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SEISMIC TESTS ON CANOZAN PANO ELECTRICAL PANEL

MODEL:

CANOZAN WEPAN	WM WD WH	SERIES	FORM 4B

TEST REPORT

ON BEHALF OF: CANOZAN PANO SAN. TAAH. VE TIC. LTD. ŞTI.

RAT-MTL-ELE20-052-R00

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Verified and approved:	Michele Civera	*Michele Civera*	27/07/2020

REVISIONS TRACK

Date	Version	Description of changes	Reference
July 2020	00	First issue	

The results are referred only to the tested items.

The Quality System of P&P LMC is in compliance with the ISO 9001:2015 standard for the following activities: Qualification of industrial products; Physical, mechanical and chemical testing of construction materials; Chemical analysis of environmental matrix, industrial hygiene, emissions to atmosphere; Calibration service of mechanical, electromechanical and electronic measurement devices (CSQ Certificate No. 9175.ILMC – IQNet Certificate No. IT – 20582).

P&P LMC laboratory is qualified by RINA to perform tests with “Sollecitazioni statiche e dinamiche sulle opere d’arte ferroviarie, modalità costruttive e di verifica strutturale (Static and dynamic stresses on railway products, construction methods and structural verification)” and tests (3 – 17 – 20) listed in Annex XI of D.L. 191/2010 and it is in compliance with the UNI EN 17025 standard (Qualification Certificate No. 05/2007 Rev. 3).

CONTENTS

1. GENERAL DATA

1.1. Customer

Canozan Pano San. Taah. Ve Tic. Ltd. Şti.
1082 Sk. No:5H Pamuk Plaza
Halkapınar / İZMİR
TURKEY

1.2. Unit under test

The tests were performed on *Canozan Pano electrical panel* with the following characteristics:

Model/Type: *CANOZAN - WEPAN WM - WD - WH SERIES FORM 4B*	

1.3. Manufacturer

Canozan Pano San. Taah. Ve Tic. Ltd. Şti.

1.4. Reference documents

1.4.1. Contract documents

a. Offer P&P LMC No. OFF-MTL-ELE20-048-R00, dated May 13th, 2020.

b. Order Canozan Pano: acceptance of OFF-MTL-ELE20-048-R00, dated June 9th, 2020.

1.4.2. Technical documents and standards

1. *Telcordia Technologies Generic Requirements GR-63-CORE* NEBS Requirements: Physical Protection, Issue 3, March 2006;
2. *IEC 60068-3-3:1991* Environmental testing - Part 3-3: Guidance - Seismic test methods for equipments;
3. *IEC 60068-2-6* Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal);
4. *IEC 60068-2-57* Environmental testing - Part 2-57: Tests - Test Ff: Vibration - Time-history method;
5. *IEEE Std 693-2018* IEEE Recommended Practice for Seismic Design of Substations;
6. *ISO 2041* Vibration and Shock – Vocabulary.

1.5. Test objective

The purpose of the seismic tests was to demonstrate that the unit behave in compliance with the requirements stated in doc.|1| referring to a seismic risk classified in as *Zone 4* on the Telcordia Earthquake Zone Map. The following table correlates the earthquake risk zone with the expected Richter Magnitude, Modified Marcalli Index, and the expected ground and building accelerations.

Earthquake Risk Zone	Richter Magnitude	Modified Marcalli Index (MMI)	Low Frequency Ground Acceleration (g's)	Low Frequency Upper Building Floor Acceleration (g's)
0	< 4.3	V	< 0.05	< 0.2
1	4.3 - 5.7	V - VII	0.05 - 0.1	0.2 - 0.3
2	5.7 - 6.3	VII - VIII	0.1 - 0.2	0.3 - 0.4
3	6.3 - 7.0	VIII - IX	0.2 - 0.4	0.4 - 0.6
4	7.0 - 8.3	IX - XII	0.4 - 0.8	0.6 - 1.0

1.6. Testing laboratory

P&P LMC S.r.l.
via Pastrengo, 9
24068 Seriate (BG)
ITALY

1.7. Test date

July 16th - 17th, 2020.

1.8. Responsibilities

M. Civera; test responsible – M. Amadei; test engineer.

1.9. Witnesses

No witnesses.

2. TESTING PROCEDURES

2.1. General remarks

To perform the tests, three reference directions have been considered for the unit: X (front - rear), Y (side - side) and Z (vertical).

The sequence of the seismic tests has been:

- *initial resonance frequency search*, performed in three directions (X, Y, Z);
- *earthquake test*, performed in three directions (X, Y, Z);
- *final resonance frequency search*, performed in three directions (X, Y, Z).

All the applied vibrations were monodirectional.

Tests in Z direction were performed on a vertical shaking table moved by an electro-dynamic shaker. For the other excitation directions, a horizontal shaking table was used. Excitation directions are shown in the photographs.

All the performed tests are listed in the table of page 17. Tests were numbered following the chronological sequence.

2.2. Mounting techniques

For all tests the unit was mounted in its intended operating configuration.

The unit was fixed to the shaking table with No. 4 M14 screws, with a tightening torque of 80 Nm.

2.3. Control and measuring positions

During all the tests, for the motion control, the signal of a monoaxial accelerometer (CP1) in the excitation direction was used. Moreover, two triaxial accelerometers (MP1 and MP2) were placed on the unit for the vibration measurement (see photos).

In the following table are summarized model and serial number of the transducers mounted in the control and measuring positions during the tests.

<table>
<tr><th rowspan="2">Point ID</th><th colspan="2">Accelerometer</th><th rowspan="2">Tests</th></tr>
<tr><th>Model</th><th>Serial Number</th></tr>
<tr><td>CP1 (X,Y,Z)
Control position located on shaking table</td><td>PCB 353B03
(monoaxial)</td><td>210159</td><td>All tests</td></tr>
<tr><td rowspan="3">MP1 (X,Y,Z)
Measuring position located on the top of the panel</td><td rowspan="3">DYTRAN 3023A6
(triaxial)</td><td>982901 (X)</td><td rowspan="3">All tests</td></tr>
<tr><td>982902 (Y)</td></tr>
<tr><td>982903 (Z)</td></tr>
<tr><td rowspan="3">MP2 (X,Y,Z)
Measuring position located at middle height of the panel</td><td rowspan="3">DYTRAN 3023A6
(triaxial)</td><td>983002 (X)</td><td rowspan="3">All tests</td></tr>
<tr><td>983003 (Y)</td></tr>
<tr><td>983001 (Z)</td></tr>
</table>

2.4. Seismic tests

2.4.1. Resonance frequency search

The aim of these tests was to find the resonance frequencies of the unit. In X, Y and Z direction, the unit was subjected to sine sweep, with the parameters defined in the following table.

	Sine vibration parameters		
RESONANCE FREQUENCY SEARCH	*Frequency range:*	1 – 50 Hz	
	Level:	1 – 2,23 Hz	10 mm (peak displacement)
		2,23 – 50 Hz	0,2 g (peak acceleration)
	Sweep rate:	1 oct/min	
	Duration:	1 sweep	
	Direction:	X, Y, Z	

Signals from measuring accelerometers were processed to obtain the absolute response functions of the control channel and the frequency transfer functions of the measuring channels on the panel.

2.4.2. Earthquake test

In X, Y and Z direction, the earthquake was performed with reference to the Required Response Spectrum (RRS) reported in doc. |1| for Zone 4 risk area, with the parameters defined in the table.

	Earthquake parameters (Zone 4)		
EARTHQUAKE TEST	*Frequency range:*	0,3 – 50 Hz	
	RRS level:	0,3 Hz	0,2 g
		0,6 Hz	2,0 g
		2 Hz	5,0 g
		5 Hz	5,0 g
		15 Hz	1,6 g
		50 Hz	1,6 g
	Damping:	2 % (Q = 25)	
	Duration:	30 seconds / axis	
	Number of events:	1 / axis	
	Direction:	X, Y, Z	

The filtered time history was applied to the unit after acceptance of Customer's technicians, based on duration, amplitude, shape and degree of envelope of the Required Response Spectrum.

3. MEASURING, EXCITATION AND DATA PROCESSING EQUIPMENT

3.1. Excitation equipment

Vibration tests in vertical direction were carried out using an electrodynamic shaker manufactured by ELIN, type MZV 210 W 20 S/N 713255, with the following characteristics:

- maximum sinusoidal dynamic force:	100 kN;
- moving element weight:	100 kg;
- frequency range:	0 ÷ 2000 Hz;
- max. displacement (peak to peak):	50,8 mm;
- max. acceleration:	100 g.

Vibration tests in horizontal directions were carried out using a magnesium slip table (operated by the previously described ELIN shaker) with the following characteristics:

- maximum sinusoidal dynamic force:	100 kN;
- moving element weight:	300 kg;
- frequency range:	0 ÷ 2000 Hz;
- max. displacement (peak to peak):	50,8 mm;
- max. acceleration:	33,3 g

3.2. Measuring equipment

Accelerometers employed during all the tests were PCB 353B03, monoaxial accelerometer, and DYTRAN 3023A6, triaxial accelerometers, with incorporated amplifiers.

The main characteristics of the accelerometers are listed below:

PCB 353B03:

- Nominal sensitivity:	10 mV/g;
- Transverse sensitivity (max):	< 5%;
- Frequency range:	1 ÷ 7000 Hz;
- Max. acceleration:	+/- 500 g;
- Resolution:	0,01g;
- Weight:	0,105 N

DYTRAN 3023A6:

- Nominal sensitivity:	5 mV/g
- Transverse sensitivity (max):	< 5%
- Frequency range axis 1 & 2:	1,5 ÷ 5000 Hz
- Frequency range axis 3:	1,5 ÷ 10000 Hz
- Max. acceleration:	+/- 1000 g
- Resolution:	0,010g
- Weight:	0,04 N

The frequency response of the whole measuring chain is flat, in the frequency range from 3 to 3000 Hz, with an accuracy of ± 5%.

Serial number of the employed accelerometer is listed in the above reported table. The instrumentation is submitted to a calibration program in accordance with internal procedures.

3.3. Data acquisition and processing instrumentation

During all the tests the shaker was controlled by a computer based system (the digital system LMS International) which is composed by an acquisition panel of 16 channels and by a PC. This control system generates the motion with the requested characteristics and feeds-back the shaker motion using the signal coming from the accelerometer chosen for the control.

Analogue signals coming from the accelerometers were amplified and conveyed to an analogue/digital converter, which sent the data to the disk storage of the aforementioned minicomputer for subsequent processing.

The block scheme of the excitation, acquisition and processing equipment is shown at page 16.

4. TEST RESULTS

4.1. Seismic tests

The seismic tests were performed by applying an artificial time history obtained starting from the Required Response Spectrum as reported in doc. |1|, with a 200 Hz sampling frequency. In order to fit the required displacement with the maximum allowable displacement of the test equipment, the drive signal was filtered with a high-pass filter at 4 Hz: the filtering was imposed on the basis of the results of the resonance frequency search performed in all the three excitation directions, showing that the cut-off frequency was lower of the lowest natural frequency of the unit before the earthquake test. In this case the Test Response Spectrum of the obtained shaking table acceleration (TRS CP1) is dominating the Required Response Spectrum (Telcordia RRS - Zone 4) of the reference doc. |1| in the frequency range from 4 to 50 Hz and the test can be accepted because the specimen was correctly excited around its natural frequencies. For every direction a comparison is given of the Required Response Spectrum with the Test Response Spectrum at a damping value of 2% analyzed with 12 points per octave. In any case the test was run in order to get a peak acceleration of the excitation time history greater than the Zero Period Acceleration of the specified Required Response Spectrum.

4.1.1. Tests in X direction

Initial resonance frequency search

Figures at pages 18 - 20 show the absolute response function relevant to the control accelerometer (AvgCtrl) and the frequency transfer functions relevant to the measuring accelerometers (MP1 and MP2) placed on the unit, recorded during the initial resonance frequency search performed before the earthquake test.

Earthquake test

Figures at page 21 show the acceleration time history relevant to the control accelerometer (CP1) and the relative displacement time history of the top of the unit, obtained during the earthquake simulation.

Figures at pages 22 - 23 show the acceleration time histories relevant to the measuring accelerometers (MP1 and MP2), obtained during the earthquake simulation.

Figure at page 24 show the Test Response Spectrum (TRS - solid line) compared with Telcordia Zone 4 Required Response Spectrum (RRS - dashed line), obtained during the earthquake simulation.

Final resonance frequency search

Figures at pages 25 - 27 show the absolute response function relevant to the control accelerometer (AvgCtrl) and the frequency transfer functions relevant to the measuring accelerometers (MP1 and MP2) placed on the unit, recorded during the final resonance frequency search performed after the earthquake test.

4.1.2. Tests in Y direction

Initial resonance frequency search

Figures at pages 28 - 30 show the absolute response function relevant to the control accelerometer (AvgCtrl) and the frequency transfer functions relevant to the measuring accelerometers (MP1 and

MP2) placed on the unit, recorded during the initial resonance frequency search performed before the earthquake test.

Earthquake test

Figures at page 31 show the acceleration time history relevant to the control accelerometer (CP1) and the relative displacement time history of the top of the unit, obtained during the earthquake simulation.

Figures at pages 32 - 33 show the acceleration time histories relevant to the measuring accelerometers (MP1 and MP2), obtained during the earthquake simulation.

Figure at page 34 show the Test Response Spectrum (TRS - solid line) compared with Telcordia Zone 4 Required Response Spectrum (RRS - dashed line), obtained during the earthquake simulation.

Final resonance frequency search

Figures at pages 35 - 37 show the absolute response function relevant to the control accelerometer (AvgCtrl) and the frequency transfer functions relevant to the measuring accelerometers (MP1 and MP2) placed on the unit, recorded during the final resonance frequency search performed after the earthquake test.

4.1.3. Tests in Z direction

Initial resonance frequency search

Figures at pages 38 - 40 show the absolute response function relevant to the control accelerometer (AvgCtrl) and the frequency transfer functions relevant to the measuring accelerometers (MP1 and MP2) placed on the unit, recorded during the initial resonance frequency search performed before the earthquake test.

Earthquake test

Figures at page 41 show the acceleration time history relevant to the control accelerometer (CP1) and the relative displacement time history of the top of the unit, obtained during the earthquake simulation.

Figures at pages 42 - 43 show the acceleration time histories relevant to the measuring accelerometers (MP1 and MP2), obtained during the earthquake simulation.

Figure at page 44 show the Test Response Spectrum (TRS - solid line) compared with Telcordia Zone 4 Required Response Spectrum (RRS - dashed line), obtained during the earthquake simulation.

Final resonance frequency search

Figures at pages 45 - 47 show the absolute response function relevant to the control accelerometer (AvgCtrl) and the frequency transfer functions relevant to the measuring accelerometers (MP1 and MP2) placed on the unit, recorded during the final resonance frequency search performed after the earthquake test.

4.2. General remarks

At the end of the tests, at a visual inspection, no mechanical failure was detected on the unit.

Considering the requirement stated in doc |1|, the unit supported the Earthquake Test forecasted for Risk Zone 4.

The results of further checks on the unit are of Customer's responsibility.