
	During the test		
	Normal operation 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		☒ Store (Power OFF) ☐ Action (Power ON)	EN 50155:2021
Severities of test		☐ a) upper temperature: 40 °C ☒ b) upper temperature: 55 °C	EN 50155:2021
Selection of variant		☐ Variant 1 ☒ Variant 2	EN 50155:2021
Number of cycles		☐ 1 ☒ 2 ☐ 6 ☐ 12 ☐ 21 ☐ 56	EN 50155:2021
Pre treatment condition	Applicability	☒ No Regulations ☐ 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 (During the operational check at the beginning of the 2 nd cycle)	See Figure 1 of 8.2 Profiles of Cyclic damp heat test
Recovery	Applicability	☐ No Regulations ☒ Regulations	EN 50155:2021
	Condition	☐ Standard atmospheric conditions ☒ 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		☒ No special precautions ☐ special precautions	-



8.2 Profiles of Cyclic damp heat test

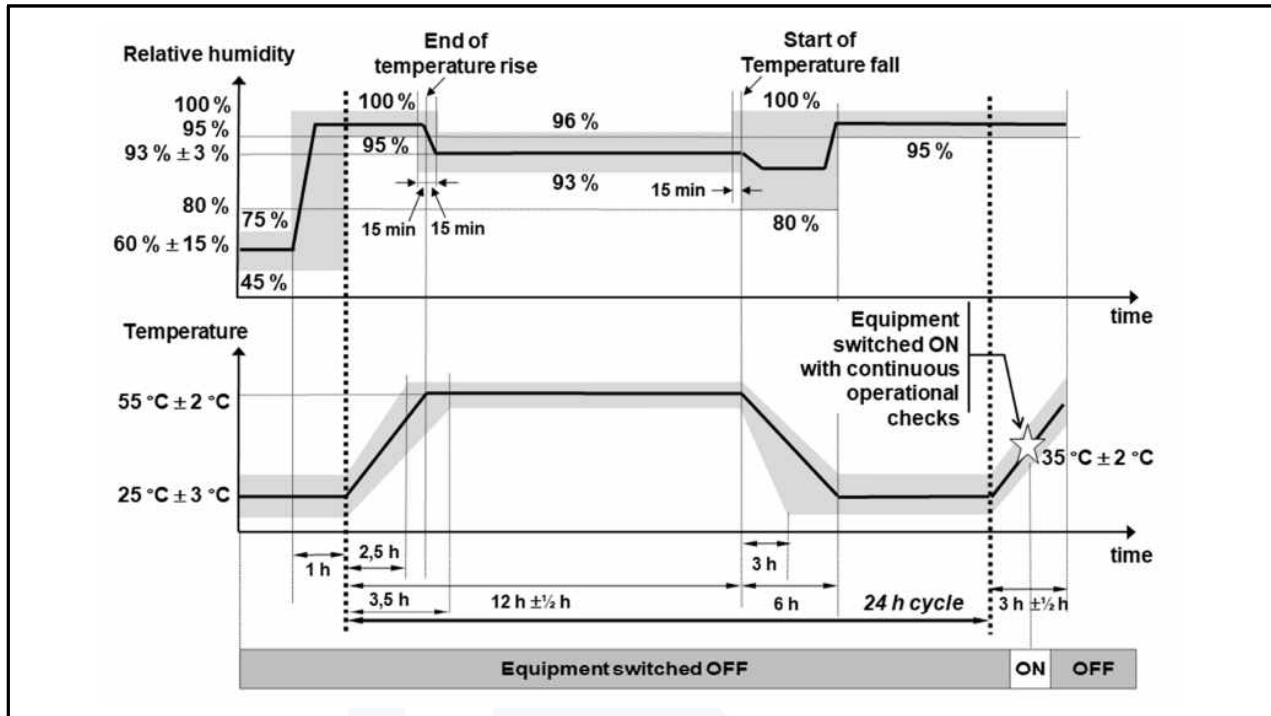


Figure 1 - Cyclic damp heat test: 1st and begin of 2nd 24-h cycle

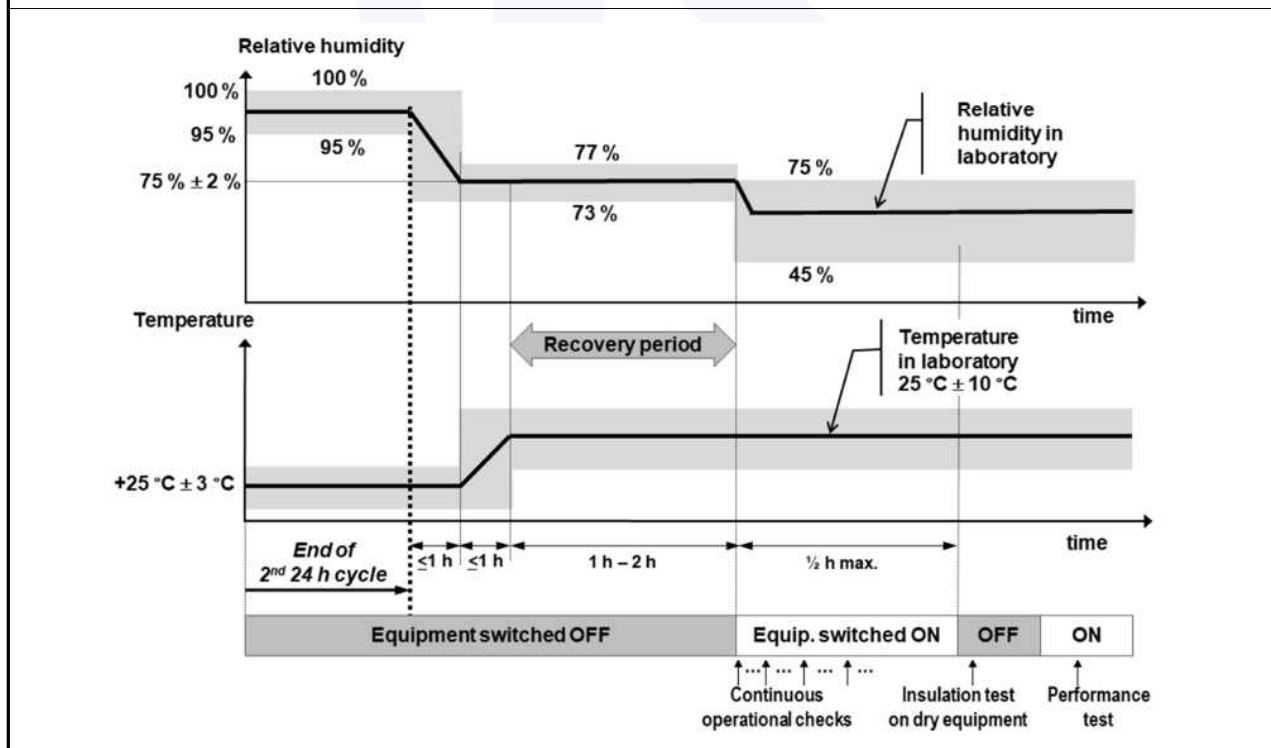
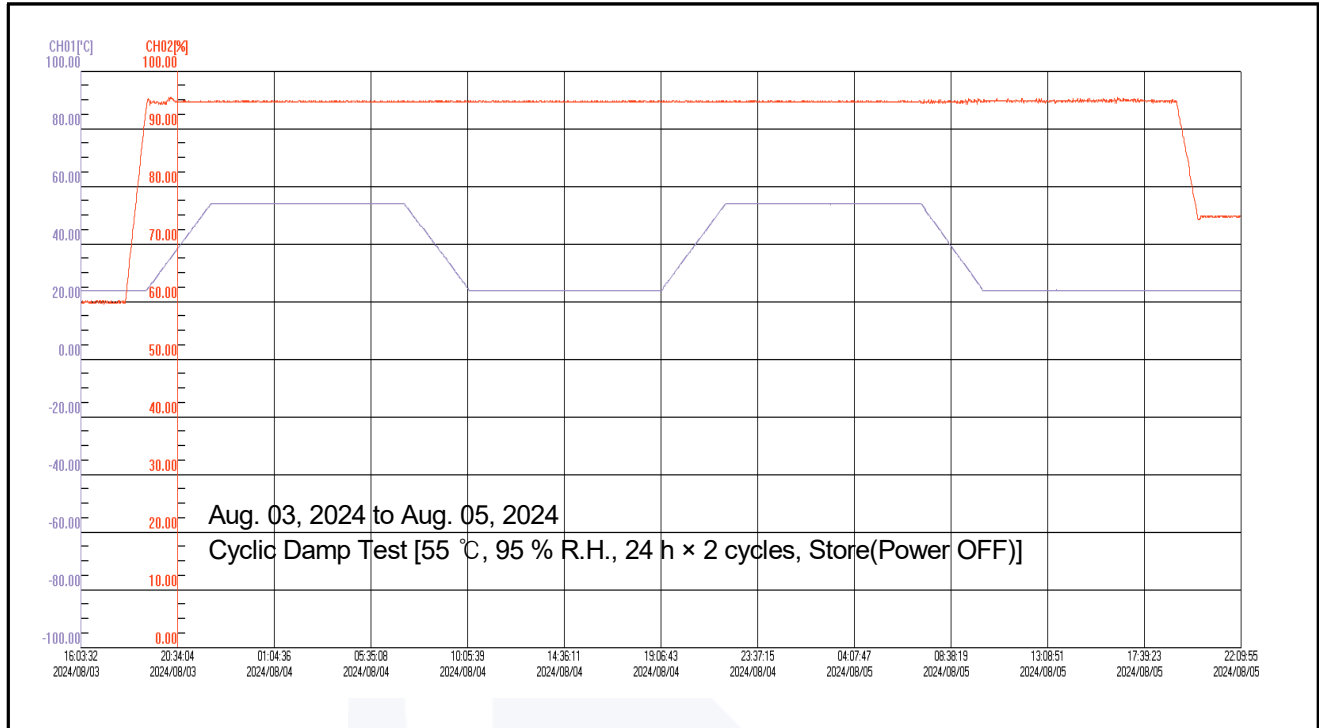


Figure 2 - Cyclic damp heat test: End of 2nd cycle and recovery period



8.3 Graph of Cyclic damp heat test

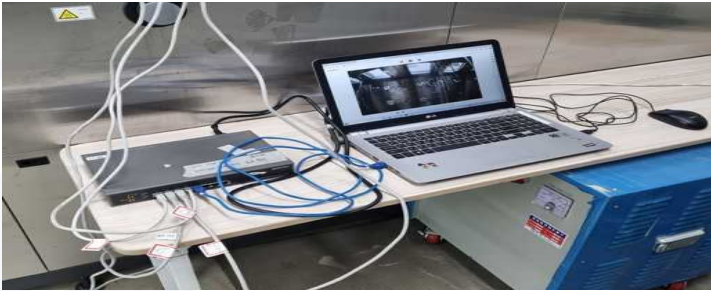
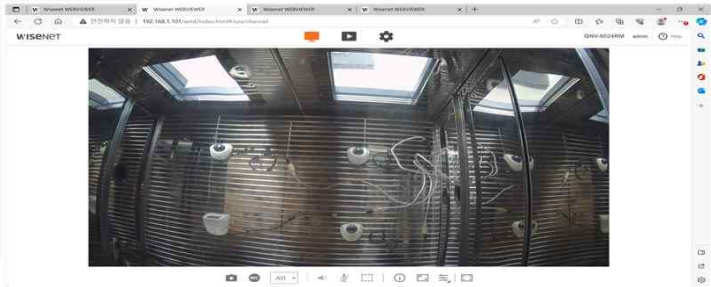
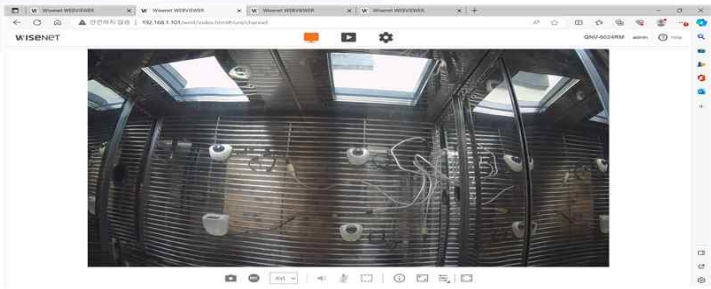
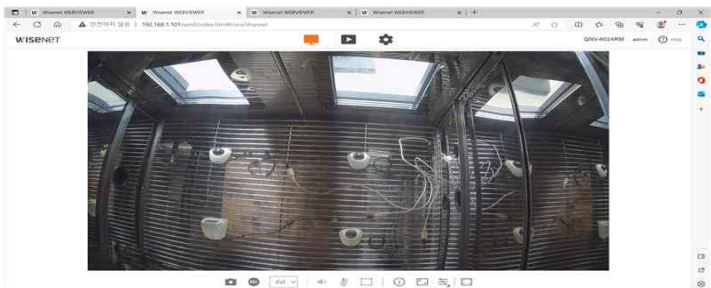


8.4 Test result

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. 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

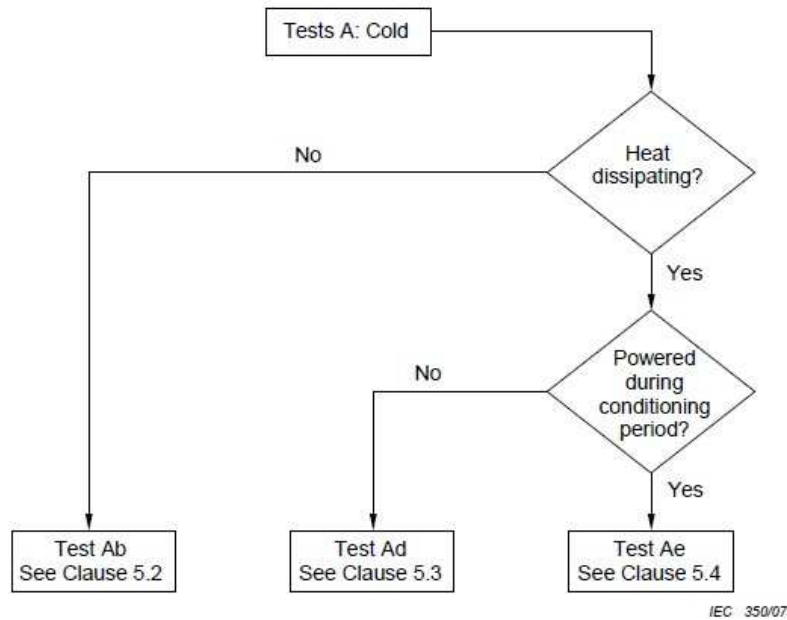
Cyclic damp heat test of EN 50155: 2021	Internal chamber		
	During the test		
	Normal operation check	Initial	
		Intermediate	
		Final	



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)	≤ 1 K/min

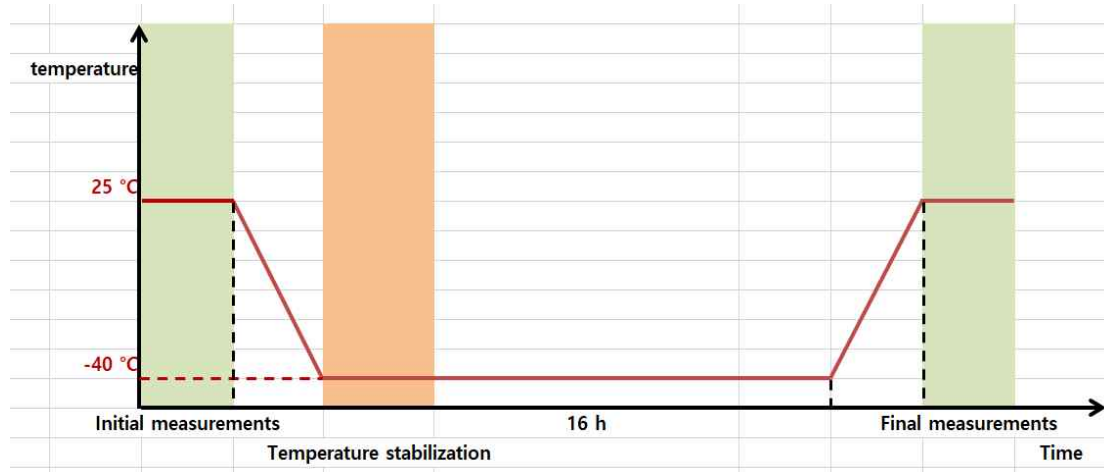


9.3 Test condition

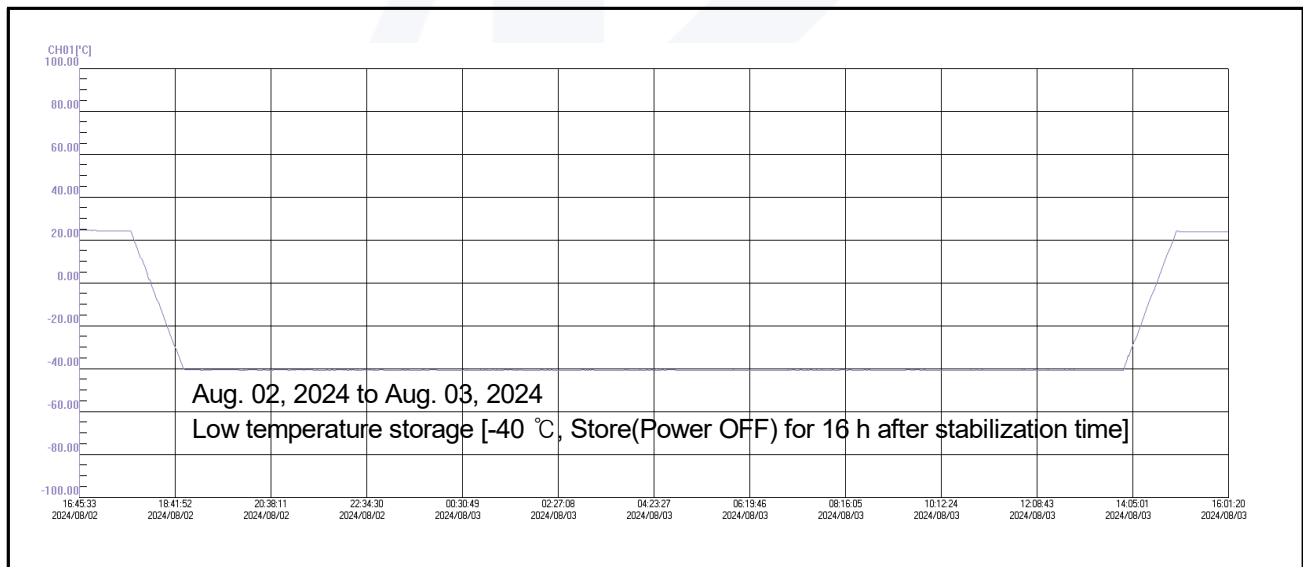
Item		Detailed description	Remarks
Test date		Aug. 02, 2024 to Aug. 03, 2024	-
Atmospheric condition		(25.0 ± 10.0) °C, (50 ± 25) % R.H.	-
Power state		☒ Store (Power OFF) ☐ Action (Power ON)	EN 50155:2021
Additional condition		Equipment without transportation packaging is placed	-
Specimen classification		☒ Non heat-dissipating specimens ☐ heat-dissipating specimens	-
Type of test		☒ Test Ab ☐ Test Ad ☐ Test Ae	EN 50155:2021
Severity	Temperature	☐ -65 °C ☐ -55 °C ☐ -50 °C ☒ -40 °C ☐ -33 °C ☐ -25 °C ☐ -20 °C ☐ -10 °C ☐ -5 °C ☐ +5 °C ☐ Etc	EN 50155:2021
	Duration	☐ 2 h ☒ 16 h ☐ 72 h ☐ 96 h ☐ Etc.	EN 50155:2021
Pretreatment condition	Applicability	☒ No Regulations ☐ 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	☐ No Regulations ☒ Regulations	-
	Condition	☒ Recovery from standard atmospheric conditions ☐ 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

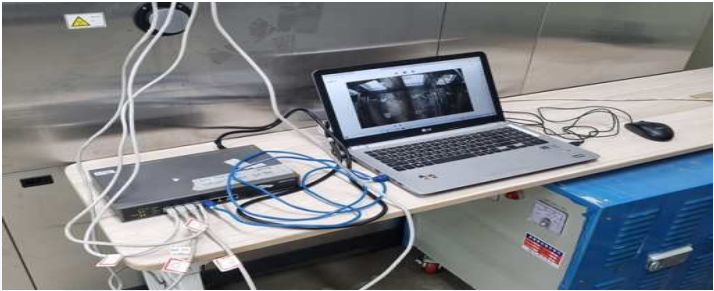
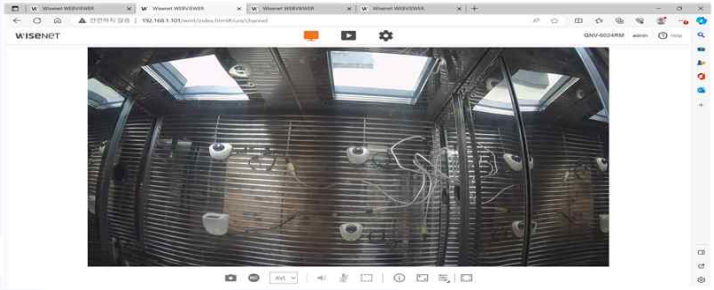
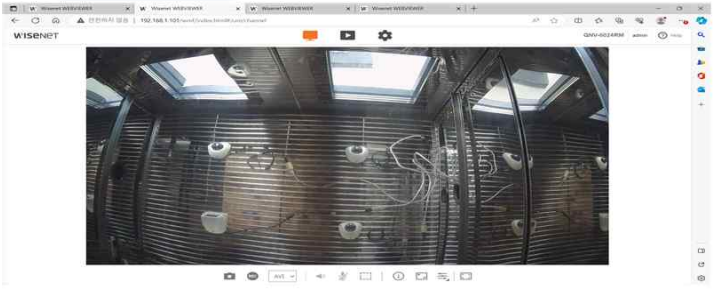


9.6 Test result

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

10.3 General

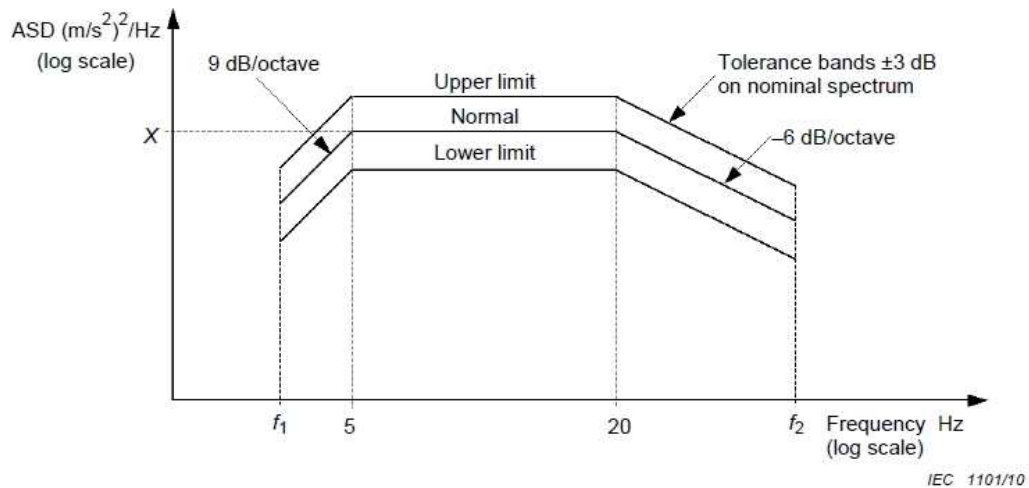
This standard is intended to highlight any weakness/error which may result in problems as a consequence of operation under environments where vibration and shock are known to occur in service on a railway vehicle. This is not intended to represent a full life test. However, the test conditions are sufficient 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		☒ Store (Power OFF) ☐ Action (Power ON)				-
Examination		☒ Category 1 (☐ Class A ☒ Class B) ☐ Category 2 ☐ Category 3				Client requirements
when mass		☒ ≤ 500 kg ☐ > 500 kg, ≤ 1 250 kg ☐ > 1 250 kg				
Direction time and test level						
	Axis	Vertical (5 h)	Transverse (5 h)	Longitudinal (5 h)		
	Frequency [Hz]	ASD Levels [(m/s ²) ² /Hz]	ASD Levels [(m/s ²) ² /Hz]	ASD Levels [(m/s ²) ² /Hz]		
	<i>f</i> ₁ to 5	9 dB/oct	9 dB/oct	9 dB/oct		
	5 to 20	0.964	0.192	0.461		
	20 to <i>f</i> ₂	-6 dB/oct	-6 dB/oct	-6 dB/oct		
RMS value		5.72 m/s ²	2.55 m/s ²	3.96 m/s ²		
ASD spectrum		Category 1 (☐ Class A ☒ 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 ≤ 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

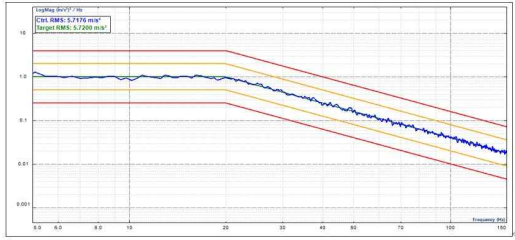
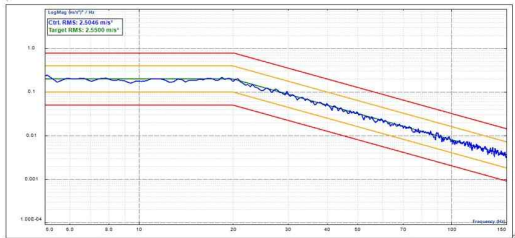
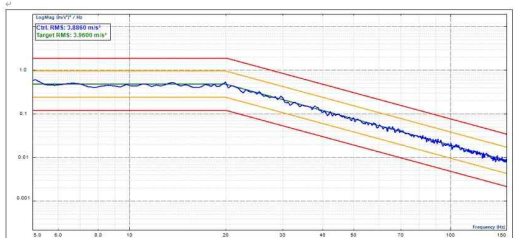
when mass $> 1\,250$ kg: $f_1 = 2$ Hz $f_2 = 60$ Hz

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.	-

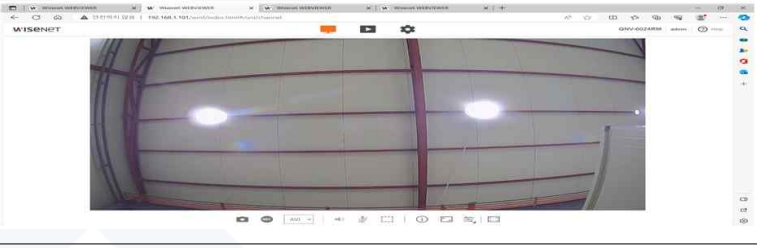
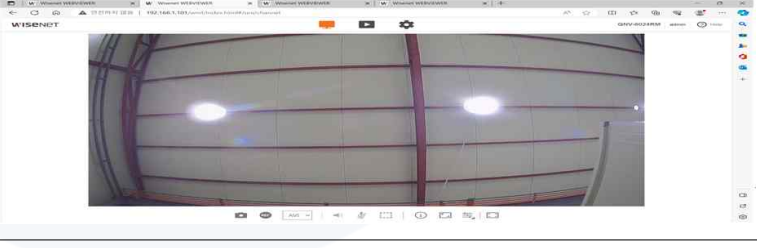
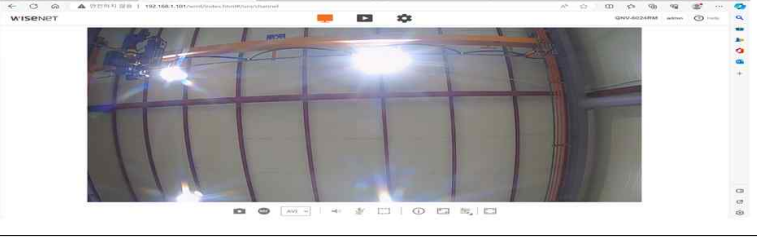
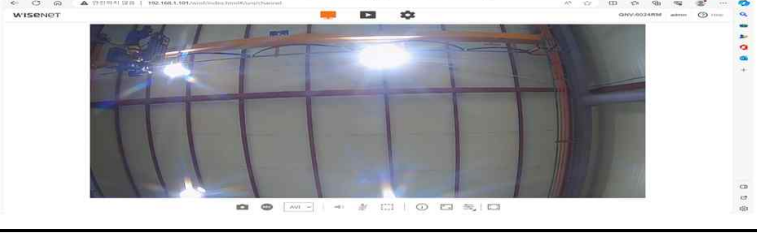


10.4.4 Test photos & graphs

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



10.4.5 Normal operation check of Simulated long-life testing

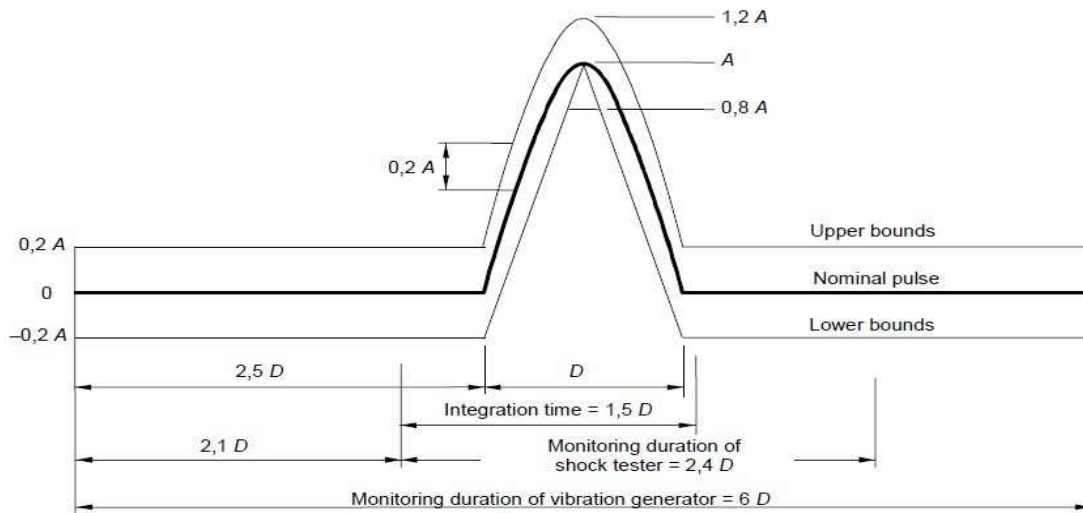
Normal operation check of Simulated long-life testing	Vertical	Initial	
		Final	
	Transverse	Initial	
		Final	
	Longitudinal	Initial	
		Final	

**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		☐ Store (Power OFF) ☒ Action (Power ON)			-
Examination		☒ Category 1 (☐ Class A ☒ Class B) ☐ Category 2 ☐ Category 3			Client requirements
when mass		☒ ≤ 500 kg ☐ > 500 kg, ≤ 1 250 kg ☐ > 1 250 kg			
Direction time and test level			Vertical	Transverse	Longitudinal
	Peak acceleration A (m/s ²)		30	30	50
	Nominal duration D (ms)		30	30	30
	Number of repetitions (+, -)		3 / 3	3 / 3	3 / 3
	Pulse shape		Half-sine pulse	Half-sine pulse	Half-sine pulse
Allowable width of half-sine pulse		Category 1 (☐ Class A ☒ Class B)			Reference of 10.5.2 Allowable width of half-sine pulse
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			-



10.5.2 Allowable width of half-sine pulse



10.5.3 Test result

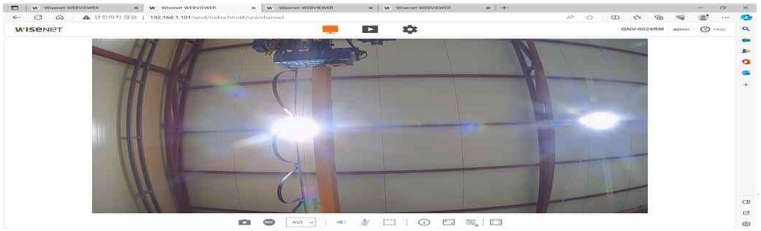
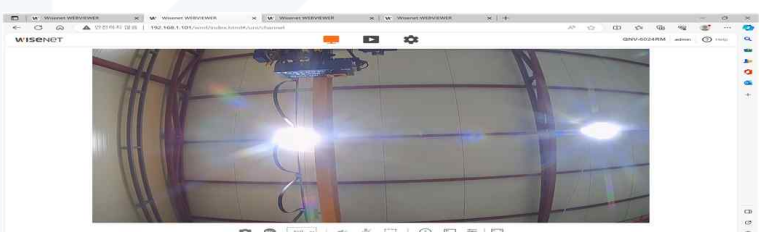
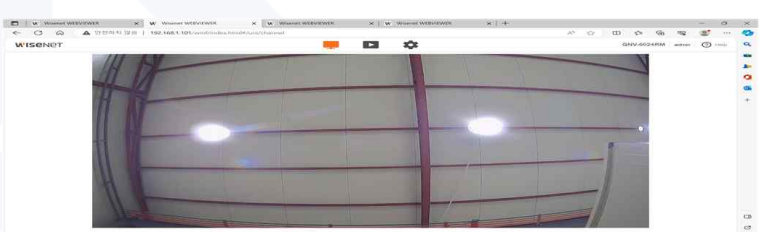
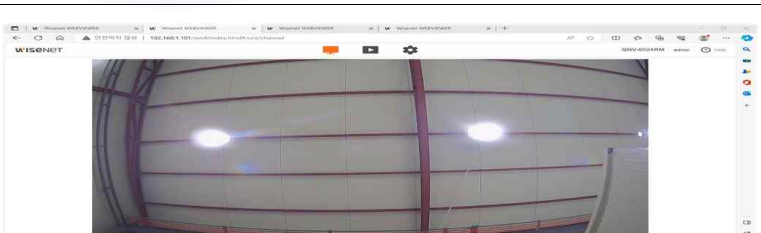
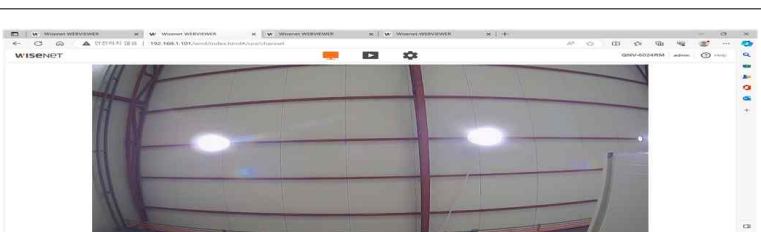
Test Items	Test standard	Test result	Remarks
Shock testing	Shock testing of EN 50155:2021, carried out in accordance with EN 61373:2010, Clause 10 - Category 1, Class B test method. No abnormalities and no mechanical defects when the performance tests are confirmed at the initial, intermediate and final 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	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-13-2024 15:19:43 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:	2024. 08. 13. / 15:23:04	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-13-2024 15:23:04 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:
		2024. 08. 11. / 14:28:25	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-11-2024 14:28:25 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:	2024. 08. 11. / 14:29:52	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-11-2024 14:29:52 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:
Transverse		2024. 08. 11. / 14:28:25	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-11-2024 14:28:25 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:	2024. 08. 11. / 14:29:52	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-11-2024 14:29:52 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:
		2024. 08. 12. / 14:43:37	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-12-2024 14:43:37 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:	2024. 08. 12. / 14:45:46	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-12-2024 14:45:46 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:
Longitudinal		2024. 08. 12. / 14:43:37	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-12-2024 14:43:37 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:	2024. 08. 12. / 14:45:46	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-12-2024 14:45:46 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:
		2024. 08. 12. / 14:43:37	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-12-2024 14:43:37 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:	2024. 08. 12. / 14:45:46	Test Report Testing time: 00:00 Remaining pulse: 0.0 Run Start Time: Aug-12-2024 14:45:46 Total elapsed: 15.0 Full level elapsed: 3.0 Test parameters: Sampling Rate (Hz): 2560.00 Hz Frequency range (Hz): 1000.00 Hz Block Size: 2048 Block Time: 0.0 s * Control Composite:

**10.5.5 Normal operation check of Shock testing**

Normal operation check of Shock testing	Vertical	Initial	
		Intermediate	
		Final	
	Trans verse	Initial	
		Intermediate	
		Final	



10.5.5 Normal operation check of Shock testing (continued)

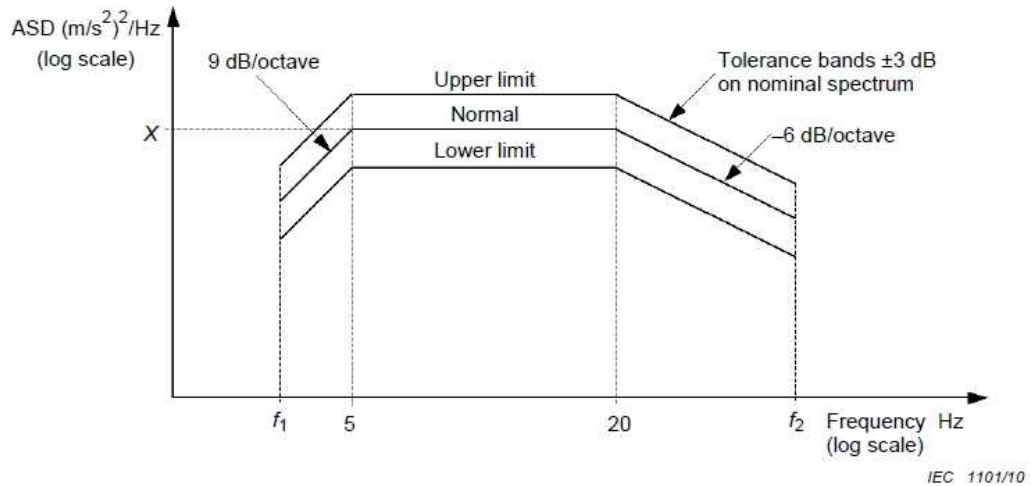
Normal operation check of Shock testing	Longitudinal	Initial	
		Intermediate	
		Final	

**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		☐ Store (Power OFF) ☒ Action (Power ON)				-
Examination		☒ Category 1 (☐ Class A ☒ Class B) ☐ Category 2 ☐ Category 3				Client requirements
when mass		☒ ≤ 500 kg ☐ > 500 kg, ≤ 1 250 kg ☐ > 1 250 kg				
Direction time and test level						
	Axis	Vertical (15 min)	Transverse (15 min)	Longitudinal (15 min)		
	Frequency [Hz]	ASD Levels [(m/s ²) ² /Hz]	ASD Levels [(m/s ²) ² /Hz]	ASD Levels [(m/s ²) ² /Hz]		
	f ₁ 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 ₂	-6 dB/oct	-6 dB/oct	-6 dB/oct		
RMS value		1.01 m/s ²	0.450 m/s ²	0.700 m/s ²		
ASD spectrum		Category 1 (☐ Class A ☒ 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



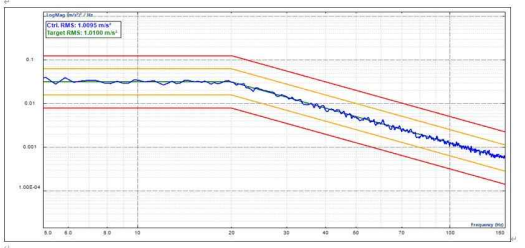
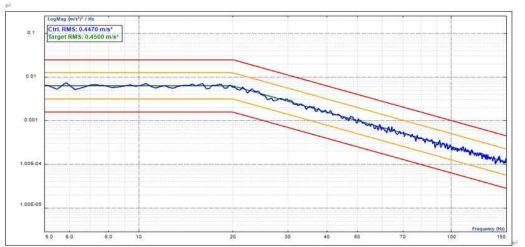
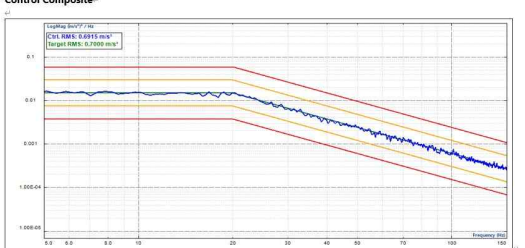
when mass	≤ 500 kg:	$f_1 = 5$ Hz	$f_2 = 150$ Hz
when mass	> 500 kg $\leq 1\,250$ kg:	$f_1 = \frac{1\,250}{\text{mass}} \times 2$ Hz	$f_2 = \frac{1\,250}{\text{mass}} \times 60$ Hz
when mass	$> 1\,250$ kg:	$f_1 = 2$ Hz	$f_2 = 60$ Hz

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. 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.	-

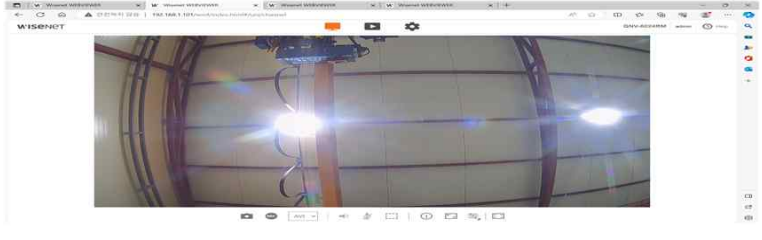
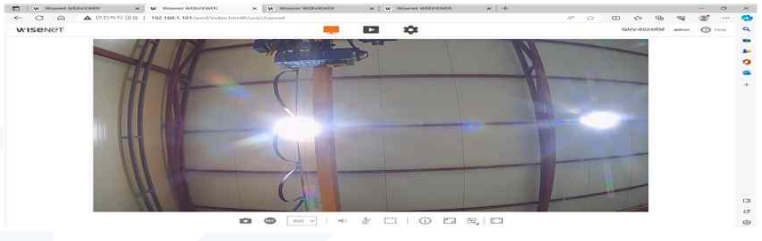
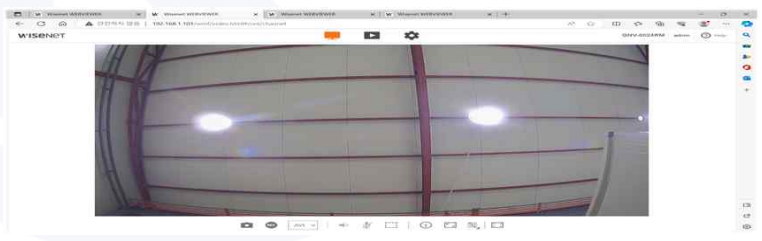
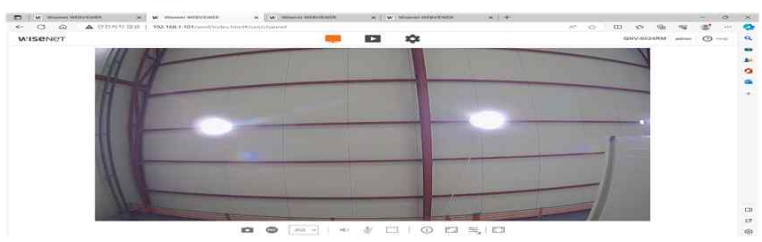
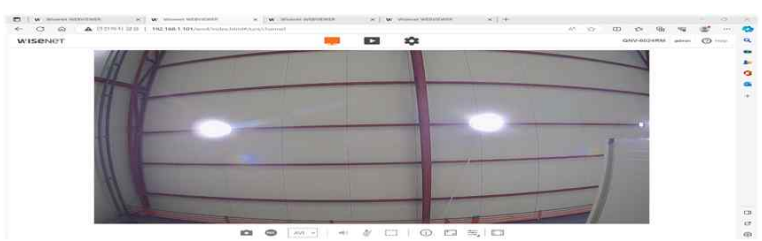


10.6.4 Test photos & graphs

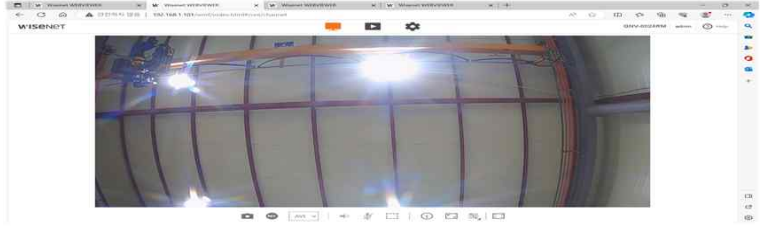
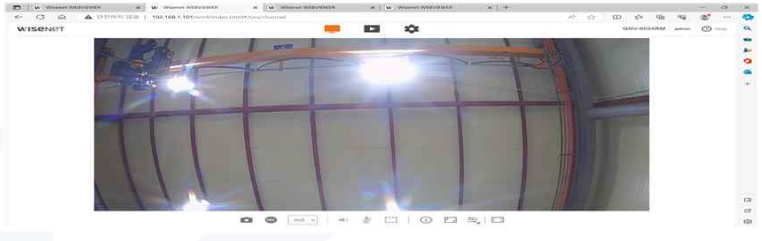
Vertical		2024. 08. 13. / 15:27:11 Test Report Testing time: Remaining Time: 00:00:00 Run Start Time: Aug-13-2024 15:27:11 Total elapsed time: 00:15:53 Full level elapsed time: 00:15:00 Test parameters: Lines: 400 Average: 64 DOF: 64 Frequency range (f₀): Calculated by profile * Control Composite 
Trans verse		2024. 08. 11. / 14:34:06 Test Report Testing time: Remaining Time: 00:00:00 Run Start Time: Aug-11-2024 14:34:06 Total elapsed time: 00:16:02 Full level elapsed time: 00:15:00 Test parameters: Lines: 400 Average: 64 DOF: 64 Frequency range (f₀): Calculated by profile * Control Composite 
Longitu dinal		2024. 08. 12. / 14:51:33 Test Report Testing time: Remaining Time: 00:00:00 Run Start Time: Aug-12-2024 14:51:33 Total elapsed time: 00:16:02 Full level elapsed time: 00:15:00 Test parameters: Lines: 400 Average: 64 DOF: 64 Frequency range (f₀): Calculated by profile * Control Composite 



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 -