EXPERIMENTAL RESEARCH AND LABORATORY TESTS FOR SEISMIC QUALIFICATION OF AN "AUTOMATICA - PL2023 JUNCTION BOX"

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ABSTRACT

The paper deals with some aspects regarding "Experimental Research and Laboratory Testing for Seismic Qualification DBE B, Seismic Edge HCLPF = 0.4g, Automatica 1 (2) - 52900 - PL2023 Junction Box". Seismic qualification was performed by physical experiment on the 150 kN Shaking Table at INCD URBAN INCERC IASI. The provisions of the - Technical Specification. Safety Systems Equipment Cabinets. Cernavodă 2. 82–68000–TS - 003, Revision 0, November 2001, - Addendum to Technical Specification 82–68000–TS–003, Rev. 0, Safety Systems Equipment Cabinets and - SR EN 60068-3-3:1994. Environmental testing. Part 3: Guidance. Seismic test methods for equipments, have been observed. The seismic qualification results and the related conclusions are contained in the paper.

Keywords: Shaking Table; Seismic qualification; CNE equipment.

REZUMAT

Prezentul articol tratează unele aspecte privind "Cercetări experimentale şi încercări de laborator pentru calificarea seismică DBE B, margine seismică HCLPF = 0.4g, a unei cutii de joncţiune Automatica 1(2) – 52900 – PL2023". Calificarea seismică a fost efectuată prin acţiune cu experiment fizic efectuată pe platforma seismică de 150 kN din dotarea INCD URBAN INCERC IASI. Au fost respectate prevederile normelor -Technical Specification. Safety Systems Equipment Cabinets. Cernavodă 2. 82–68000–TS- 003, Revision 0, November 2001, Addendum to Technical Specification 82–68000–TS–003, Rev. 0, Safety Systems Equipment Cabinets şi - SR EN 60068-3-3:1994. Environmental testing. Part 3: Guidance. Seismic test methods for equipments. Rezultatele de calificare seismică şi concluziile aferente sunt cuprinse în lucrare.

Cuvinte cheie: Platformă seismică; Calificare seismică; Echipament CNE.

1. INTRODUCTION

The paper deals with some aspects regarding the experimental researches and the laboratory tests for seismic qualification DBE, seismic edge HCLPF = 0.4g, of an AUTOMATICA junction box 1 (2) - 52900 - PL2023.

The seismic qualification vas performed on the 150 kN Shaking Table at INCD URBAN INCERC IASI.

2. LIST OF NORMATIVE REFERENCE ACTS

- Technical Specification. Safety Systems Equipment Cabinets. Cernavodă 2. 82–68000–TS - 003, Revision 0, November 2001.
- Addendum to Technical Specification 82–68000–TS–003, Rev. 0, Safety Systems Equipment Cabinets.
- IEEE 344 - Recommended Practice for Seismic Qualification of Class 1E

Equipment for Nuclear Power Generating Stations.
- SR EN 60068-3-3:1994. Environmental testing. Part 3: Guidance. Seismic test methods for equipments. [1, 2, 4].

3. LIST OF EQUIPMENT AND INSTRUMENTATION

- 150 kN Shaking Table that generates continuous sinus, sweep sinus, white noise;
- Output data capture equipment with a sampling frequency of 0.020 sec, composed of piezotronics triaxial accelerometers PCB type, disposed after NS and alternative EW direction, CATMAN AP - HBM data acquisition program, H & P data acquisition laptop.

4. SEISMIC QUALIFICATION REQUIREMENTS IMPLEMENTED BY STANDARDS

According to Technical Specification. Safety Systems Equipment Cabinets. Cernavoda 2. 82-68000-TS-003, Revision 0, November 2001 and Addendum to Technical Specification 82-68000-TS-003, Rev. 0, Safety Systems Equipment Cabinets.)**:**

4.1. Identifying the resonance domain

Before and after the seismic qualification test, two ascending and descending exploratory sweep sinus passes in the 2...33 Hz frequency range, with an octave rate per minute and an input acceleration level of 0.4g.

4.2. Seismic qualification method

The conditions for seismic qualification are:
- Input frequency: 1-33 Hz:
- Input acceleration at the platform base (Fig. 1):
a) A_0 = 0.4g at 1 Hz, linear increase to A_0 = 2g and to 5 Hz;
- from 1 Hz to 4 Hz: 1 Hz / min, + 0%, -15%;
b) A_0 = 2g in the range of 5 - 33 Hz;
- from 4 Hz to 33 Hz: (f^2 / 1000) Hz / sec, + 0%, -15%, where "f" denotes the frequency.

4.3. Acceptance criterion

- The resonance frequency of the test cabinet after each axis, during the sweep sinus value of A0 = 0.4g, in the frequency range of 2 - 33 Hz, remains unchanged after the seismic qualification test.
- The cabinet must remain mechanically and structurally intact without visible deformations after the seismic qualification test and ensure functional continuity during and after the test is terminated.

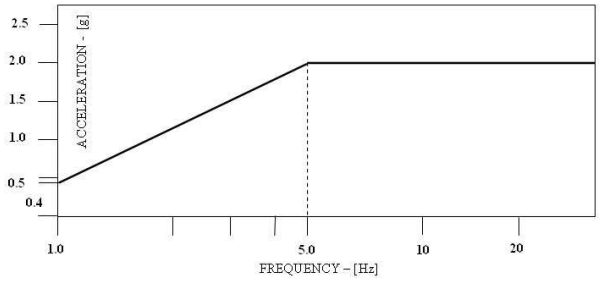


Fig. 1. Required Table Input for Unidirectional Single Frequency Test

5. TEST AND RESULTS DATA

5.1. Characteristic sketches and photos

Complete and in-service equipment has been subjected to vibration in the form of a sine wave with frequency modulation. The input and the response acceleration values were recorded.

Fig.2 schematically presents the geometric aspect of the tested equipment.

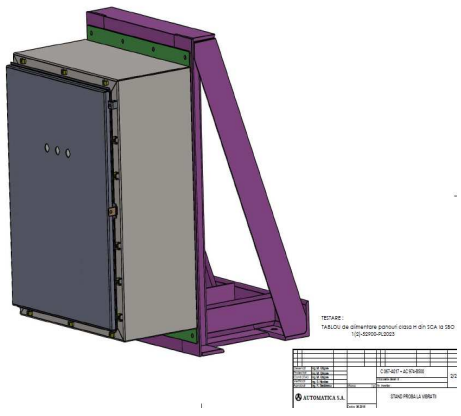


Fig. 2. The Geometric Aspect of the Tested Equipment

Photo 1 presents aspects regarding the arrangement of the equipment on the seismic platform for testing.

Photo. 1 Aspects regarding the arrangement of the equipment on the seismic platform for testing.

5.2. Layout of measurement points

The following measurement points were disposed:

- A0: triaxial accelerometer disposed on the seismic platform;
- A1 triaxial accelerometer disposed left on the dome of the equipment;
- A2 triaxial accelerometer disposed right on the dome of the equipment;

The arrangement of the measuring points is shown in Fig. 3 and Fig. 4.

5.3. Experimental results

The equipment called "Automatic Junction Box 1 (2) - 52900 - PL2023" was placed on the seismic platform, first for seismic qualification in the longitudinal direction of drive and then for seismic qualification in the transverse direction of drive, according to the dynamic test program presented in Table 1.

Prior to the commencement of the seismic qualification procedure, the equipment was provided with external consumers for the 4 three-phase circuits and for the 3 single-phase circuits; During the entire dynamic testing program, the power supply to consumers has not been interrupted.

The seismic qualification of the "Automatica 1 (2) - 52900 - PL2023 junction box" was carried out in the presence of authorized representatives of the customer.

5.3.1. Experimental results in longitudinal direction

Analyzing data from Table 1, the following results:

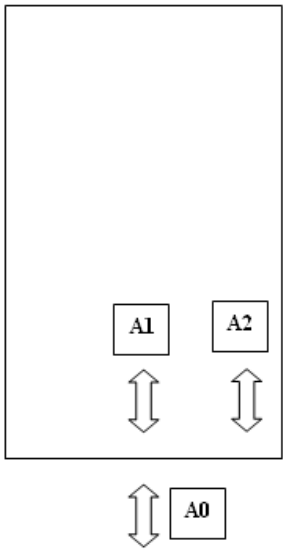


Fig. 3. Longitudinal direction

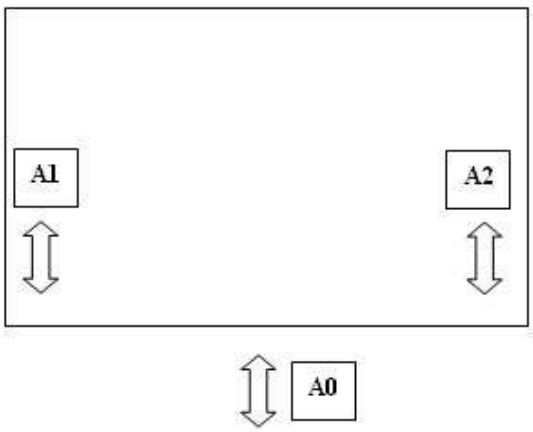


Fig. 4. Transverse direction

Table 1. *Predicted seismic qualification program. Seismic qualification program.*

Action sense	Test type	Frequency range [Hz]	Forecast A_0 [g]	Achieved A_0 [g]	Predicted duration [sec.]	Achieved duration [sec.]
Longitudinal action with the axis of the equipment	Ascending sweep sinus before qualifying	2-10	0.4	±1.0	60	58
		10-18	0.4	±0.7	60	58
		18-26	0.4	±0.8... 0.6	60	80
		26-33	0.4	±0.5	60	67
	Downward sweep sinus before qualifying	33-26	0.4	±0.5	60	62
		26-18	0.4	±0.5	60	52
		18-10	0.4	±0.5	60	65
		10-2	0.4	±0.9	60	72
	Seismic qualification	1-33	2.0	±2.0... 1.0	278	375
	Ascending sweep sinus after qualifying	2-10	0.4	±1.0	60	68
		10-18	0.4	±0.8	60	71
		18-26	0.4	±0.7	60	65
		26-33	0.4	±0.6... 0.5	60	63
	Downward sweep sinus after qualifying	33-26	0.4	±0.5	60	68
		26-18	0.4	±0.7	60	73
		18-10	0.4	±0.8	60	82
		10-2	0.4	±1.0	60	68
Transverse action with the axis of the equipment	Ascending sweep sinus before qualifying	2-10	0.4	±1.4...±0.5	60	54
		10-18	0.4	±0.7	60	65
		18-26	0.4	±0.7	60	65
		26-33	0.4	±0.7	60	51
	Downward sweep sinus before qualifying	33-26	0.4	±0.4...±0.6	60	69
		26-18	0.4	±0.7	60	62
		18-10	0.4	±0.5...±0.6	60	39
		10-2	0.4	±0.5...±1.0	60	50
	Seismic qualification	1-33	2.0	±1.9...±1.0	278	285
	Ascending sweep sinus after qualifying	2-10	0.4	±1.5.. ±0.7	60	61
		10-18	0.4	±0.7...±0.5	60	49
		18-26	0.4	±0.7	60	51
		26-33	0.4	±0.4	60	63
	Downward sweep sinus after qualifying	33-26	0.4	±0.7...±0.6	60	53
		26-18	0.4	±0.7	60	57
		18-10	0.4	±0.6	60	51
		10-2	0.4	±0.7...±1.4	60	50

The seismic platform base action level during longitudinal sweep sinus, both ascending and descending, before and after seismic qualification, **had** acceleration values A_0 within ± 0.5 ... ± 1.0g, superior to those required by the Technical Specification. Safety Systems Equipment Cabinets. Cernavoda 2. 82-68000-TS-003, Revision 0, November 2001 and Addendum to Technical Specification 82-68000-TS-003, Rev. 0, Safety Systems Equipment Cabinets, 0.4g.

- The A_0 action level during the longitudinal direction of the seismic qualification **was** in the range of A_0 = [± 1.0 ...± 2.0g], predominantly in the range of [±1.5...±2.0g].

- The duration of the 375 second of the seismic qualification action was **longer** than the expected duration of the action, of 278 seconds, with a value of +35% over the

specification provided by the norm specification.

- Analyzing the actual frequency response spectrum of Action A_0 (TRS), compared to the values required by Addendum to Technical Specification 82-68000-TS-003, Rev. 0, Safety Systems Equipment Cabinets, Fig. A-1 (RRS), it is found that the envelope of the TRS test spectral values exceeds the required RRS spectral values over the entire frequency range of 1 - 33Hz, in relation to at least 250 200% in the frequency range [20 ... 33Hz] – Fig. 5.

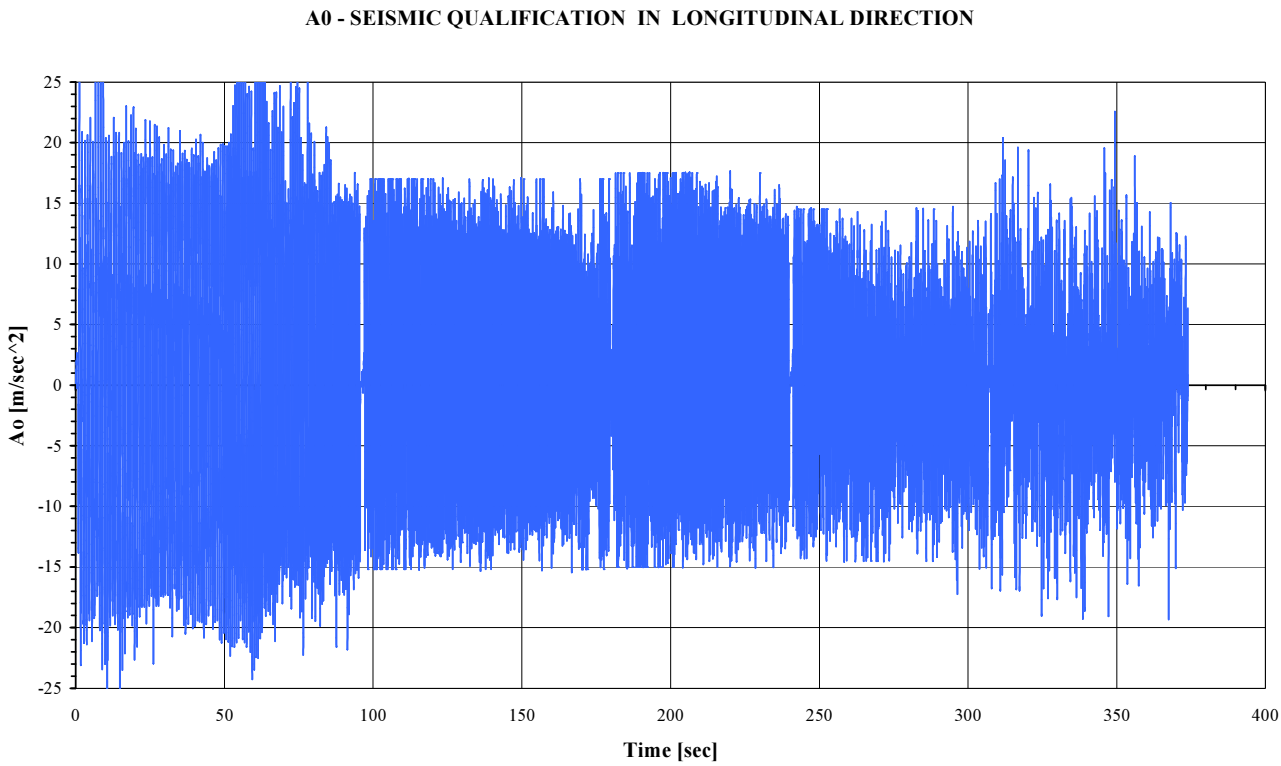
5.3.2. Experimental results in transverse direction

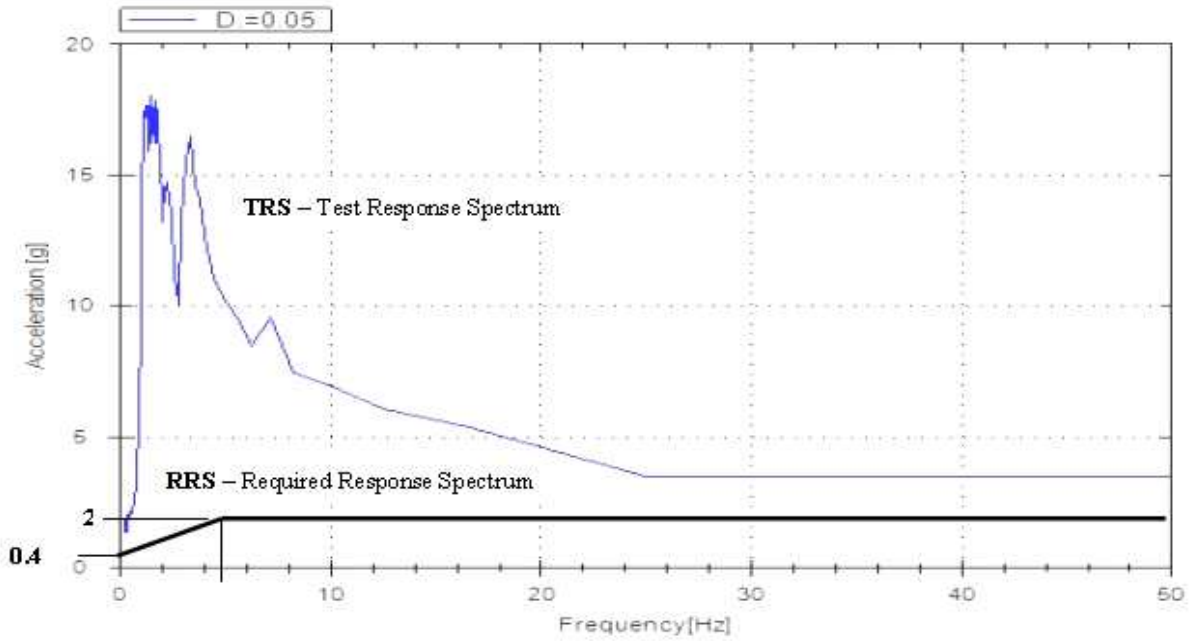
Analyzing data from Table 1, the following results:

- The level of action at the base of the seismic platform during the transverse sweep sinus, both ascending and descending, before and after seismic qualification, **had** acceleration values of A_0 ranging from [± 0.4 ... ± 1.0g], superior to those required by the Technical Specification. Safety Systems Equipment Cabinets. Cernavoda 2. 82-68000-TS-003, Revision 0, November 2001 and Addendum to Technical Specification 82-68000-TS-003, Rev. 0.

- The A_0 drive level during the transverse direction seismic qualification was in the range of A0 = [± 1.0...± 1.9g], predominantly in the range [±1.4...±1.9g].
- The duration of the 285 second of the seismic qualification action was longer than the expected duration of the action, of 278 seconds, with a value of + 2.5% above the norm specification.

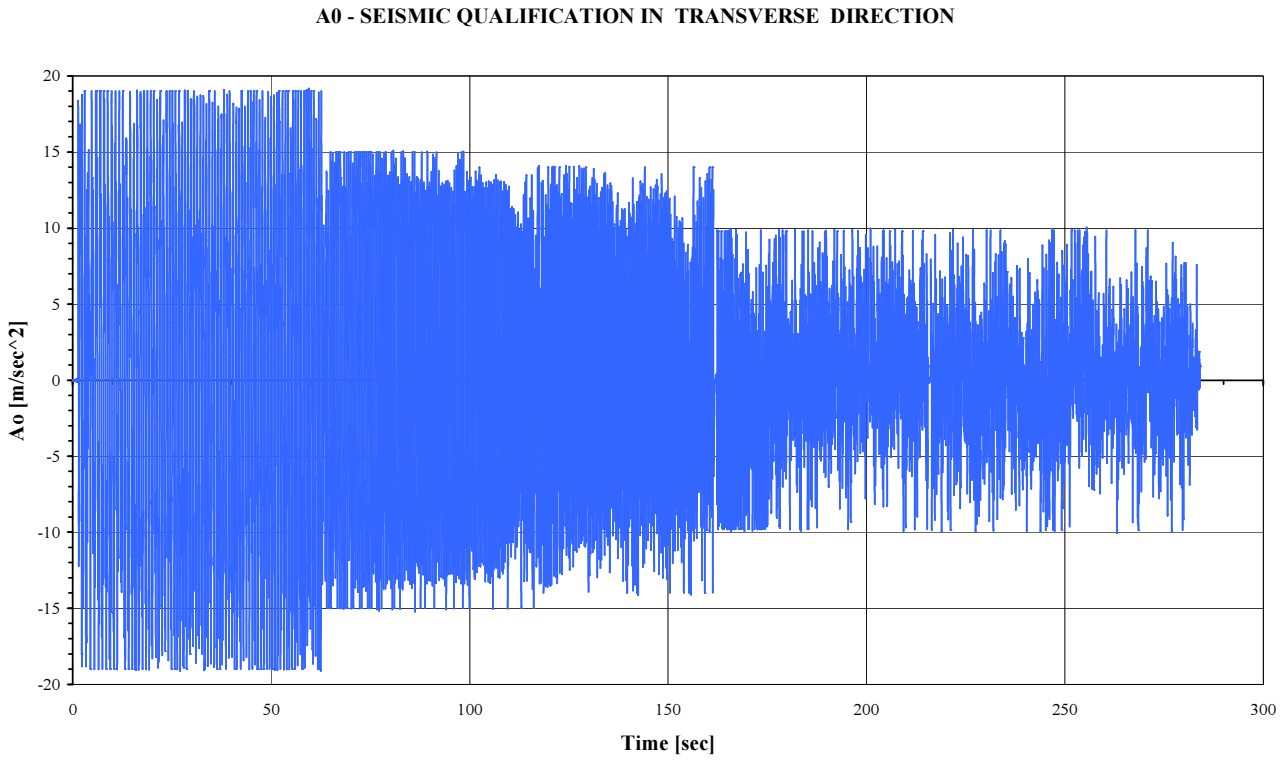
- Analyzing the actual frequency response spectrum of Action A0 (TRS), compared to the values required by Addendum to Technical Specification 82-68000-TS-003, Rev. 0, Safety Systems Equipment Cabinets, Fig. A-1 (RRS), it is found that the envelope of the TRS test spectral values exceeds the required RRS spectral values over the entire frequency range of 1 - 33Hz, in relation to at least 200 ... 150% in the frequency range [20 .... 33Hz] – Fig. 6.

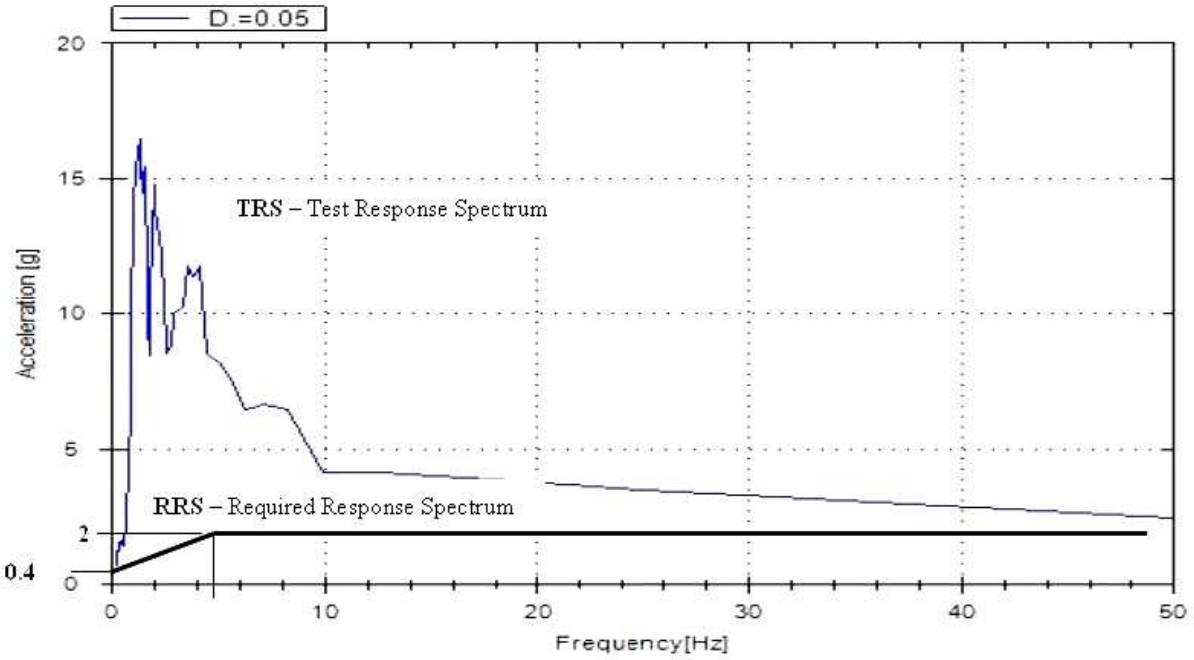




Ao - Longitudinal acceleration frequency input spectrum at the base of the unidirectional platform, for the fraction of the critical damping υ = 5%

Fig. 5 Seismic qualification in longitudinal direction





Ao - Transverse acceleration frequency input spectrum at the base of the unidirectional platform, for the fraction of the critical damping υ = 5%

Fig. 6 Seismic qualification in transverse direction

6. CONSIDERATIONS

The beneficiary provided the tested equipment, participated - through its delegates - both in the installation of the equipment and in the testing, without signaling any malfunction (deformations of the enclosure, detachments, component parts, joints weakening, opening the panels, etc.).

Throughout the longitudinal and the transverse directional sliding and descending sinking exploratory tests, the equipment has been maintained in conditions both longitudinally and transversely to the actuation and throughout the seismic qualification tests, both functional and structural integrity.

7. CONCLUSIONS

According to the visual observations and to the results of the processing of the experimental values and to the functional checks, the equipment "Automatic Joint Box 1 (2) - 52900 - PL2023" is seismically qualified.

REFERENCES

1. Technical Specification. Safety Systems Equipment Cabinets. Cernavodă 2. 82–68000–TS - 003, Revision 0, November 2001.

2. Addendum to Technical Specification 82–68000–TS–003, Rev. 0, Safety Systems Equipment Cabinets.

3. IEEE 344 - Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

4. SR EN 60068-3-3:1994. Environmental testing. Part 3: Guidance. Seismic test methods for equipments.