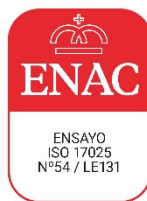


**REPORT OF THE SEISMIC TESTS
CARRIED OUT ON A**

“UPS CABINET”

SUPPLIED BY SALICRU



Documents and activities marked with (*), as well as information and activities indicated as supplied or performed by the client, are not covered by ENAC accreditation

NOTE: According to section 7.8.2 of standard ISO-IEC 17025:2017, it is stated that:

- The results of the present report apply only and exclusively to the samples subjected to test.
- The partial reproduction of this document without the previous written permission of the Laboratory is forbidden.
- The Laboratory is not responsible for the information and activities indicated as supplied or performed by the client.

VIRLAB, S.A.
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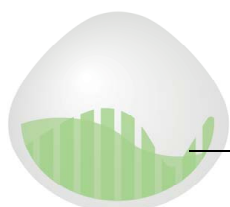
Technical Director

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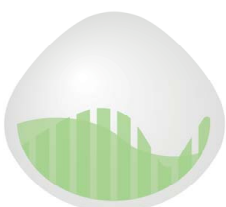
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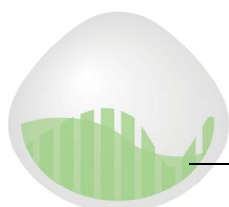
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- INSTALLATION DIAGRAM.
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107 to 125



1.0.- REPORT NUMBER

24358901, consisting of 125 pages, distributed in a Memorandum with Figures, Tables and Pictures; and seven (7) Appendices.

2.0.- CLIENT

SALICRU
Avda. de la Serra 100
08460 Palautordera
BARCELONA (Spain)

3.0.- EQUIPMENT TESTED

According to the information provided by the client, the tested **UPS SLC ADAPT2 Cabinet**, supplied by SALICRU, has external dimensions of 1615x640x885 mm and weight of ~336 kg.

The **Cabinet** arrived at the Laboratory on 24th January 2024, carrying out the tests between 08th and 09th February 2024.

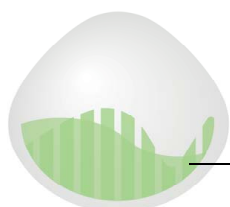
4.0.- REFERENCES

4.1 APPLICABLE STANDARD

- Standard **IEC 60068-3-3:2019/COR1:2021**: “*Environmental testing – Part 3-3: Supporting documentation and guidance – Seismic tests methods for equipment*”.

4.2 OTHER DOCUMENTS

- VIRLAB document number **231002E1**, revision 0, dated 19/10/2023: “*TEST PROCEDURE FOR THE SEISMIC TESTS OF EQUIPMENT ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021*”. (*)
- Uniform Building Code 1997, “**UBC 1997**”. (*)
- Standard **IEC 60068-2-6:2007**: “*Environmental testing. Part 2-6: Tests. Test Fc: Vibration (sinusoidal)*”.
- Standard **IEC 60068-2-57:2013**: “*Environmental testing - Part 2-57: Tests - Test Ff: Vibration - Time-history and sine-beat method*”.
- Standard **IEC 60068-2-47:2005**: “*Environmental testing. Part 2-47: Tests. Mounting of specimens for vibration, impact and similar dynamic tests*”.



5.0.- DESTINATION

Electrical applications.

6.0.- TEST PLATFORM

The tests have been carried out at VIRLAB facilities on the EDB 120x120 test platform, which measures 1200 mm (47 1/4") wide by 1200 mm. (47 1/4") long.

This independent biaxial action platform has two servo-hydraulic cylinders, one for the horizontal shaft and the other for the vertical one.

Both cylinders are independent with their own servo valves and multi frequency generators. Each cylinder has a static force of 100 kN, and a maximum run of ± 125 mm.

The hydraulic equipment, which drives the test platforms, comprises seven motors, with a horsepower of up to 330 HP, and can pump a flow rate of up to 640 litres/minute at a pressure of 210 bars.

For the resonance frequency research tests, the signal is generated by means of a vibration controller, while for the seismic tests, the signal is generated by means of a multi-frequency signal generator for each cylinder, each composed of sinusoidal oscillators, adjustable in amplitude and independent phase.

7.0.- MEASURE, RECORD AND ANALYSIS EQUIPMENT

APPENDIX VI includes a list of the Laboratory instrumentation used, which states the calibration date before performing the tests and the calibration expiration date, as well as the uncertainty of the instrumentation used.

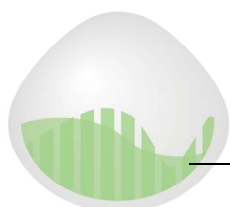
8.0.- TEST PROCEDURE

The tests, the results of which are described in this report, have been performed in accordance with the standard **IEC 60068-3-3:2019/COR1:2021**.

Other test conditions are described in VIRLAB test procedure **231002E1**, revision 0, dated 19/10/2023, included in **APPENDIX VII**. (*)

8.1 REQUIRED RESPONSE SPECTRA (RRS)

The applicable **Required Response Spectra, RRS**, has been obtained from VIRLAB test procedure **231002E1**, issue 0, dated 19/10/2023.



FIGURES 1 and 2 represent the **RRS**, for a 5% damping, corresponding to the **S2** level (**ZONE 4**), to be applied in the horizontal (*OY and OX*) and the vertical (*OZ*) (*2/3 of horizontal level*) directions, respectively.

FIGURES 3 and 4 represent the **RRS**, for a 5% damping, corresponding to the **S2 (ZONE 3)** level, to be applied in the horizontal and the vertical (*2/3 of horizontal level*) directions, respectively.

FIGURES 5 and 6 represent the **RRS**, for a 5% damping, corresponding to the **S1 (ZONE 4)** and **S1 (ZONE 3)** level, to be applied in the horizontal and the vertical directions, obtained from the **S2 (ZONE 4)** level and **S2 (ZONE 3)** level spectra applying a coefficient of 0.5, respectively.

The **Test Response Spectra, TRS**, of the control accelerometers, must envelop the corresponding **RRS**, calculated with a resolution of 1/6 octave, for a 5% damping, having a duration of at least 30 seconds (*strong part shall be not less than 20 seconds*).

8.2 TEST SEQUENCE

The sequence of tests is the one described as follows:

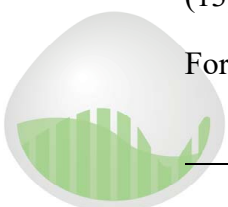
1. Initial functional verification (*performed by the client*) (*)
2. Resonance Search Tests
 - a. Resonance Search Test in OZ direction
 - b. Resonance Search Test in OX direction
 - c. Resonance Search Test in OY direction
3. Biaxial OY-OZ Direction
 - a. Five (5) **S1 (ZONE 3 & ZONE 4)** level Seismic Tests
 - b. One (1) **S2 (ZONE 3)** level Seismic Tests
4. Biaxial OX-OZ Direction.
 - a. Five (5) **S1 (ZONE 3 & ZONE 4)** level Seismic Tests
 - b. One (1) **S2 (ZONE 3)** level Seismic Tests
 - c. One (1) **S2 (ZONE 4)** level Seismic Tests
5. Biaxial OY-OZ Direction
 - a. One (1) **S2 (ZONE 4)** level Seismic Tests
6. Final functional verification (*performed by the client*) (*)

9.0.- SECURING THE EQUIPMENT TO THE TEST PLATFORM

The **Cabinet** has four (4) support legs, which are fixed in pairs to two (2) metal plates of dimensions 850x250 mm, supplied by VIRLAB, by means of two (2) M12 screws, with a grower washer under the head of the screw and a flat washer under the previous one, per support leg, applying a tightening torque of 76 Nm.

In turn, the two (2) metal plates are fastened to the test platform by means of thirteen (13) M12 Allen screws per plate.

For safety reasons, the **Cabinet** is tied down using straps.



10.0.- ACCELEROMETERS LOCATION

Four (4) groups of accelerometers are placed, as indicated in **TABLE I**, as can be seen in **PICTURES Number 1 to 4**.

One (1) control group (*point 1*) is placed on the test platform, to ensure that the applied vibration level corresponds to the one required.

Three (3) measure groups (*points 2 to 4*) are placed on different parts of the **Cabinet**, to obtain the resonance frequencies and the damping. (*)

11.0.- DESCRIPTION AND RESULTS OF THE TESTS

After the reception of the **Cabinet**, it is submitted to a visual inspection in which no anomalies are detected.

The **Cabinet** is mounted on the test platform as described in section 9.0, performing the tests indicated in section 8.2.

Before starting the tests, SALICRU personnel carry out their functional verification. It is set to AGING mode, in single phase and 50% load, indicated by the client. (*)

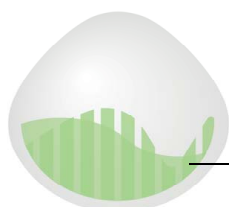
11.1 RESONANCE SEARCH TESTS

Tests number 1, 2 and 3 correspond to the resonance search tests performed in vertical “Z”, horizontal “X” (*front-to-back*) and horizontal “Y” (*side-to-side*) directions, as can be seen in **PICTURES Number 5 and 6**.

These tests are performed applying a sinusoidal excitation varying the frequency between 1 and 35 Hz, up and down, at 1 octave per minute, with an acceleration level of 1 m/s^2 , as can be seen in the Frequency Spectra of group 1 of accelerometers, included in **APPENDIX I**.

From the analysis of the Transfer Functions of groups 2 to 4 of accelerometers relative to group 1, obtained in those tests, included in **APPENDIX II**, the following main resonances on the **Cabinet** are deduced:

POINT NUMBER		Vertical Direction “Z” (Test number 1)		Horizontal Direction “X” (Test number 2)		Horizontal Direction “Y” (Test number 3)	
		Frequency (Hz)	Amplification	Frequency (Hz)	Amplification	Frequency (Hz)	Amplification
Inside Cabinet	2 (lower part)	-	-	11.0	2.2	6.0	2.2
	3 (medium part)	-	-	11.0	2.5	6.3	3.5
4 (Superior corner Cabinet)		-	-	9.5	2.7	6.3	4.6



APPENDIX III includes the Transmissibility Function of group 4 of accelerometers relative to group 1, obtained in the resonance search tests performed in horizontal directions. The damping at the main resonance frequency has been calculated (*by the Half Power Bandwidth method*): (*)

POINT NUMBER	Horizontal Direction “X” (Test number 2)		Horizontal Direction “Y” (Test number 3)	
	Damping (%)	Frequency (Hz)	Damping (%)	Frequency (Hz)
4 <i>Superior corner of the Cabinet)</i>	32.9	<i>9.0</i>	24.3	<i>6.4</i>

At the end of the resonance search tests in horizontal “Y” direction (*test number 3*), the client reports a malfunction of the **Cabinet**. (*)

After an inspection of the **Cabinet** carried out by the client, the concludes that this is due to the operating mode at the time (*AGING mode - monophase*) is not able to sustain operation for more than a few minutes, as indicated by the client. (*)

The client decides to change the operating mode to AGING – three-phase, at 50% of nominal capacity, before continuing with the tests. (*)

11.2 SEISMIC TESTS

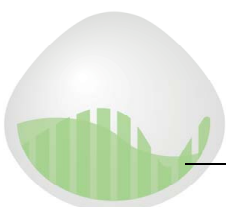
The seismic tests are carried out in “YZ” and “XZ” directions, as can be seen in **PICTURES Number 6 and 7**.

The Test Response Spectra (TRS) of the seismic tests have been calculated with a 1/6 octave resolution, for a damping of 5%. **APPENDIX IV** contains the TRS of group 1 of accelerometers, superimposed with the corresponding Required Response Spectra (RRS).

The duration of each test is 30 seconds, as can be seen in the accelerograms of group 1 of the accelerometers, which can be found in **APPENDIX V**.

The results of the seismic tests are summarized in the following table:

Test Number	Direction	Level	Valid / Not Valid ¹
4	“YZ”	S1 (Zone 3) & S1 (Zone 4)	Valid
5			Valid
6			Valid
7			Valid
8			Valid
9		S2 (Zone 3)	Valid



Test Number	Direction	Level	Valid / Not Valid ¹
10	"XZ"	S1 (Zone 3) & S1 (Zone 4)	Valid
11			Valid
12			Valid
13			Valid
14			Valid
15		S2 (Zone 3)	Valid
16		S2 (Zone 4)	Valid
17	"YZ"		Valid

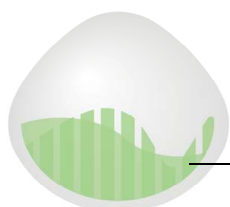
1. Valid: TRS envelope RRS / Not Valid: TRS cut RRS (see APPENDIX IV).

After the seismic tests level **S2 (ZONE 4)** in "XZ" direction (*test number 16*), it has been detected that the **Cabinet** door opens due to damage to the locking system. (see **PICTURE Number 8**). The client closes the door again and the tests continue.

After the seismic tests level **S2 (ZONE 4)** in "YZ" direction (*test number 17*), it has been detected that the **Cabinet** door opens again due to damage to the locking system detected after the test number 16 (see **PICTURE Number 9**).

At the end of the seismic tests the **Cabinet** is submitted to a visual inspection, in which fractures have been detected in the welds of the **Cabinet's** legs, as can be seen in the **PICTURE Number 10**.

At the end of the tests, SALICRU personnel carry out their functional verification. (*)



12.0.- CONCLUSIONS

One (1) **UPS Cabinet** supplied by SALICRU, described in section 3.0, has been submitted to *Resonance Search and Seismic Tests* in accordance with standard **IEC 60068-3-3:2019/COR1:2021**, as described in section 8.0.

The results of the tests performed in the three main axes of the **Cabinet** are described in section 11.0.

During the tests carried out on the **Cabinet**, the following incidents have been detected:

- After the seismic tests level **S2 (ZONE 4)** in “XZ” direction (*test number 16*), it has been detected that the **Cabinet** door opens due to damage to the locking system. The client closes the door again and the tests continue.
- After the seismic tests level **S2 (ZONE 4)** in “YZ” direction (*test number 17*), it has been detected that the **Cabinet** door opens again due to damage to the locking system detected after the test number 16.
- At the end of the seismic tests the **Cabinet** is submitted to a visual inspection, in which fractures have been detected in the welds of the **Cabinet** 's legs.

APPENDIX I includes the Frequency Spectra of group 1 of accelerometers, placed on the test platform, which show the level of acceleration applied in the *Resonance Search Tests* performed in the three main directions of the **Cabinet**.

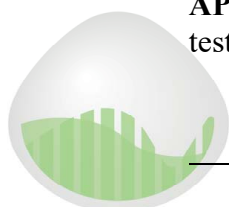
APPENDIX II includes the Transfer Functions of groups 2 to 4 of accelerometers, placed on the **Cabinet**, obtained from the *Resonance Search Tests*, from which the **Cabinet**’s most significant resonance frequencies have been inferred.

APPENDIX III includes the Transmissibility Functions of group 4 of accelerometers placed on the top of the **Cabinet**, obtained during the *Resonance Search Tests* performed in horizontal directions, from which the damping of the **Cabinet** at the main resonances have been calculated by means of the vibration controller (*by the Half Power Bandwidth method*).
(*)

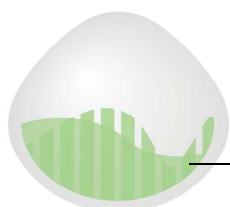
APPENDIX IV includes the Test Response Spectra (TRS), for a damping of 5%, of group 1 of accelerometers, placed on the test platform, obtained during the *Seismic Tests*, performed in the “YZ” and “XZ” directions.

These spectra are superimposed with the corresponding Required Response Spectra (RRS). In addition, the numerical values of the TRS are included.

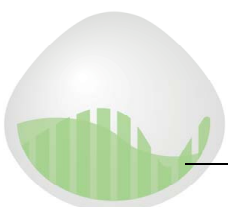
APPENDIX V includes the Accelerograms of group 1 of accelerometers, placed on the test platform, obtained from the *Seismic Tests*.



FIGURES, TABLES AND PICTURES

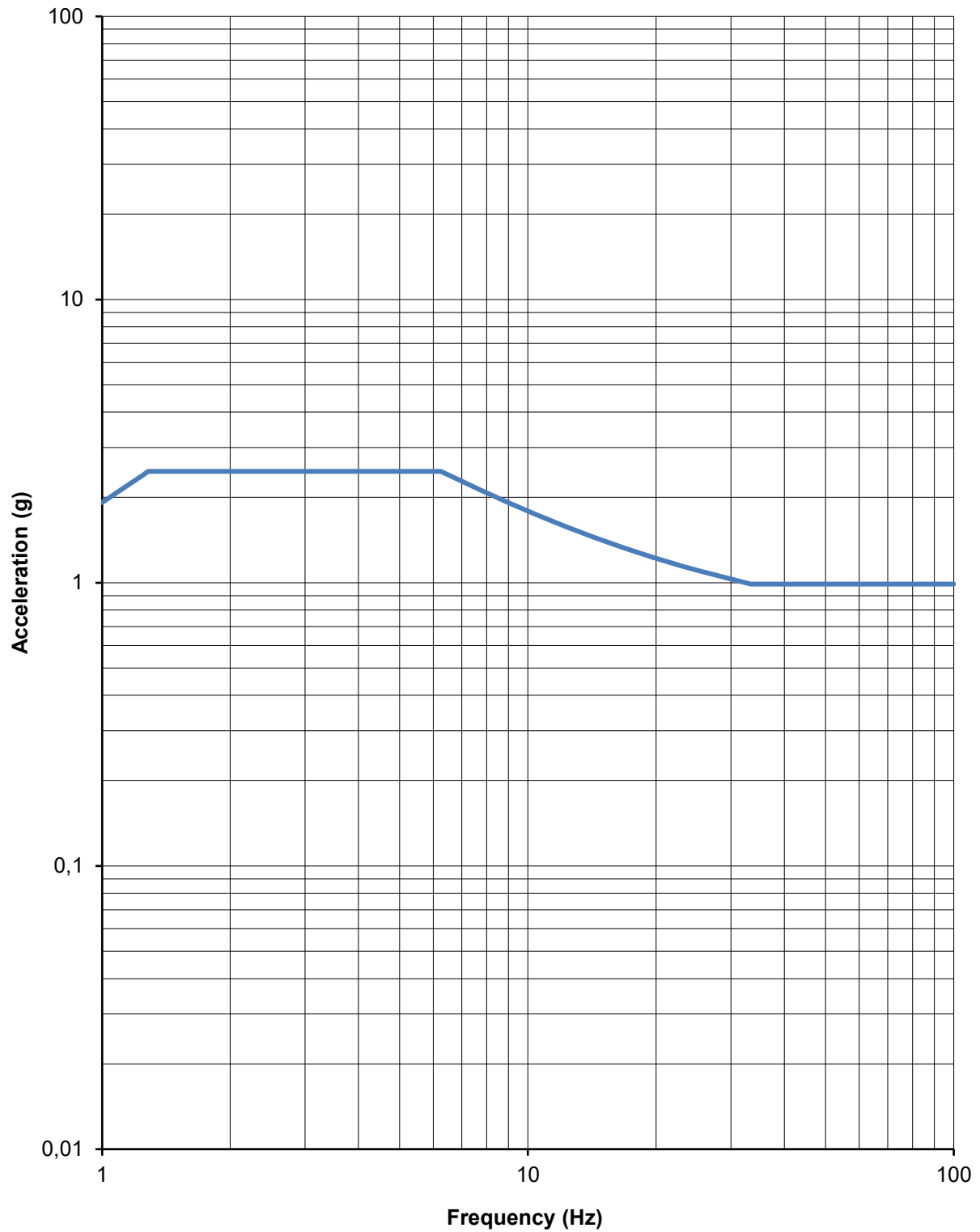


FIGURES



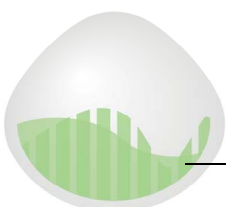
REQUIRED RESPONSE SPECTRUM, RRS

S2-H Level - 5% Damping
HORIZONTAL Direction



RRS S2-H
(UBC1997 Zone 4 Ip1,5)

FIGURE 1



REQUIRED RESPONSE SPECTRUM, RRS

S2-V (2/3 S2-H) Level - 5% Damping
VERTICAL Direction

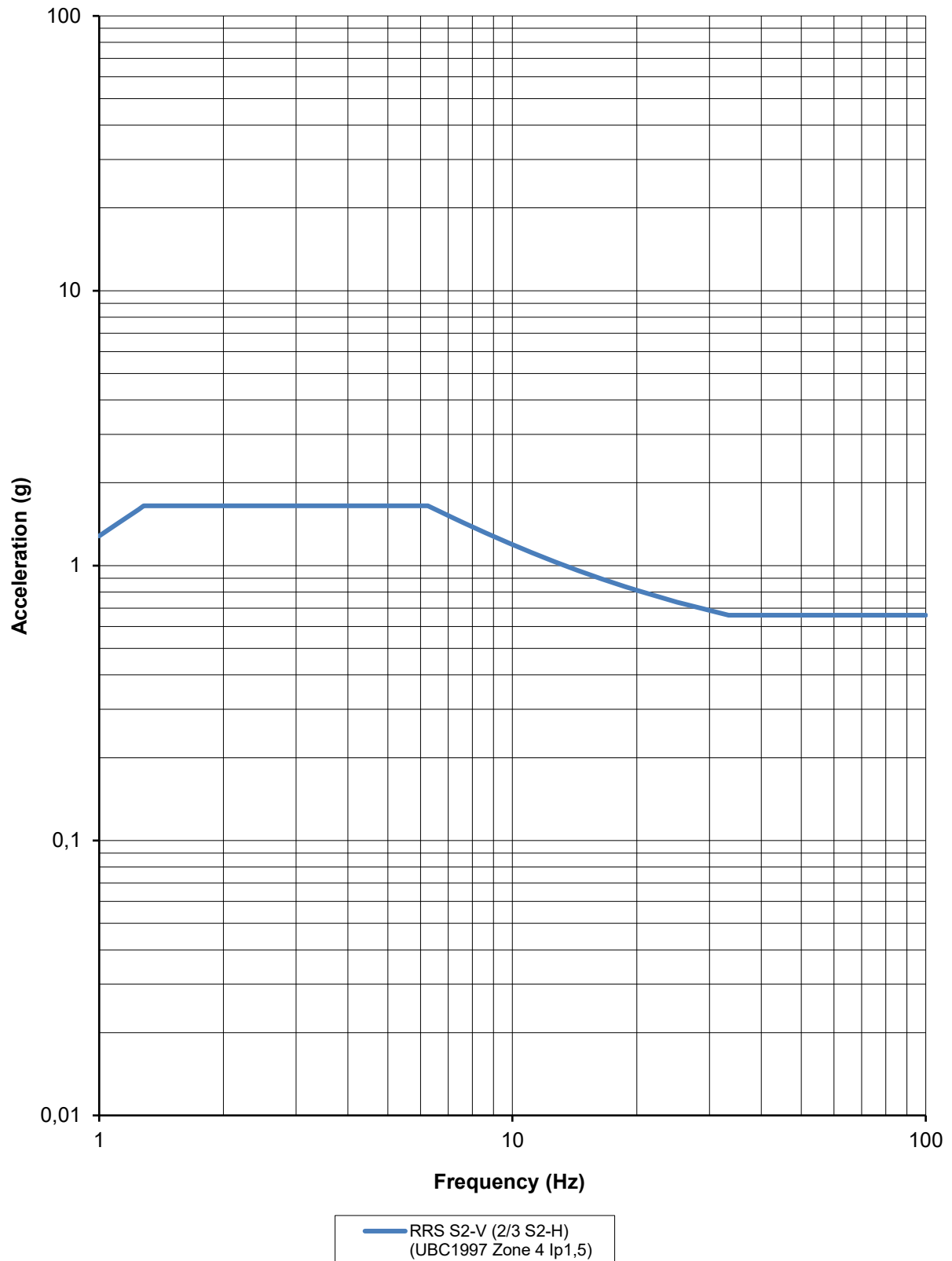
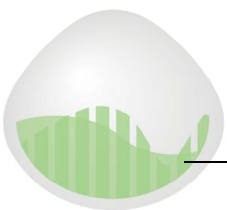
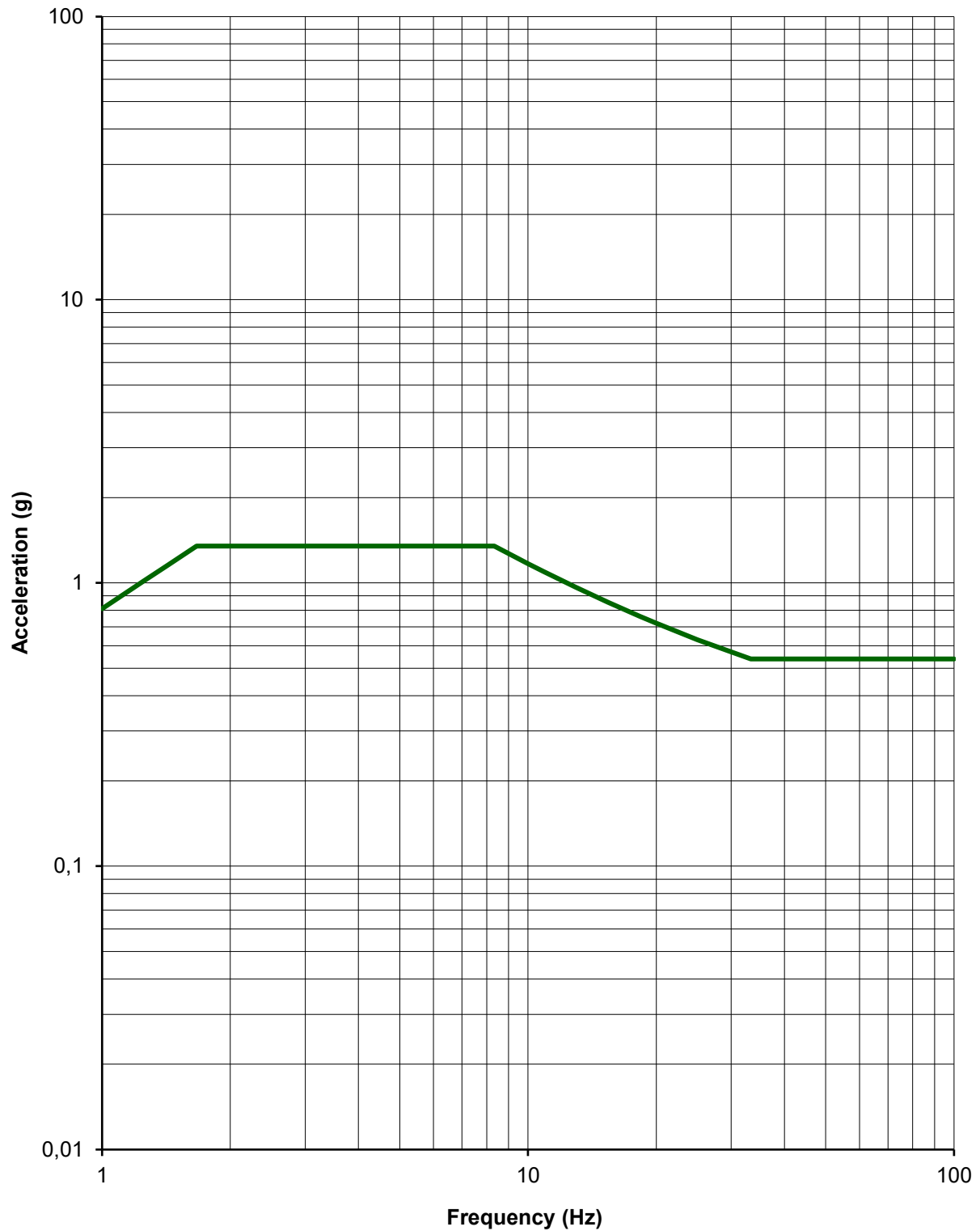


FIGURE 2



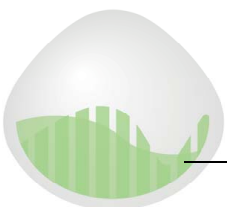
REQUIRED RESPONSE SPECTRUM, RRS

S2-H Level - 5% Damping
HORIZONTAL Direction



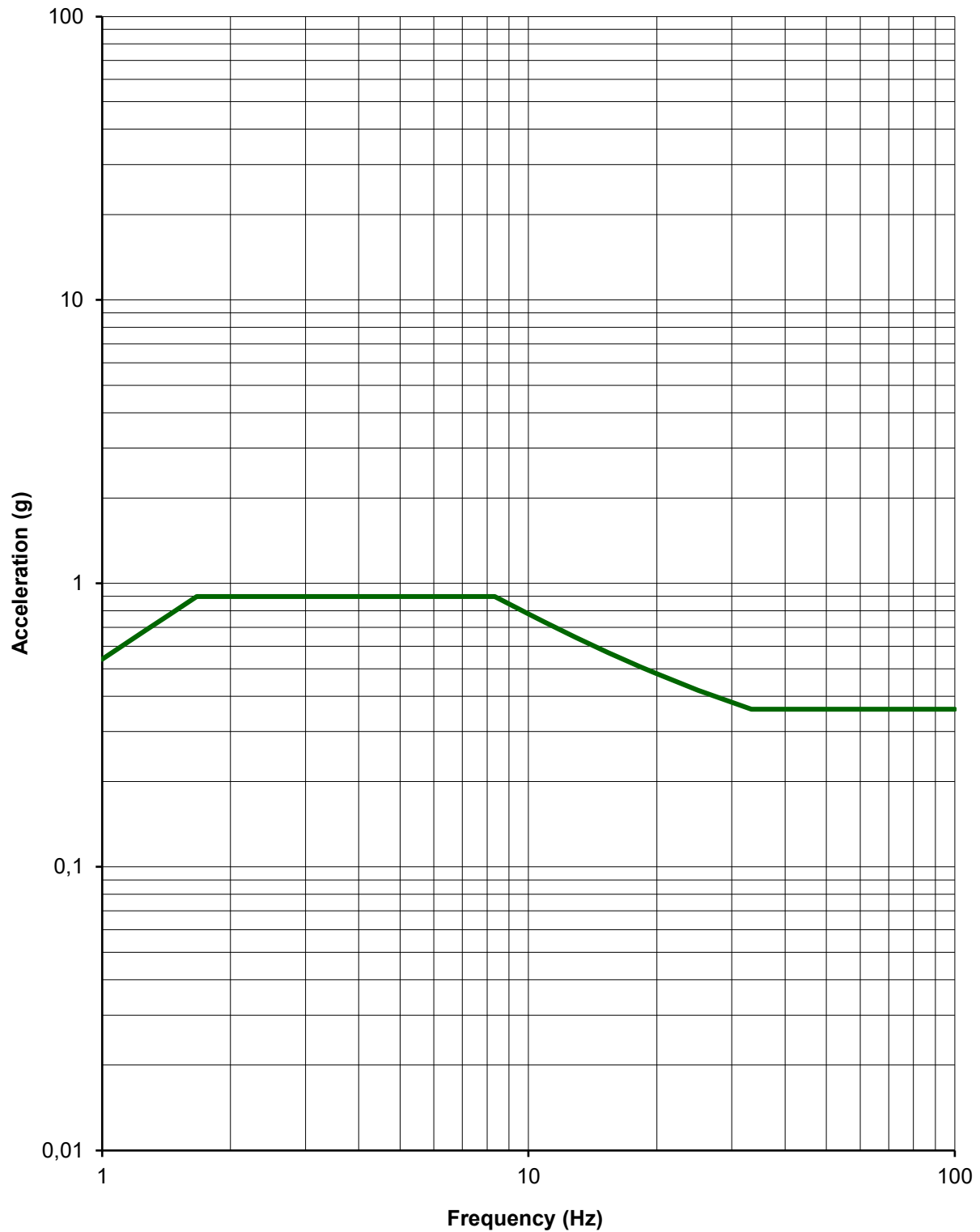
RRS S2-H
(UBC1997 Zone 3 Ip1,5)

FIGURE 3



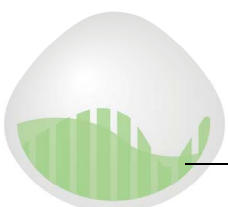
REQUIRED RESPONSE SPECTRUM, RRS

S2-V (2/3 S2-H) Level - 5% Damping
VERTICAL Direction



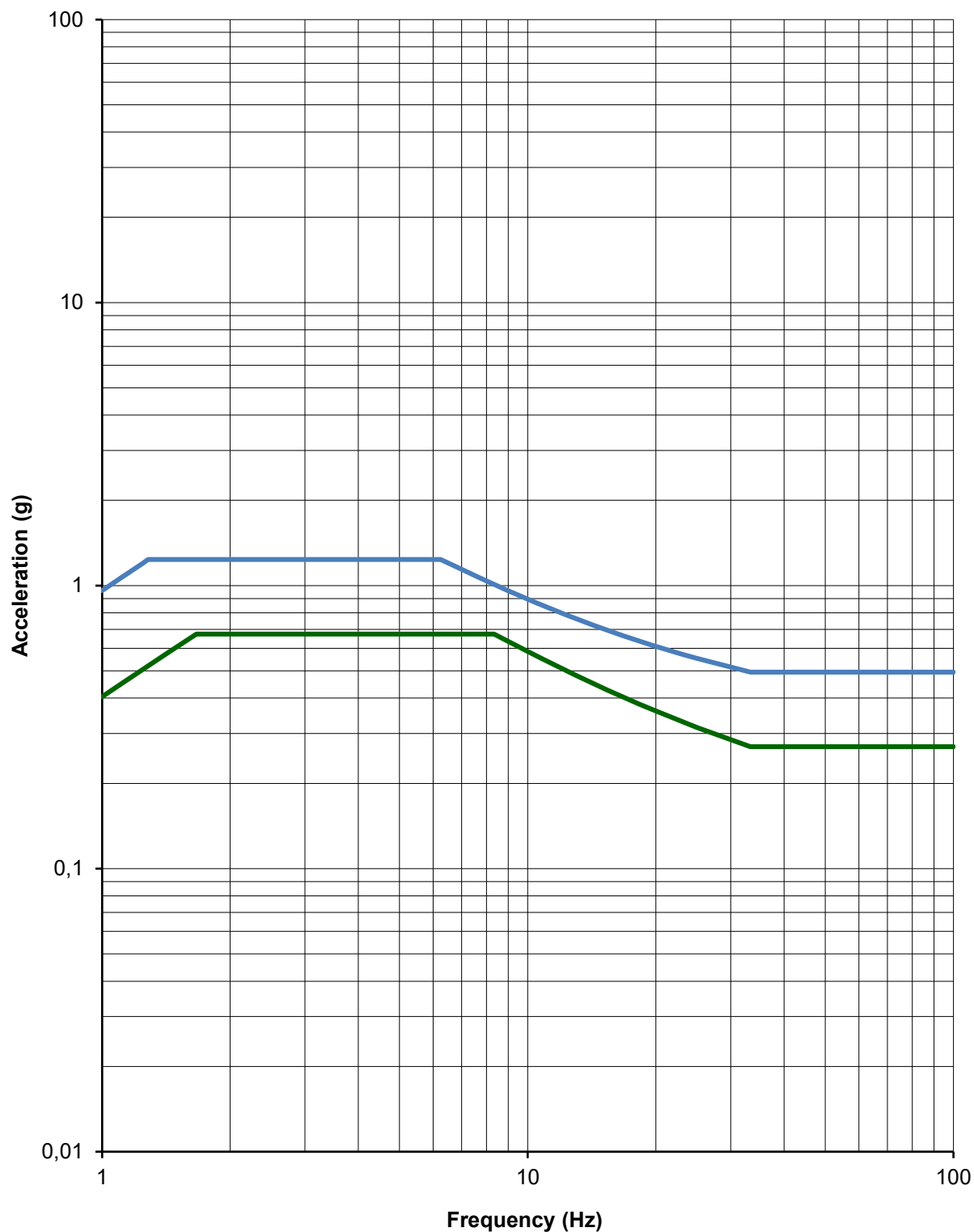
RRS S2-V (2/3 S2-H)
(UBC1997 Zone 3 Ip1,5)

FIGURE 4



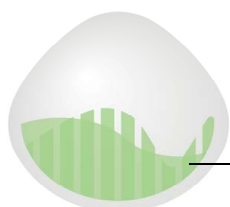
REQUIRED RESPONSE SPECTRA, RRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



RRS S1-H (50% S2-H) (UBC1997 Zone 3 Ip1,5) RRS S1-H (50% S2-H) (UBC1997 Zone 4 Ip1,5)

FIGURE 5



REQUIRED RESPONSE SPECTRA, RRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction

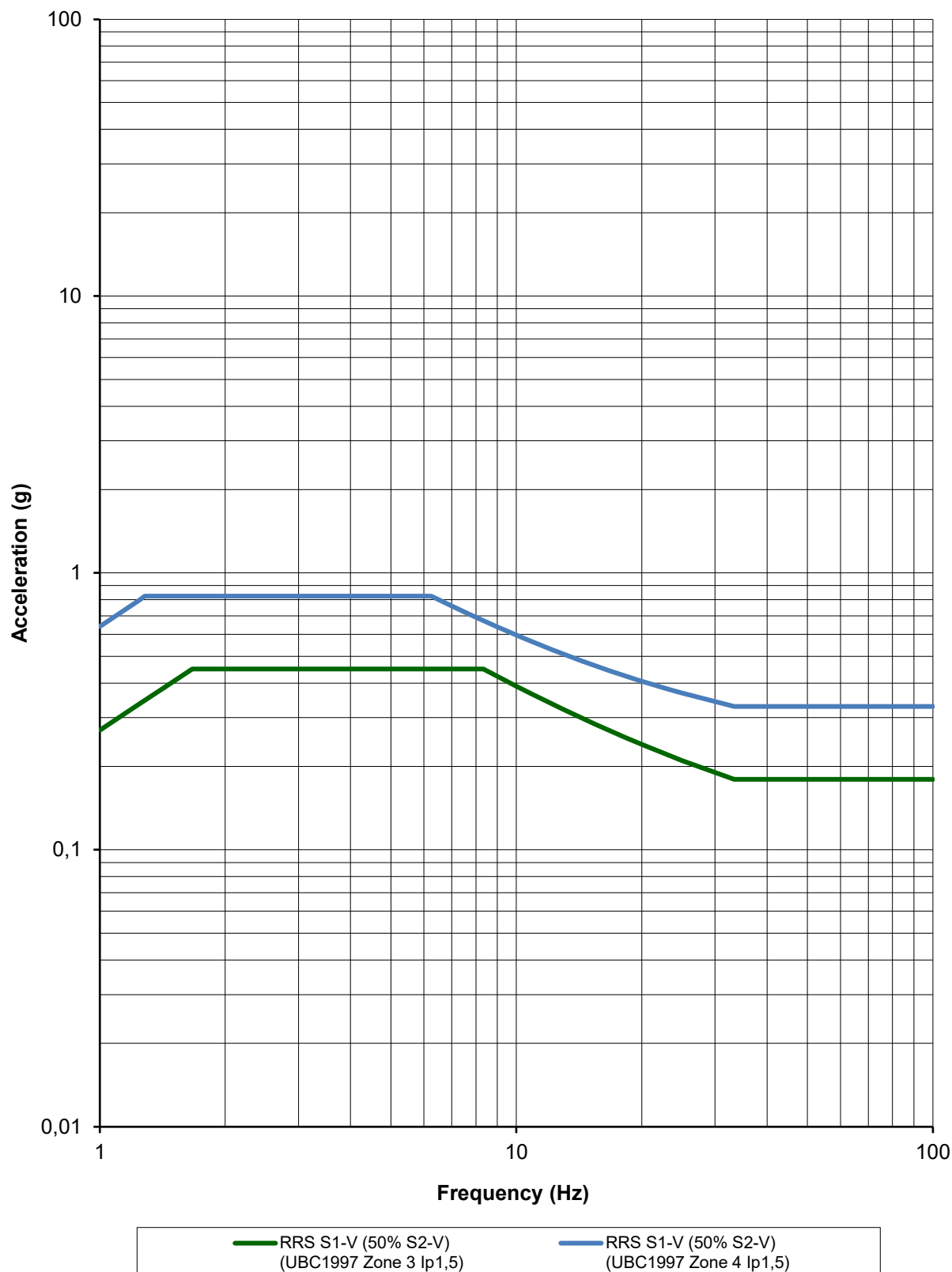
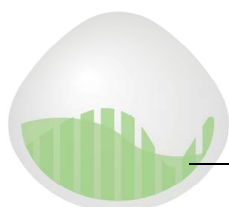


FIGURE 6



TABLES

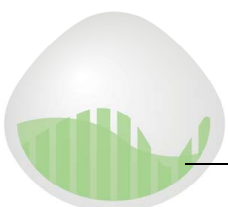
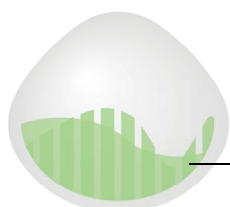
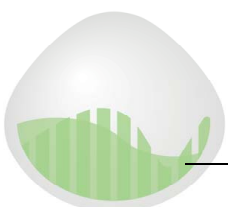


TABLE I
ACCELEROMETERS LOCATION

POINT	ACCELEROMETER NUMBER	DIRECTION	LOCATION	PICTURE NUMBER	PAGE NUMBER
1	AS 005/UI	HORIZONTAL	Test platform	1	23
	AS 006/UI	VERTICAL			
2	AS 007/UI	HORIZONTAL	Inside the <i>Cabinet</i> , lower part	2	24
	AS 008/UI	VERTICAL			
3	AS 009/UI	HORIZONTAL	Inside the <i>Cabinet</i> , medium part	3	25
	AS 010/UI	VERTICAL			
4	AS 011/UI	HORIZONTAL	On the superior corner of the <i>Cabinet</i>	4	26
	AS 012/UI	VERTICAL			



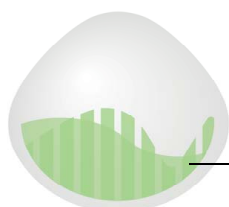
PICTURES





PICTURE NUMBER 1

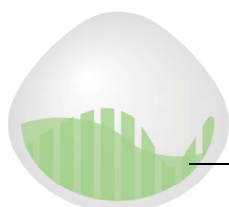
Detail of group 1 of accelerometers on the test platform.

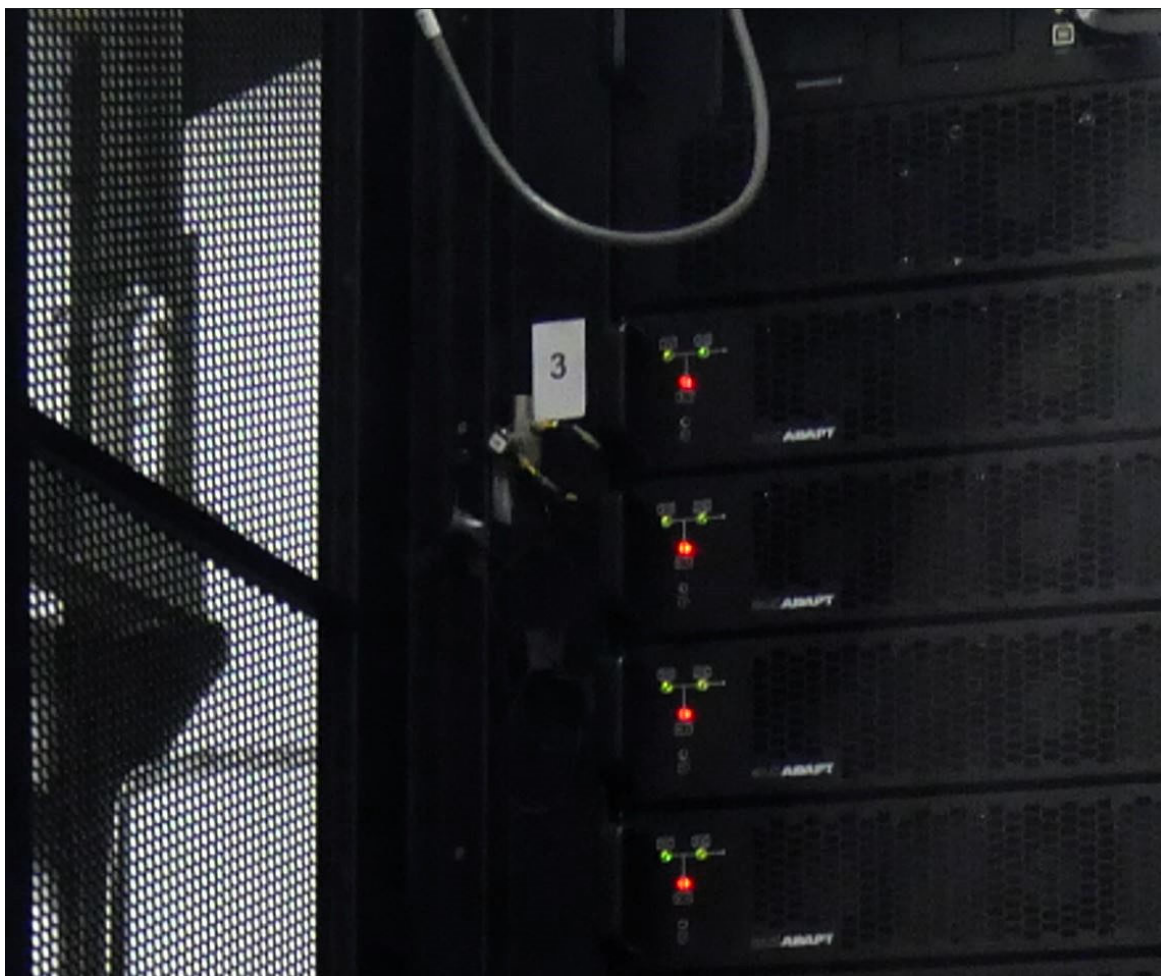




PICTURE NUMBER 2

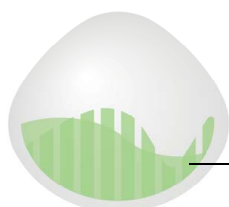
Detail of group 2 of accelerometers inside the *Cabinet*, lower part.

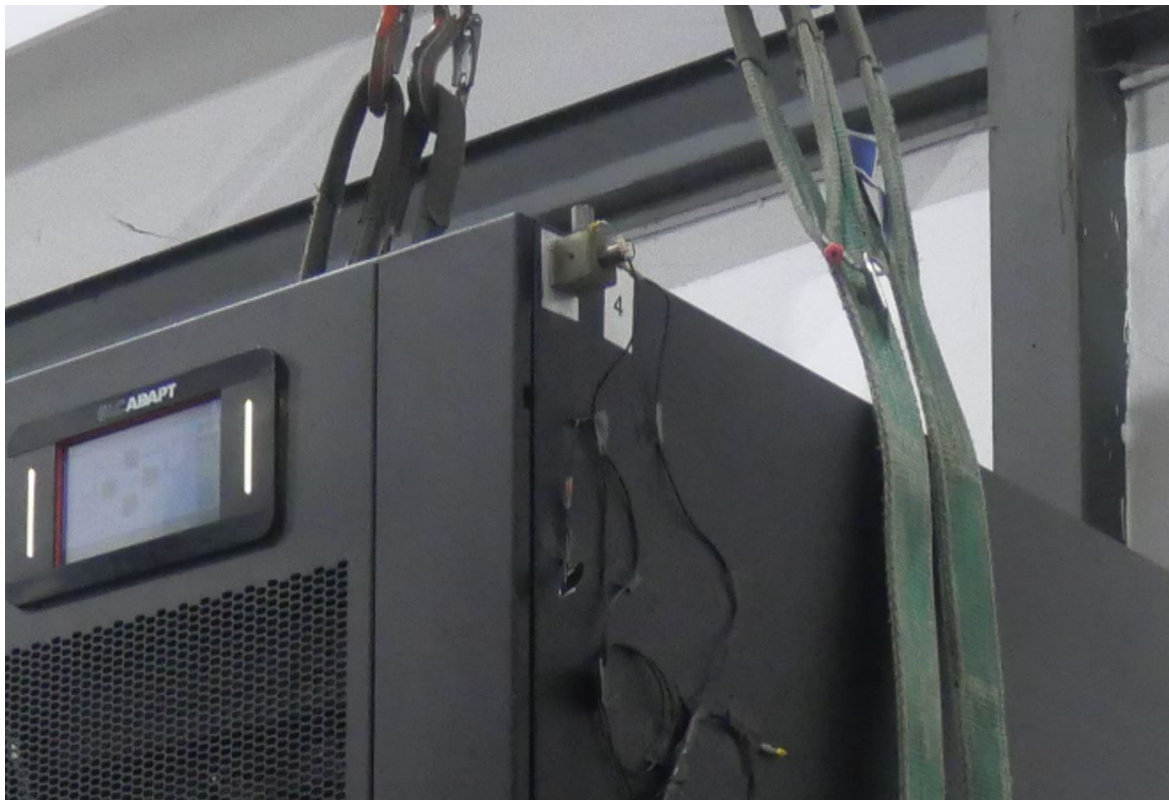




PICTURE NUMBER 3

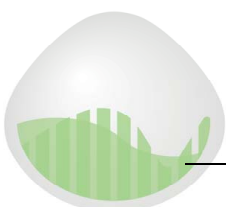
Detail of group 3 of accelerometers inside the *Cabinet*, medium part.





PICTURE NUMBER 4

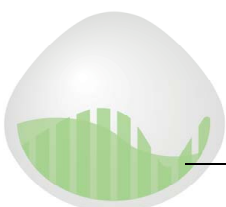
Detail of group 4 of accelerometers on the superior corner of the *Cabinet*.





PICTURE NUMBER 5

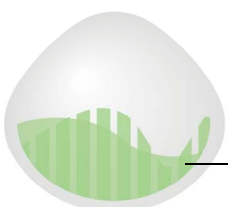
Side view of the *Cabinet* prepared to perform the resonance search test in vertical “Z” and horizontal “X” (*front-to-back*) directions.





PICTURE NUMBER 6

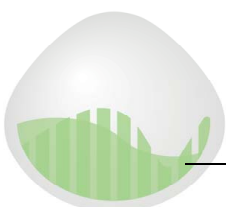
Side view of the **Cabinet** prepared to perform the resonance search test
in “Y” (*side-to-side*) direction and seismic tests
in “YZ” (*side-to-side /vertical*) direction.





PICTURE NUMBER 7

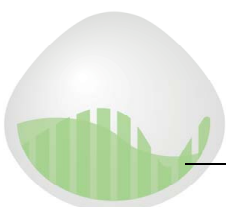
Side view of the *Cabinet* prepared to perform seismic tests
in “XZ” (front-to-back/vertical) direction.





PICTURE NUMBER 8

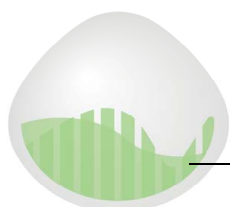
Detail of the open **Cabinet** door and damaged door lock during seismic test at level **S2 (ZONE 4)** in “XZ” (*front-to-back/vertical*) direction (*test number 16*).

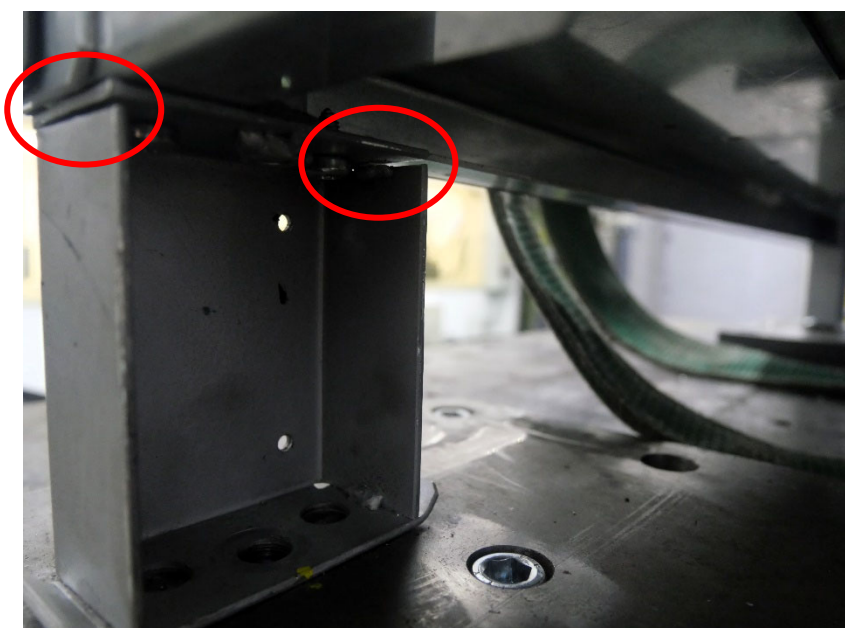




PICTURE NUMBER 9

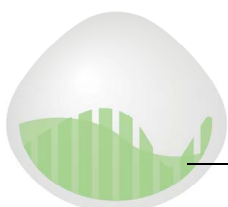
Detail of the open **Cabinet** door during seismic test at level **S2 (ZONE 4)** in "YZ" (side-to-side/vertical) direction (test number 17).





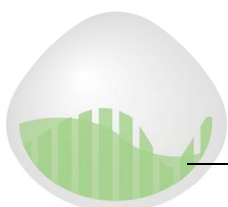
PICTURE NUMBER 10

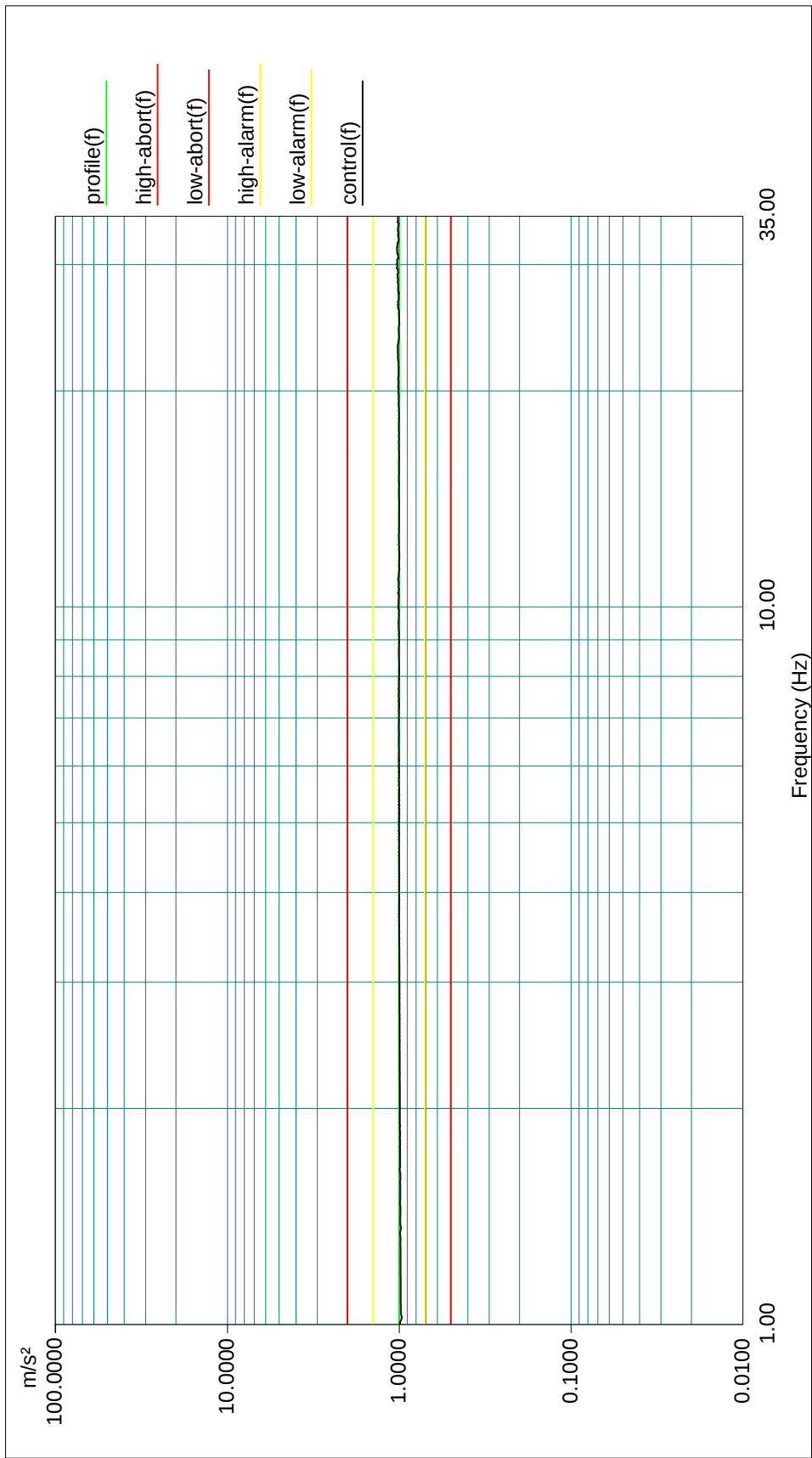
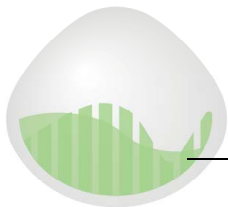
Detail of the fractures in the welds of the *Cabinet* detected in the final visual inspection, after the seismic tests had been carried out.



APPENDIX I

**FREQUENCY SPECTRA OF GROUP 1 OF ACCELEROMETERS
OBTAINED FROM THE RESONANCE SEARCH TESTS.**



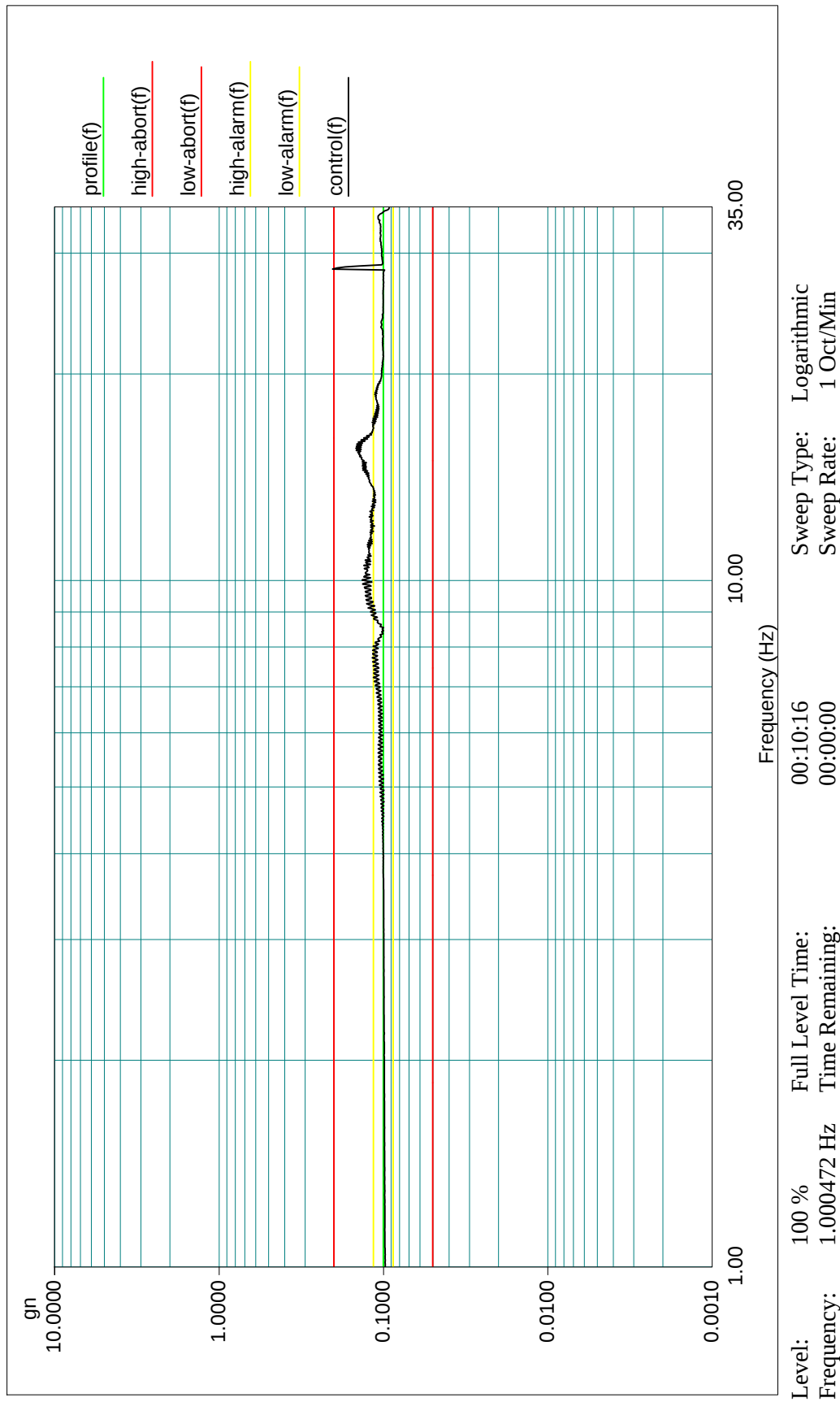


Level: 100 % Full Level Time: 00:10:16 Sweep Type: Logarithmic
Frequency: 1.000596 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min

Data saved at 11:31:03 AM, Thursday, February 08, 2024 Report created at 11:31:11 , jueves, febrero 8, 2024

SALICRU. “UPS SCL ADAPT2”
Test number 1. Resonance Search test (1-35-1 Hz). Point 1

Report number 243589
Vertical Direction, “Z”

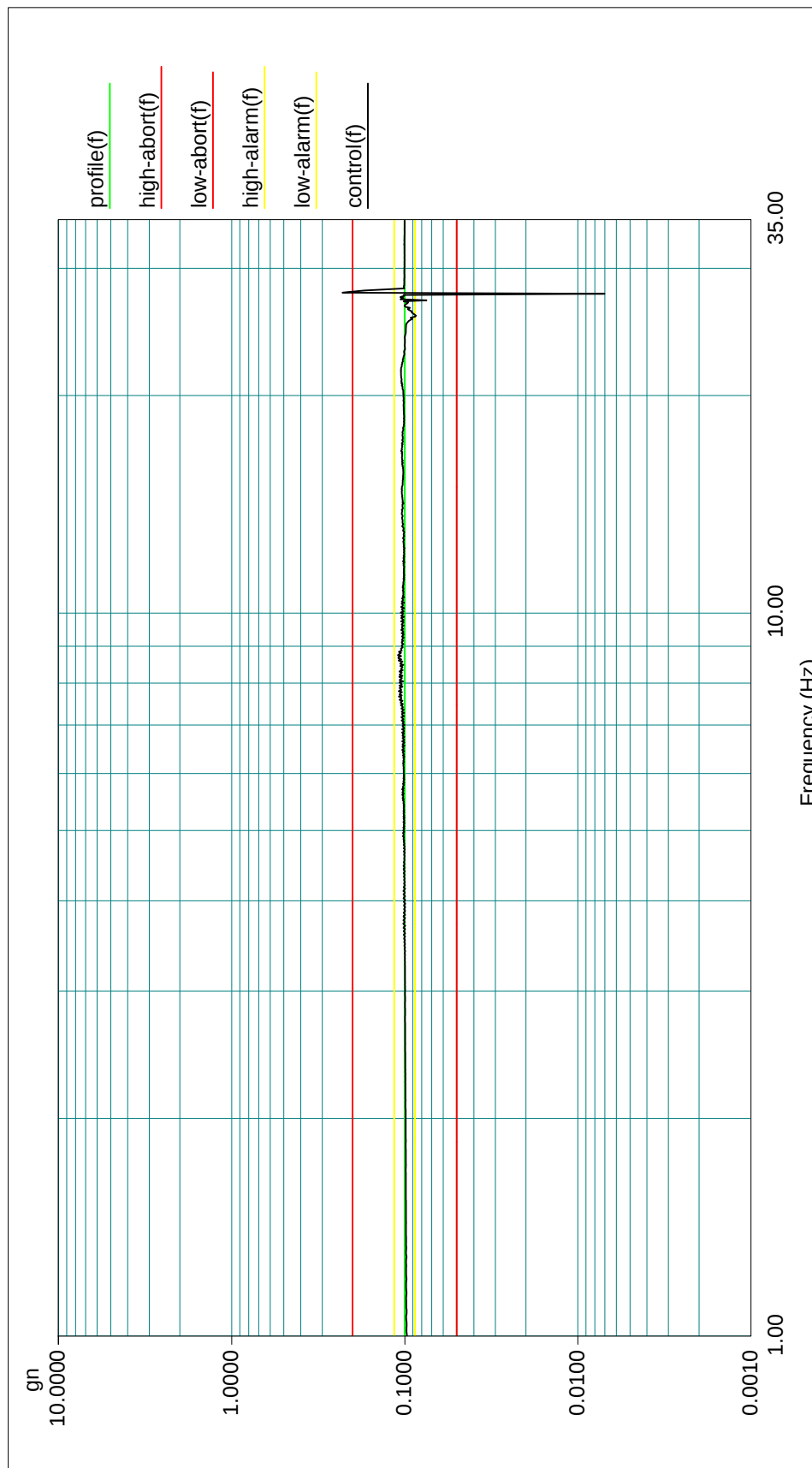
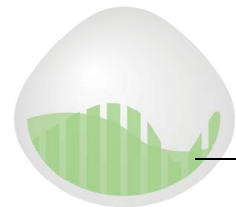


Data saved at 11:54:29 AM, Thursday, February 08, 2024

Report created at 12:27:18 , jueves, febrero 8, 2024

Report number 243589
Horizontal Direction, "X"

SALICRU. "UPS SCL ADAPT2"
Test number 2. Resonance Search test (1-35-1 Hz). Point 1



Level: 100 % Full Level Time: 00:10:16 Sweep Type: Logarithmic
Frequency: 1.000719 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min

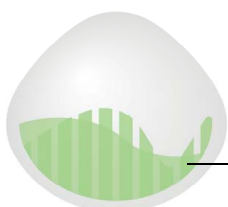
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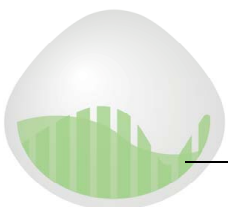
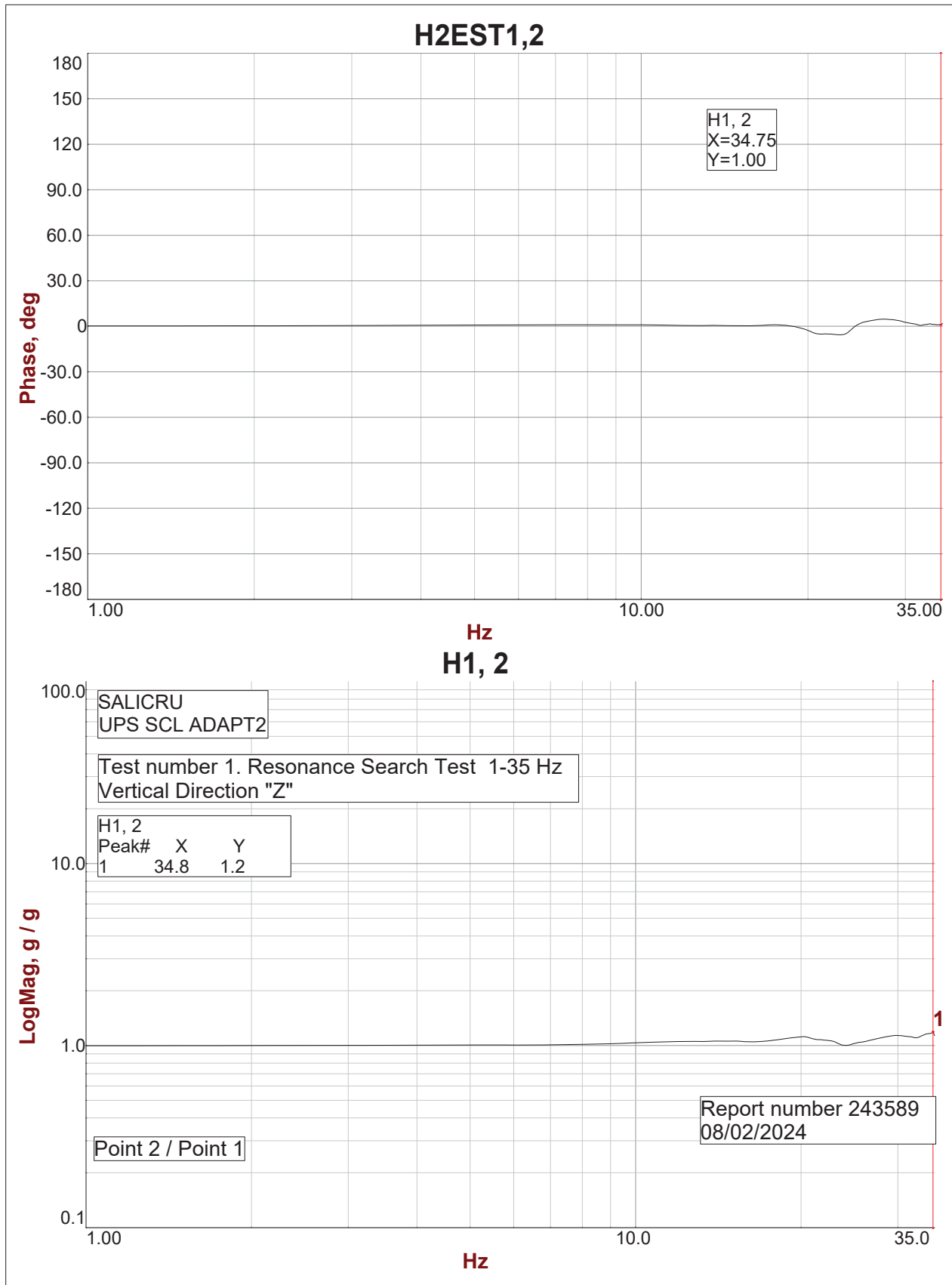
SALICRU. "UPS SCL ADAPT2"
Test number 3. Resonance Search test (1-35-1 Hz). Point 1

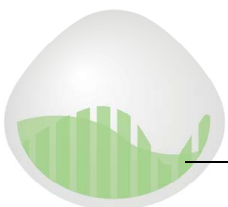
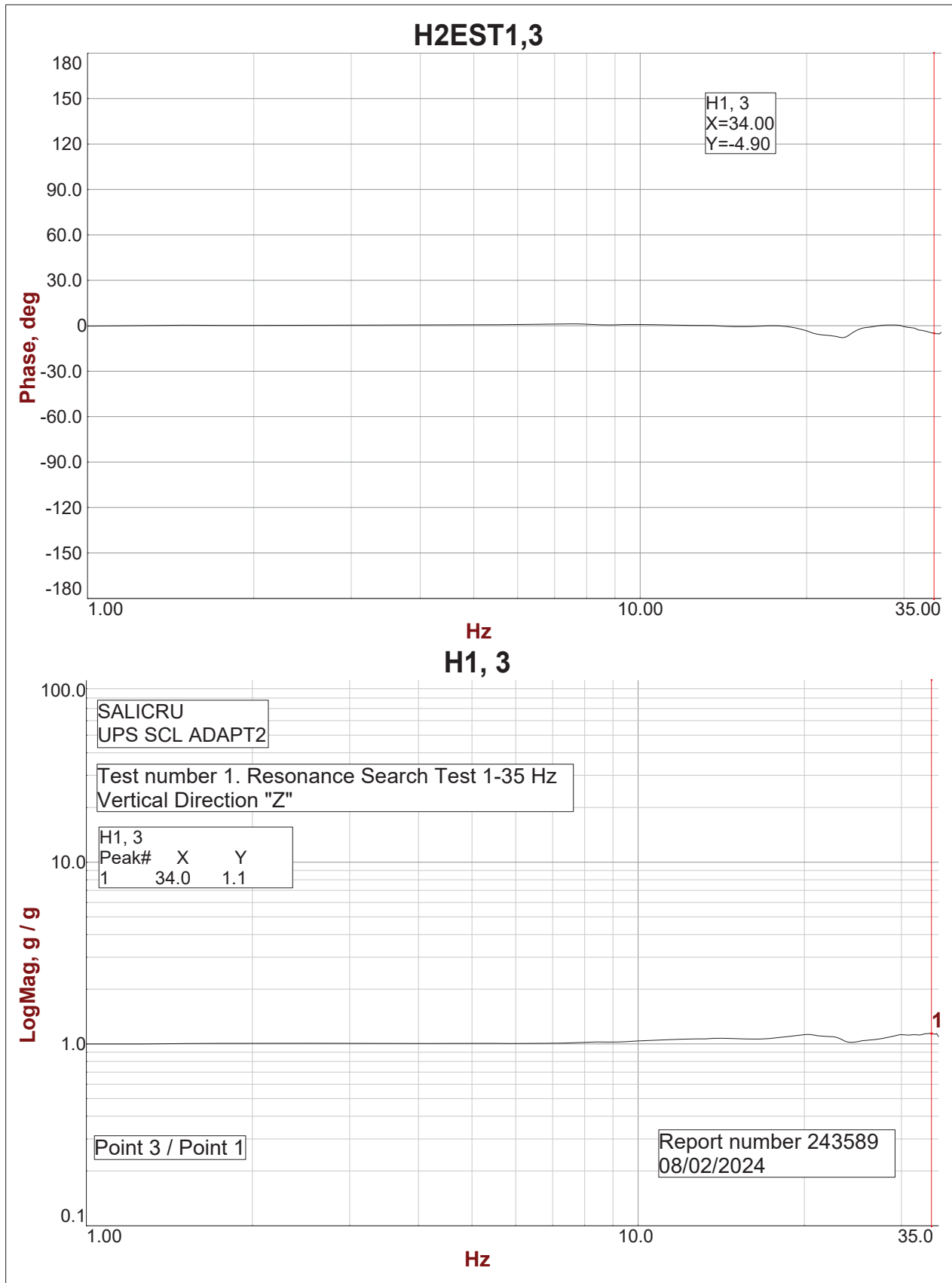
Report number 243589
Horizontal Direction, "Y"

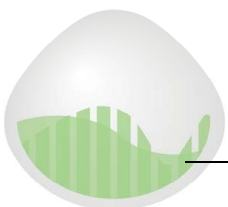
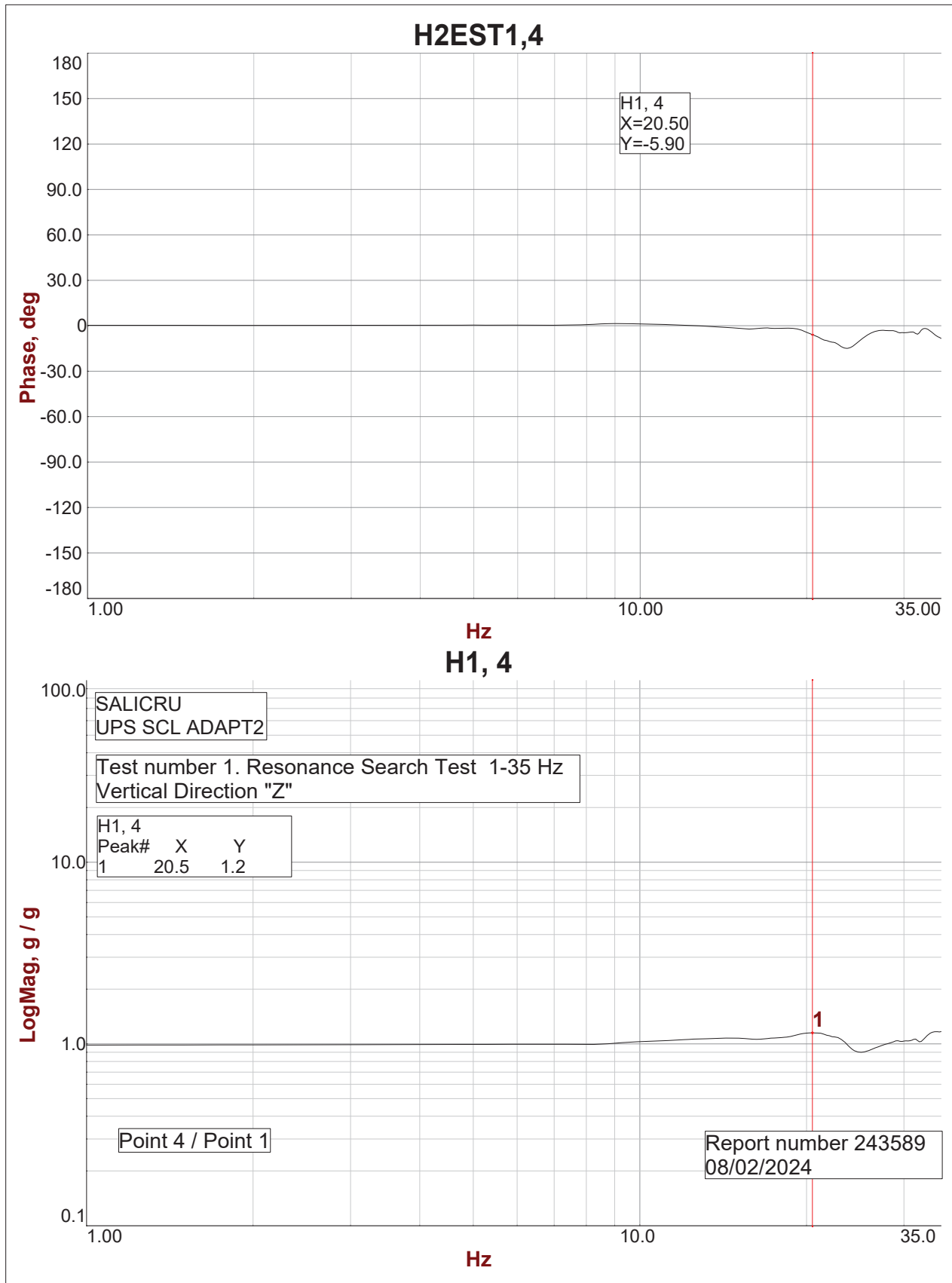
APPENDIX II

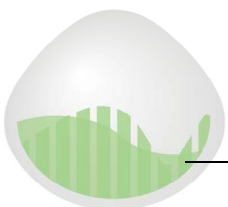
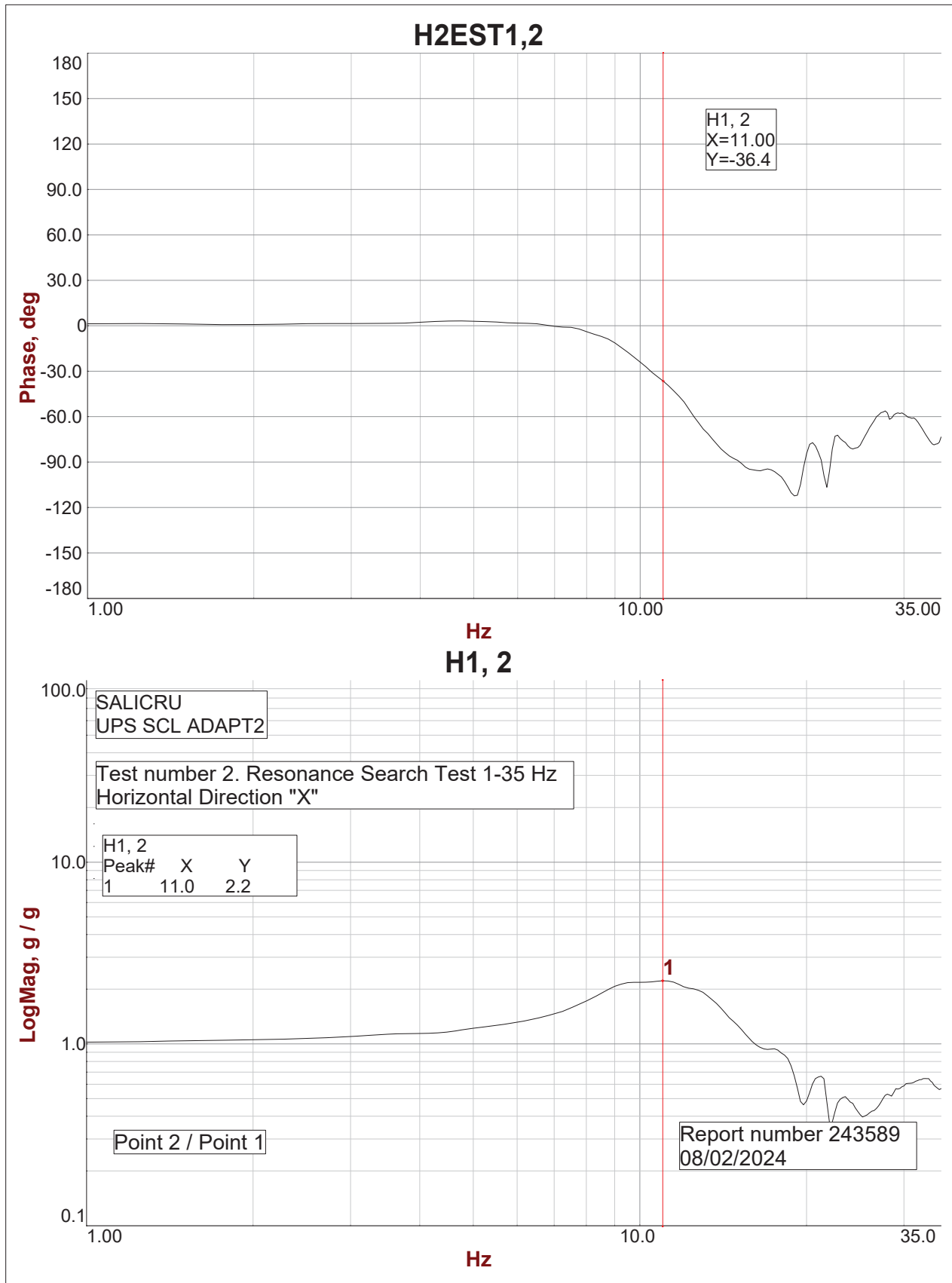
**TRANSFER FUNCTIONS OF GROUPS 2 TO 4 OF
ACCELEROMETERS OBTAINED FROM THE
RESONANCE SEARCH TESTS.**

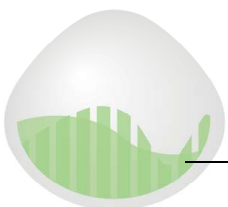
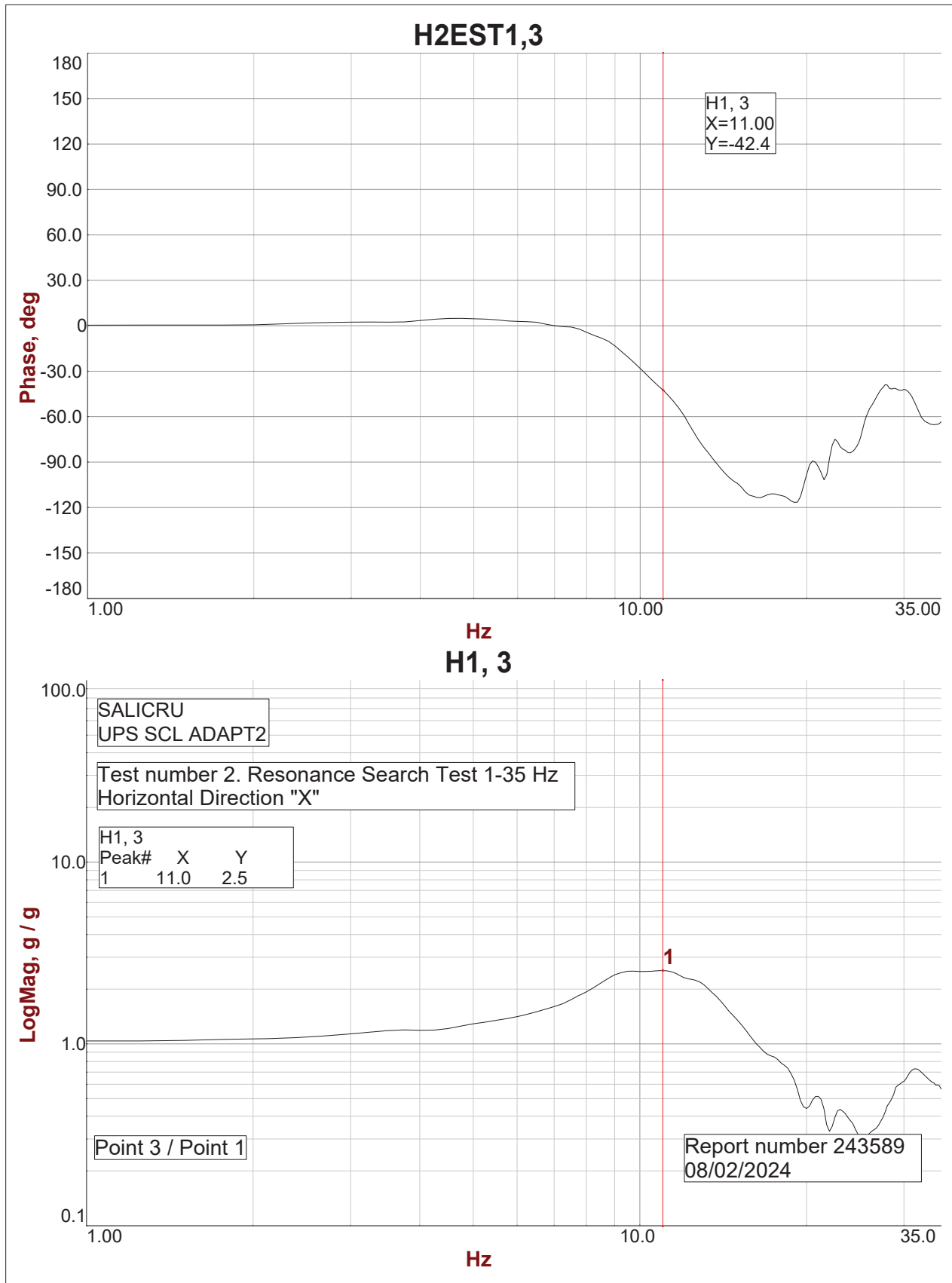


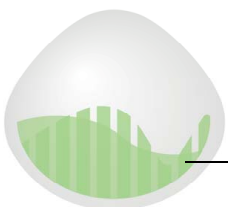
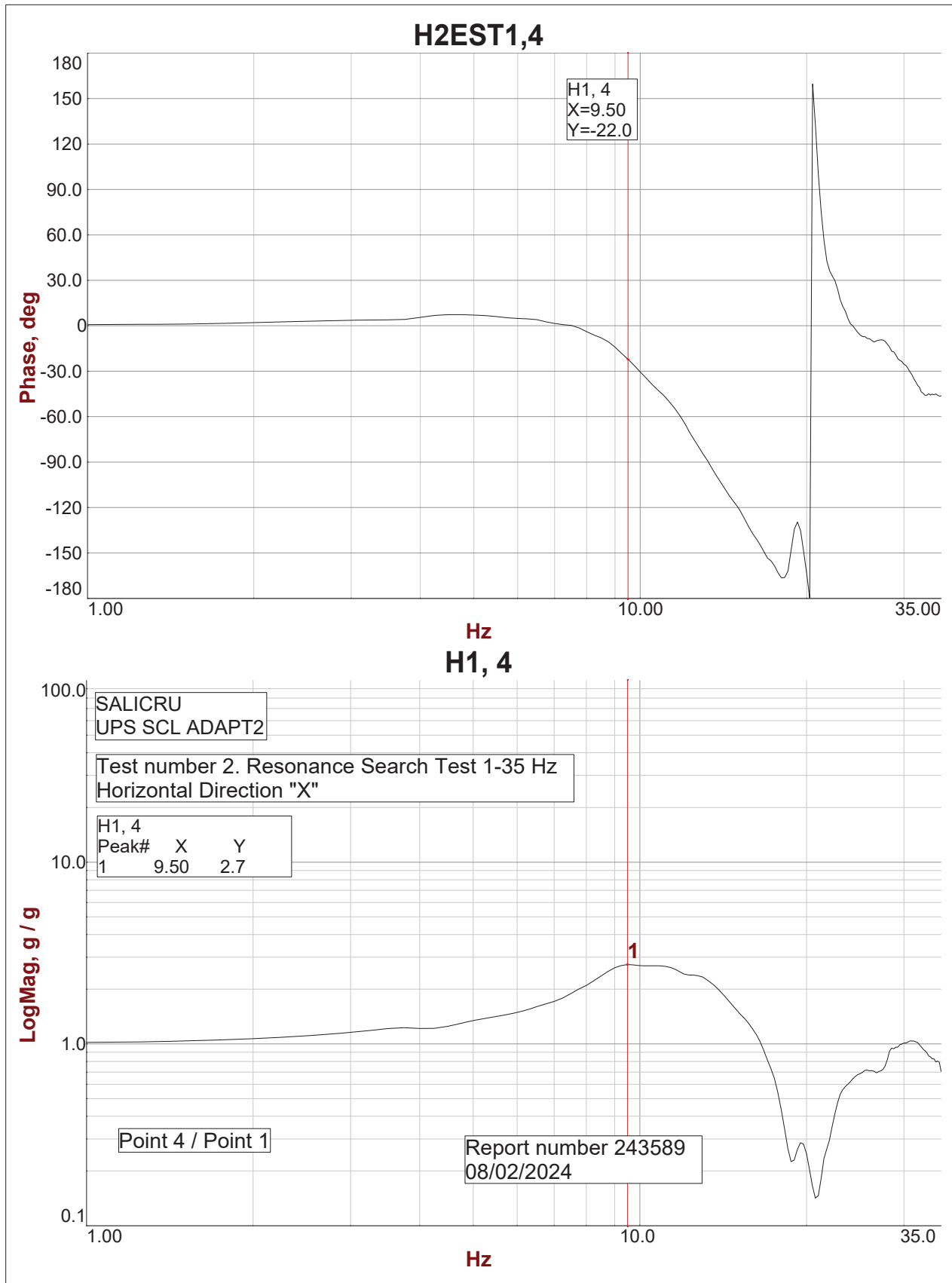


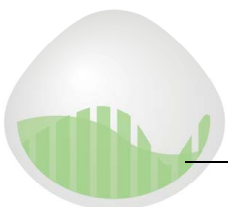
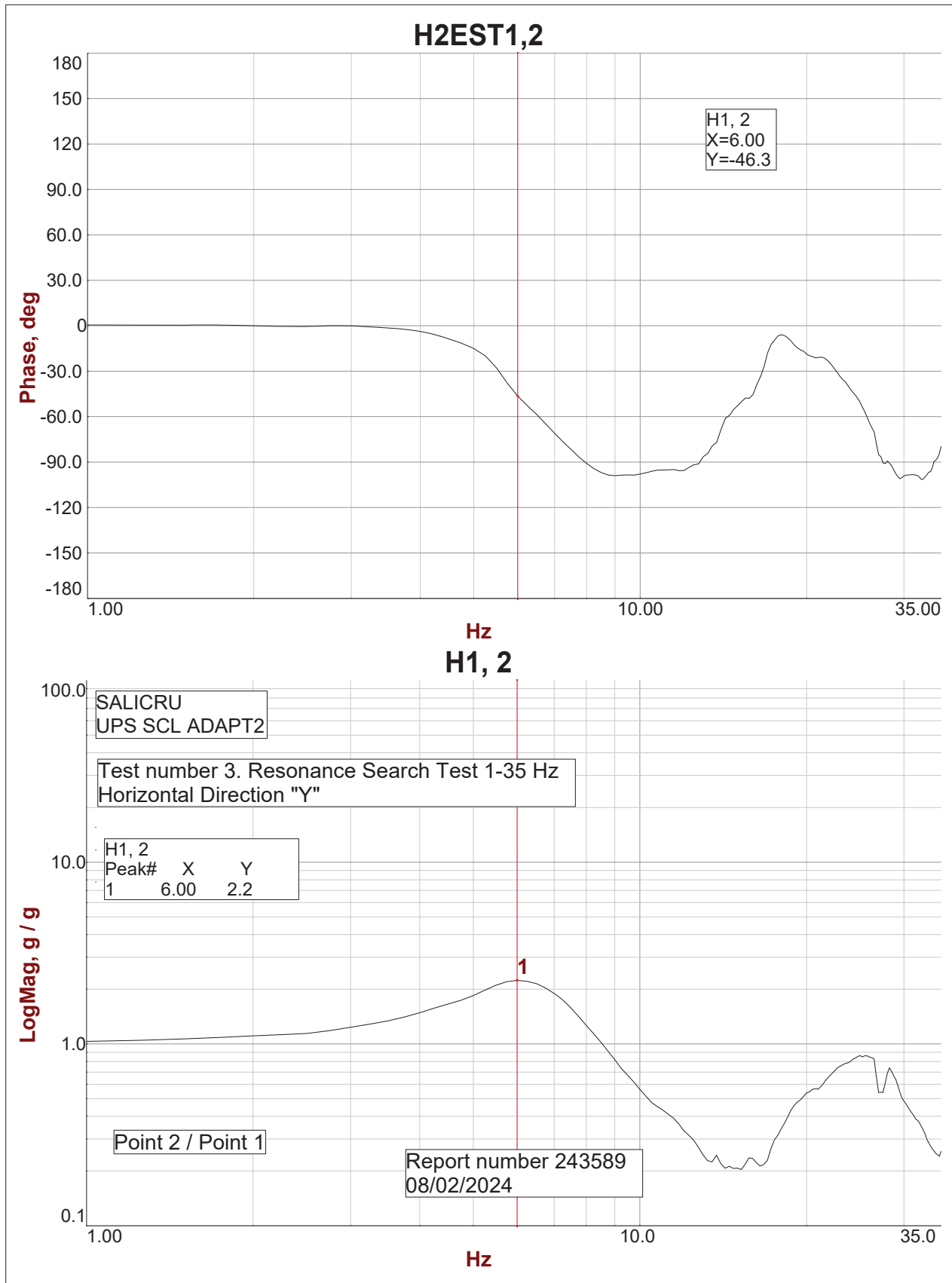


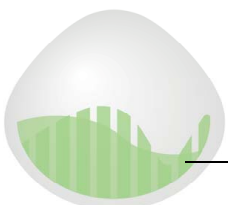
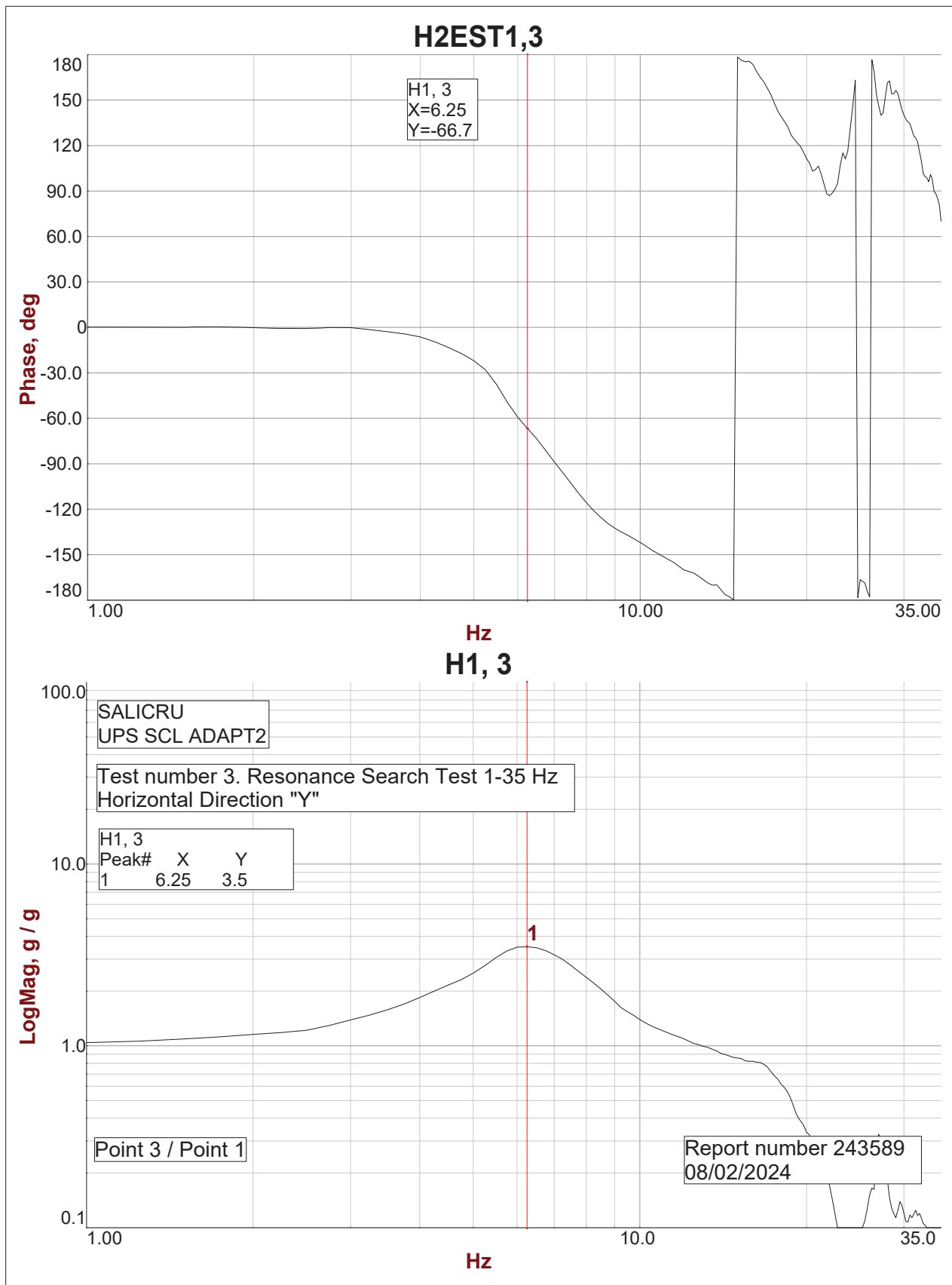


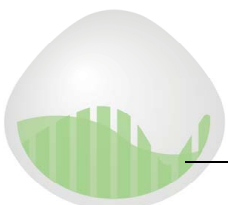
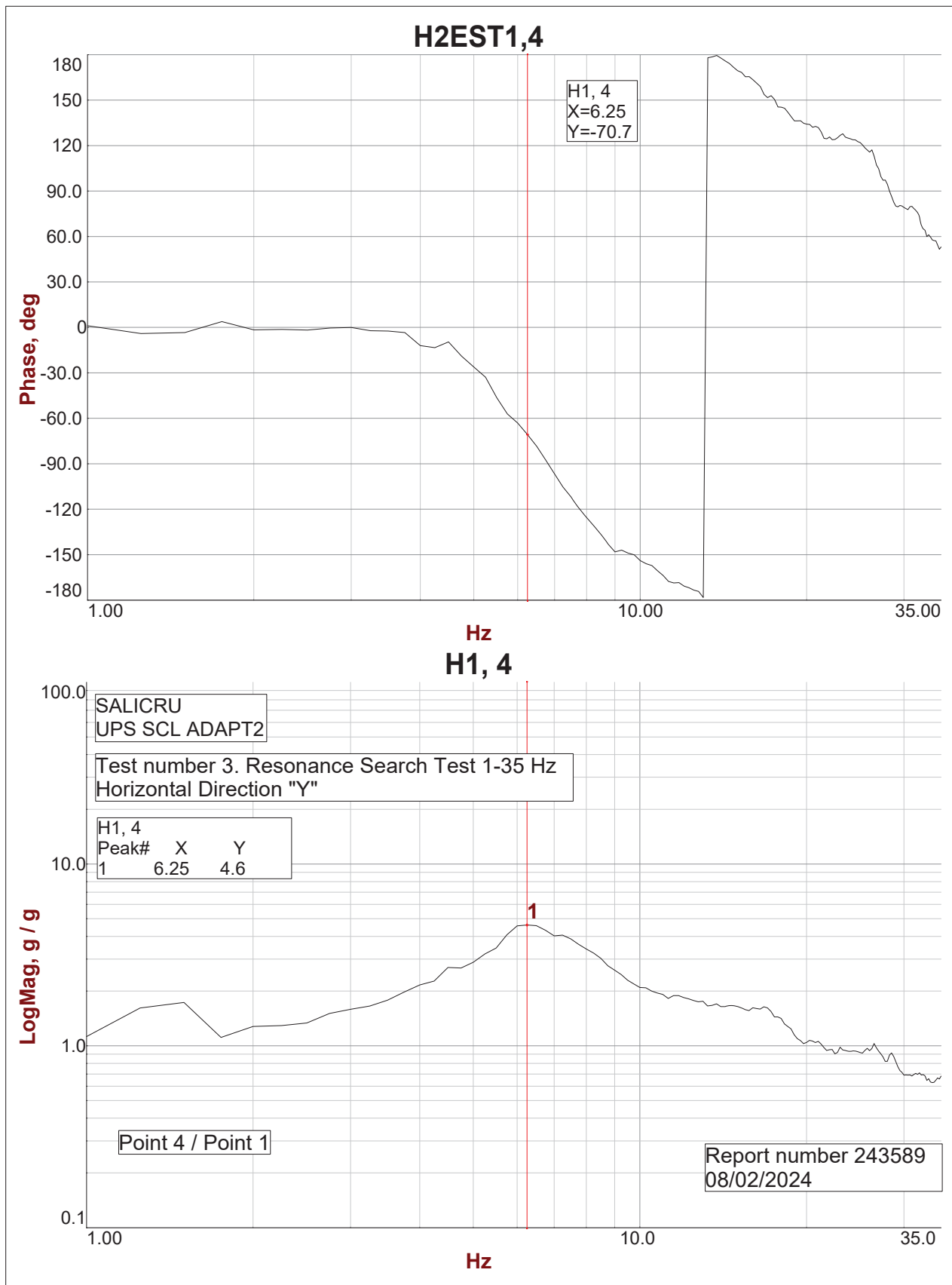






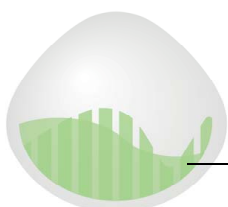


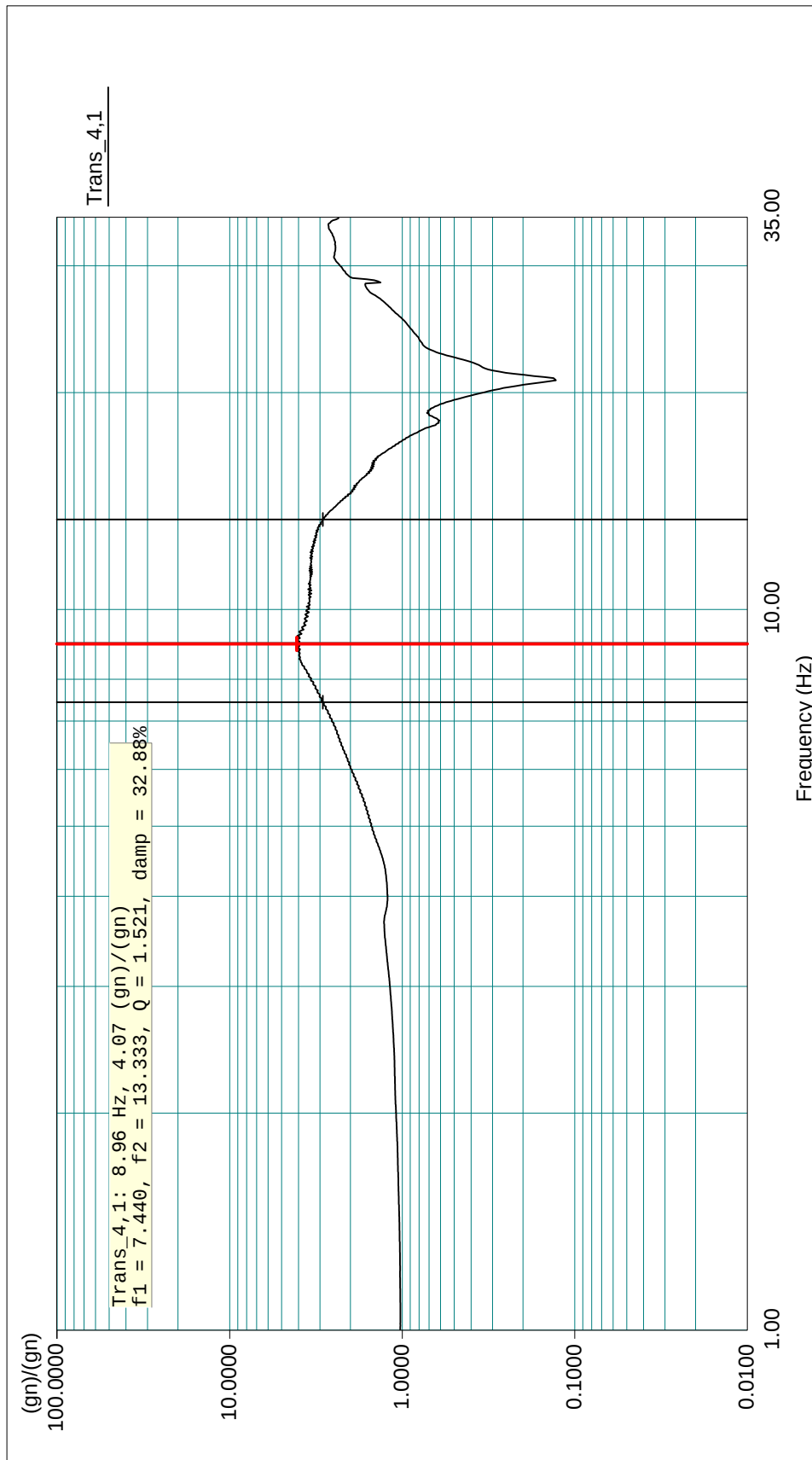




APPENDIX III (*)

**TRANSMISSIBILITY FUNCTIONS OF GROUP 4 OF
ACCELEROMETERS OBTAINED FROM **RESONANCE**
SEARCH TESTS, TO CALCULATE THE DAMPING.**



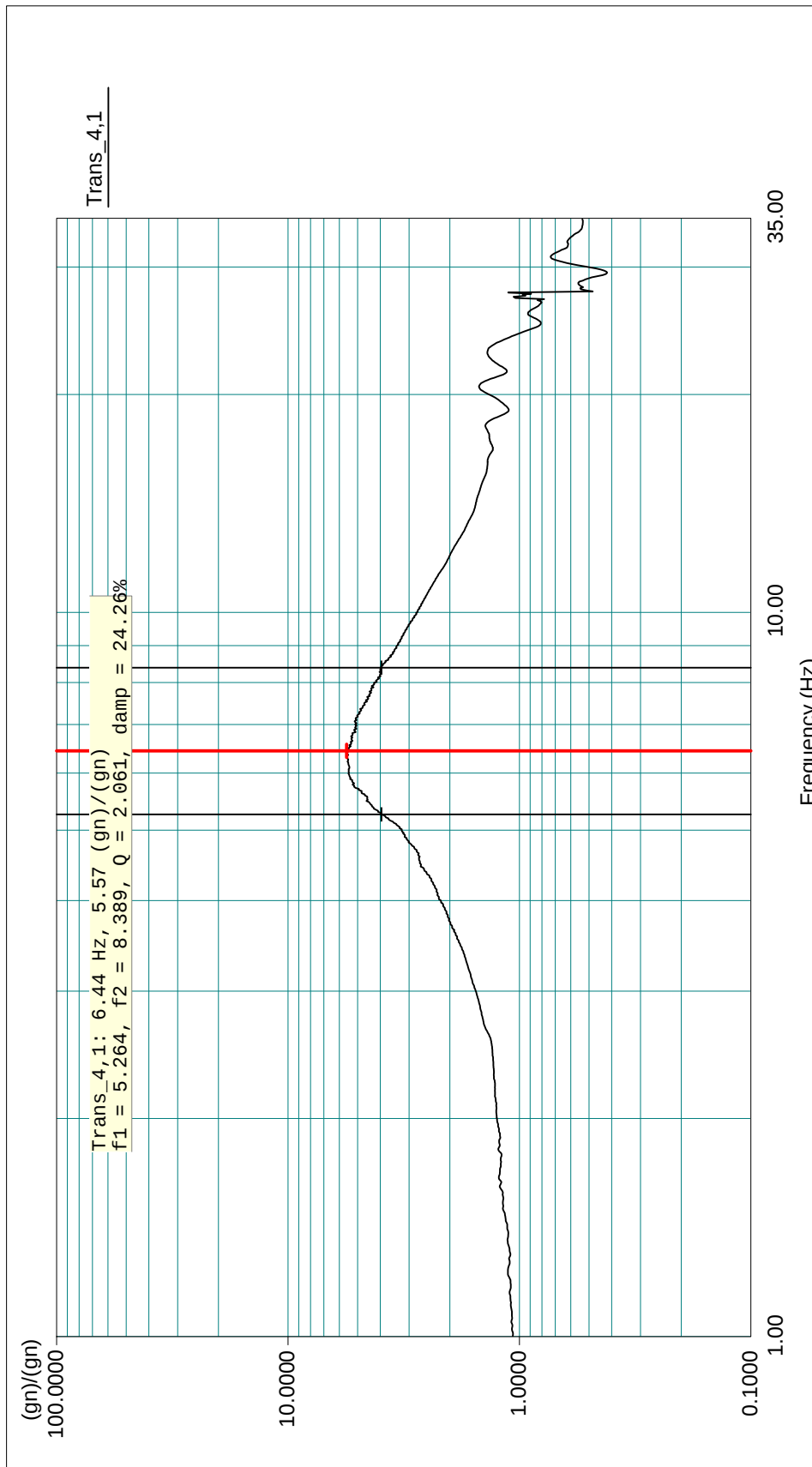


Data saved at 11:54:29 AM, Thursday, February 08, 2024

Report created at 12:27:18, jueves, febrero 8, 2024

Report number 243589
Horizontal Direction, "X"

SALICRU. "UPS SCL ADAPT2"
Test number 2. Resonance Search test (1-35-1 Hz). Point 4/Point 1



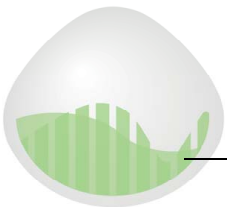
Level: 100 % Full Level Time: 00:10:16 Sweep Type: Logarithmic
Frequency: 1.000719 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min

Data saved at 12:52:14 PM, Thursday, February 08, 2024 Report created at 12:52:16 , jueves, febrero 8, 2024

SALICRU. "UPS SCL ADAPT2"

Test number 3. Resonance Search test (1-35-1 Hz). Point 4/Point 1

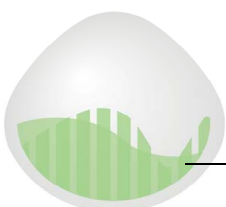
Report number 243589
Horizontal Direction, "Y"



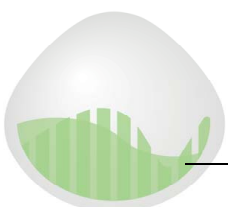
APPENDIX IV

**TEST RESPONSE SPECTRA OF GROUP 1
OF ACCELEROMETERS OBTAINED FROM THE
SEISMIC TESTS, FOR A DAMPING OF 5%.**

(GRAPHS AND NUMERICAL VALUES)

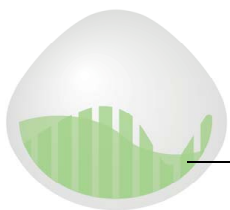
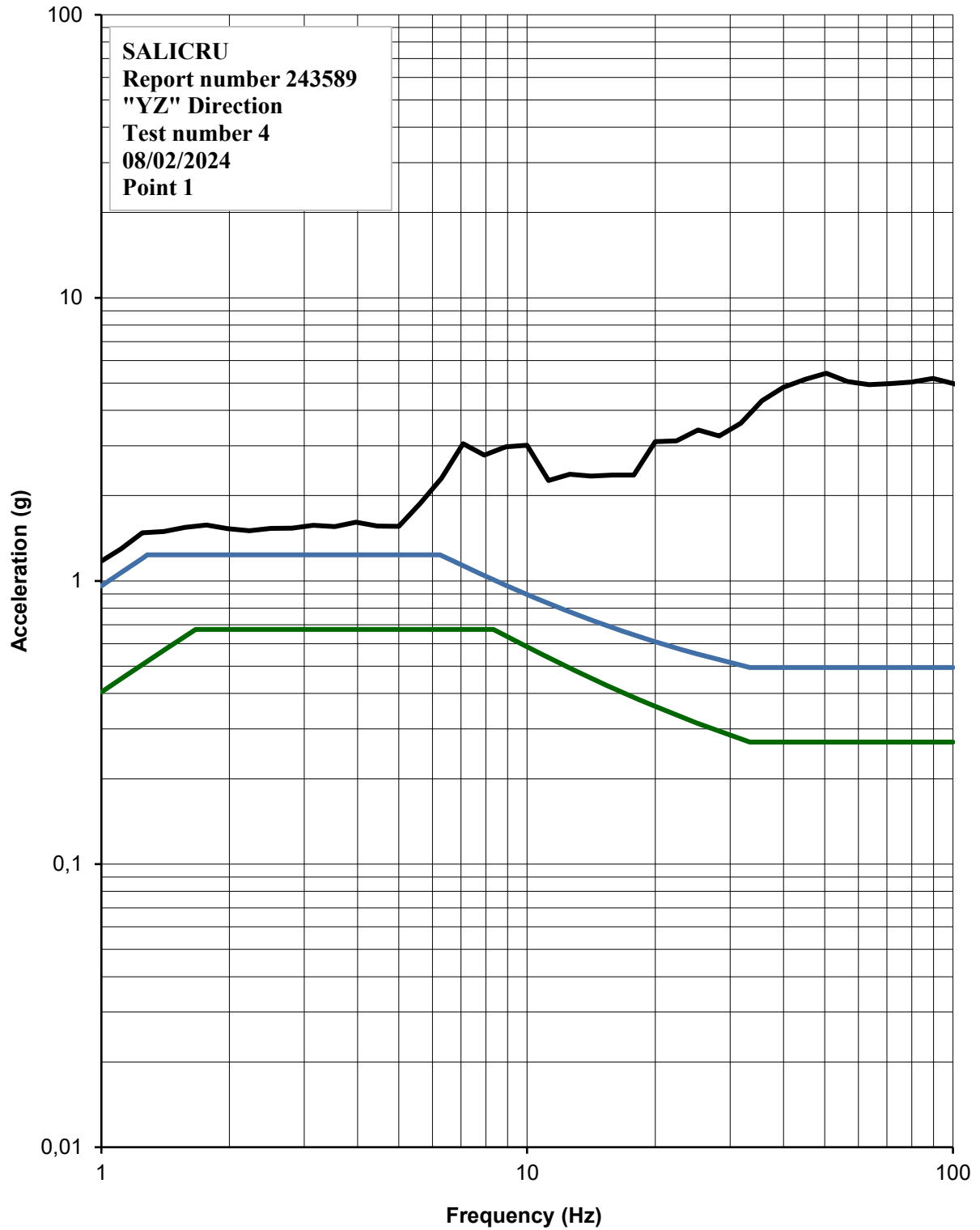


GRAPHS



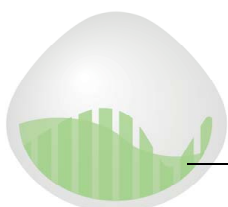
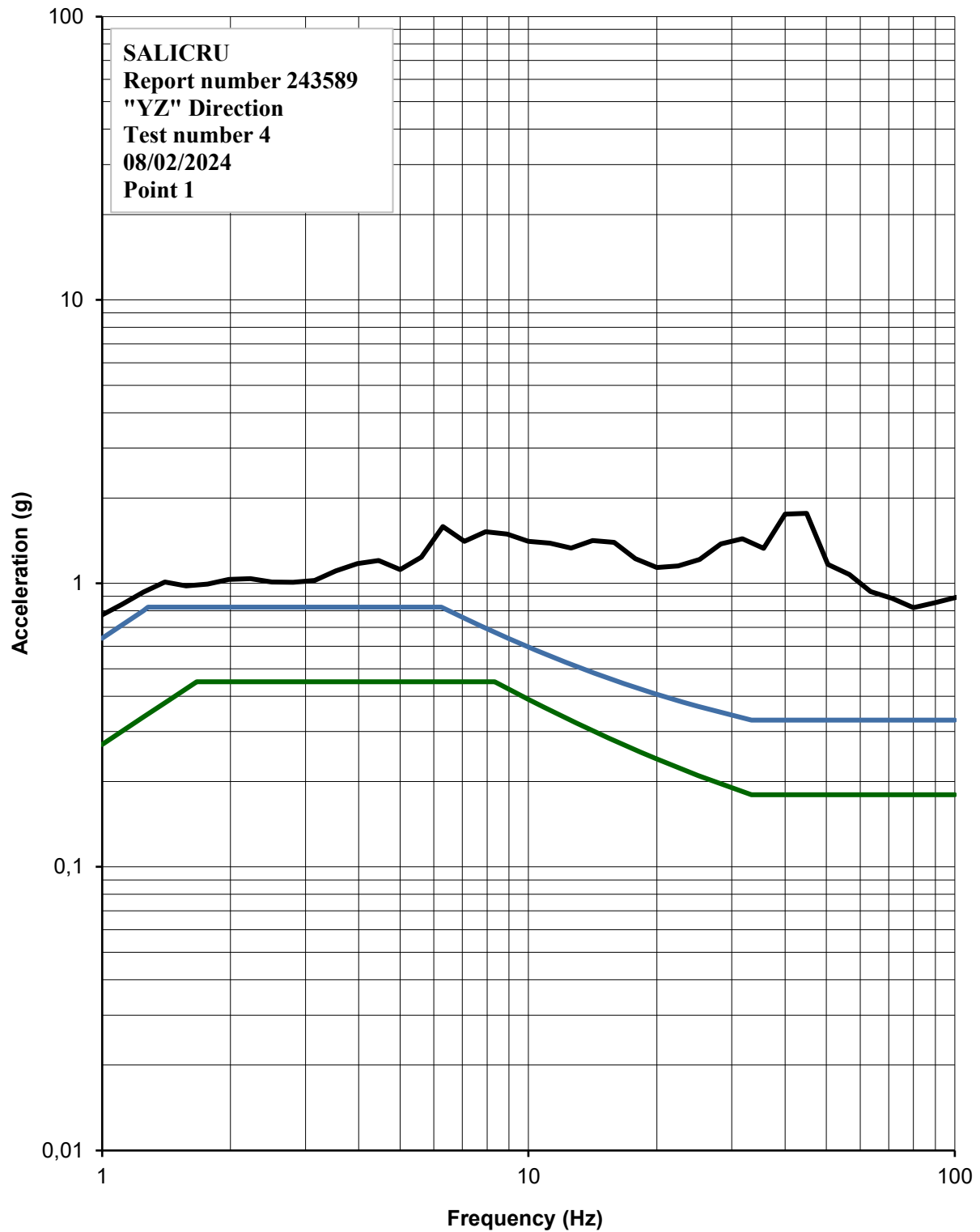
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



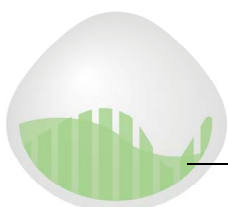
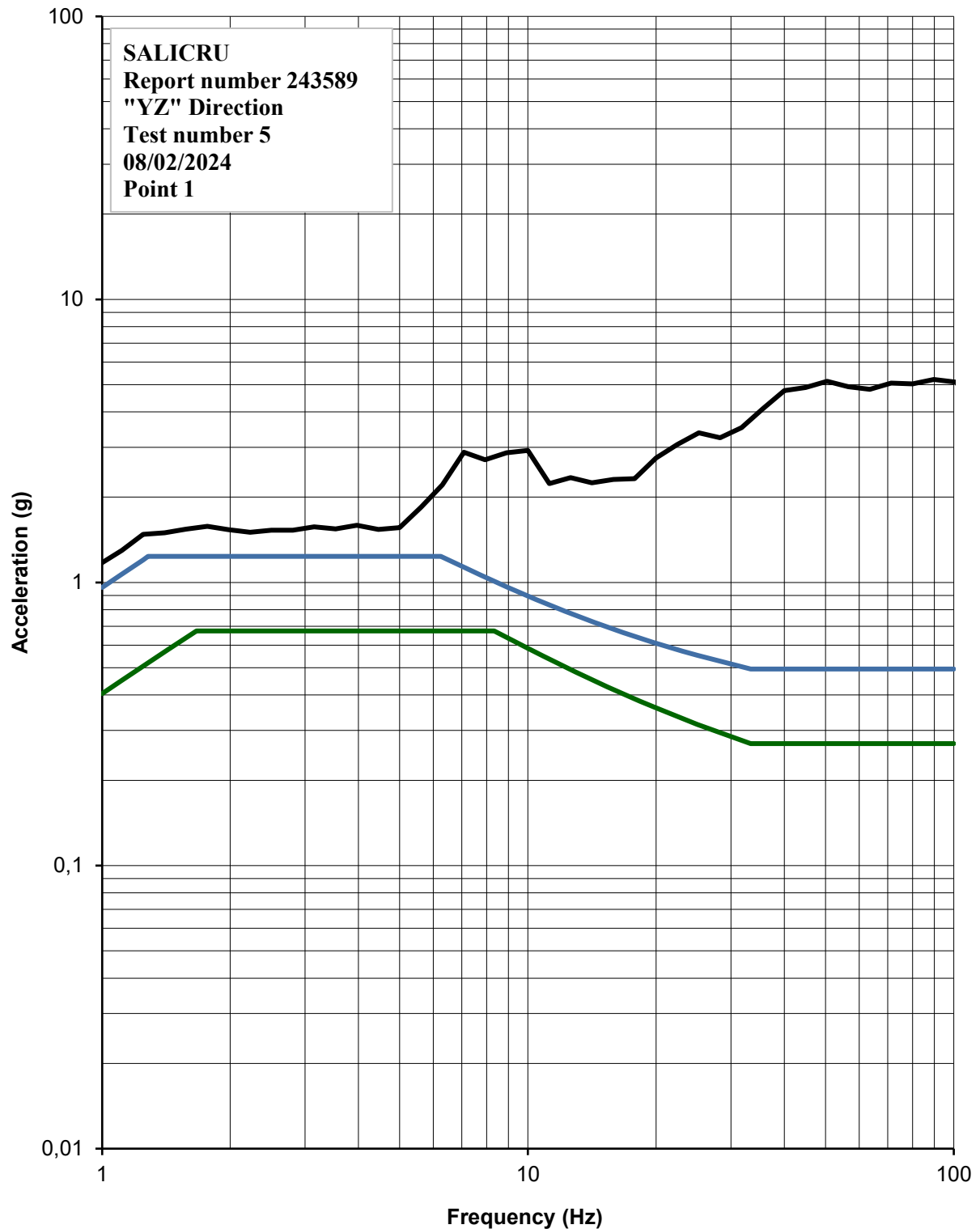
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction



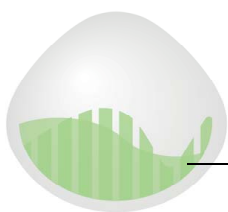
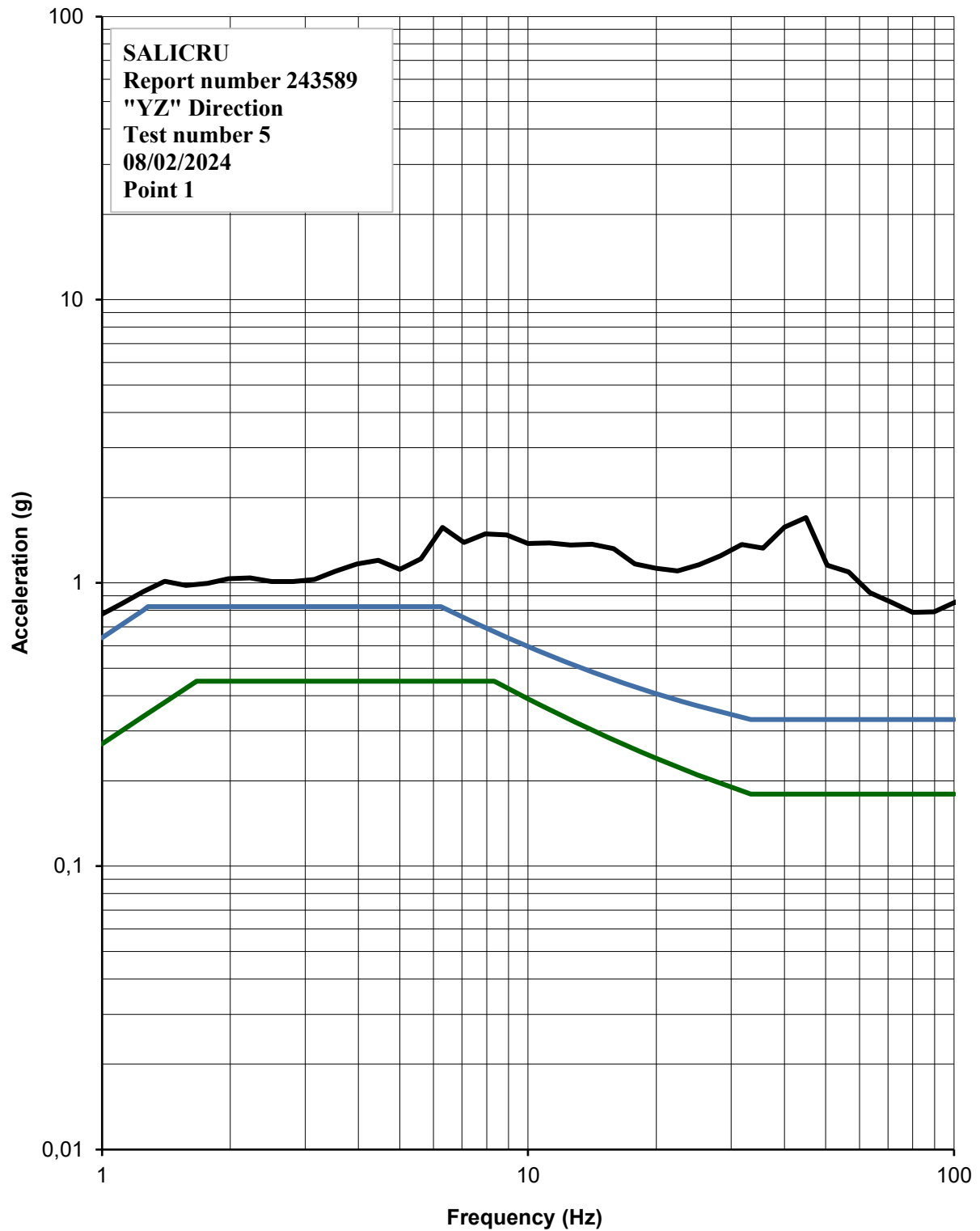
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



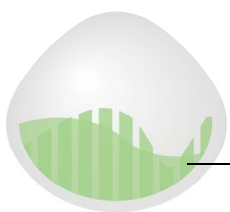
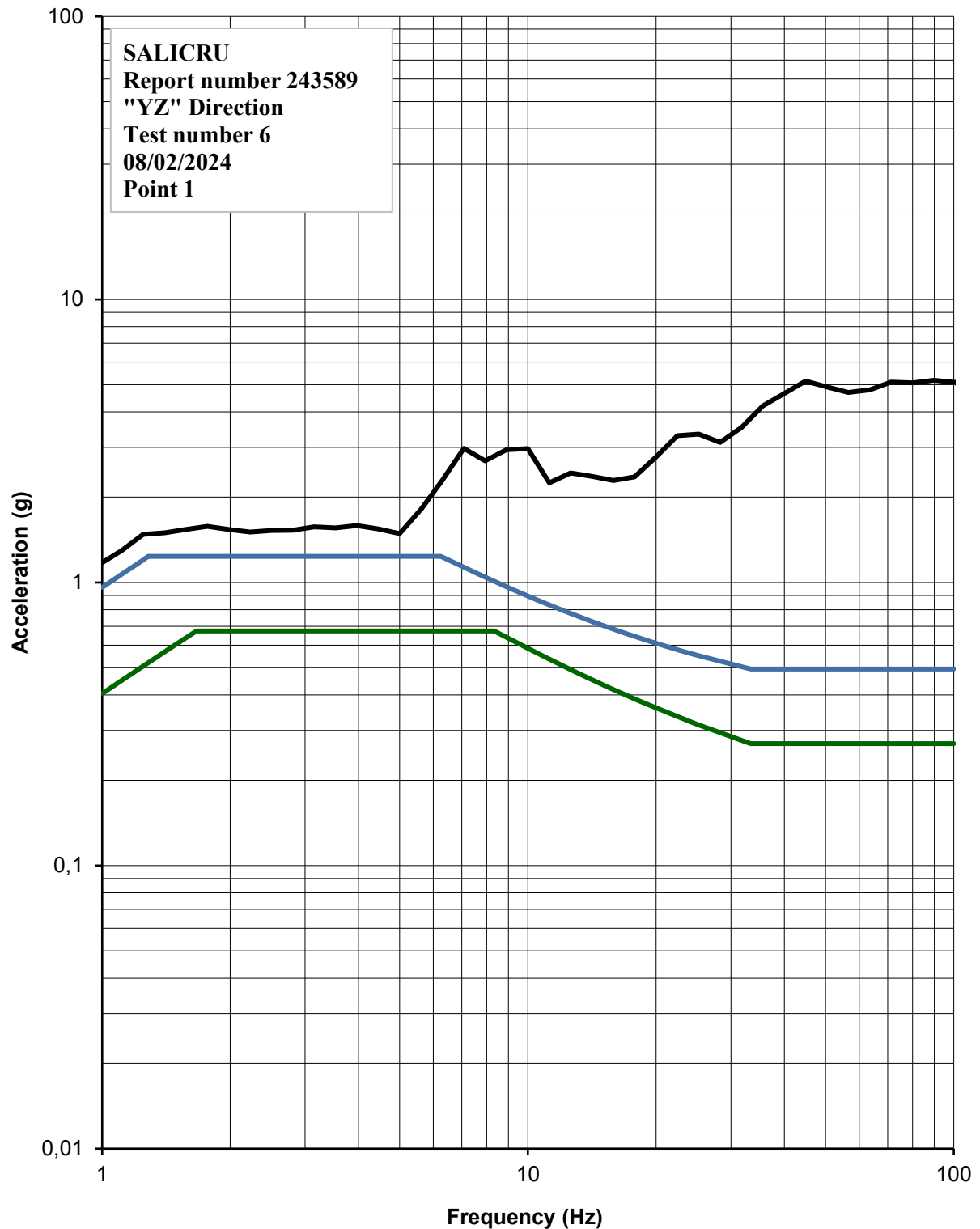
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction



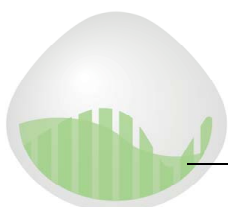
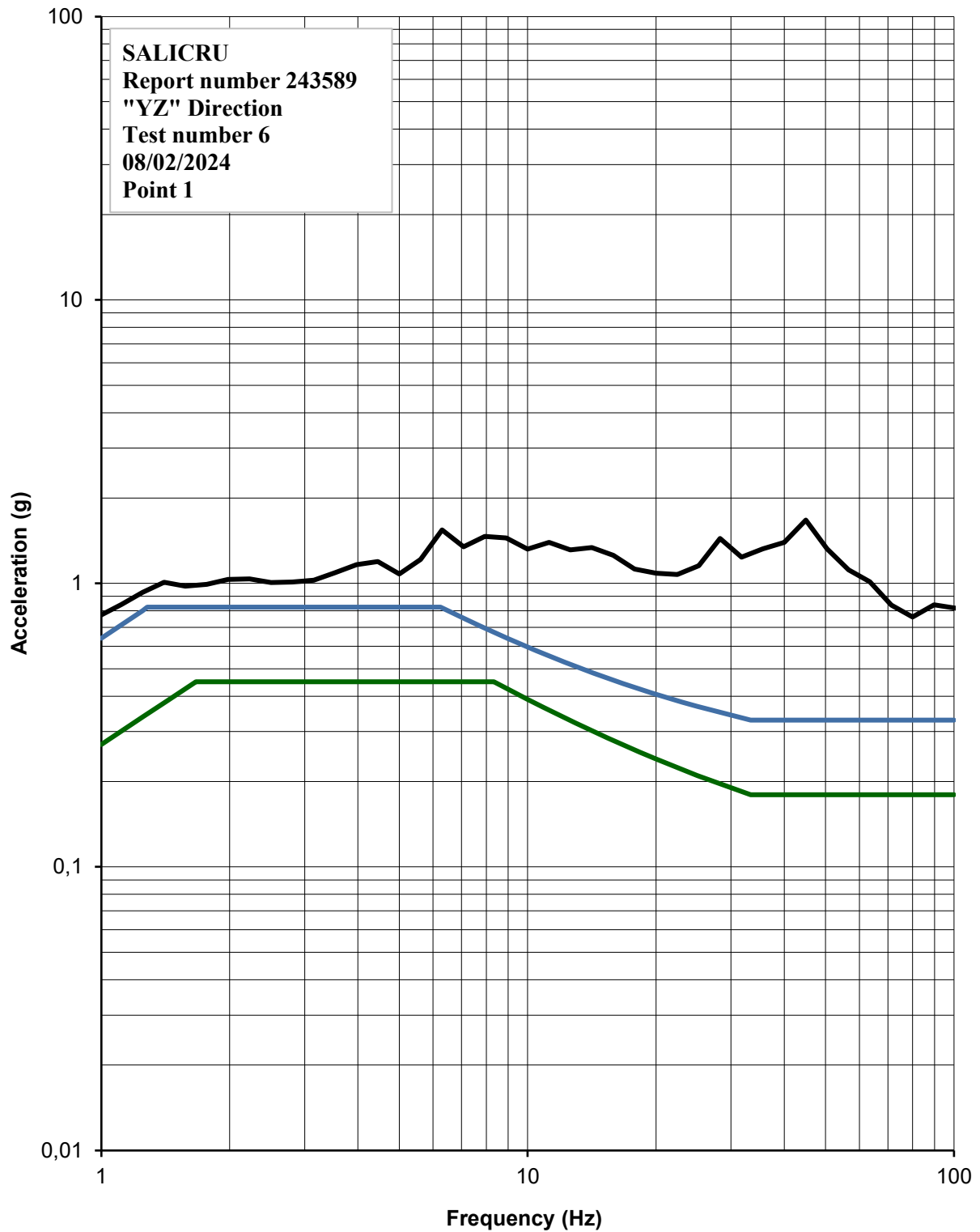
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



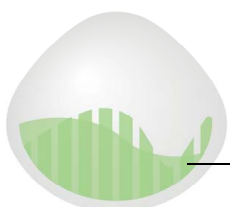
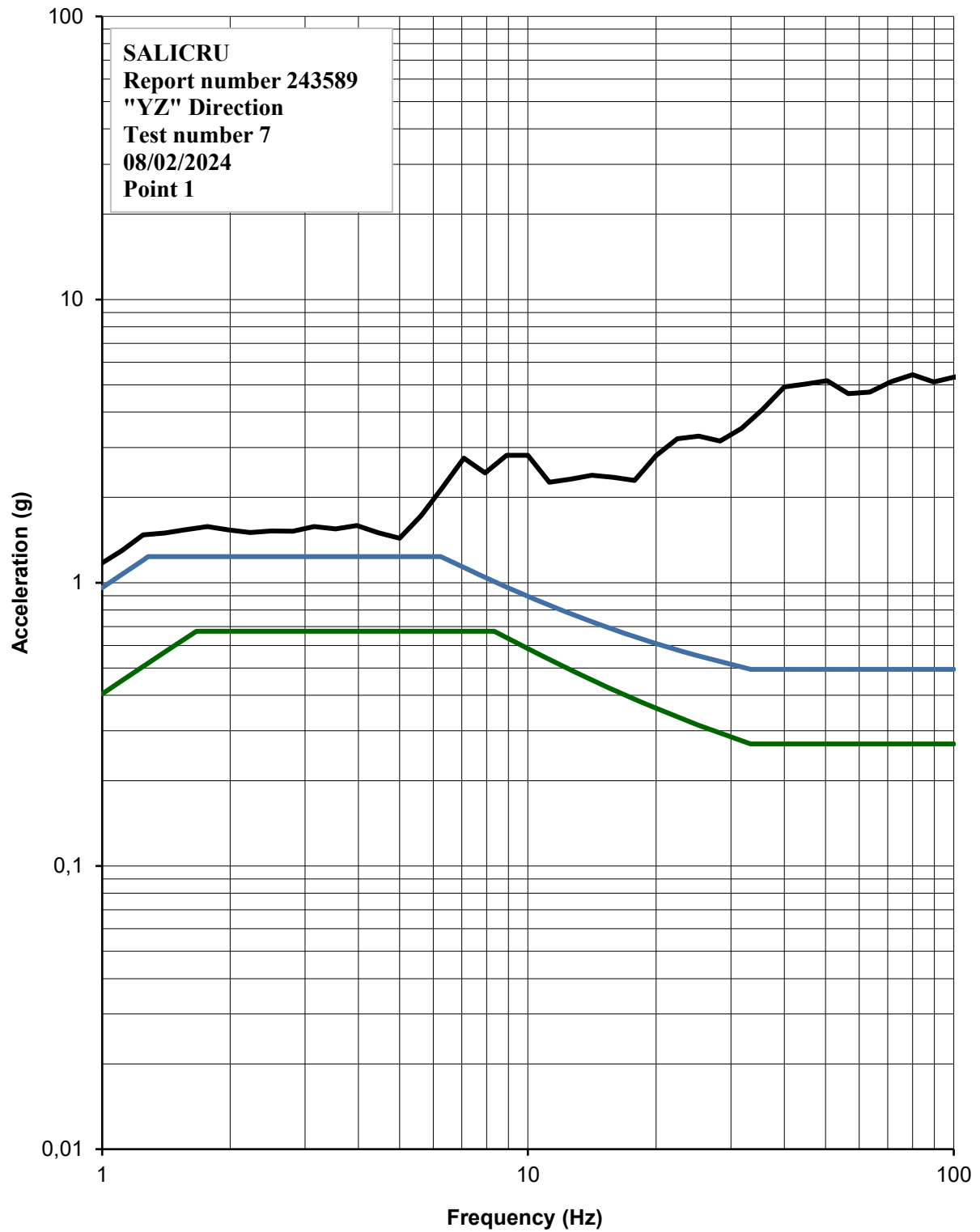
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction



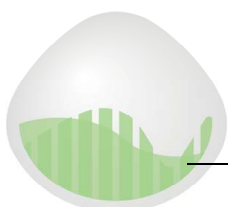
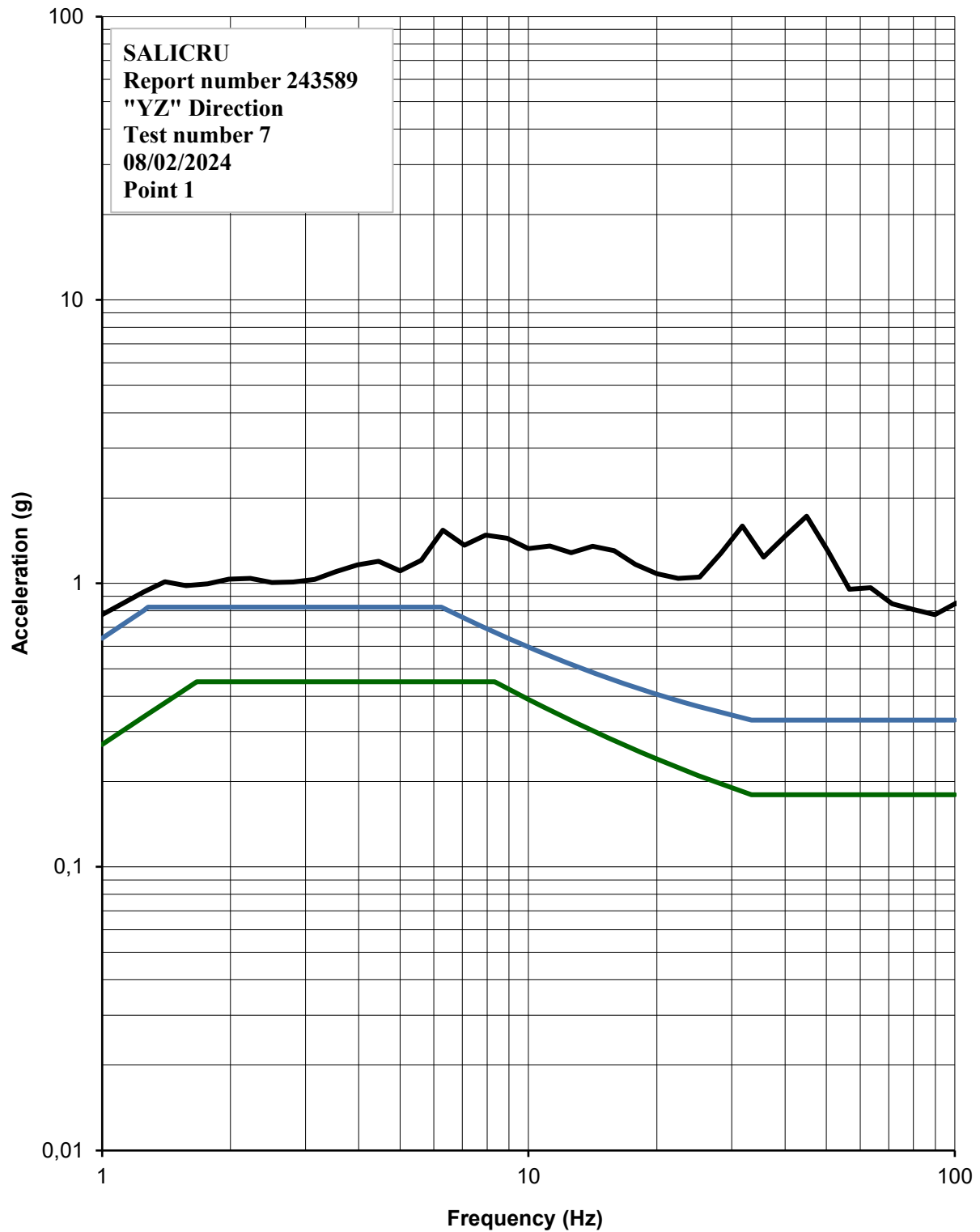
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



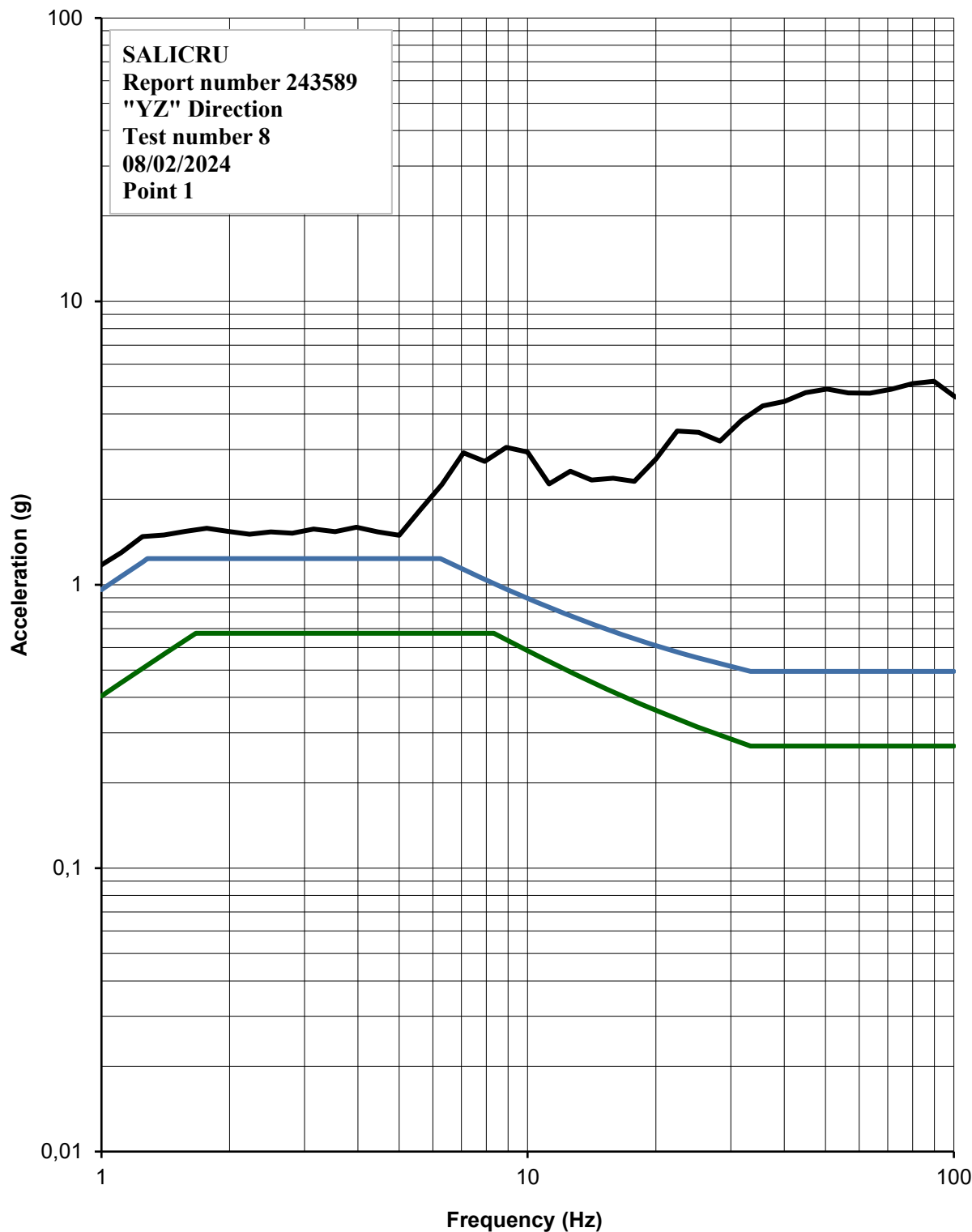
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction

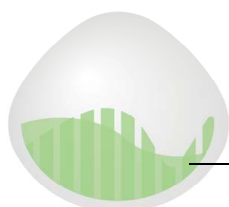


TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction

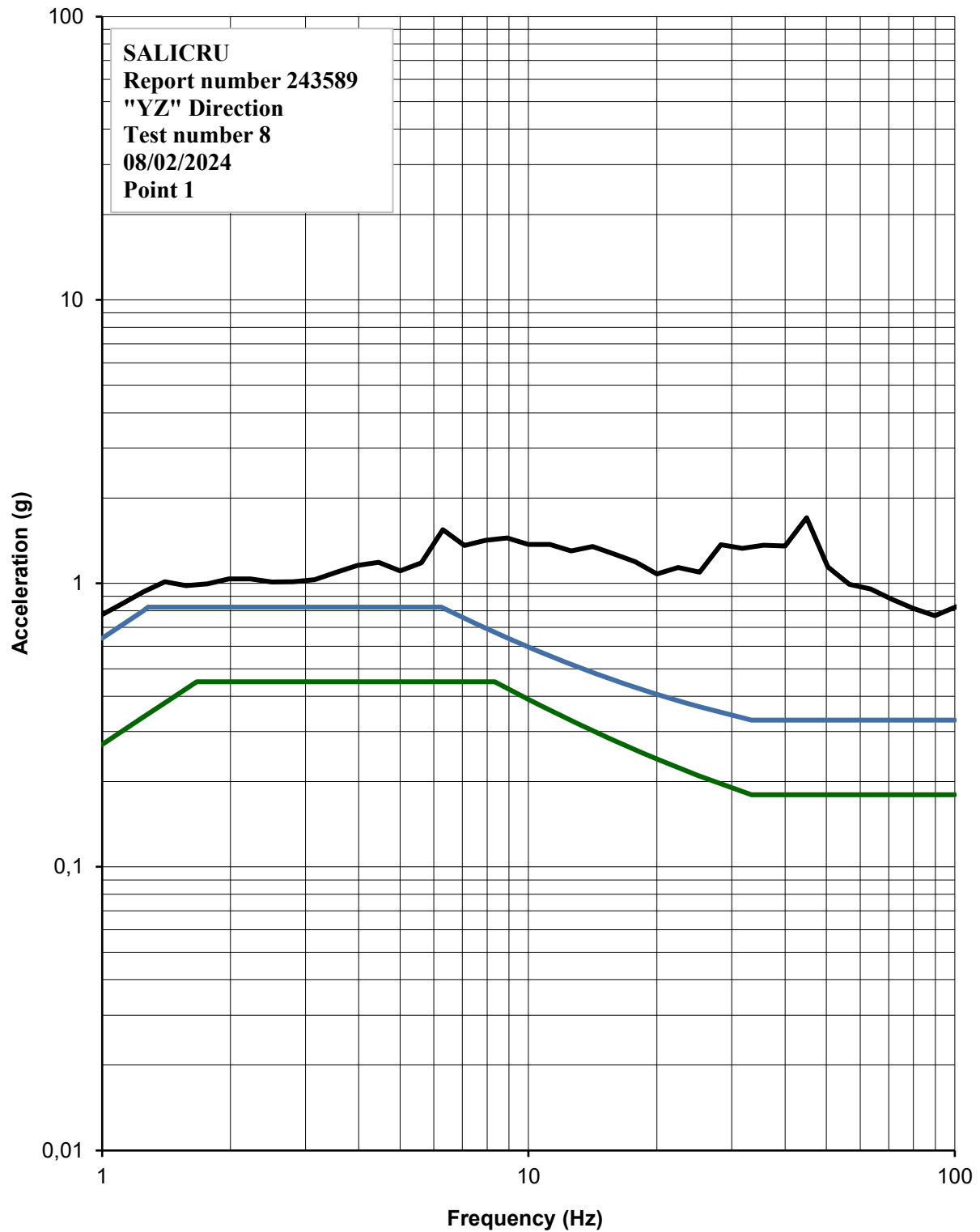


RRS S1-H (50% S2-H) (UBC1997 Zone 3 Ip1,5) RRS S1-H (50% S2-H) (UBC1997 Zone 4 Ip1,5) TRS-H

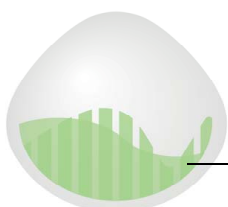


TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction

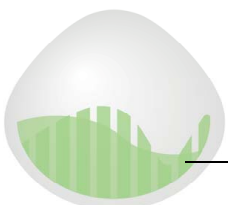
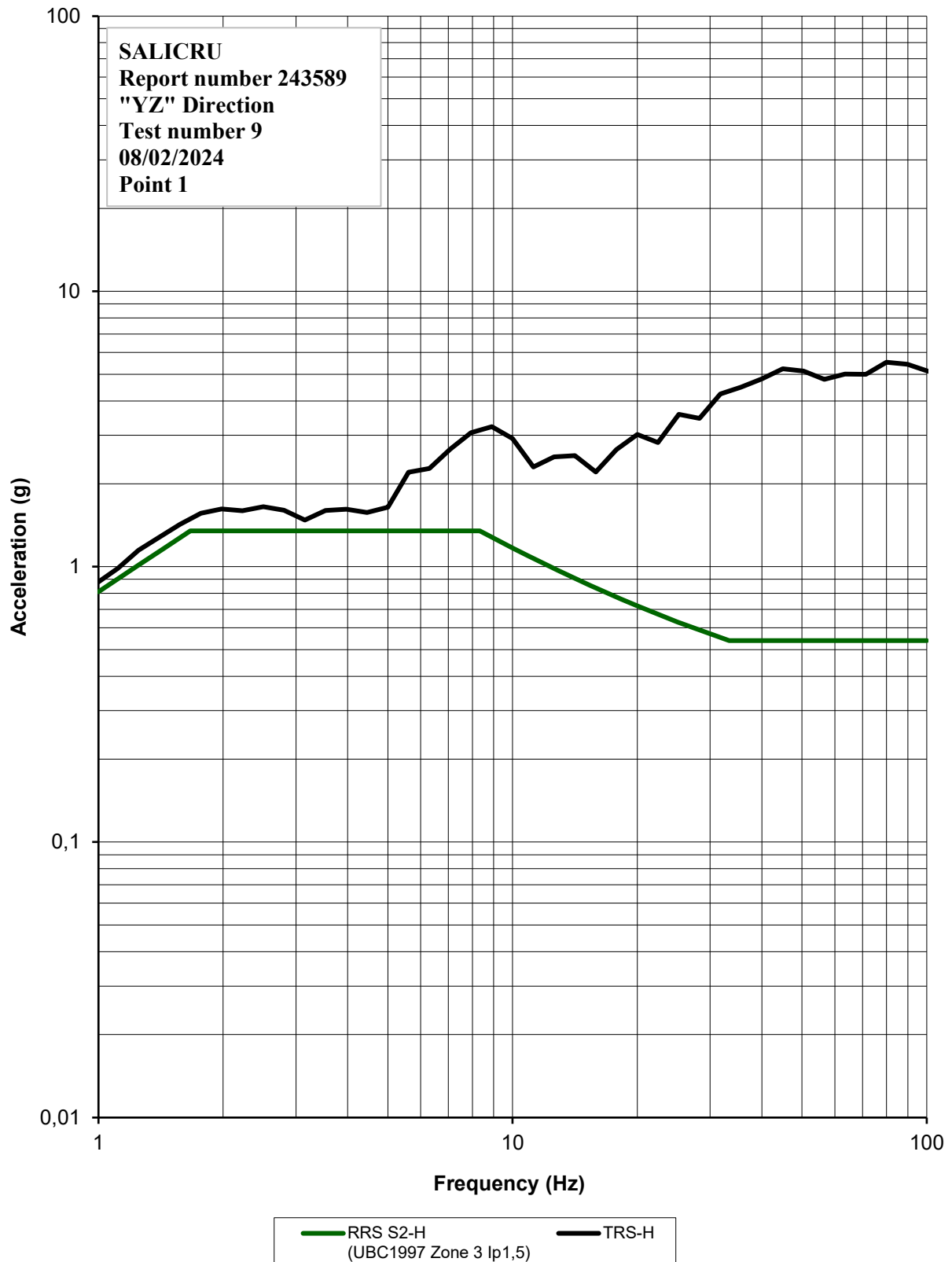


SALICRU
Report number 243589
"YZ" Direction
Test number 8
08/02/2024
Point 1



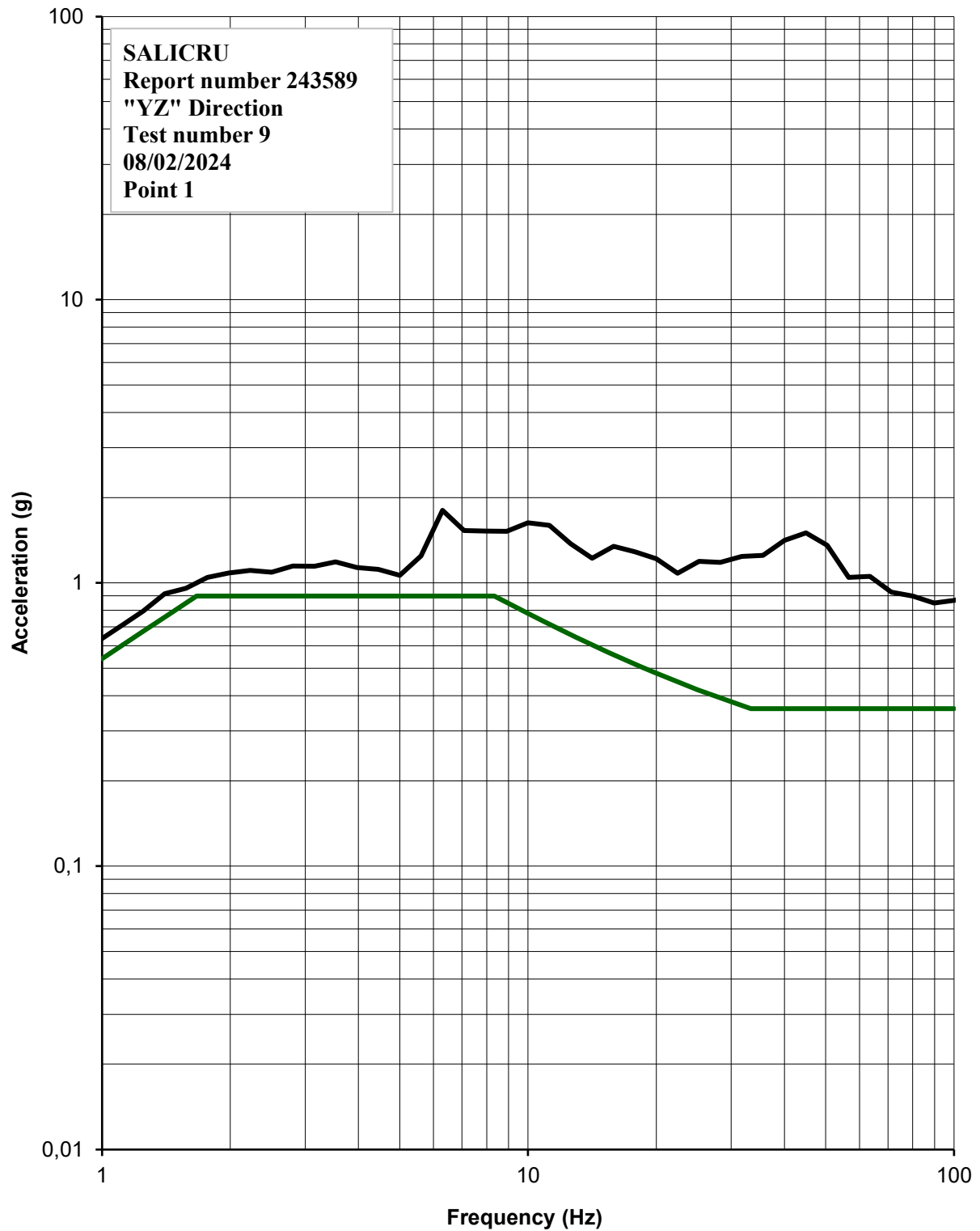
TEST RESPONSE SPECTRUM, TRS

S2-H Level - 5% Damping
HORIZONTAL Direction

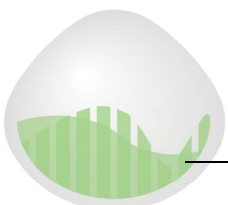


TEST RESPONSE SPECTRUM, TRS

S2-V (2/3 S2-H) Level - 5% Damping
VERTICAL Direction

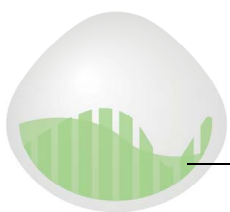
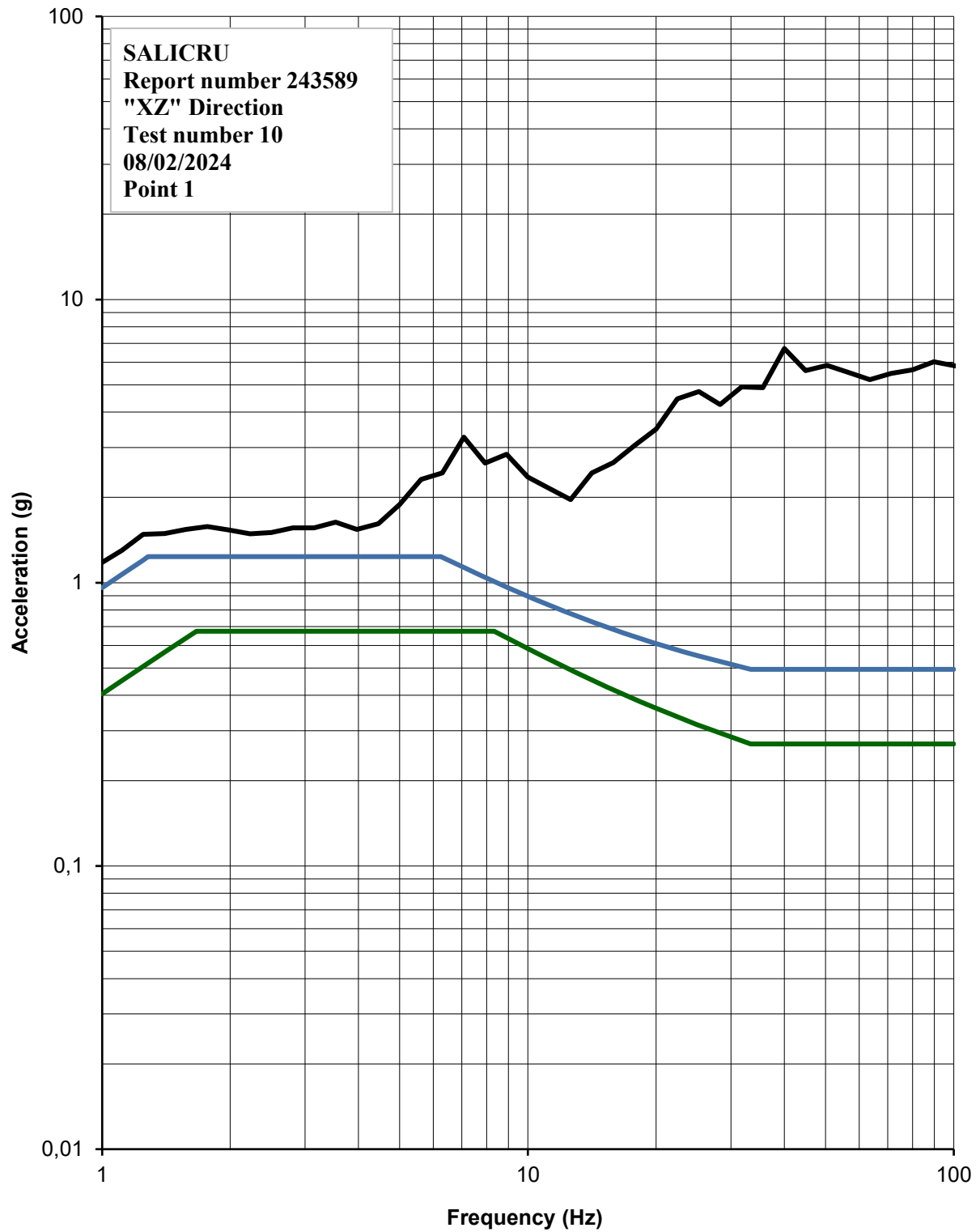


— RRS S2-V (2/3 S2-H) (UBC1997 Zone 3 Ip1,5) — TRS-V



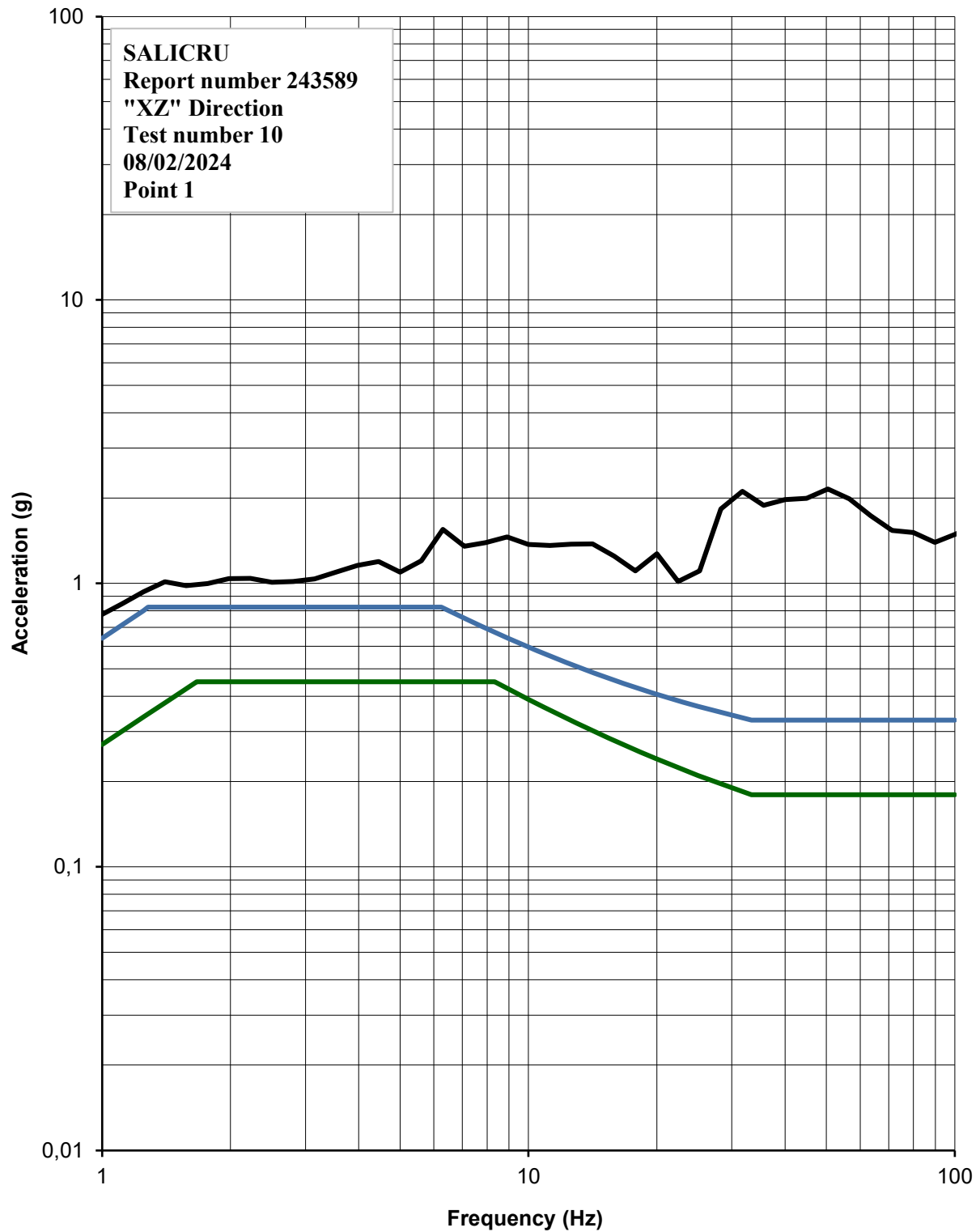
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction

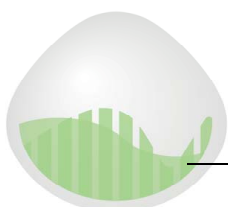


TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction

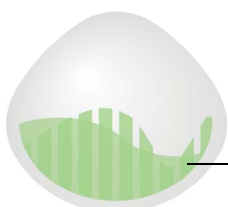
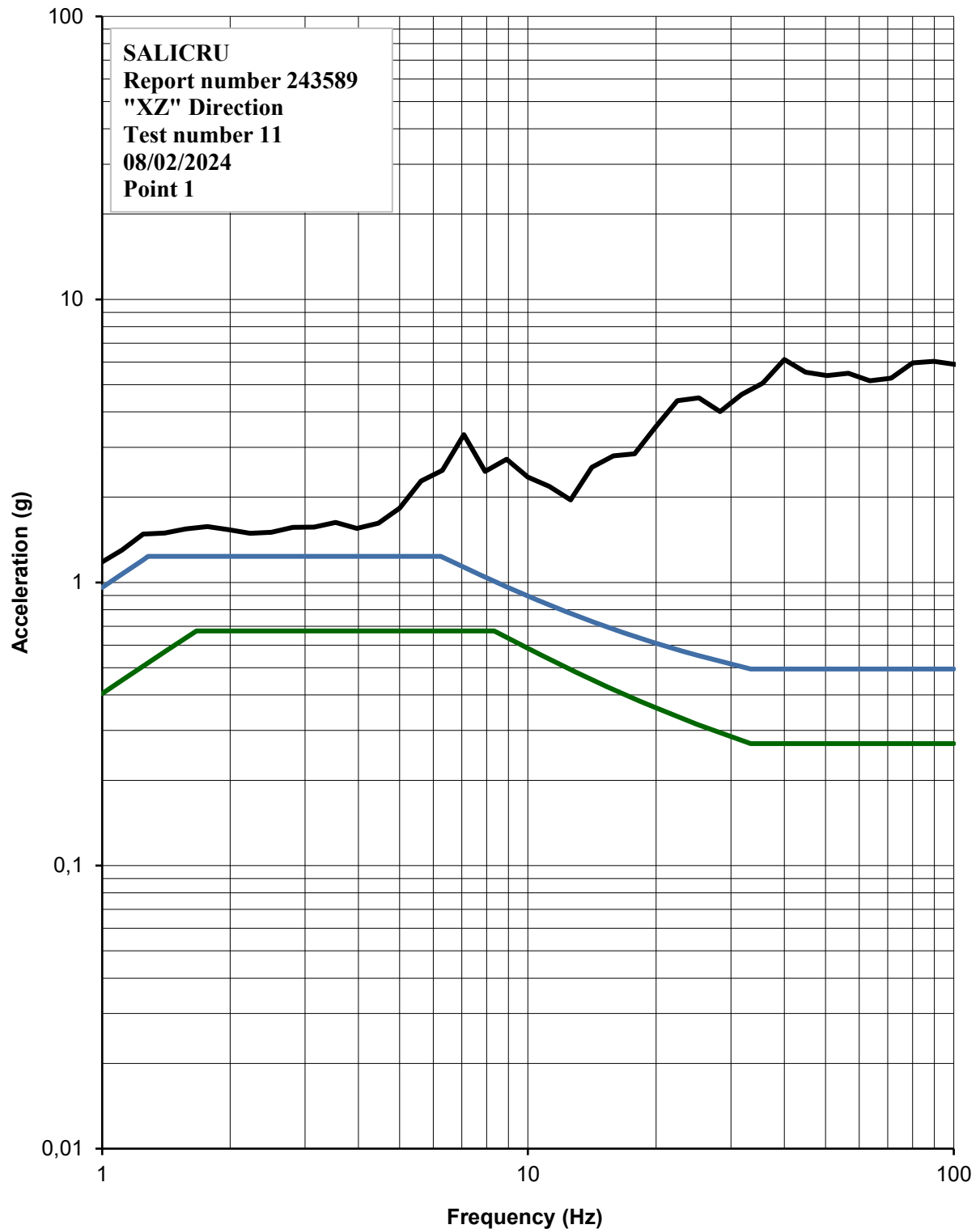


SALICRU
Report number 243589
"XZ" Direction
Test number 10
08/02/2024
Point 1



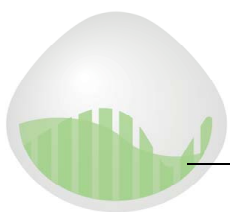
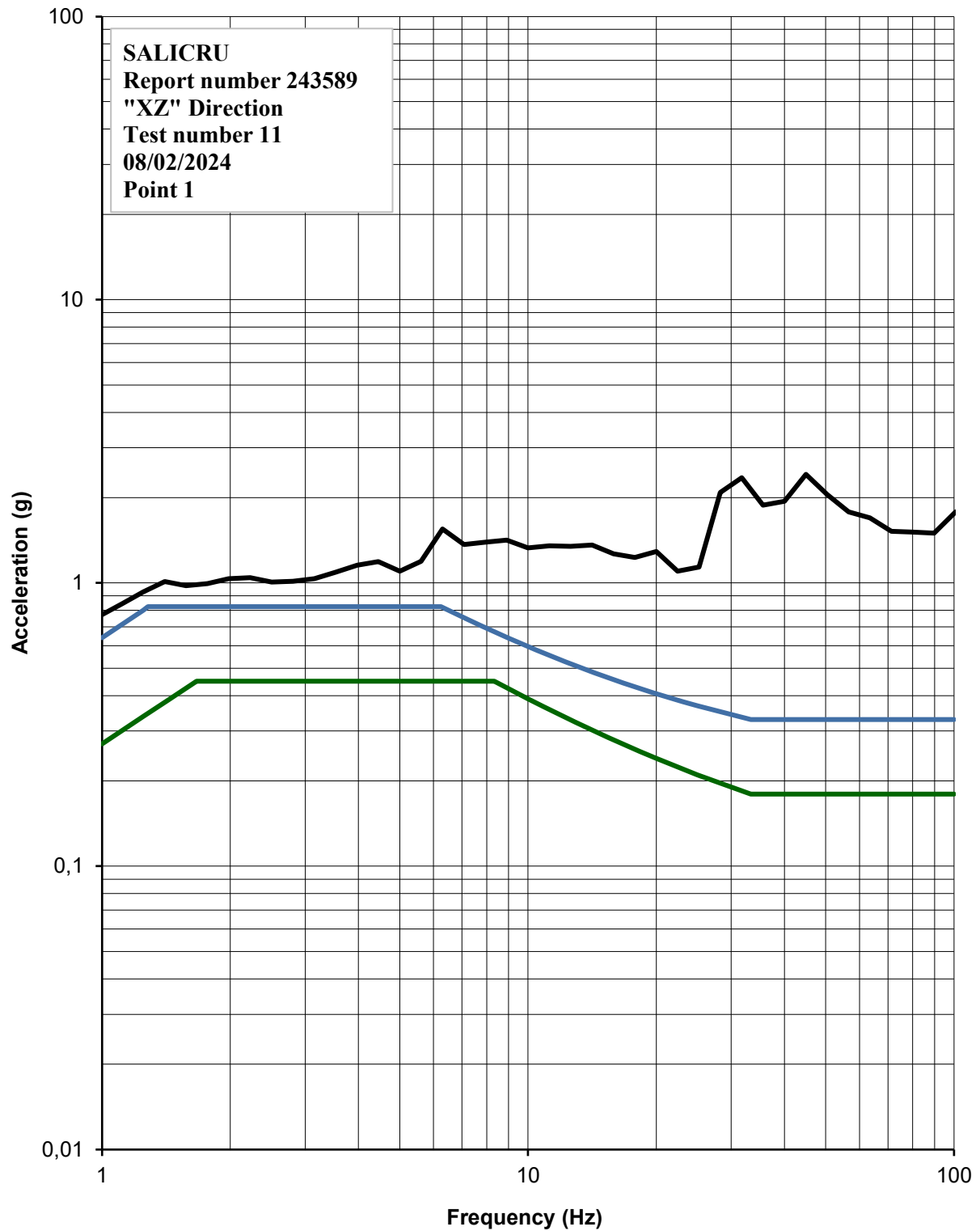
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



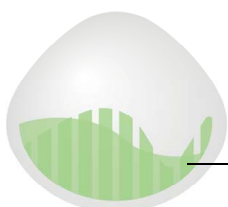
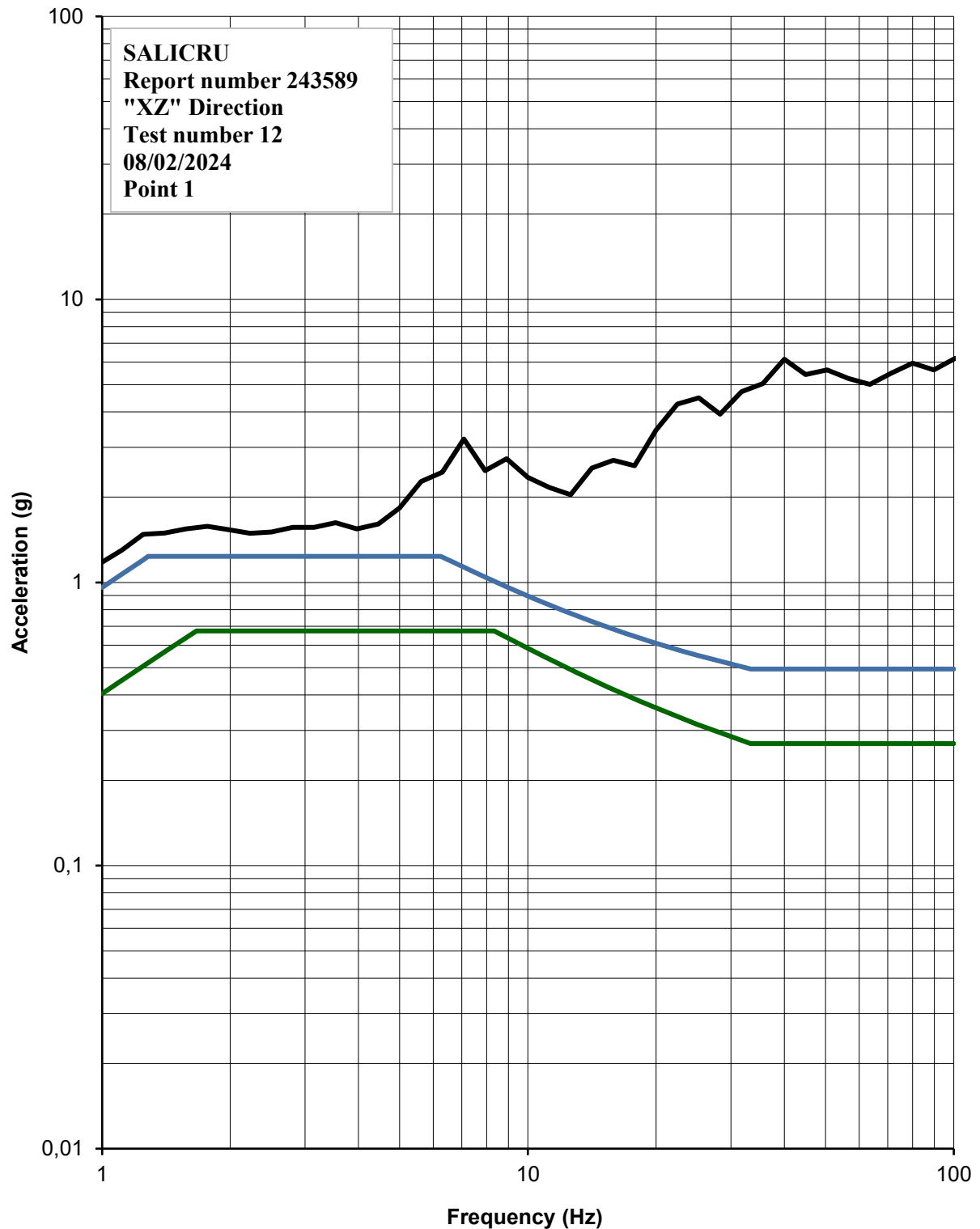
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction



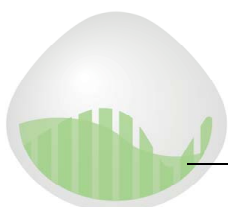
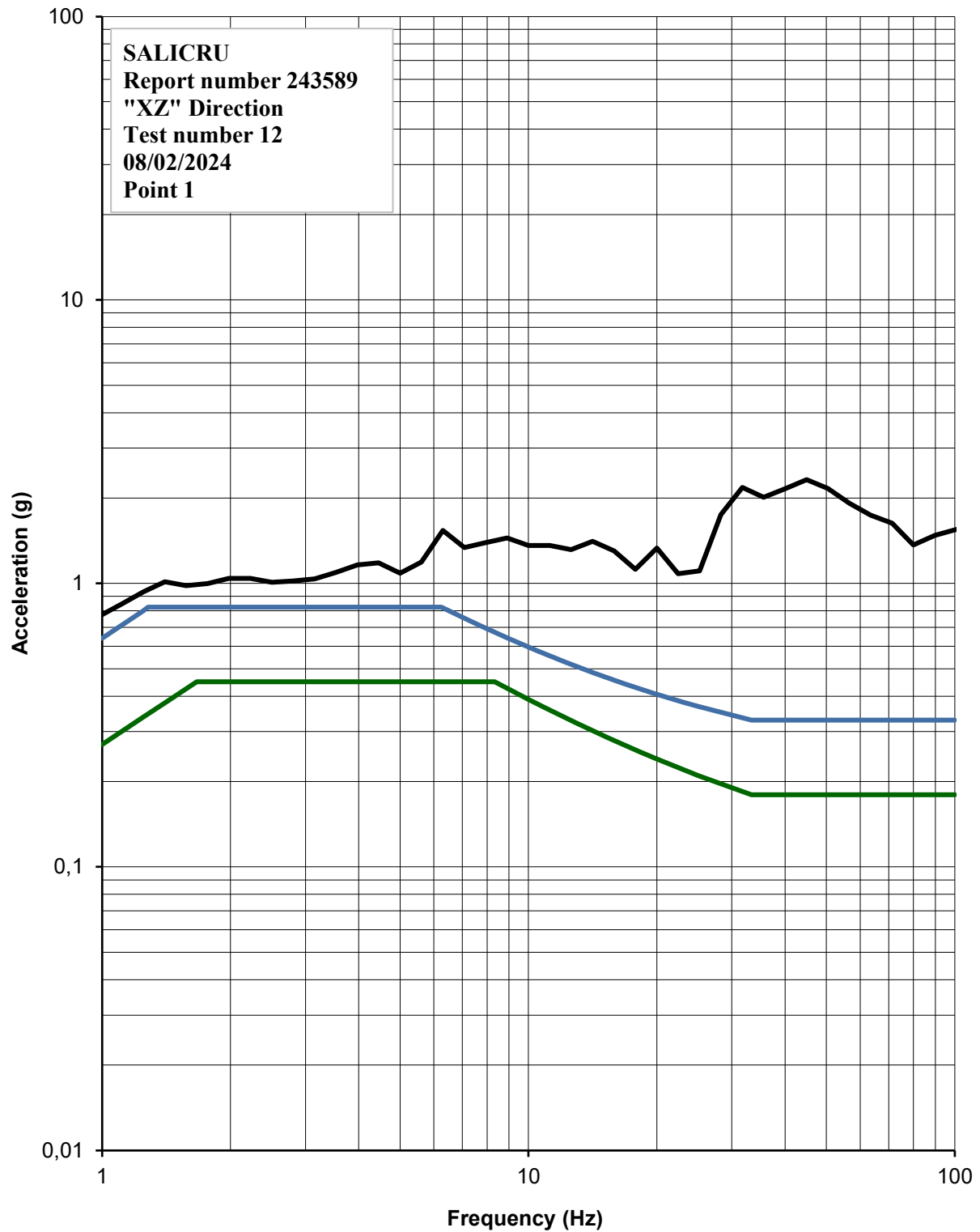
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



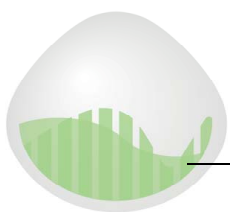
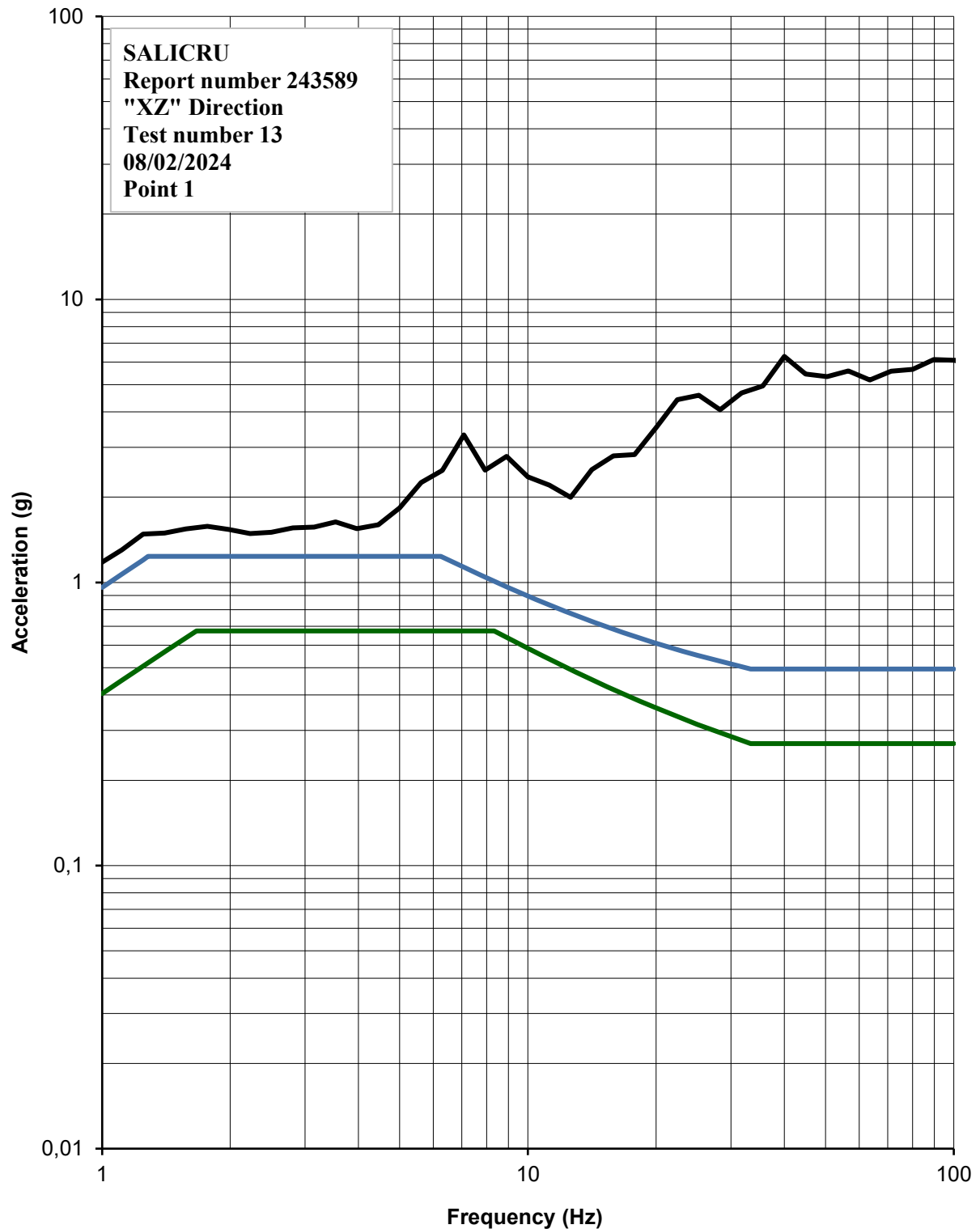
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction



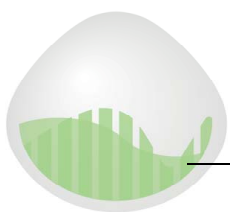
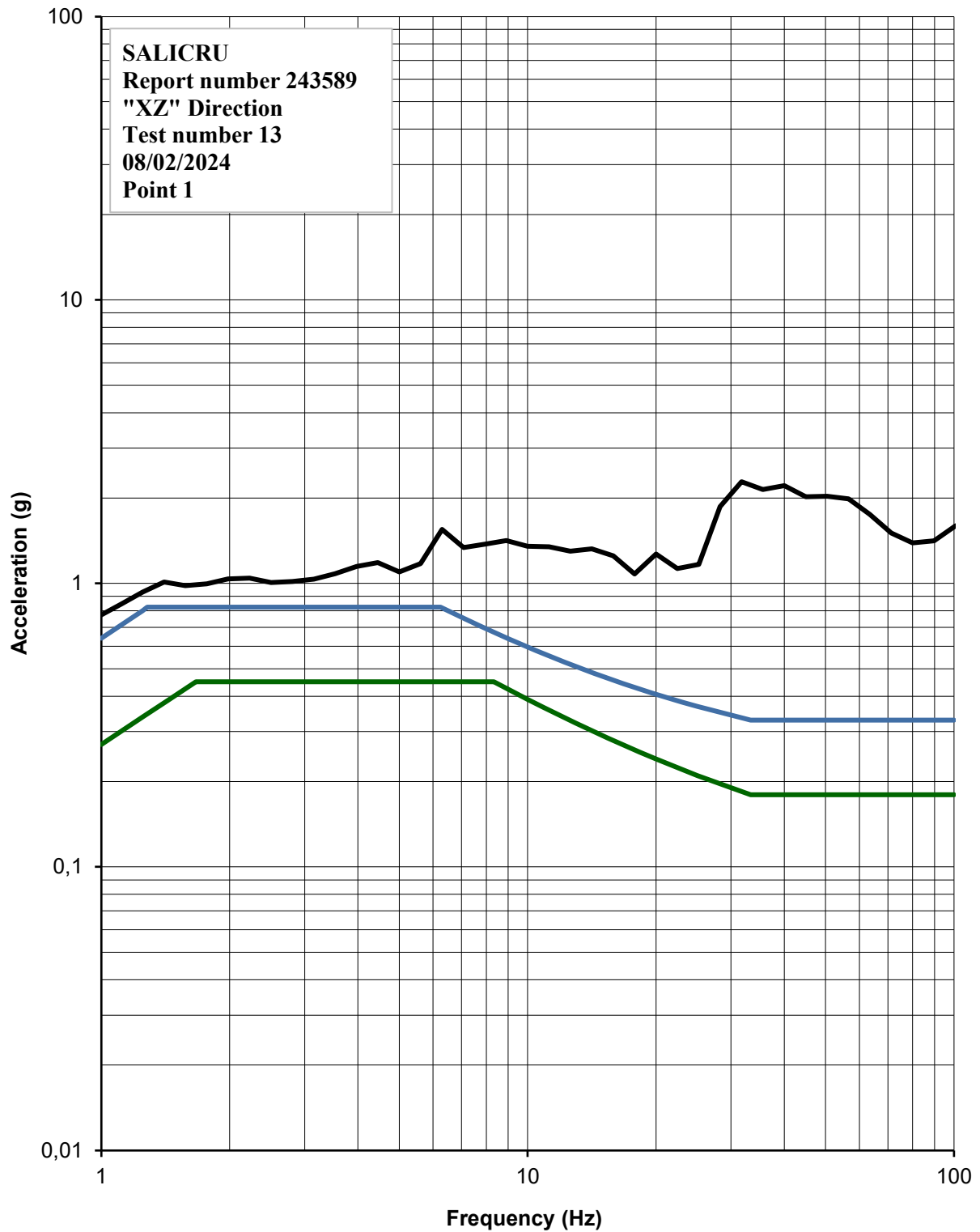
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



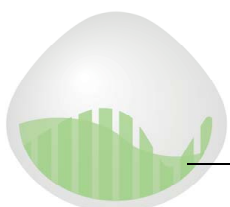
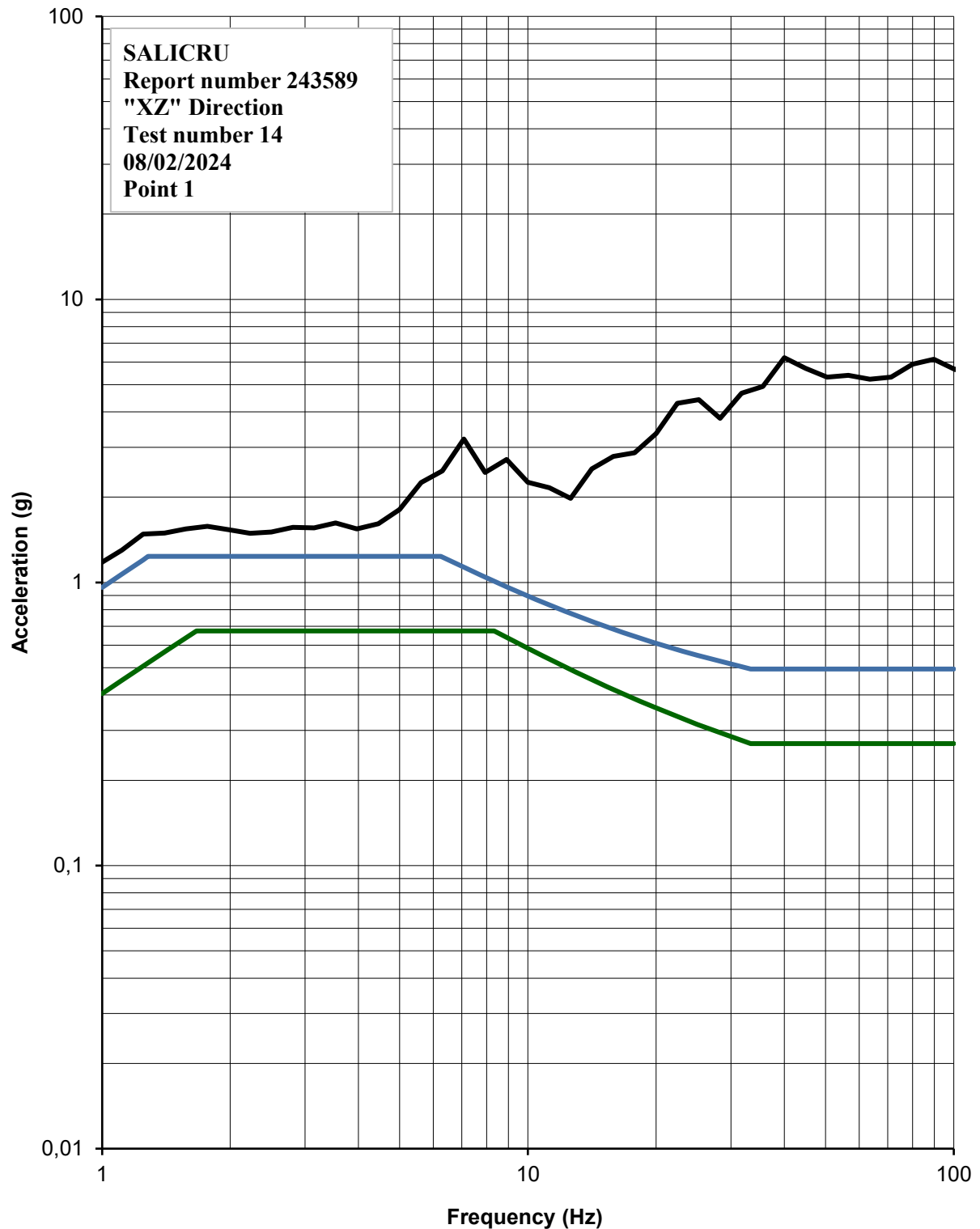
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction



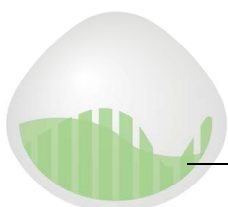
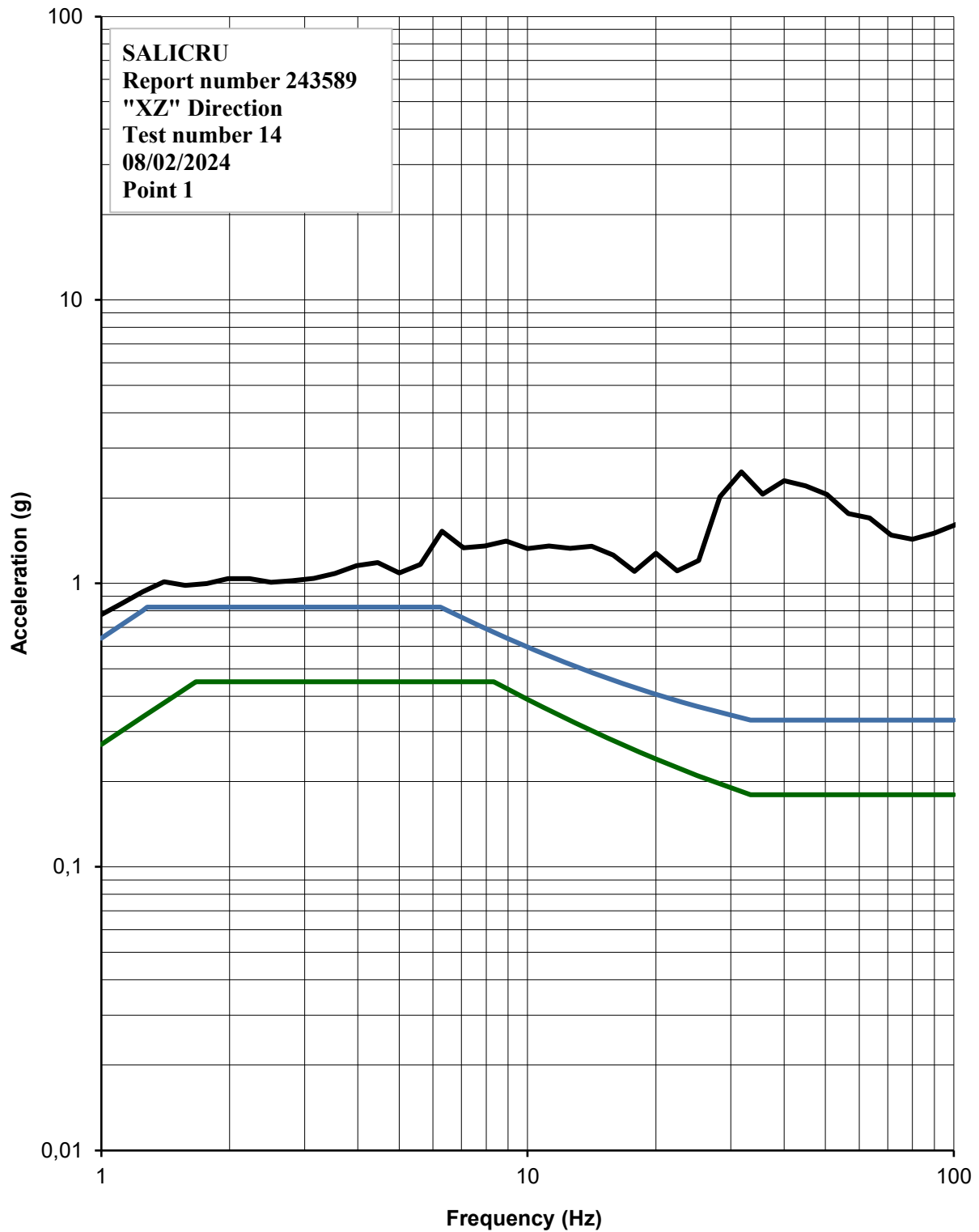
TEST RESPONSE SPECTRUM, TRS

S1-H (50% S2-H) Level - 5% Damping
HORIZONTAL Direction



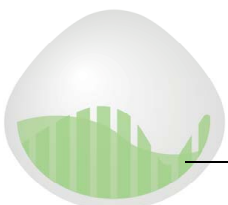
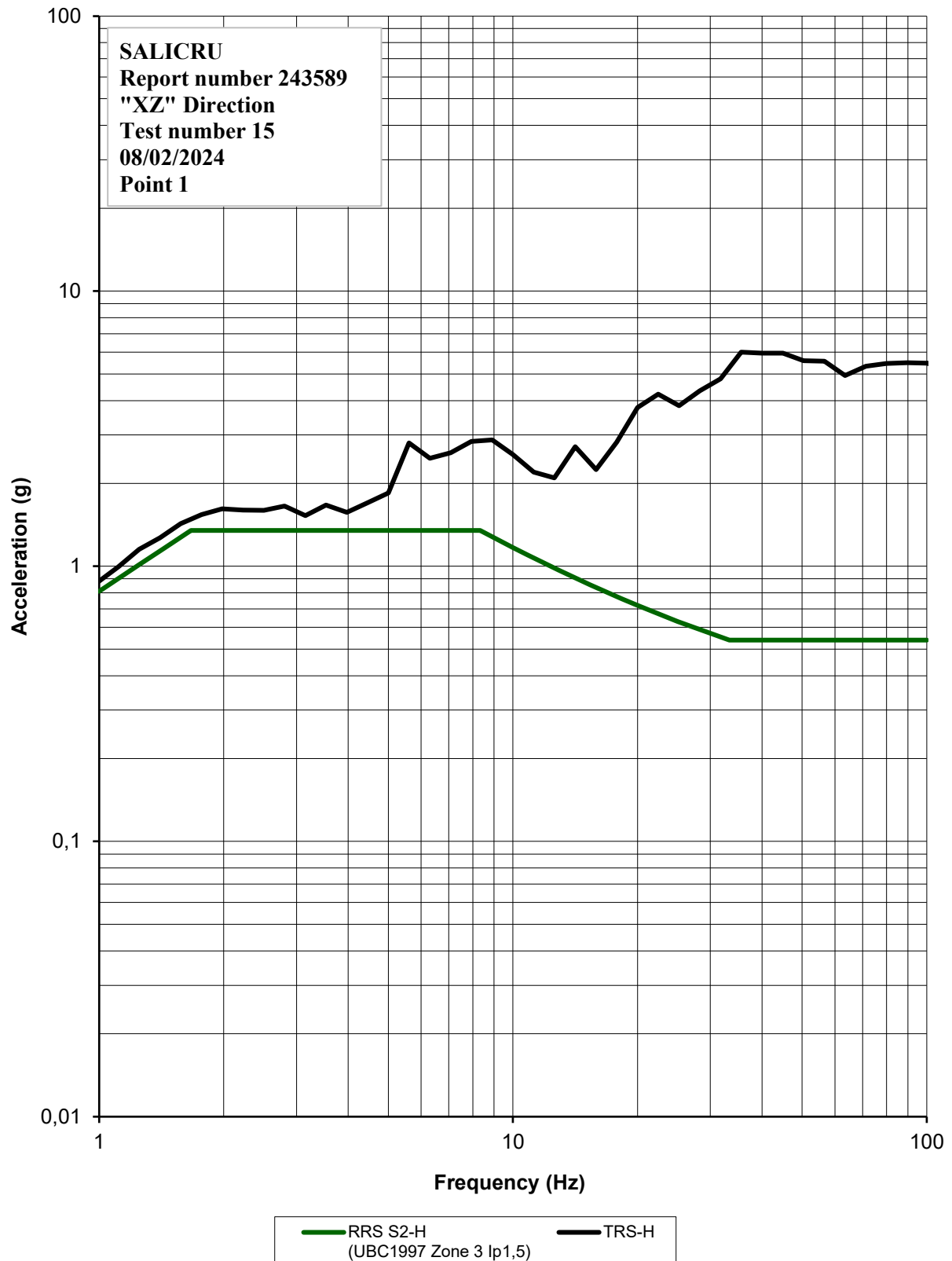
TEST RESPONSE SPECTRUM, TRS

S1-V (50% S2-V) Level - 5% Damping
VERTICAL Direction



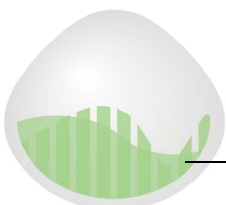
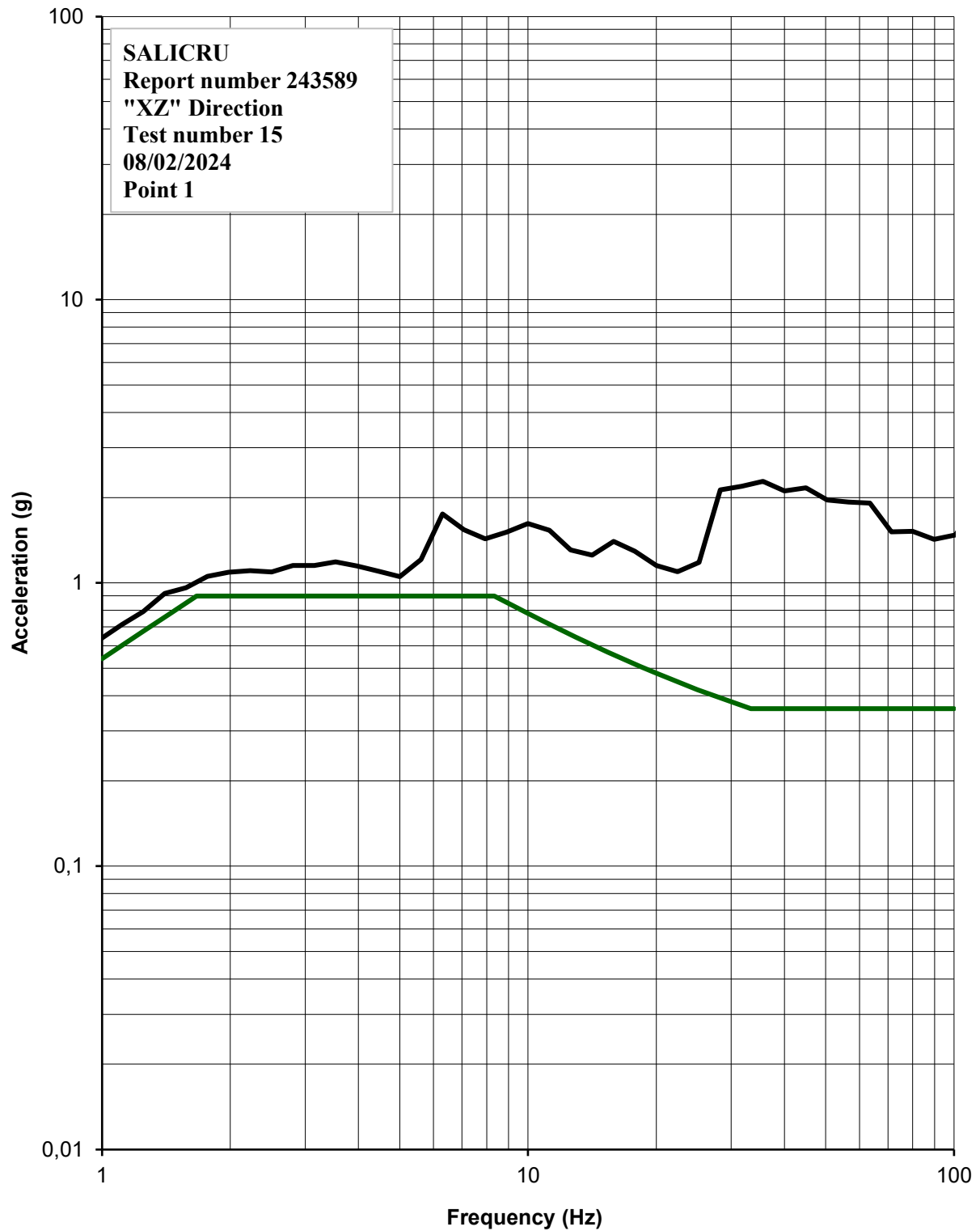
TEST RESPONSE SPECTRUM, TRS

S2-H Level - 5% Damping
HORIZONTAL Direction



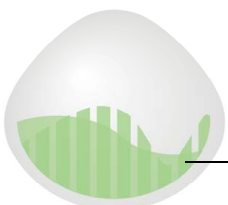
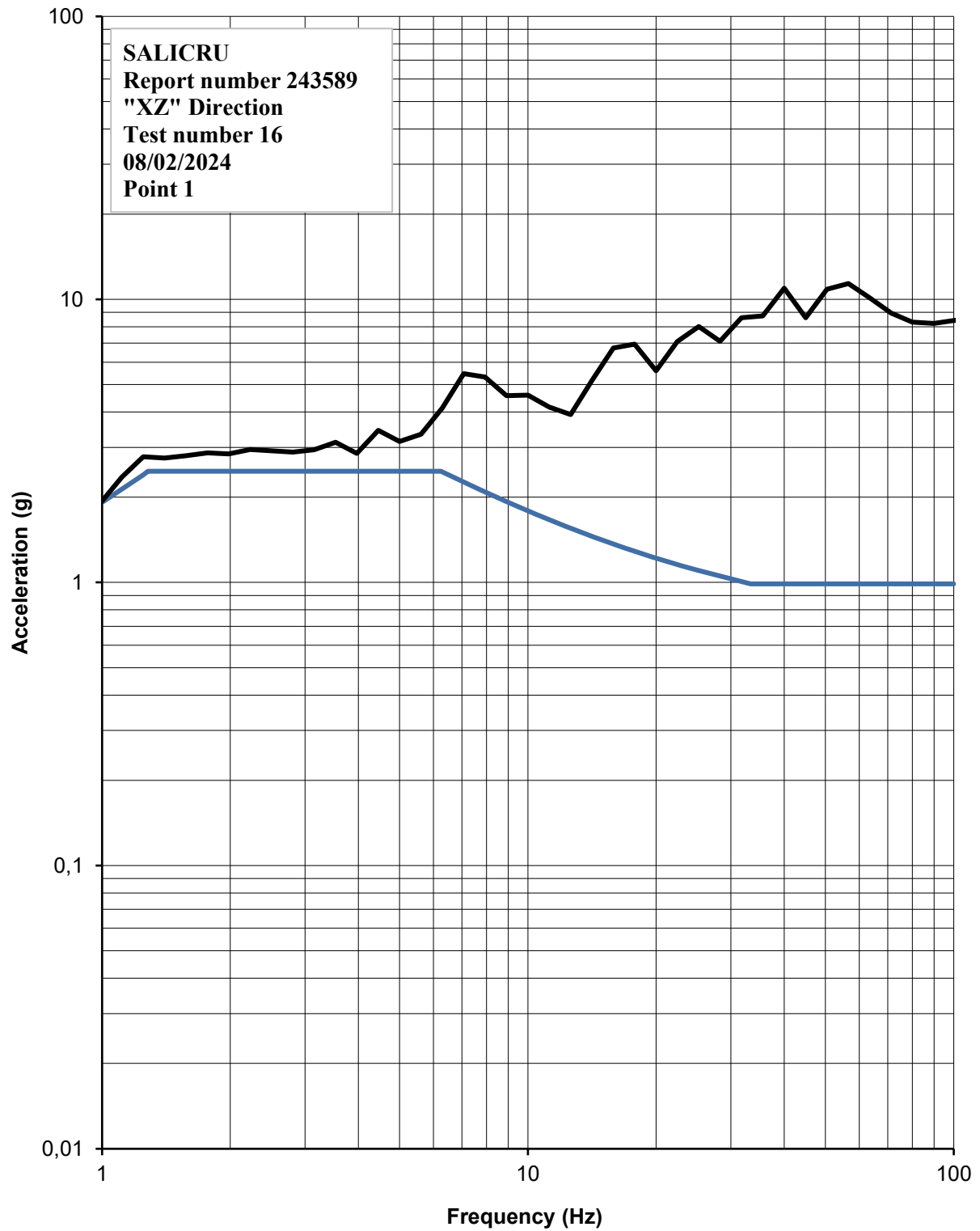
TEST RESPONSE SPECTRUM, TRS

S2-V (2/3 S2-H) Level - 5% Damping
VERTICAL Direction



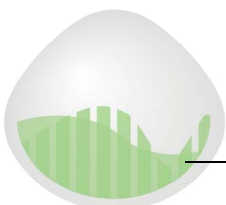
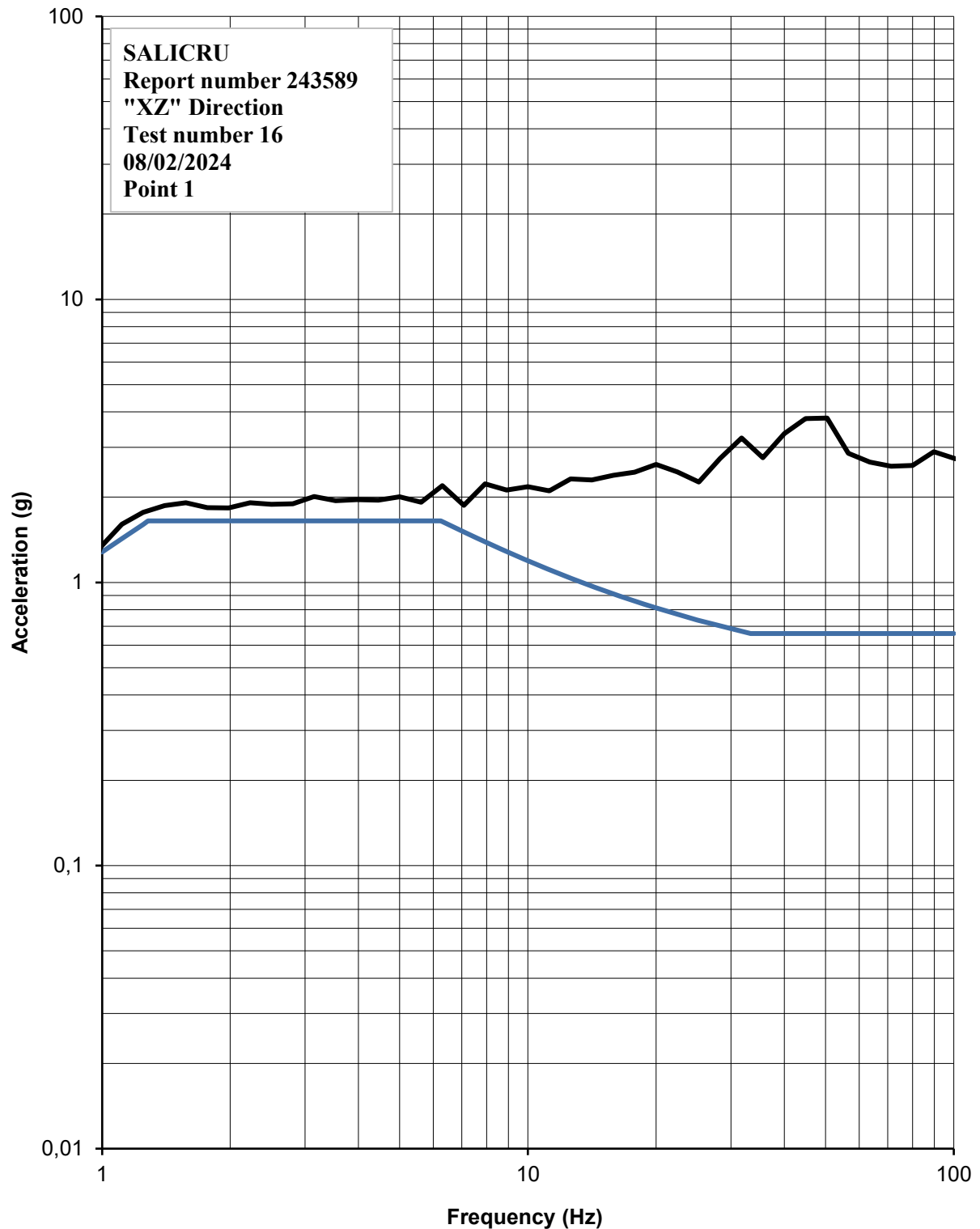
TEST RESPONSE SPECTRUM, TRS

S2-H Level - 5% Damping
HORIZONTAL Direction



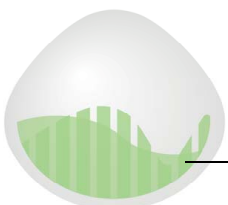
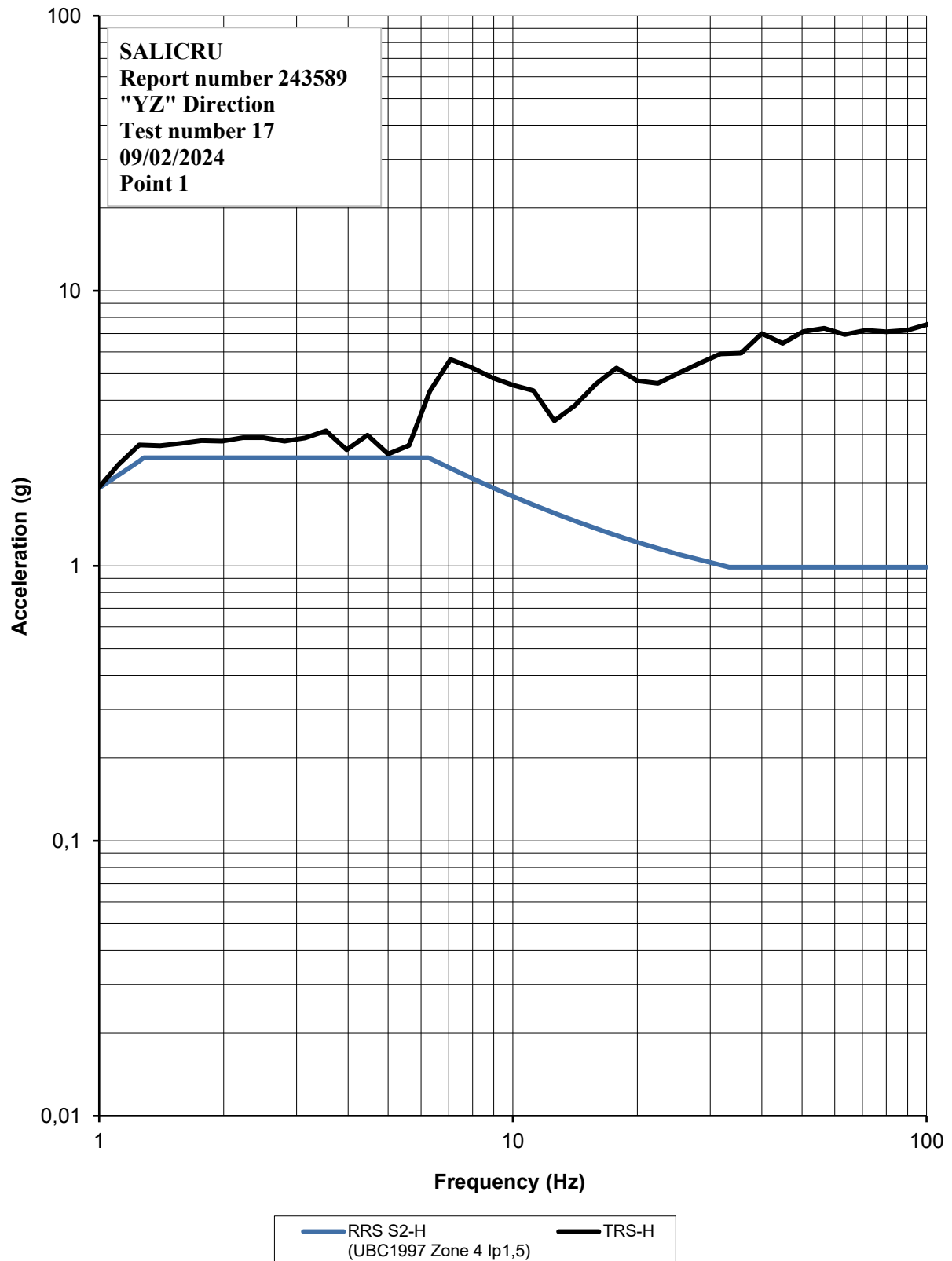
TEST RESPONSE SPECTRUM, TRS

S2-V (2/3 S2-H) Level - 5% Damping
VERTICAL Direction



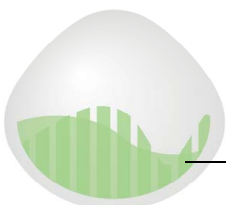
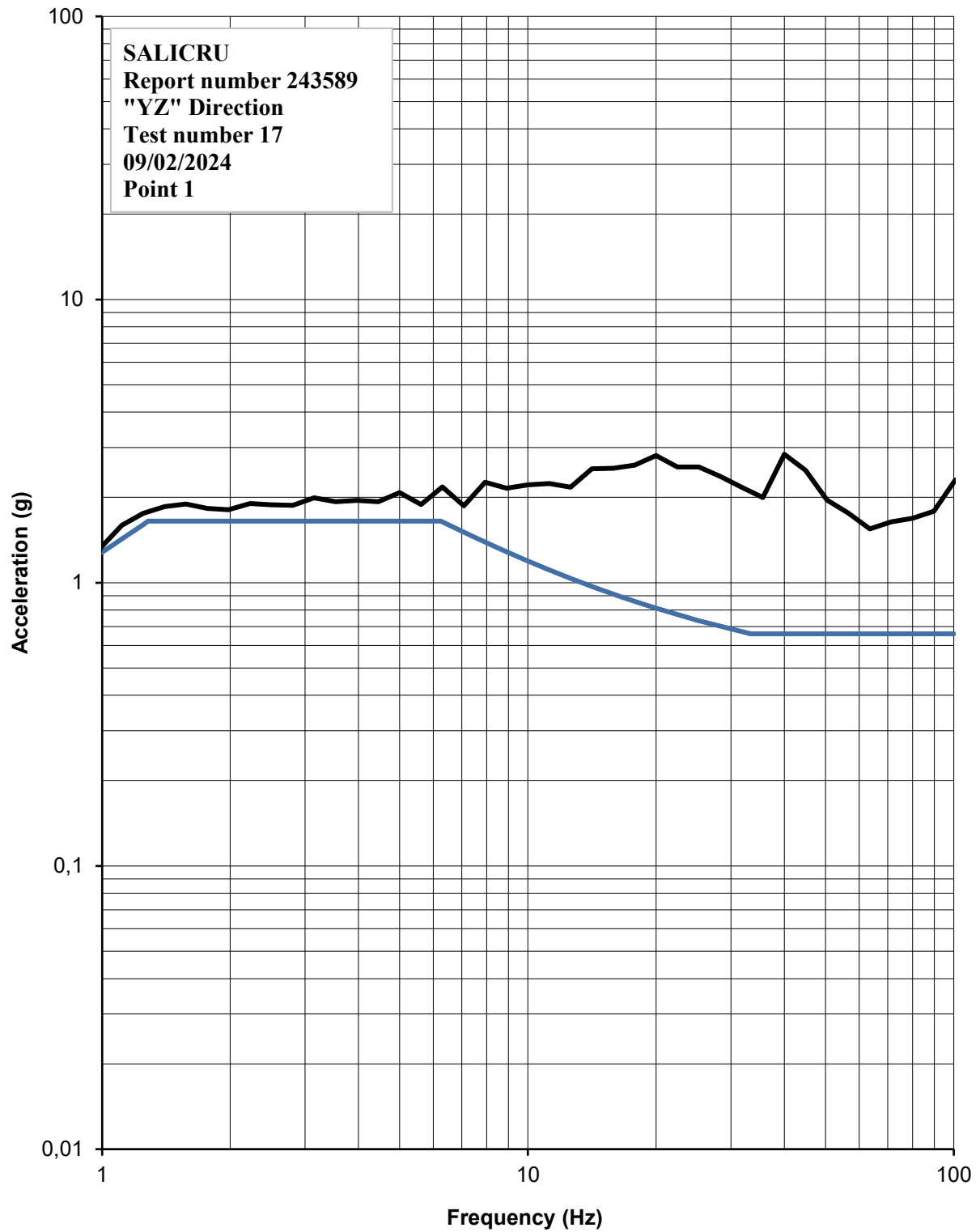
TEST RESPONSE SPECTRUM, TRS

S2-H Level - 5% Damping
HORIZONTAL Direction

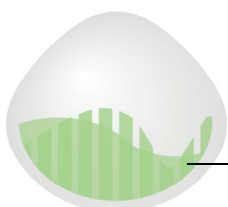


TEST RESPONSE SPECTRUM, TRS

S2-V (2/3 S2-H) Level - 5% Damping
VERTICAL Direction

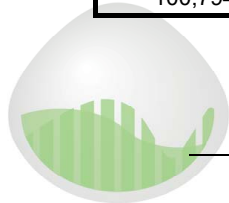


NUMERICAL VALUES



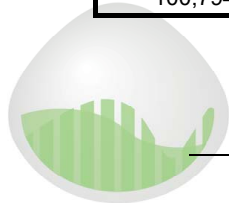
TRS, Test Response Spectra (5% Damping)
"YZ" Direction - Group 1 of accelerometers (HORIZONTAL)

Frequency (Hz)	Acceleration (g)						
	S1 (Zone 3 & 4)					S2 (Zone 3)	S2 (Zone 4)
	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 17
	1 st	2 nd	3 rd	4 th	5 th	1 st	1 st
0,884	1,054	1,054	1,054	1,053	1,055	0,798	1,141
0,992	1,165	1,165	1,164	1,165	1,166	0,872	1,902
1,114	1,297	1,297	1,297	1,296	1,298	0,987	2,330
1,250	1,477	1,478	1,477	1,476	1,480	1,148	2,751
1,403	1,494	1,496	1,496	1,496	1,498	1,279	2,733
1,575	1,545	1,543	1,539	1,539	1,543	1,426	2,787
1,768	1,576	1,577	1,578	1,577	1,582	1,562	2,855
1,984	1,528	1,534	1,538	1,534	1,541	1,622	2,838
2,227	1,504	1,505	1,505	1,503	1,506	1,597	2,928
2,500	1,534	1,530	1,526	1,524	1,536	1,652	2,924
2,806	1,535	1,530	1,530	1,519	1,520	1,605	2,839
3,150	1,573	1,571	1,573	1,576	1,572	1,478	2,919
3,536	1,554	1,545	1,559	1,547	1,539	1,598	3,093
3,969	1,613	1,591	1,587	1,591	1,596	1,617	2,644
4,454	1,560	1,540	1,545	1,499	1,535	1,574	2,986
5,000	1,559	1,561	1,488	1,435	1,495	1,644	2,551
5,612	1,880	1,846	1,812	1,724	1,844	2,204	2,743
6,300	2,307	2,210	2,296	2,162	2,257	2,274	4,319
7,071	3,054	2,881	2,972	2,750	2,918	2,674	5,631
7,937	2,778	2,710	2,687	2,442	2,723	3,066	5,267
8,909	2,974	2,867	2,946	2,816	3,051	3,224	4,840
10,000	3,011	2,923	2,969	2,815	2,935	2,923	4,544
11,225	2,260	2,234	2,246	2,262	2,267	2,303	4,333
12,599	2,381	2,345	2,436	2,320	2,516	2,504	3,369
14,142	2,345	2,248	2,371	2,393	2,340	2,530	3,827
15,874	2,364	2,309	2,292	2,353	2,375	2,206	4,580
17,818	2,363	2,323	2,358	2,296	2,314	2,664	5,243
20,000	3,103	2,752	2,776	2,812	2,776	3,021	4,704
22,449	3,123	3,068	3,297	3,220	3,487	2,826	4,614
25,198	3,408	3,377	3,343	3,289	3,446	3,573	5,021
28,284	3,250	3,245	3,126	3,166	3,207	3,454	5,455
31,748	3,604	3,522	3,532	3,509	3,797	4,239	5,894
35,636	4,333	4,103	4,201	4,101	4,274	4,483	5,938
40,000	4,834	4,759	4,652	4,909	4,430	4,812	6,998
44,899	5,143	4,876	5,144	5,029	4,760	5,228	6,442
50,397	5,418	5,136	4,896	5,165	4,901	5,129	7,106
56,569	5,064	4,910	4,692	4,654	4,749	4,785	7,307
63,496	4,927	4,808	4,790	4,713	4,744	5,008	6,941
71,272	4,972	5,058	5,102	5,118	4,892	4,998	7,191
80,000	5,042	5,028	5,071	5,433	5,128	5,538	7,094
89,797	5,192	5,220	5,183	5,107	5,225	5,433	7,195
100,794	4,969	5,101	5,087	5,333	4,595	5,123	7,570



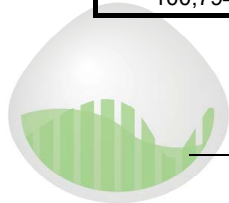
TRS, Test Response Spectra (5% Damping)
"YZ" Direction - Group 1 of accelerometers (VERTICAL)

Frequency (Hz)	Acceleration (g)						
	S1 (Zone 3 & 4)					S2 (Zone 3)	S2 (Zone 4)
	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 17
	1 st	2 nd	3 rd	4 th	5 th	1 st	1 st
0,884	1,054	1,054	1,054	1,053	1,055	0,798	1,141
0,992	1,165	1,165	1,164	1,165	1,166	0,872	1,902
1,114	1,297	1,297	1,297	1,296	1,298	0,987	2,330
1,250	1,477	1,478	1,477	1,476	1,480	1,148	2,751
1,403	1,494	1,496	1,496	1,496	1,498	1,279	2,733
1,575	1,545	1,543	1,539	1,539	1,543	1,426	2,787
1,768	1,576	1,577	1,578	1,577	1,582	1,562	2,855
1,984	1,528	1,534	1,538	1,534	1,541	1,622	2,838
2,227	1,504	1,505	1,505	1,503	1,506	1,597	2,928
2,500	1,534	1,530	1,526	1,524	1,536	1,652	2,924
2,806	1,535	1,530	1,530	1,519	1,520	1,605	2,839
3,150	1,573	1,571	1,573	1,576	1,572	1,478	2,919
3,536	1,554	1,545	1,559	1,547	1,539	1,598	3,093
3,969	1,613	1,591	1,587	1,591	1,596	1,617	2,644
4,454	1,560	1,540	1,545	1,499	1,535	1,574	2,986
5,000	1,559	1,561	1,488	1,435	1,495	1,644	2,551
5,612	1,880	1,846	1,812	1,724	1,844	2,204	2,743
6,300	2,307	2,210	2,296	2,162	2,257	2,274	4,319
7,071	3,054	2,881	2,972	2,750	2,918	2,674	5,631
7,937	2,778	2,710	2,687	2,442	2,723	3,066	5,267
8,909	2,974	2,867	2,946	2,816	3,051	3,224	4,840
10,000	3,011	2,923	2,969	2,815	2,935	2,923	4,544
11,225	2,260	2,234	2,246	2,262	2,267	2,303	4,333
12,599	2,381	2,345	2,436	2,320	2,516	2,504	3,369
14,142	2,345	2,248	2,371	2,393	2,340	2,530	3,827
15,874	2,364	2,309	2,292	2,353	2,375	2,206	4,580
17,818	2,363	2,323	2,358	2,296	2,314	2,664	5,243
20,000	3,103	2,752	2,776	2,812	2,776	3,021	4,704
22,449	3,123	3,068	3,297	3,220	3,487	2,826	4,614
25,198	3,408	3,377	3,343	3,289	3,446	3,573	5,021
28,284	3,250	3,245	3,126	3,166	3,207	3,454	5,455
31,748	3,604	3,522	3,532	3,509	3,797	4,239	5,894
35,636	4,333	4,103	4,201	4,101	4,274	4,483	5,938
40,000	4,834	4,759	4,652	4,909	4,430	4,812	6,998
44,899	5,143	4,876	5,144	5,029	4,760	5,228	6,442
50,397	5,418	5,136	4,896	5,165	4,901	5,129	7,106
56,569	5,064	4,910	4,692	4,654	4,749	4,785	7,307
63,496	4,927	4,808	4,790	4,713	4,744	5,008	6,941
71,272	4,972	5,058	5,102	5,118	4,892	4,998	7,191
80,000	5,042	5,028	5,071	5,433	5,128	5,538	7,094
89,797	5,192	5,220	5,183	5,107	5,225	5,433	7,195
100,794	4,969	5,101	5,087	5,333	4,595	5,123	7,570



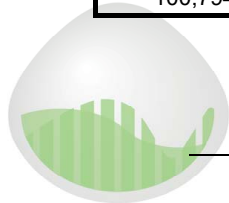
TRS, Test Response Spectra (5% Damping)
"XZ" Direction - Group 1 of accelerometers (HORIZONTAL)

Frequency (Hz)	Acceleration (g)						
	S1 (Zone 3 & 4)					S2 (Zone 3)	S2 (Zone 4)
	Test 10	Test 11	Test 12	Test 13	Test 14	Test 15	Test 16
	1 st	2 nd	3 rd	4 th	5 th	1 st	1 st
0,884	1,057	1,057	1,057	1,057	1,057	0,801	1,144
0,992	1,171	1,171	1,171	1,171	1,171	0,875	1,911
1,114	1,301	1,301	1,301	1,303	1,301	0,996	2,353
1,250	1,480	1,480	1,480	1,480	1,480	1,151	2,779
1,403	1,492	1,492	1,492	1,493	1,493	1,270	2,753
1,575	1,541	1,545	1,545	1,546	1,546	1,429	2,801
1,768	1,576	1,576	1,576	1,579	1,577	1,539	2,869
1,984	1,535	1,537	1,535	1,538	1,536	1,616	2,843
2,227	1,488	1,490	1,490	1,488	1,490	1,600	2,947
2,500	1,504	1,504	1,505	1,503	1,506	1,598	2,916
2,806	1,561	1,565	1,565	1,560	1,564	1,656	2,889
3,150	1,561	1,568	1,565	1,566	1,557	1,526	2,944
3,536	1,637	1,630	1,626	1,634	1,622	1,668	3,128
3,969	1,543	1,551	1,546	1,548	1,546	1,571	2,860
4,454	1,614	1,617	1,609	1,598	1,610	1,702	3,449
5,000	1,886	1,829	1,832	1,831	1,810	1,847	3,145
5,612	2,318	2,284	2,271	2,251	2,251	2,808	3,340
6,300	2,442	2,485	2,451	2,489	2,476	2,471	4,134
7,071	3,267	3,330	3,210	3,319	3,209	2,588	5,462
7,937	2,643	2,468	2,481	2,491	2,447	2,841	5,313
8,909	2,840	2,721	2,736	2,785	2,718	2,879	4,566
10,000	2,362	2,356	2,348	2,358	2,257	2,545	4,588
11,225	2,152	2,182	2,164	2,207	2,160	2,199	4,165
12,599	1,966	1,956	2,042	1,997	1,981	2,095	3,916
14,142	2,442	2,551	2,537	2,504	2,517	2,722	5,167
15,874	2,658	2,798	2,697	2,798	2,786	2,244	6,732
17,818	3,050	2,845	2,582	2,830	2,871	2,823	6,946
20,000	3,481	3,559	3,452	3,523	3,358	3,779	5,593
22,449	4,461	4,385	4,265	4,424	4,291	4,224	7,092
25,198	4,727	4,487	4,489	4,581	4,419	3,834	8,022
28,284	4,253	4,010	3,926	4,071	3,800	4,336	7,107
31,748	4,908	4,610	4,717	4,670	4,662	4,801	8,615
35,636	4,879	5,059	5,033	4,942	4,919	6,007	8,747
40,000	6,718	6,129	6,143	6,287	6,224	5,951	10,945
44,899	5,603	5,526	5,422	5,443	5,700	5,950	8,615
50,397	5,854	5,372	5,635	5,334	5,310	5,579	10,853
56,569	5,523	5,481	5,257	5,589	5,386	5,562	11,376
63,496	5,209	5,158	5,002	5,191	5,223	4,929	10,127
71,272	5,486	5,266	5,485	5,578	5,312	5,334	8,954
80,000	5,641	5,956	5,954	5,655	5,903	5,452	8,312
89,797	6,025	6,040	5,630	6,127	6,138	5,493	8,231
100,794	5,827	5,888	6,196	6,087	5,647	5,467	8,427



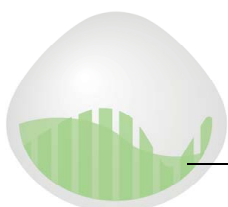
TRS, Test Response Spectra (5% Damping)
"XZ" Direction - Group 1 of accelerometers (VERTICAL)

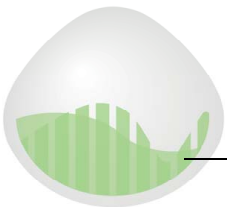
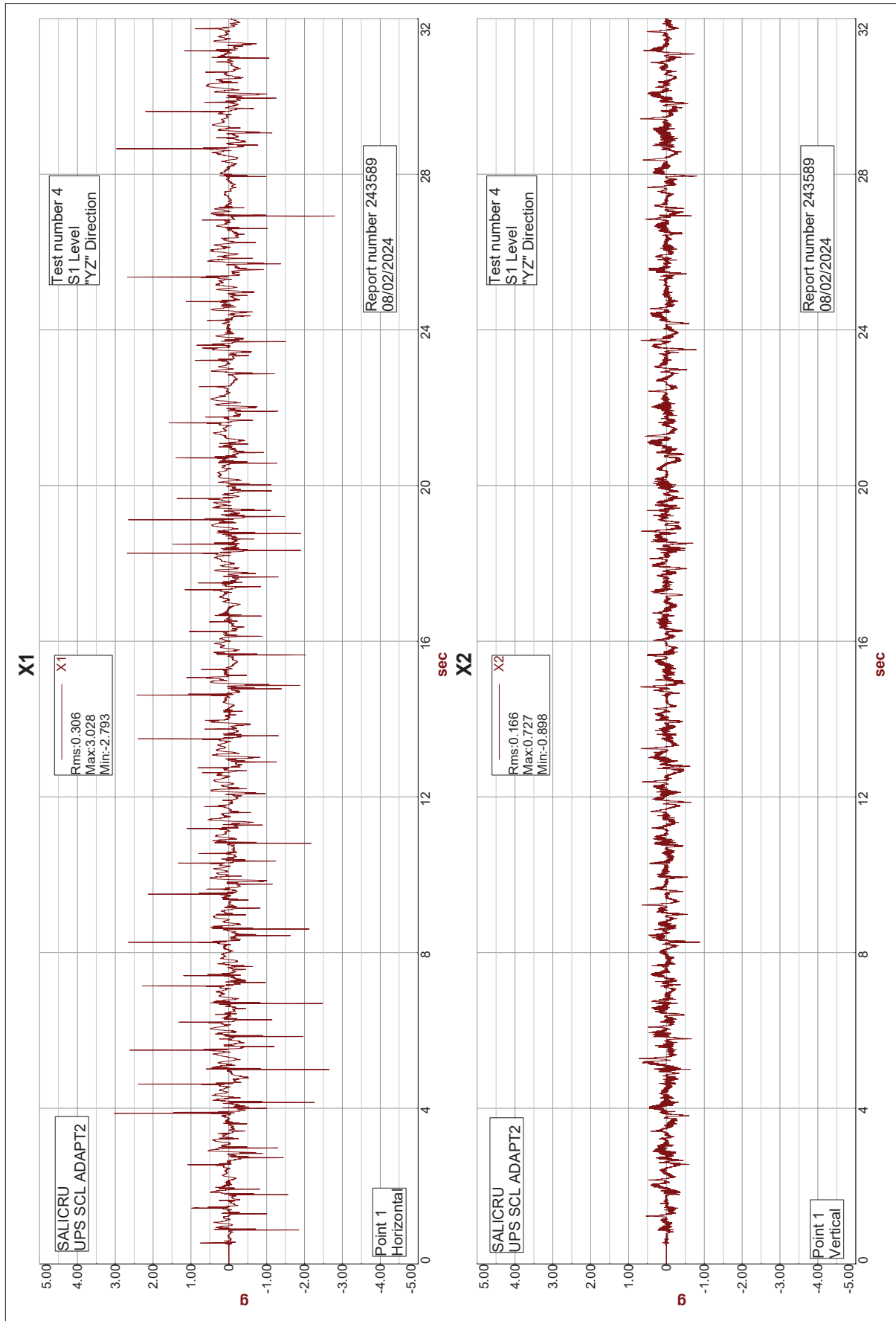
Frequency (Hz)	Acceleration (g)						
	S1 (Zone 3 & 4)					S2 (Zone 3)	S2 (Zone 4)
	Test 10	Test 11	Test 12	Test 13	Test 14	Test 15	Test 16
	1 st	2 nd	3 rd	4 th	5 th	1 st	1 st
0,884	1,057	1,057	1,057	1,057	1,057	0,801	1,144
0,992	1,171	1,171	1,171	1,171	1,171	0,875	1,911
1,114	1,301	1,301	1,301	1,303	1,301	0,996	2,353
1,250	1,480	1,480	1,480	1,480	1,480	1,151	2,779
1,403	1,492	1,492	1,492	1,493	1,493	1,270	2,753
1,575	1,541	1,545	1,545	1,546	1,546	1,429	2,801
1,768	1,576	1,576	1,576	1,579	1,577	1,539	2,869
1,984	1,535	1,537	1,535	1,538	1,536	1,616	2,843
2,227	1,488	1,490	1,490	1,488	1,490	1,600	2,947
2,500	1,504	1,504	1,505	1,503	1,506	1,598	2,916
2,806	1,561	1,565	1,565	1,560	1,564	1,656	2,889
3,150	1,561	1,568	1,565	1,566	1,557	1,526	2,944
3,536	1,637	1,630	1,626	1,634	1,622	1,668	3,128
3,969	1,543	1,551	1,546	1,548	1,546	1,571	2,860
4,454	1,614	1,617	1,609	1,598	1,610	1,702	3,449
5,000	1,886	1,829	1,832	1,831	1,810	1,847	3,145
5,612	2,318	2,284	2,271	2,251	2,251	2,808	3,340
6,300	2,442	2,485	2,451	2,489	2,476	2,471	4,134
7,071	3,267	3,330	3,210	3,319	3,209	2,588	5,462
7,937	2,643	2,468	2,481	2,491	2,447	2,841	5,313
8,909	2,840	2,721	2,736	2,785	2,718	2,879	4,566
10,000	2,362	2,356	2,348	2,358	2,257	2,545	4,588
11,225	2,152	2,182	2,164	2,207	2,160	2,199	4,165
12,599	1,966	1,956	2,042	1,997	1,981	2,095	3,916
14,142	2,442	2,551	2,537	2,504	2,517	2,722	5,167
15,874	2,658	2,798	2,697	2,798	2,786	2,244	6,732
17,818	3,050	2,845	2,582	2,830	2,871	2,823	6,946
20,000	3,481	3,559	3,452	3,523	3,358	3,779	5,593
22,449	4,461	4,385	4,265	4,424	4,291	4,224	7,092
25,198	4,727	4,487	4,489	4,581	4,419	3,834	8,022
28,284	4,253	4,010	3,926	4,071	3,800	4,336	7,107
31,748	4,908	4,610	4,717	4,670	4,662	4,801	8,615
35,636	4,879	5,059	5,033	4,942	4,919	6,007	8,747
40,000	6,718	6,129	6,143	6,287	6,224	5,951	10,945
44,899	5,603	5,526	5,422	5,443	5,700	5,950	8,615
50,397	5,854	5,372	5,635	5,334	5,310	5,579	10,853
56,569	5,523	5,481	5,257	5,589	5,386	5,562	11,376
63,496	5,209	5,158	5,002	5,191	5,223	4,929	10,127
71,272	5,486	5,266	5,485	5,578	5,312	5,334	8,954
80,000	5,641	5,956	5,954	5,655	5,903	5,452	8,312
89,797	6,025	6,040	5,630	6,127	6,138	5,493	8,231
100,794	5,827	5,888	6,196	6,087	5,647	5,467	8,427

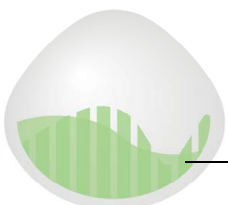
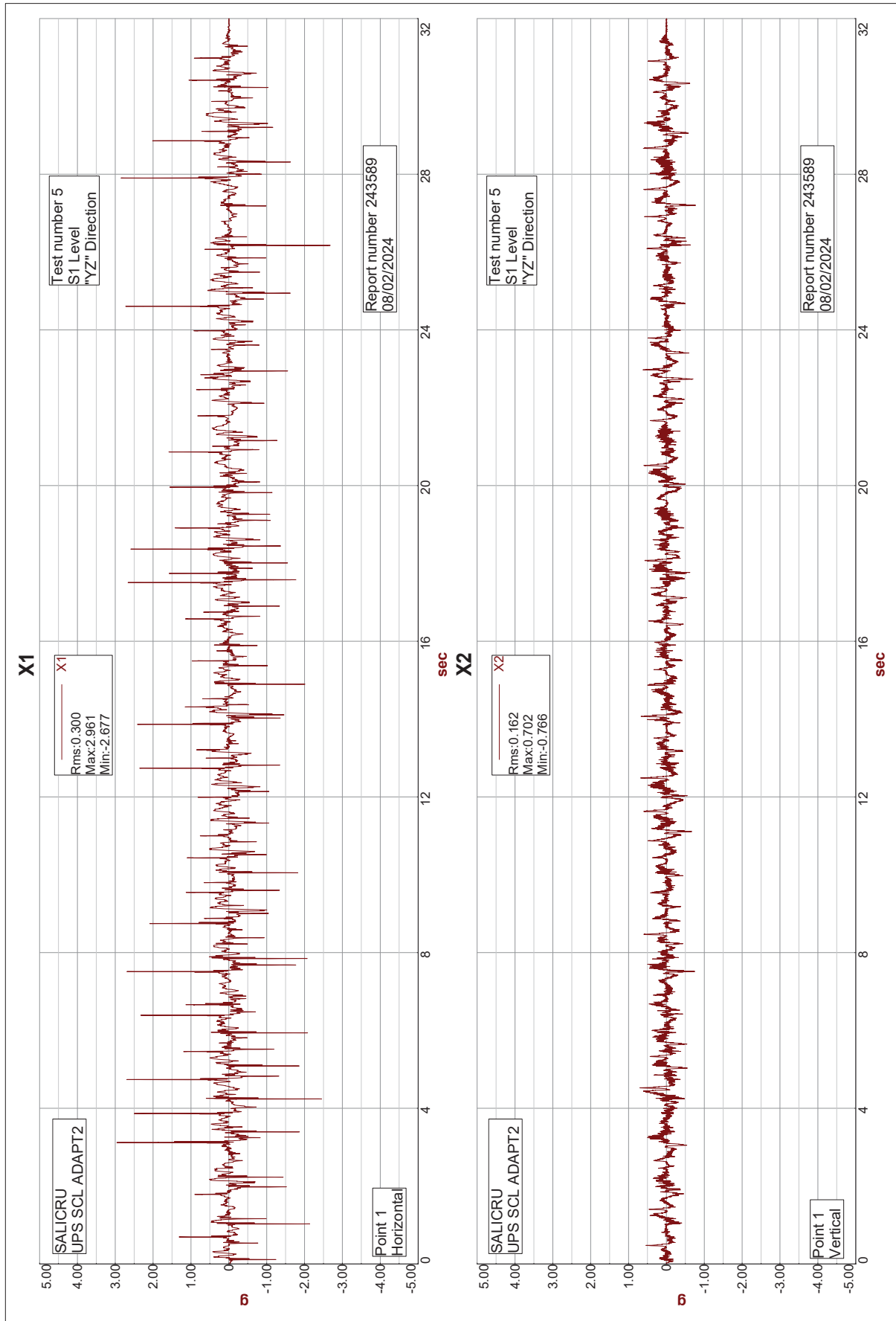


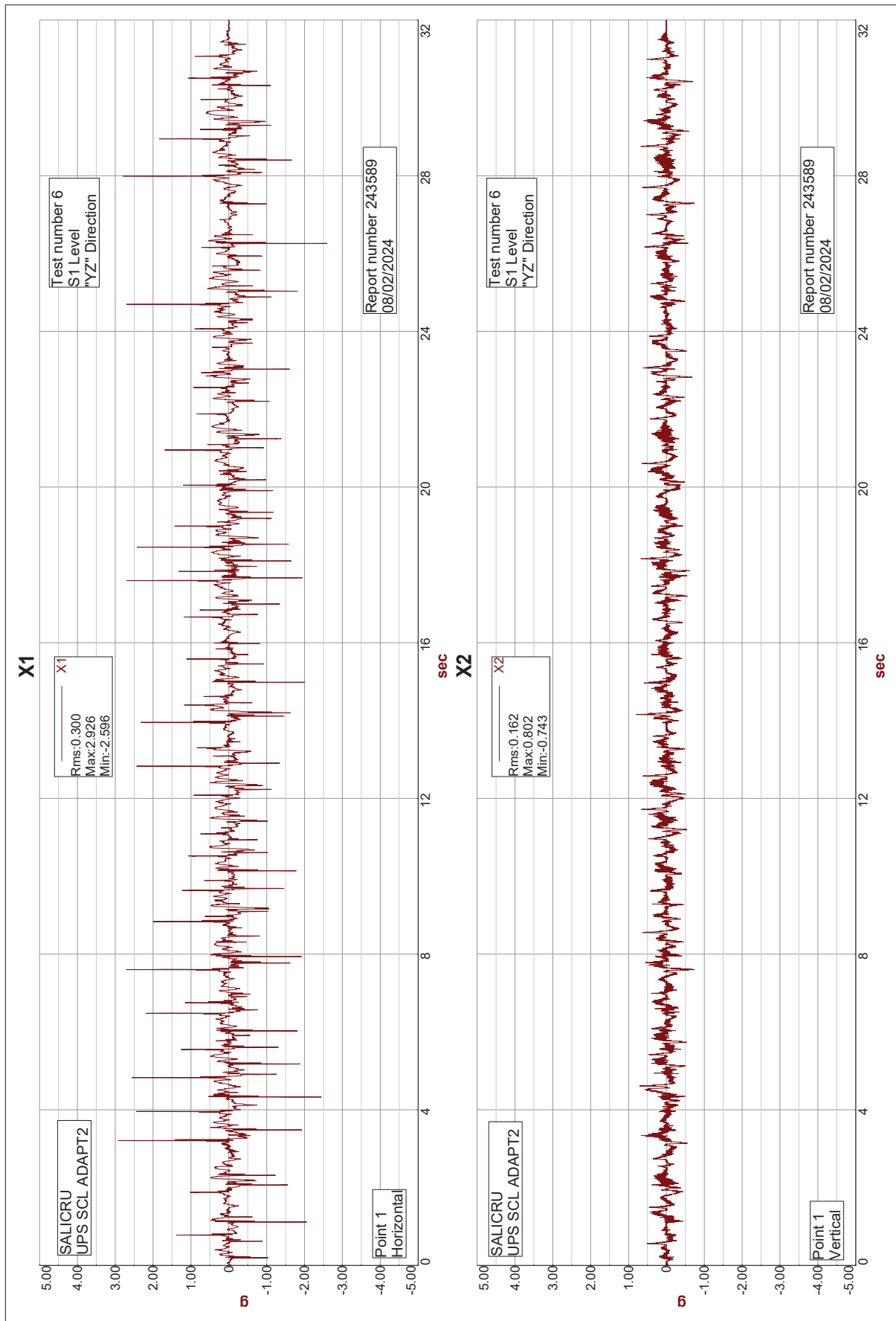
APPENDIX V

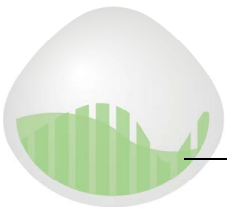
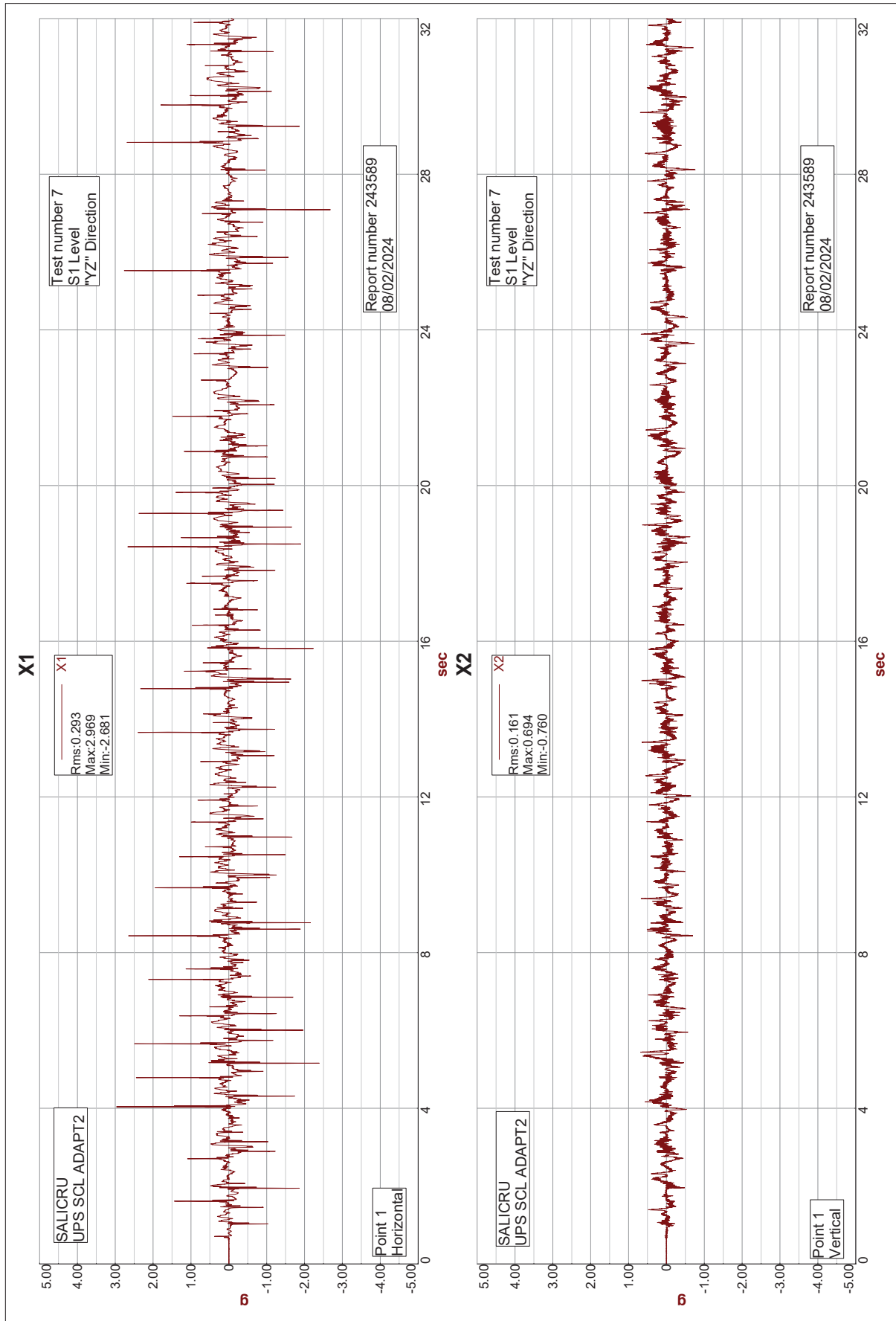
**ACCELEROGRAMS OF GROUP 1 OF ACCELEROMETERS
OBTAINED FROM THE SEISMIC TESTS.**

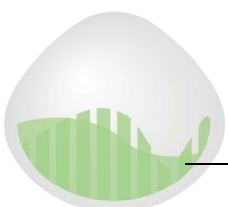
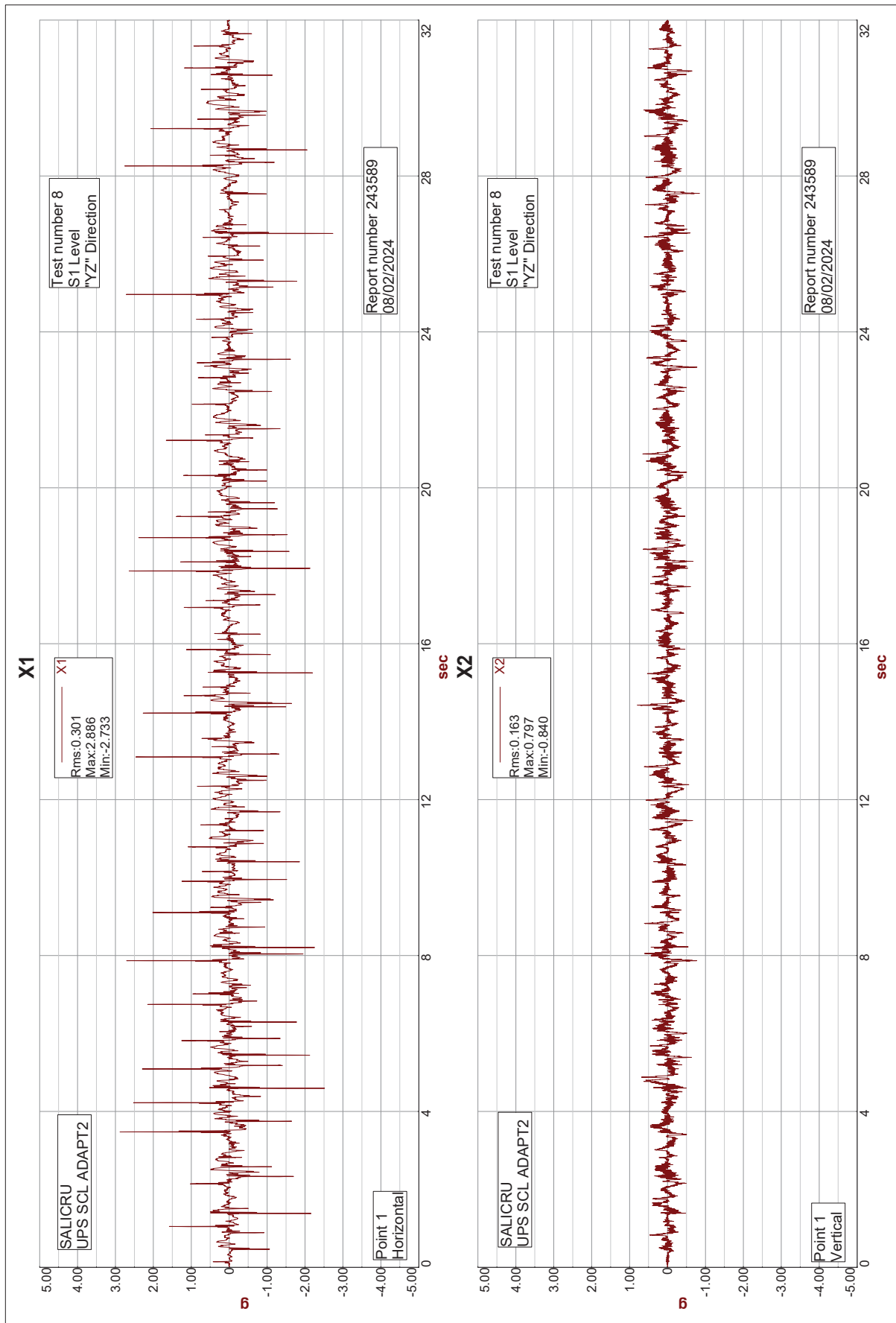


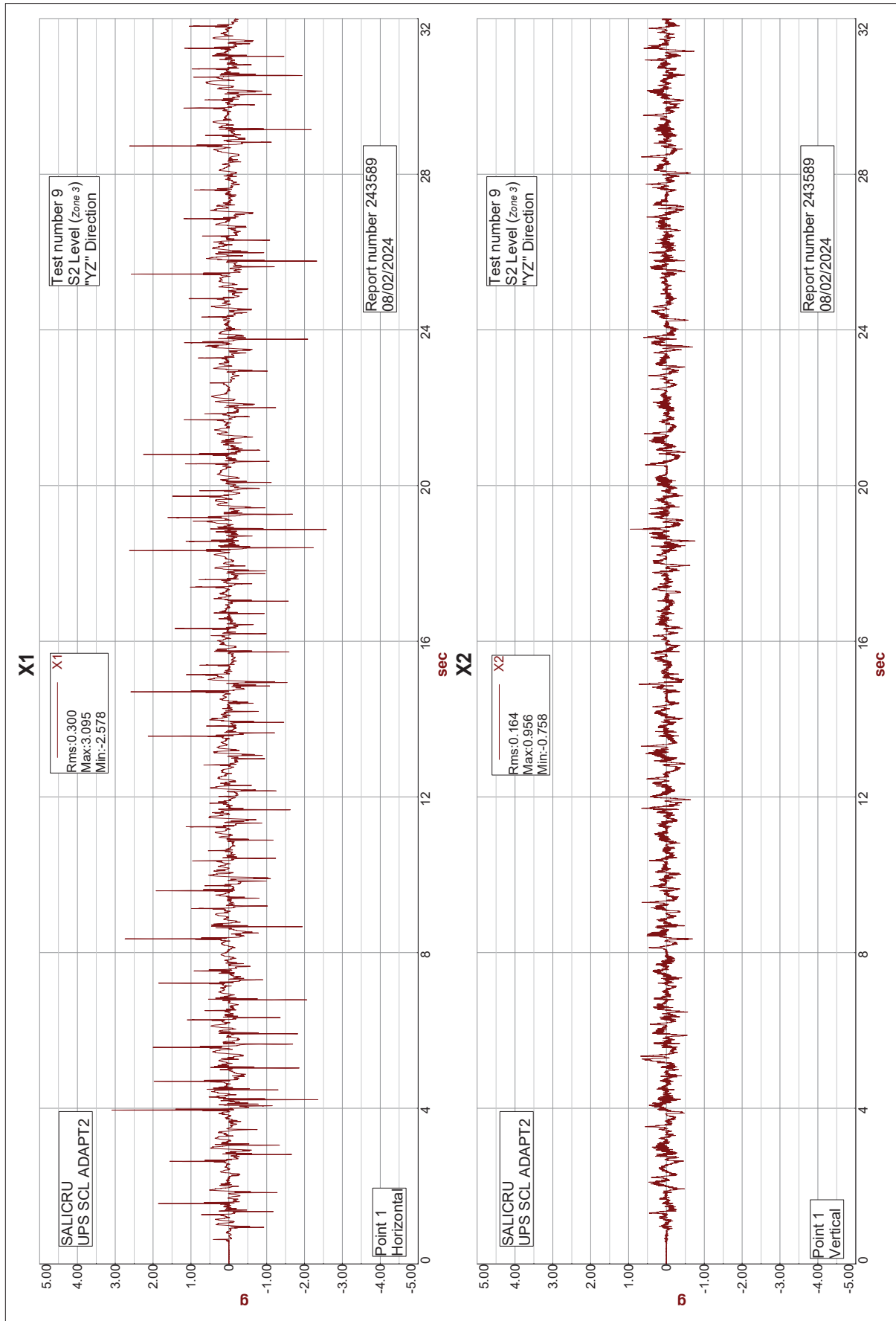


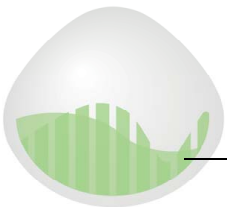
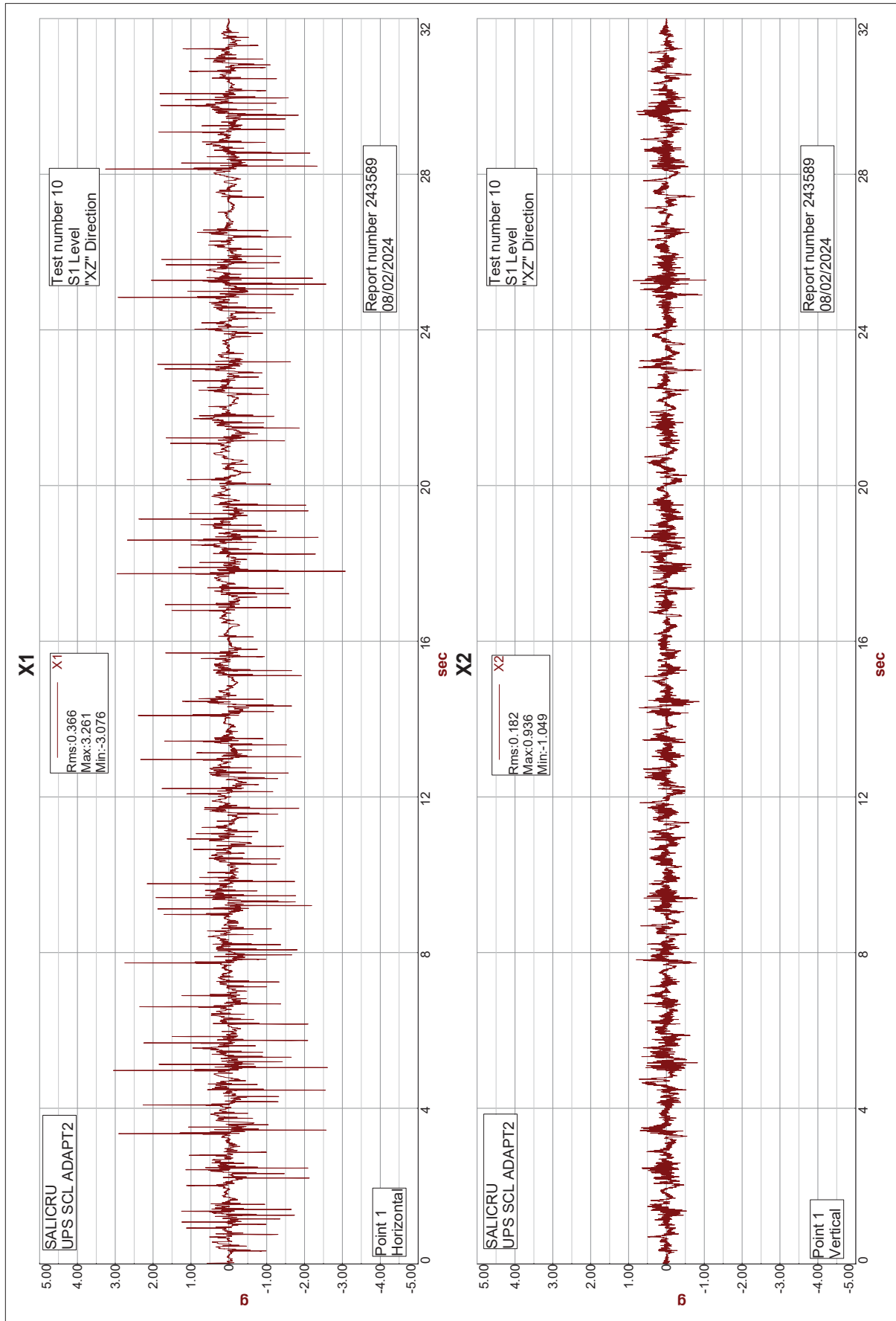


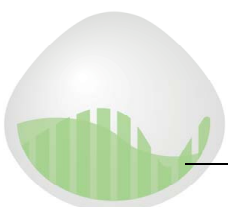
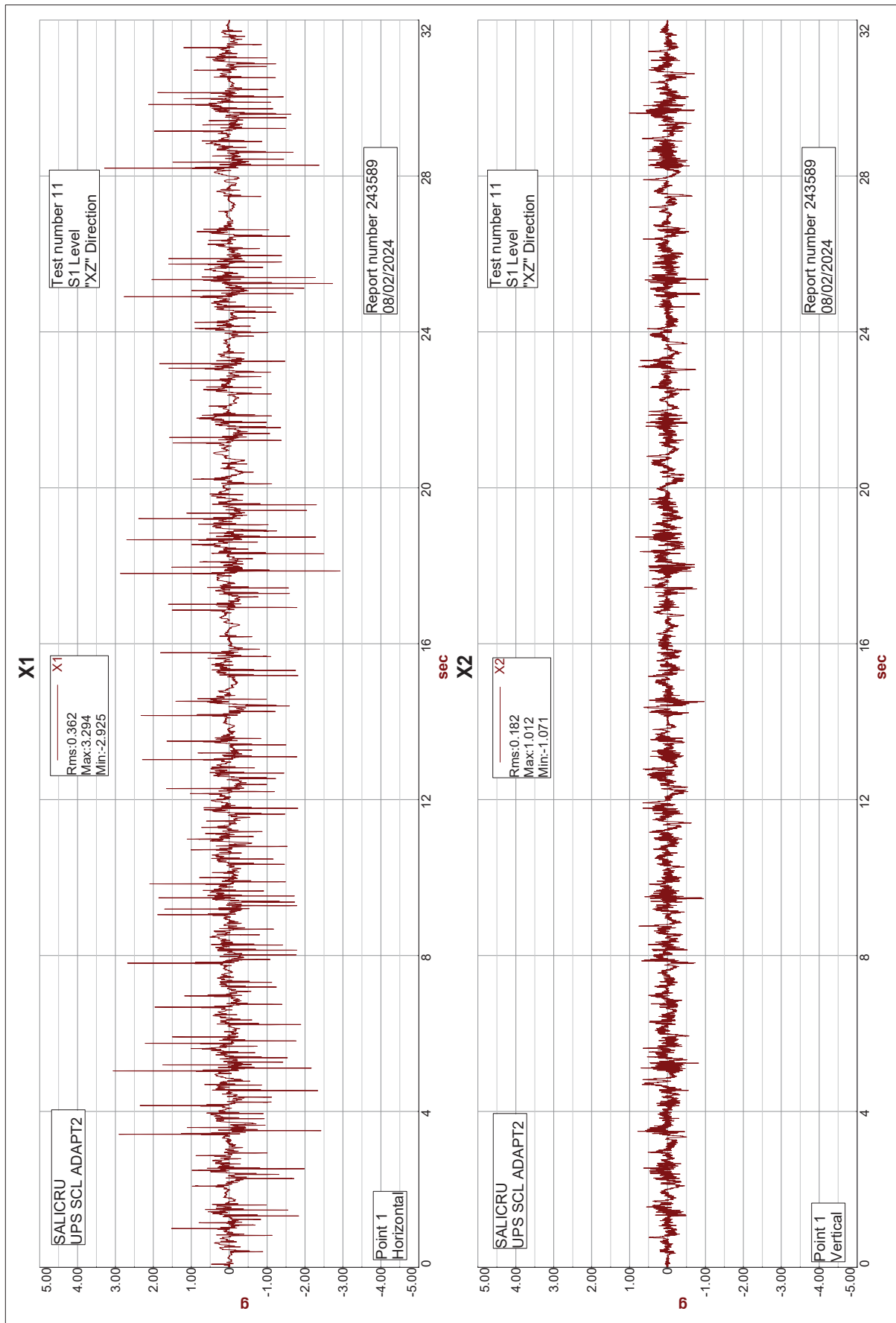


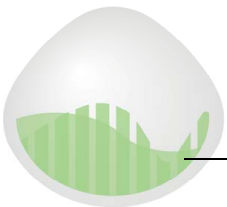
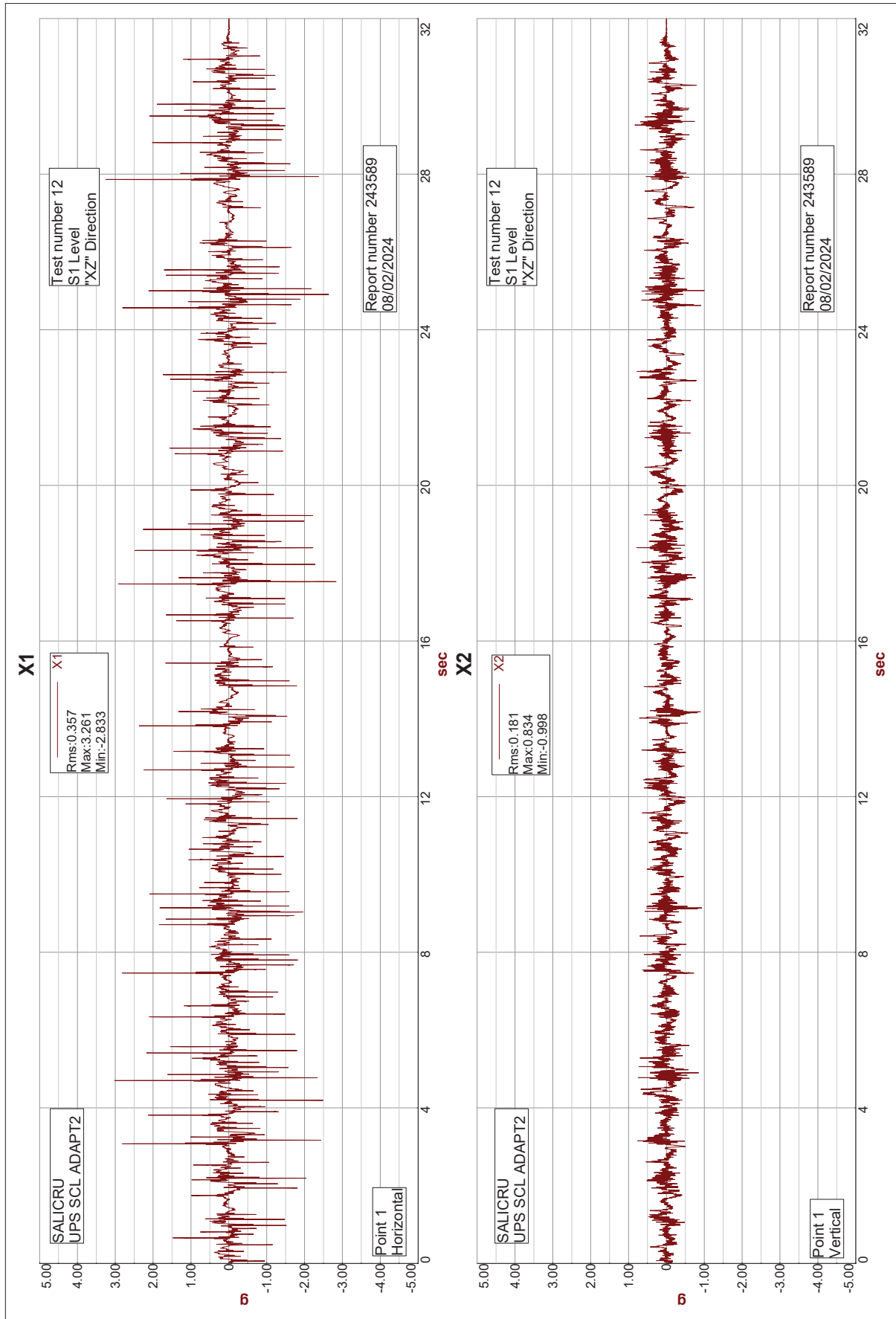


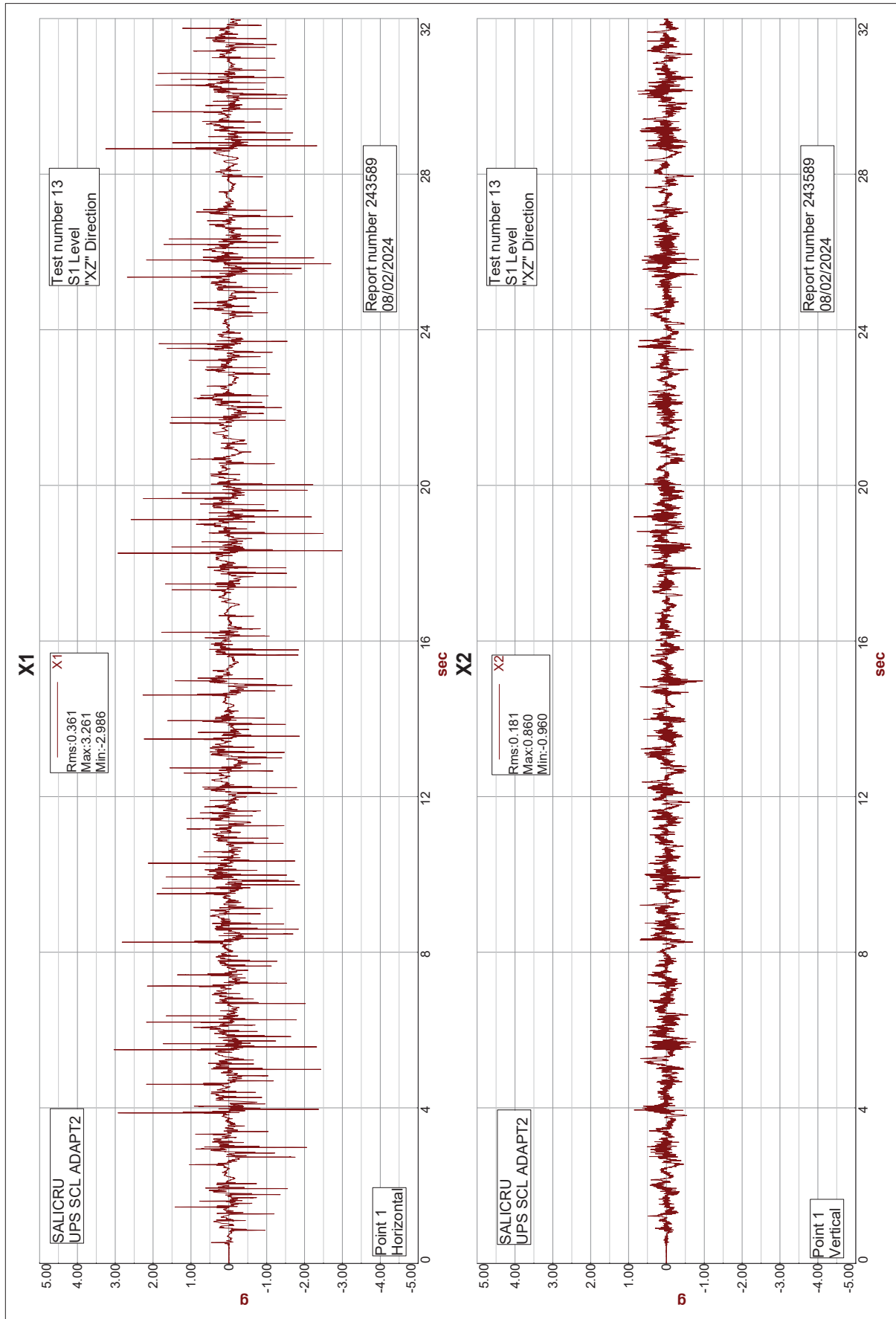


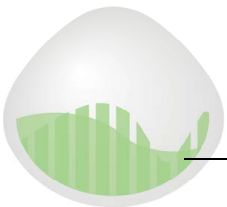
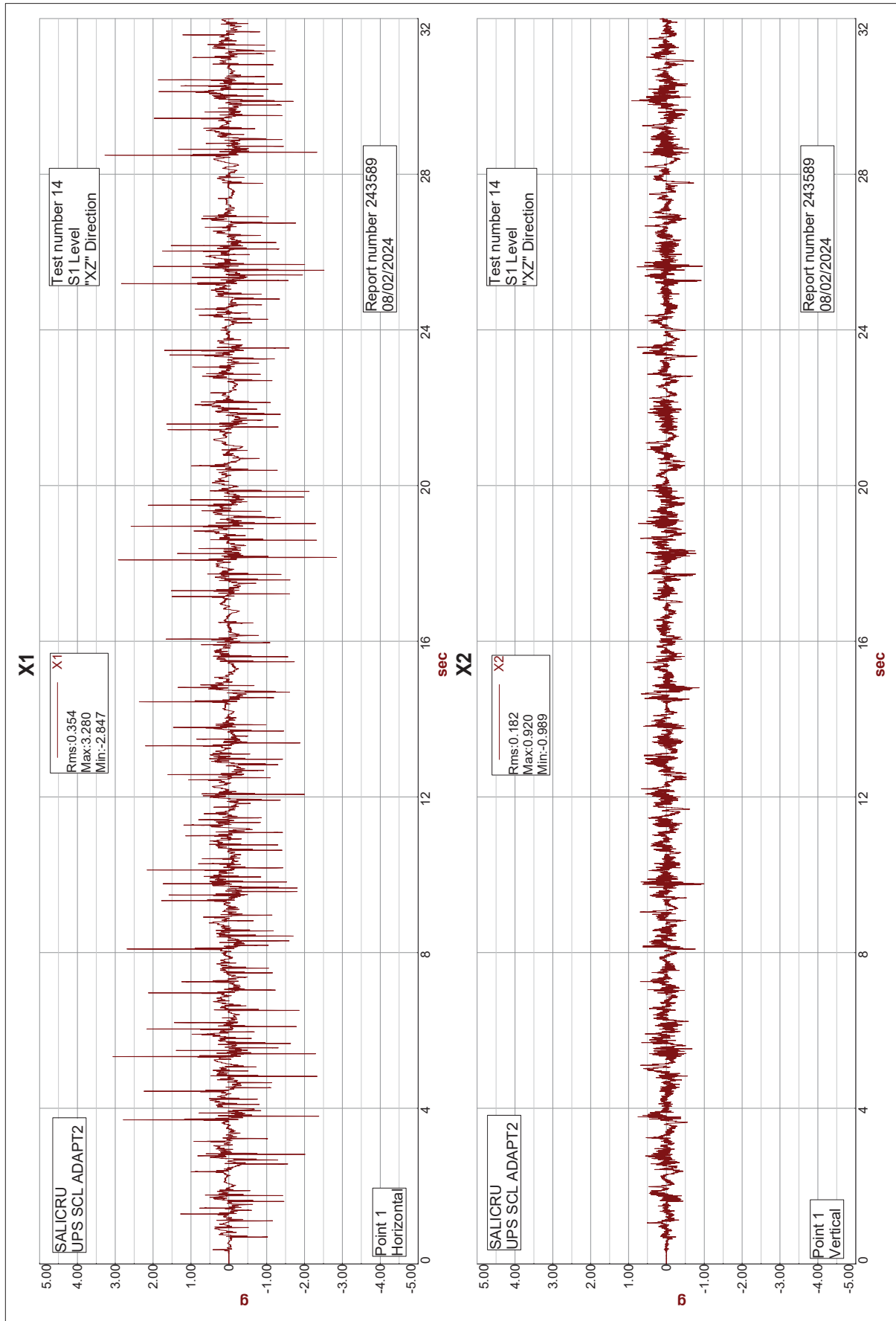


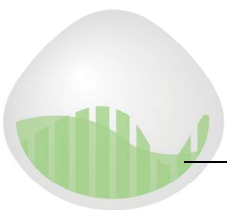
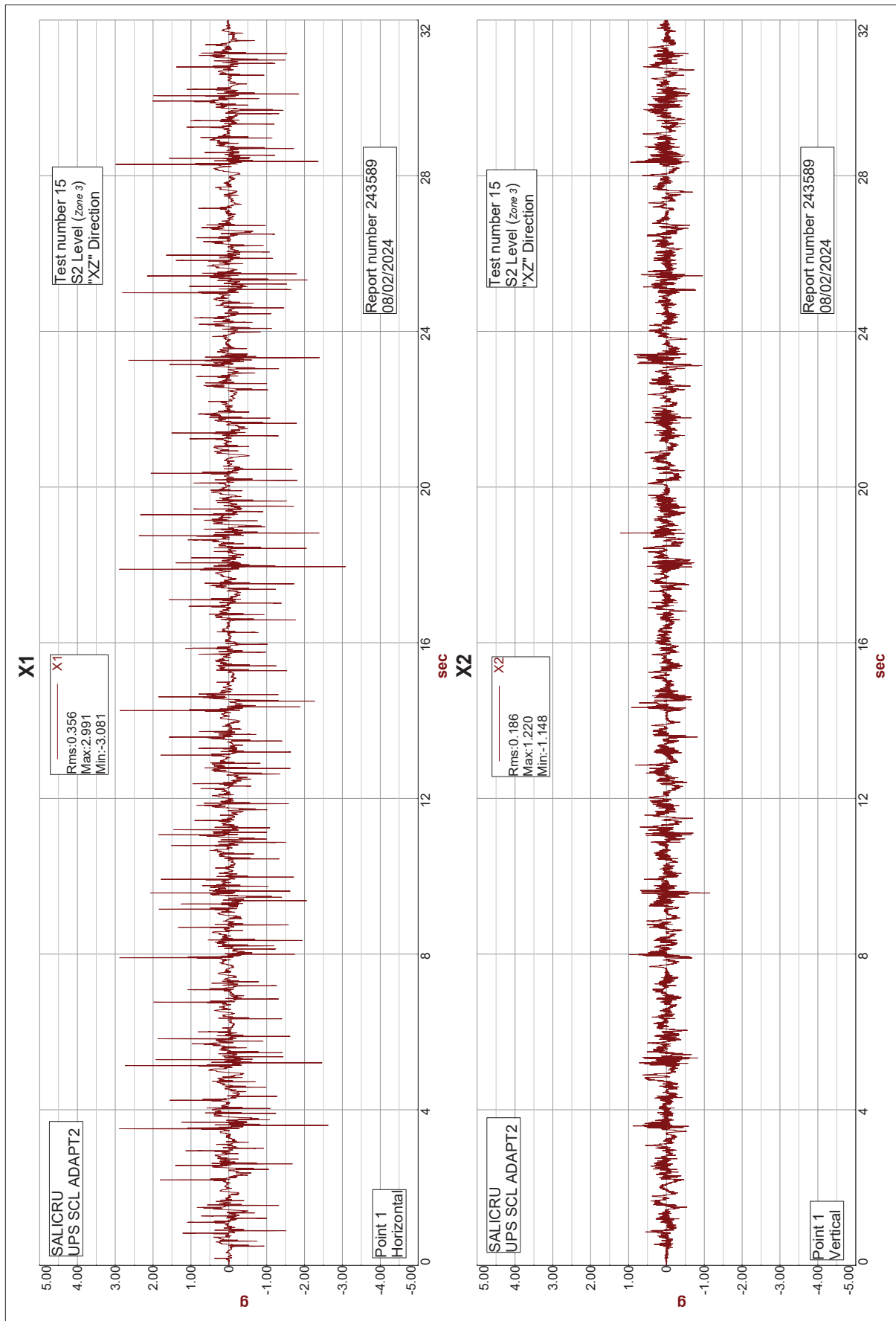


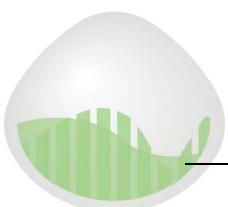
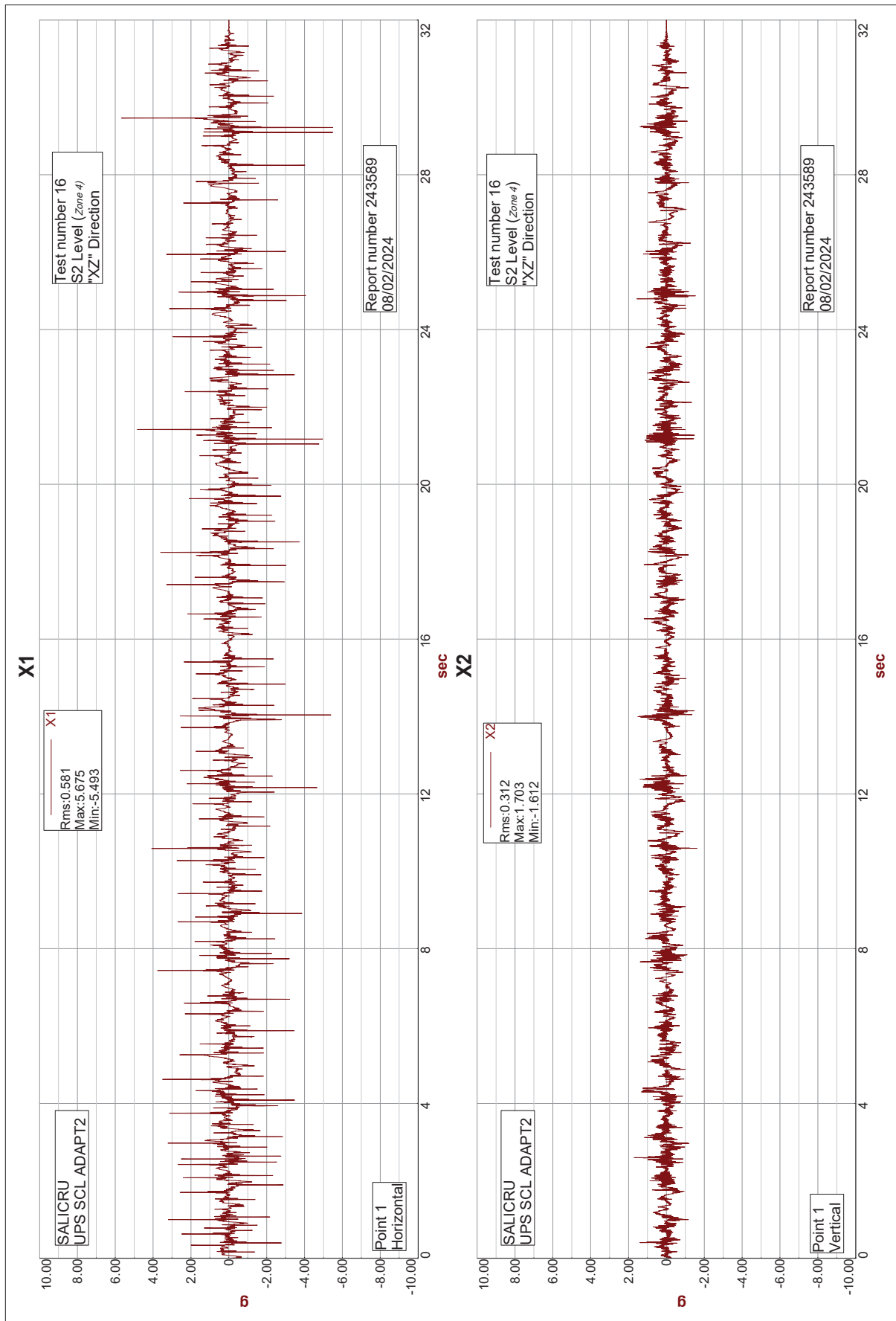


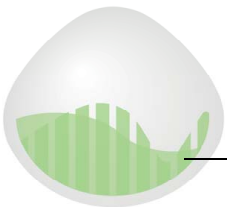
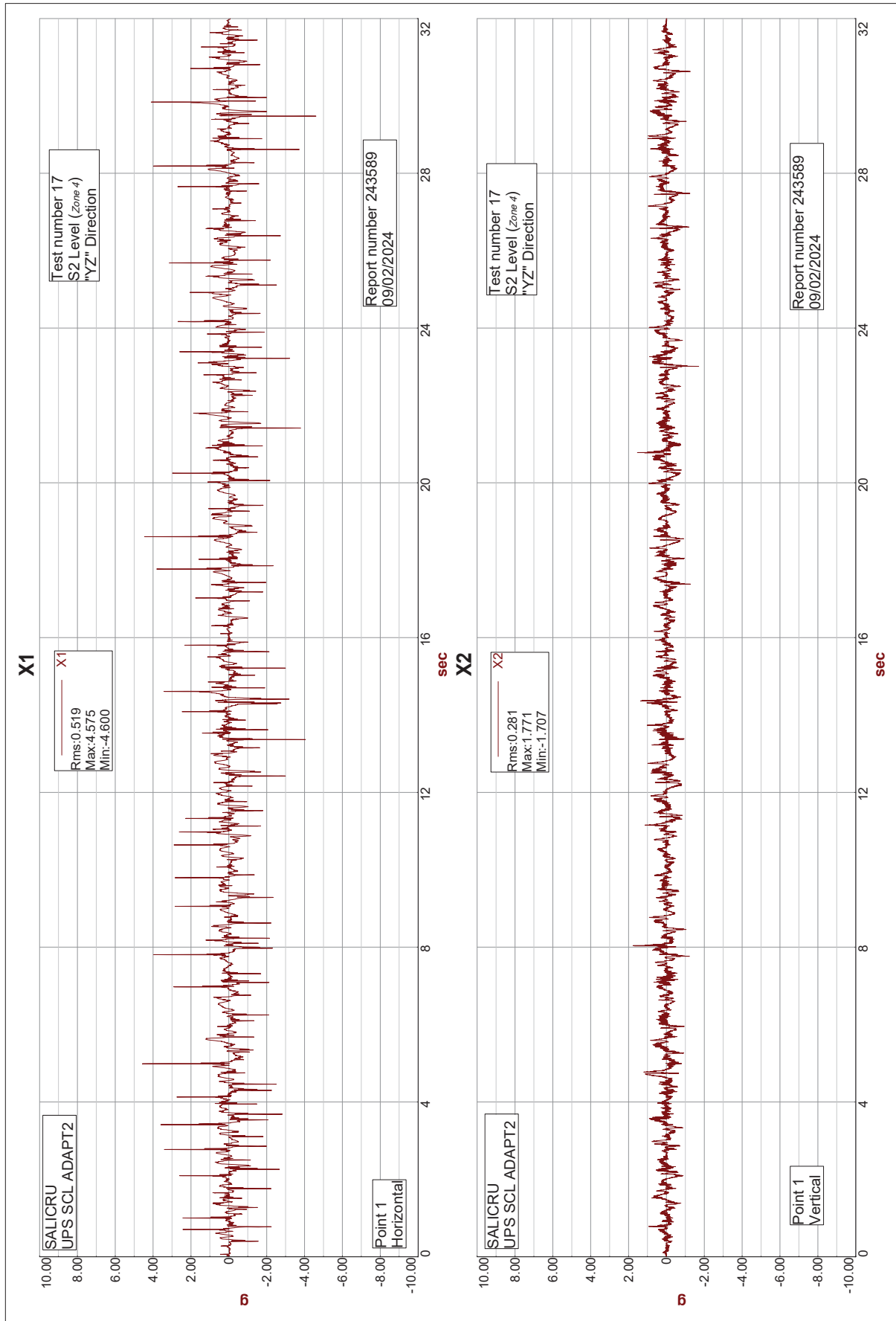






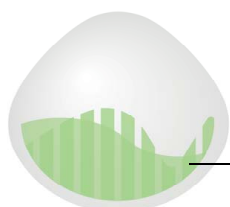




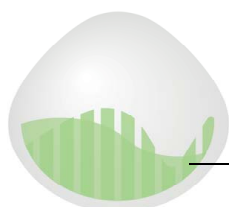


APPENDIX VI

- STAFF ATTENDING THE TESTS
- INSTALLATION DIAGRAM.
- LIST OF EQUIPMENT USED.



STAFF ATTENDING THE TESTS

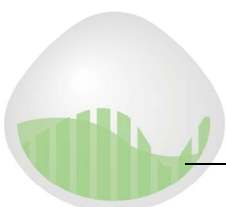


LIST OF STAFF ATTENDING THE TESTS

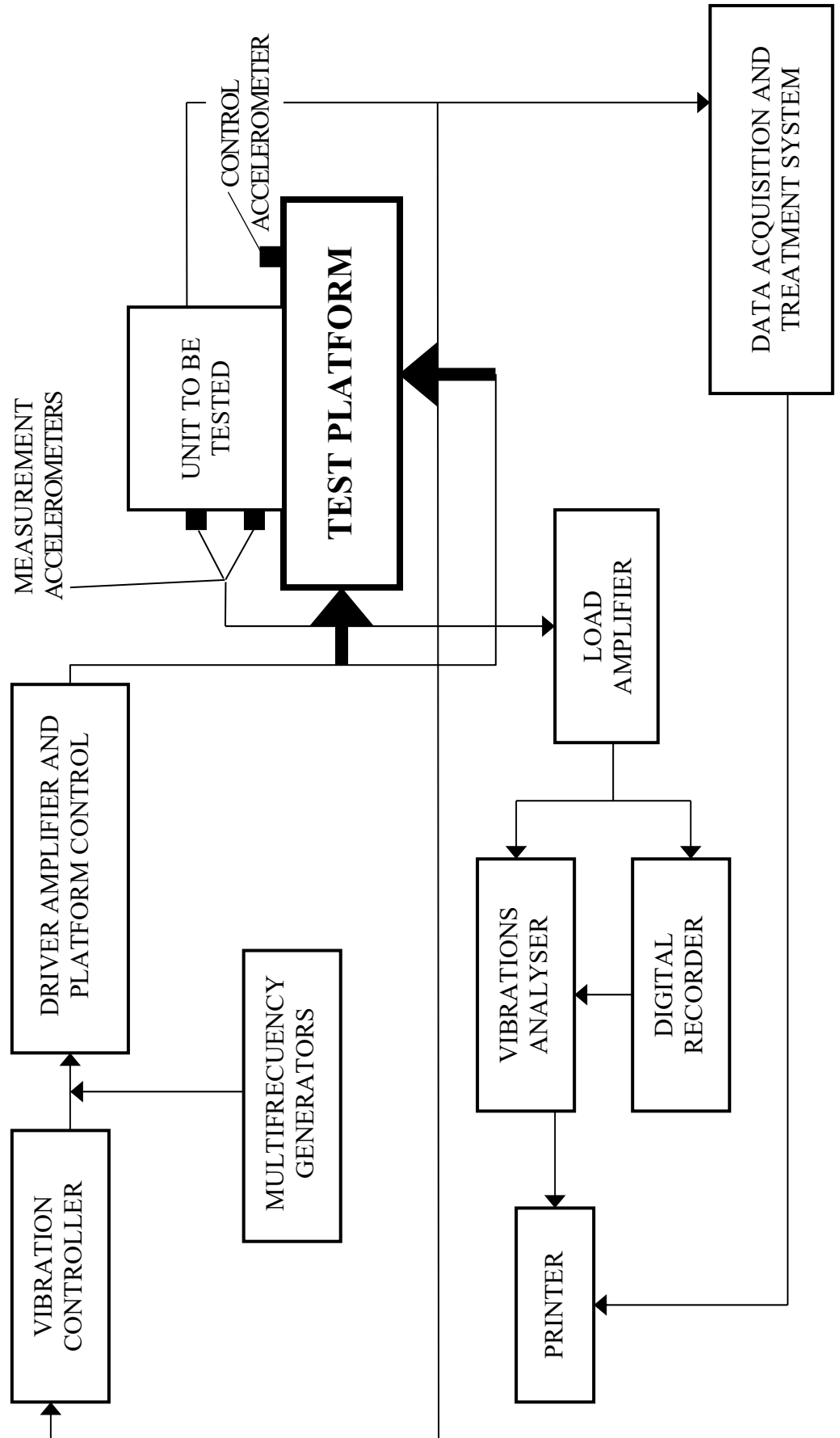
NAME	COMPANY	SIGNATURE	DATE
JONDI BARRI GONZALEZ	SALICRU		7-8/02/2024
JONDI BARRI GONZALEZ	SALICRU		9/02/2024
ASIER VELEZ DIAZ	VIRLAB S.A.		9/02/2024
PAULO GONZÁLEZ SÉNIZ	VIRLAB S.A.		07-08-09/02/24



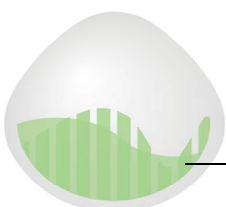
INSTALLATION DIAGRAM



INSTALLATION DIAGRAM AND MEASURING AND CONTROL EQUIPMENT OF THE DYNAMIC TEST PLATFORM



LIST OF EQUIPMENT USED

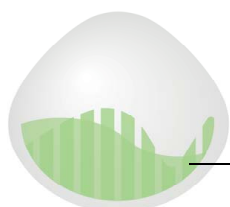


LIST OF EQUIPMENT USED

VIRLAB NUMBER	EQUIPMENT	MANUFACTURER	MODEL	SERIAL NUMBER	UNCERTAINTY	CALIBRATION DATE	CALIBRATION EXPIRATION
AS 005/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	31130 2438287	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	29/09/2022	29/03/2024
AS 006/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	31131 2438287	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	29/09/2022	29/03/2024
AS 007/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	32008 2438287	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	29/09/2022	29/03/2024
AS 008/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	31133 2438287	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	30/09/2022	30/03/2024
AS 009/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	31906 2541697	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	27/12/2023	27/06/2025
AS 010/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	32010 2541697	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	27/12/2023	27/06/2025
AS 011/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	31658 2541697	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	27/12/2023	27/06/2025
AS 012/UI	Accelerometer Amplifier	BRUEL & KJAER BRUEL & KJAER	4371 2692A014	32009 2541697	±1 % to 160 Hz ±5 % between 1 & 2500 Hz	27/12/2023	27/06/2025
AF 05/UI	16-channel signal Analyser	DATA PHYSICS CORPORATION	SIGNAL CAL DP730	S/N 09003230 System n° 70436	±1 % (Amplitude) ±0.1 % (Frequency) ±2 % (SRS Calculus)	14/02/2023	14/02/2024
GF 06/UI	Vibration Controller 8 channels input + 1 output	LING DYNAMIC SYSTEM	LASERusb	4620671	±2 % (Amplitude) ±0.1 % (Frequency)	25/05/2023	25/05/2024
GMF 04/UI	Multifrequency Generator	MC-Measurement Computing	USB-310IFS	1B79FF3	±0.25 %	17/03/2023	17/03/2025
LLD 08/UI	Adjustable Torque Wrench	HAZET	6121-1CT	00-324083	±0.29 Nm 21 Nm ±0.77 Nm 44 Nm ±1.2 Nm 76 Nm ±2.1 Nm 120 Nm	26/07/2023	26/07/2024
RD 02/UI	Digital Recorder	TEAC Corporation	Wide Band Data Recorder WX-7032	WX1561	±0.21 % (Amplitude) ±0.064 % (Frequency)	01/02/2024	01/02/2025
THG 02/UI	Thermohygrometer	PCE	PCE-HT110	S.051893	±0.29 °C. between 15 & 30 °C ±4.0 % HR. between 25 & 80 % HR	24/11/2022	24/11/2024
EDB 120x120	Biaxial Action Platform Test	VIRLAB S.A.	EDB 120x120	-	-	-	-

APPENDIX VII (*)

Document number **231002E1**, revision 0, dated 19/10/2023, of VIRLAB: “*TEST PROCEDURE FOR THE SEISMIC TESTS OF EQUIPMENT ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021*”.

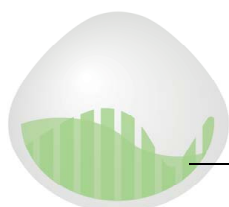


 VIRLAB	TEST PROCEDURE FOR SEISMIC TESTS OF EQUIPMENT ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021	N° 231002E1 Page 1/18 Issue: 0 Date: 19/10/23
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**TITLE: TEST PROCEDURE FOR SEISMIC TESTS OF EQUIPMENT
ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021**

REVIEWS

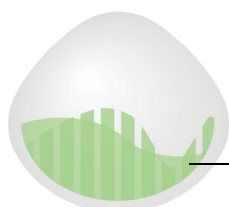
Reviews	Date	Carried out by	Revised and approved by
0	19/10/2023	 Firmado digitalmente por Jon IRIZAR Fecha: 2023.10.19 12:58:17 +02'00' Jon IRIZAR (VIRLAB)	 Firmado digitalmente por Alberto CORRAL Fecha: 2023.10.19 16:55:46 +02'00' Alberto CORRAL (VIRLAB)



 VIRLAB	TEST PROCEDURE FOR SEISMIC TESTS OF EQUIPMENT ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021	N° 231002E1 Page 2/18 Issue: 0 Date: 19/10/23
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LIST OF MODIFICATIONS

Rev. number	Date	Point Revised	Objective of the Revision
0	19/10/2023	All	Original edition



 VIRLAB	TEST PROCEDURE FOR SEISMIC TESTS OF EQUIPMENT ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021	N° 231002E1 Page 3/18 Issue: 0 Date: 19/10/23
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1.0.- **OBJECTIVE.**

The purpose of this document is to describe the procedure to be followed to perform seismic tests to **Equipment** described in section 2.0 of this document following the guidelines of the International Standard IEC 60068-3-3:2019/COR1:2021.

This procedure also considers, for the calculation of the required response spectra (RRS), the International Code “**UBC-1997**”.

2.0.- **SCOPE.**

This procedure is applicable to customer-defined equipment on a case-by-case basis. Taking into account that the applicable RRS are defined from the International Code “**UBC-1997**”, it will normally apply to Equipment to be installed in countries with a high seismic risk.

For the location of the Equipment the most conservative case is considered corresponding to Essential facilities in the table 16.K of the Code “**UBC-1997**” with a Seismic Importance Factor I_p of 1.5.

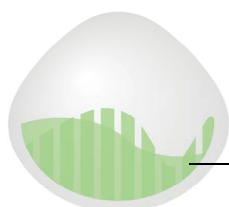
3.0.- **REFERENCES.**

3.1 **APPLICABLE STANDARD.-**

- International Standard IEC 60068-3-3:2019/COR1:2021: “*Environmental testing – Part 3-3: Supporting documentation and guidance – Seismic test methods for equipment*”.

3.2 **OTHER DOCUMENTS.-**

- Uniform Building Code 1997, “**UBC1997**”.
- International Standard IEC 60068-2-6:2007: “*Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*”.
- International Standard IEC 60068-2-57:2013: “*Environmental testing – Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method*”.
- International Standard IEC 60068-2-47:2005: “*Environmental testing – Part 2-47: Tests. Mounting of specimens for vibration, impact and similar dynamic tests*”.



 VIRLAB	TEST PROCEDURE FOR SEISMIC TESTS OF EQUIPMENT ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021	N° 231002E1 Page 4/18 Issue: 0 Date: 19/10/23
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4.0.- GENERAL.-

This procedure describes the Seismic Tests to which *Equipment* must be subjected according to the standard **IEC 60068-3-3:2019/COR1:2021**, applying the required response spectra obtained from the International Code "**UBC-1997**".

Prior to the performance of the tests, it is agreed with the client that the level of accelerations applied shall be the one corresponding to the envelopes included in **ANNEX I**, obtained from the spectra corresponding to **UBC1997** Code, "**Zone 3 & Zone 4**" with and Seismic Importance Factor, 1.5.

The corresponding spectra are obtained from the international code "UBC 1997" (**Zone 3 & Zone 4; I_p 1.5**), included in **ANNEX I** of this document. **Zone 4** presents a level ~80%, higher than **Zone 3**, so, the first objective of this test is to test the *Equipment* according to level defined by **Zone 3**. Provided the *Equipment* supports the referred level, it will be tested immediately with the level described by **Zone 4**.

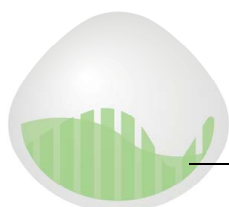
Zone 3 considers a Zero Period Acceleration (ground level) of 0.54 g in the horizontal direction and 0.36 g in the vertical direction (2/3 of the horizontal component), reaching maximum spectral accelerations of 1.35 g between 1.67 and 8.33 Hz, for 5% damping.

Zone 4 considers a Zero Period Acceleration (ground level) of 0.99 g in the horizontal direction and 0.66 g in the vertical direction (2/3 of the horizontal component), reaching maximum spectral accelerations of 2.48 g between 1.28 and 6.25 Hz, for 5% damping.

These tests will be carried out by fixing the *Equipment* to the test platform, trying to reproduce its real fixing system, following the recommendations indicated in the standard **IEC 60068-2-47:2005**.

The seismic test will be carried out on EDB 250x250 or EDB 120x120 platforms, with independent biaxial action. Therefore, and according to the standard **IEC 60068-3-3:2019/COR1:2021**, the seismic test shall be performed in two horizontal directions, orthogonal to each other and coinciding with the main directions of the equipment, both cases simultaneously with the vertical direction.

ANNEX II includes a diagram of the measuring and control equipment employed by the Laboratory to perform the seismic qualification tests.



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4.1 TEST PLATFORM

Depending on the weight and dimensions of the *Equipment* to be tested the tests may be performed in the test platforms described here below:

- EDB 250x250 biaxial platform, of 2500 x 2500 mm surface. This platform is equipped with two cylinders, each one with 150 kN of force, which can work either independently or together.
- EDB 120x120 biaxial platform, of 1200x1200 mm surface. This platform is equipped with two cylinders, each one with 100 kN of force, which can work either independently or together.

The hydraulic group, supplying oil to the cylinders, is equipped with seven motors with a total power of 330 HP, which can drive up to 640 l/min at the working pressure of 210 Kg/cm².

The hydraulic group, supplying oil to the cylinders, is equipped with seven motors with a total power of 330 HP, which can drive up to 640 l/min at the working pressure of 210 Kg/cm².

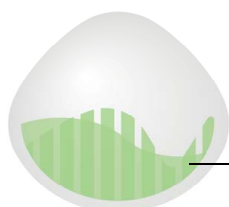
4.2 MEASURING, RECORDING AND ANALYSIS EQUIPMENT

The measurement of vibrations will be carried out by means of accelerometers, with their corresponding load conditioners.

The signals detected during the tests by the accelerometers and amplified in the load conditioners, are recorded in a digital recorder, of up to twenty-four input and eight output channels.

The analysis of vibrations will be carried out by means of analysis software, the corresponding recordings being drawn in colour.

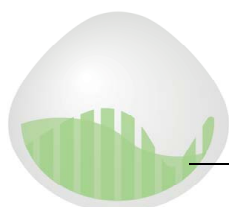
The specifications of the main instruments usually employed are the indicated in the Table below:



 VIRLAB	TEST PROCEDURE FOR SEISMIC TESTS OF EQUIPMENT ACCORDING TO INTERNATIONAL IEC 60068-3-3:2019/COR1:2021	N° 231002E1 Page 6/18 Issue: 0 Date: 19/10/23
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VIRLAB	EQUIPMENT	MANUFACTURER	MODEL	SPECIFICATIONS
AS 001/UI to AS 016/UI	Accelerometers Amplifiers	Brüel & Kjær	4371 2692A014	0.1 Hz to 100 kHz 0.1mV/pC to 10 V/pC
AS 017/UI a AS 024/UI	Accelerometers Amplifiers	Brüel & Kjær	4371 2635	0.2 Hz to 100 kHz 0.1mV/pC to 10 V/pC
AS 025/UI a AS 032/UI	Accelerometers Amplifiers	Brüel & Kjær	4371 2692A014	0.1 Hz to 100 kHz 0.1mV/pC to 10 V/pC
AF 04/UI	4-channel FFT Analyser	DATA PHYSICS CORPORATION	SIGNAL CAL DP730	DC to 40 kHz
AF 05/UI	16-channel FFT Analyser	DATA PHYSICS CORPORATION	SIGNAL CAL DP730	DC to 40 kHz
AF 06/UI	8-channel FFT Analyser	DATA PHYSICS CORPORATION	SIGNAL CAL DP730	DC to 40 kHz
AG 01/UI AG 02/UI	Isolated High-voltage System	KRENEL	12 Channel Isolation System	DC to ±500 V DC to ±600 V
DFC 01/UI DFC 02/UI	Fault Detectors 12-channel	KRENEL	KR/PD	0.5 to 20 ms
DM 04/UI	Digital Multimeter	AGILENT TECHNOLOGIES	34401A	500 V ac - 750 V dc
FAC 01/UI	DC Power Supply	HEWLETT PACKARD	6010 A	1000 W – 200 V
LLD 03/UI	Dynamometer key	PALMERA	200054	8 to 54 Nm
GF 06/UI & GF 08/UI	Vibration Controller	Ling Dynamic System	LASERusb	• 8 input channels • 1 output channel
GF 07/UI	Vibration Controller	Data Physics Corporation	ABACUS DP720-DP780	• 4 input channels • 2 output channels
GF 09/UI	Vibration Controller	Data Physics Corporation	ABACUS DP720-DP780	• 16 input channels • 2 output channels
GF 10/UI	Vibration Controller	Data Physics Corporation	ABACUS DP720-DP780	• 8 input channels • 1 output channel
GMF 03/UI	Multifrequency Generator	IOTECH INC + DASYPAL	Personal DAQ/3000 series	0.1-1000 Hz
GMF 04/UI	Multifrequency Generator	MC Measurement computing + DASYPAL	USB-3101FS	0.1-1000 Hz
PA 02/UI	Clamp Ammeter DC/AC	FLUKE	336	600A; 600V; 6000Ω
PA 04/UI	Clamp Ammeter DC/AC	FLUKE	i30	20A ac / 30 Adc
PA 05/UI	Clamp Ammeter DC/AC	FLUKE	i310s	30A / 300 A
RD 01/UI	Digital Recorder	ZODIAC DATA SYSTEM GMBH	DATaRec 4	24 input channels 12 output channels DC to 80 kHz
SAD 01/UI	Data Acquisition System	IOTECH INC.	DAQBOOK 2000A	30 channels 200 kHz
SAD 03/UI	Data Acquisition System	IOTECH INC.	WAVEBOOK 516E	40 channels 1 MHz

Table 1: Instrumentation



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4.3 UNCERTAINTY OF THE MEASUREMENTS

The uncertainty of the measurements in tests will be performed according to indicated in VIRLAB general procedure number POC-VIRLAB/16, "Procedure to calculate the uncertainty of the measurements in tests and / or calibrations", elaborated according to publication EA-4/02 of the European co-operation for Accreditation.

In the final report to be carried out at the conclusions of the seismic tests, the uncertainties of the instrumentation employed will be indicated.

5.0.- IMPLEMENTATION.-

Before starting the tests, the *Equipment* tested will be submitted to a visual inspection, also checking that they correspond to the described in this procedure.

5.1 FIXING

The *Equipment* shall be fixed to the test platform, simulating as far as possible its fastening system in the real location, as described in the standard **IEC 60068-2-47:2005**.

5.2 ACCELEROMETER LOCATION

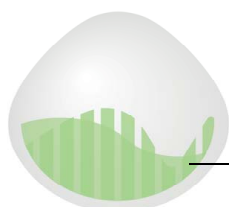
Accelerometers are to be placed at least in the following positions:

- The Test Platform,
- Approximately, at the level of the centre of gravity, CG (*if possible*).
- At the upper extremity of the *Equipment* and
- In points considered of interest by the customer and the laboratory responsible.

5.3 CHECKS TO BE CARRIED OUT BEFORE STARTING THE TESTS.-

Before starting the vibration and seismic tests, the Equipment to be tested will be subjected to the following verifications:

- Identification of the equipment tested.
- Visual inspection, with the purpose of detecting possible anomalies produced during transport.
- Checking the correct running of the *Equipment*, according to the manufacturer instructions (*in the charge of the client*).



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- Provided that equipment with porcelain isolators is tested, stresses at the base of the **Equipment** will be measured, by placing two strain gauges located 90° apart in the base of the highest stressed porcelain insulator. These gauges shall be located 5 cm to 8 cm above stiffener plates and welds.

5.4 TEST PROCEDURE

5.4.1 Resonance Search Tests

A resonance search test will be performed to detect the main resonance frequencies, in each one of the three main directions of the **Equipment** to be tested, longitudinal, transversal and vertical to it.

This test will be performed by sweeping the frequency excitation of the test platform, on a single axis sinusoidal vibration, from **1 to 35 Hz and from 35 to 1 Hz**, at speed rate of **1 octave per minute** (*the frequency doubles itself in one minute*), keeping the acceleration level constant in **0.1 g (~1 m/s²)**.

Transfer Functions of points located on the **Equipment** will be obtained from the decreasing part of the sweep.

These functions will show the resonance frequencies of the **Equipment**, in the range of 1 to 35 Hz, considering as resonances the frequencies with amplifications factors higher than 2 (*point 3.22 of IEC 60068-3-3:2019/COR1:2021*).

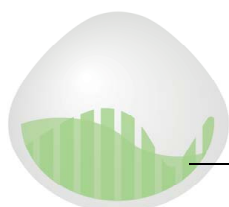
After having identified the main resonance frequencies of the **Equipment** the damping will be calculated, by the “**Half Power Bandwidth**” method, from the transmissibility function of the accelerometer located close to the Centre of Gravity, CG. If it is not possible to place an accelerometer on the CG, the accelerometer on top of the **Equipment** will be employed.

As it is indicated by this method the **Equipment** damping will be deduced calculating the previous (F1) and the post (F2) frequencies to the resonance (Fr) frequency, in which the amplification is 3 dB ($\sqrt{2} = 1.4142$) lower than the one presented at the resonance. The damping, β , will be calculated from the following expression:

$$\beta (\%) = (F2 - F1) / 2Fr$$

5.4.2 Seismic Tests

After having performed the resonance search tests, the seismic tests will be carried out, “**Multifrequency**” type tests, in the way described here below:

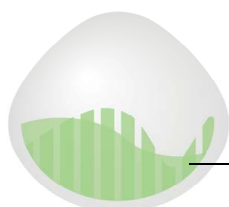


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- a) The vibrating platform shall be excited under the simultaneous action of a horizontal and a vertical component, testing the equipment in each of its two main horizontal directions ("front-to-back", *X* and "side-to-side", *Y*).
- b) According to the standard **IEC 60068-3-3:2019/COR1:2021**, a damping value of 5% is recommended, and the signal applied to the test platform shall be generated with a resolution of at least 6 divisions per octave (1/6).
- c) The damping of the **RRS** (*Required Response Spectrum*) shall therefore be 5% with respect to the critical one, as also described in the **UBC-1997** code, and the same damping shall be applied for the vertical component as for the horizontal component.
- d) The test response spectra (*horizontal and vertical*), **TRS**, (*Test Response Spectra*), of the control accelerometers, placed on the vibrating platform, shall also be calculated for 5% damping and shall envelop the corresponding RRS with a resolution of 1/6 octave.
- e) The Test Response Spectra, **TRS**, shall envelop the Required Response Spectra, **RRS**, in the frequency range between 1 and 100 Hz.
- f) In accordance with the standard **IEC 60068-3-3: 2019/COR1:2021**, in each of the two main horizontal directions (*front-to-back and side-to-side*) of the **Equipment**, simultaneously with the vertical, five (5) level tests shall be performed. "**S1**" level (*50% S2 level*), followed by one (1) "**S2**" level test.
- g) The total duration of the tests shall be at least 30 seconds, while the duration of the strong part of the test shall not be less than 20 seconds, the strong part being the time interval between the moment when the acceleration of the accelerogram reaches 25% of the ZPA and the moment when it decays below said 25% of maximum amplitude.
- h) If there are two or more critical service conditions, as would be the case of a circuit breaker in "open" or "closed" positions, the S2 level tests shall be performed in each of the possible service conditions.
- i) The *Required Response Spectrum*, **RRS**, of level **S2**, corresponding to the horizontal and vertical direction are attached in **FIGURES 1 to 4**. The vertical RRS is obtained from the horizontal one applying a reduction coefficient of 2/3:
 - Figure 1, Horizontal S2 corresponding to **UBC1997, Zone 3**,
 - Figure 2, Vertical S2 corresponding to **UBC1997, Zone 3**, 2/3 Figure 1,
 - Figure 3, Horizontal S2 corresponding to **UBC1997, Zone 4**,
 - Figure 4, Vertical S2 corresponding to **UBC1997, Zone 4**, 2/3 Figure 3,

The levels described here below will be applied:

1. The corresponding to **UBC1997, Zone 3, Ip 1.5**:
 - Zone, 3 (*Z-factor, 0.3*)
 - Type of ground profile, SD (*rigid or unknown ground*)
 - Seismic coefficient, Ca, 0.36
 - Seismic coefficient, Cv, 0.54
 - Control period, Ts, 0.60 (*Cv/2.5 Ca*)
 - Control period, To, 0.12 (*0.2 Ts*)



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- Seismic Importance Factor I_p 1.5

2. The corresponding to **UBC1997, Zone 4, I_p 1.5:**

- Zone, 4 (*Z-factor*, = 0.4)
- Type of ground profile, SD (*rigid or unknown ground*)
- Seismic coefficient, C_a , 0.66
- Seismic coefficient, C_v , 1.28
- Control period, T_s , 0.78 ($C_v/2.5 C_a$)
- Control period, T_0 , 0.16 ($0.2 T_s$)
- Seismic Importance Factor I_p 1.5

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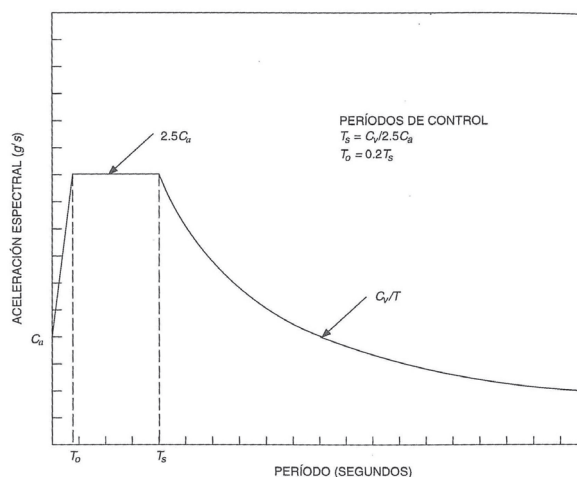


FIGURA 16-3—ESPECTROS DE RESPUESTA DE DISEÑO

S1 level tests will be the 50% of the S2 level corresponding to **Zone 4**.

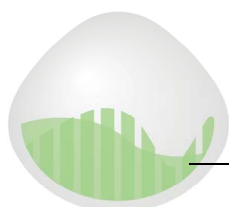
5.4.3 Sequence of Tests

The sequence of tests will be the one described here below:

1. **RESONANCE SEARCH TESTS**

Vertical, Z direction
Front-to-back, X direction
Rotation 90°
Side-to-side, Y direction

2. **SEISMIC TESTS**



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YZ Direction

5 S1 (50% S2 Zone 4)

1 S2 (Zone 3)

Rotation 90°

XZ Direction

5 S1 (50% S2 Zone 4)

1 S2 (Zone 3)

SEQUENCE OF TESTS FOR ZONE 3 LEVEL FINISHED

XZ Direction

1 S2 (Zone 4)

Rotation 90°

YZ Direction

1 S2 (Zone 4)

SEQUENCE OF TESTS FOR ZONE 4 LEVEL FINISHED

5.5 RUNNING SIMULATION.-

The **Equipment** will be tested simulating its operating conditions, according to manufacturer instructions.

The necessary signals to show the operating conditions (*indicated by the client*) will be monitored by means of a Data Acquisition and Treatment System, with a sampling speed of at least 1000 samples per second.

5.6 CHECKS TO BE MADE UPON CONCLUSION OF THE TESTS.-

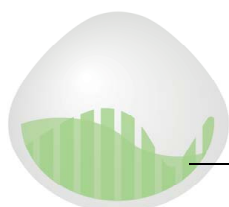
Once the resonance search and seismic tests have been carried out, the **Equipment** will be subjected to the same tests as those described in point 5.3:

- Visual inspection, to evaluate if it has been damaged during the tests.
- Checking the correct running of the **Equipment**, according to the manufacturer instructions (in the charge of the client).

5.7 ACCEPTANCE CRITERIA

The acceptance criteria should be defined by the client for each particular Equipment.

Anyway, the consideration of the compliance of the acceptance criteria is the responsibility of the client.

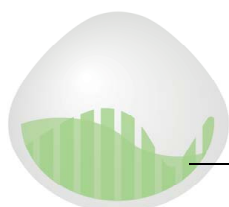


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5.8 REPORT

The Laboratory will elaborate a final report of the test results, which will contain the following information:

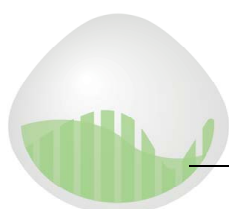
- Name and address of the Laboratory.
- Identification of the document and each of its pages.
- Name and address of the client.
- Description and identification of the tested material.
- Description of the platform on which the tests were carried out.
- Location of the accelerometers.
- Reception date of the tested material and date of the test performance.
- Reference of the standards, procedures and specifications applied.
- Results of the test, with drawings, figures, tables, photographs, information obtained (*TRS over RRS*), etc., as well as possible faults detected.
- The acceptance criteria.
- Signature and position held by the person with technical responsibility for the test report and the date of its issue.
- A warning that the report should not be reproduced without the approval of the Laboratory except when it is entirely in facsimile.
- Reference of the incertitude of the instrumentation to be employed.
- Test measurement equipment and state of calibration.



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ANNEX I

REQUIRED RESPONSE SPECTRUM OF LEVEL S2





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UBC_1997 - Zone-3
Importance Factor 1,5

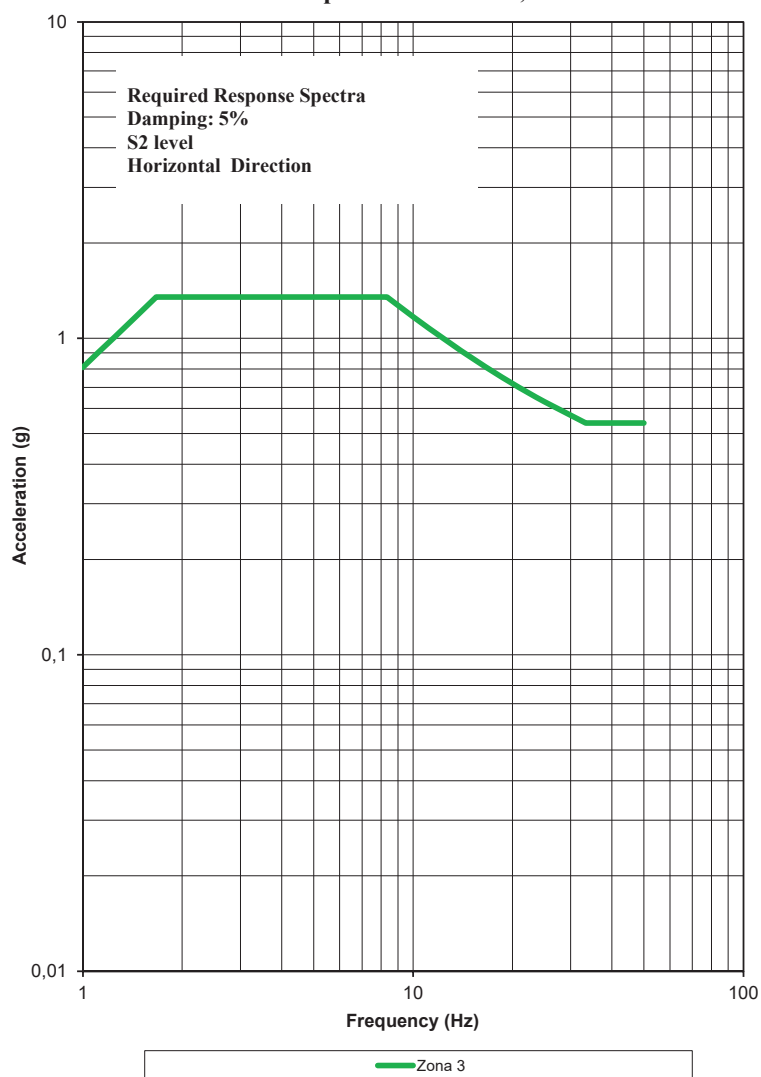
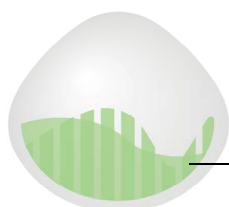


FIGURE 1: HORIZONTAL REQUIRED RESPONSE SPECTRUM,
RRS (UBC 1997 Zone 3, Ip 1,5)





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UBC_1997 - Zone-3
Importance Factor 1,5

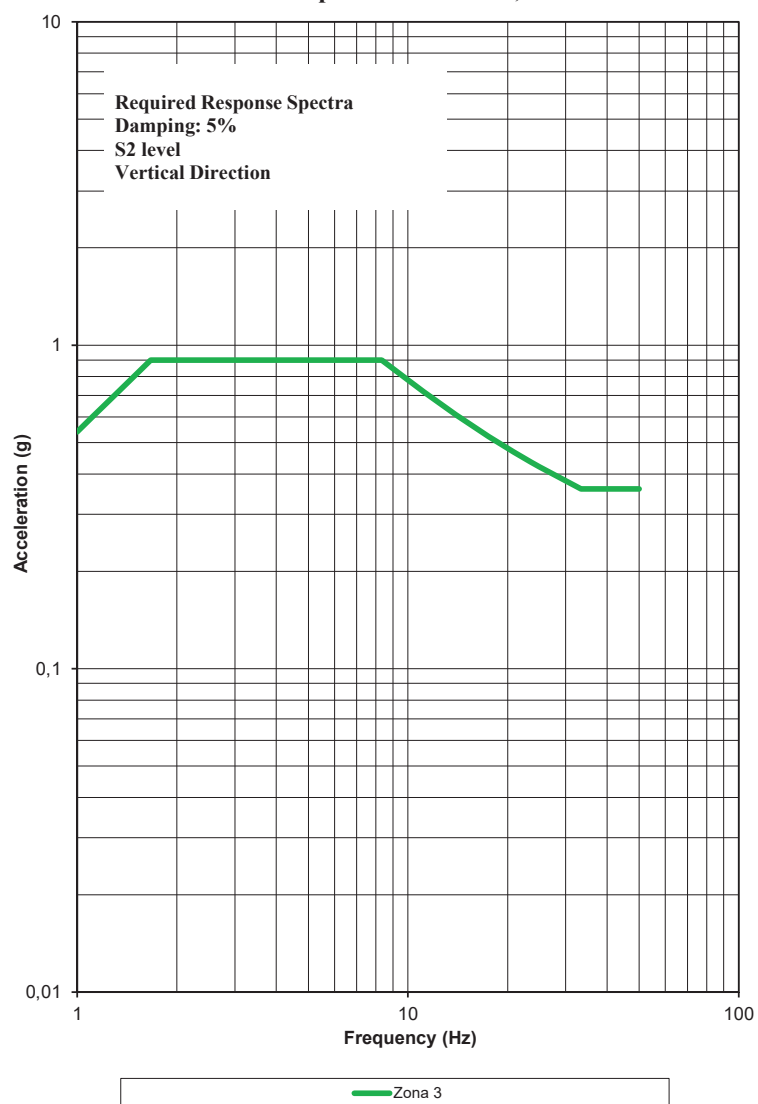
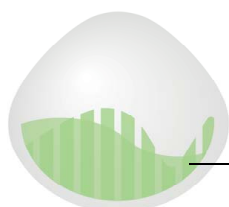


FIGURE 2: VERTICAL REQUIRED RESPONSE SPECTRUM,
RRS (UBC 1997 Zone 3, I_p 1,5)





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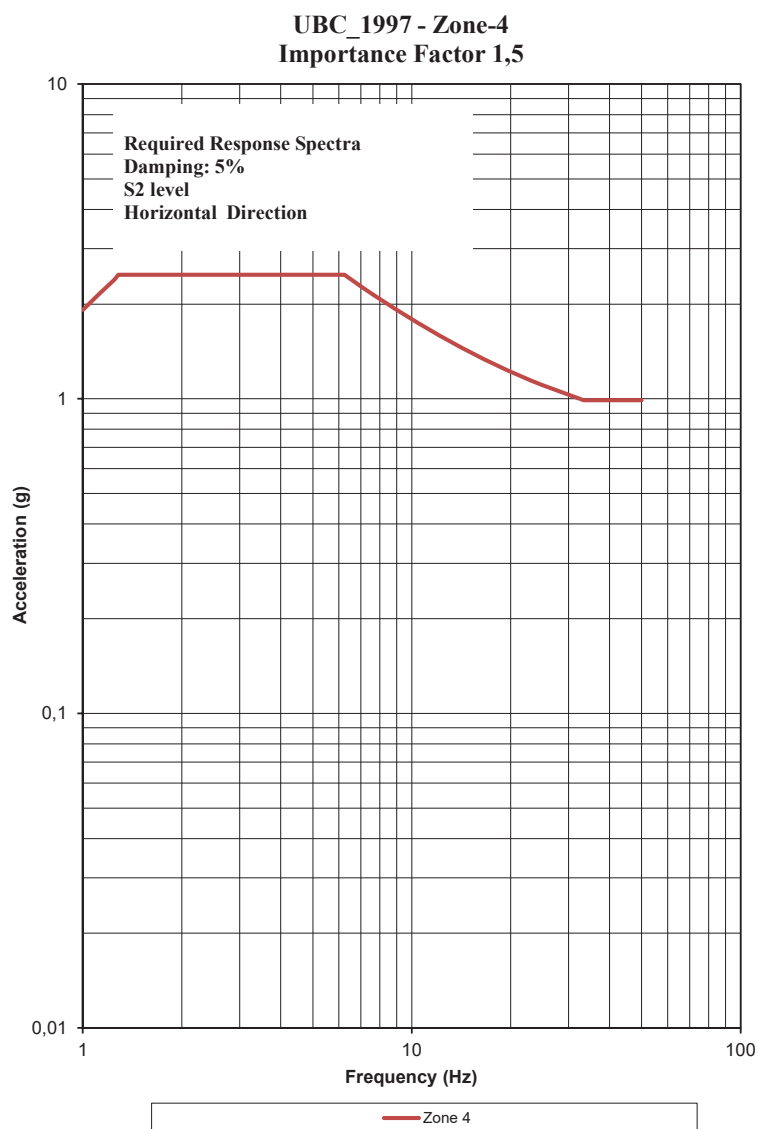
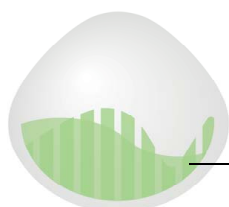


FIGURE 3: HORIZONTAL REQUIRED RESPONSE SPECTRUM,
RRS (UBC 1997 Zone 4, I_p 1,5)





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UBC_1997 - Zone-4
Importance Factor 1,5

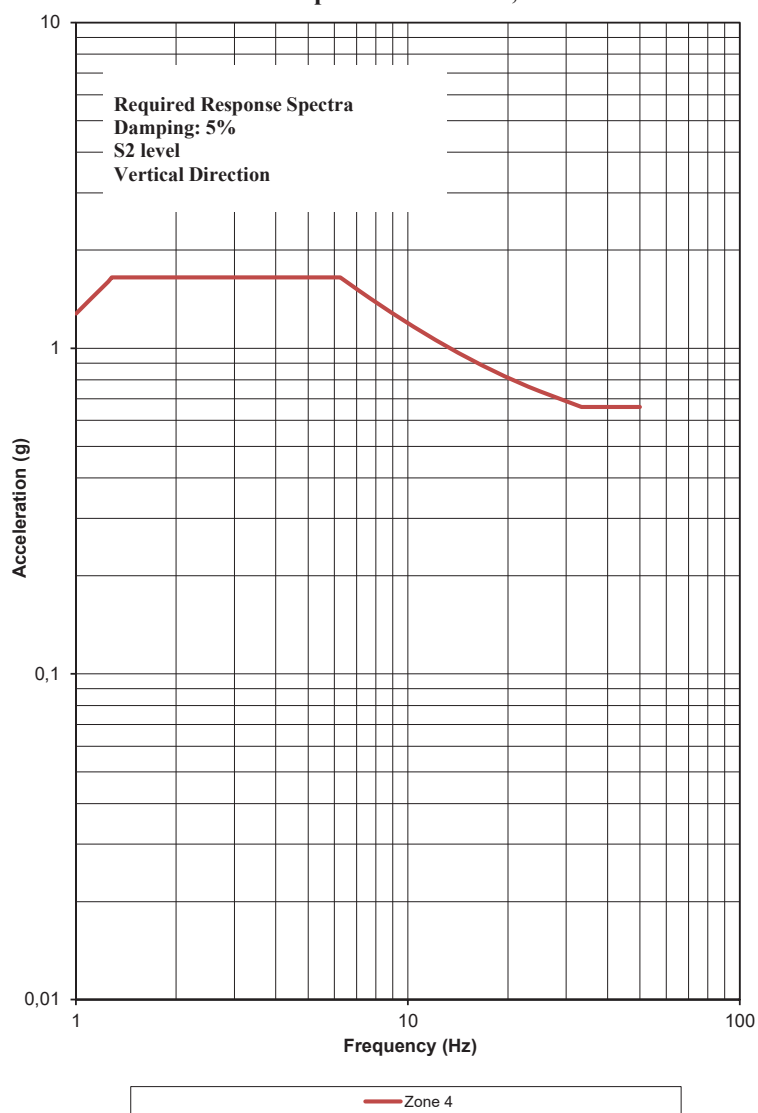
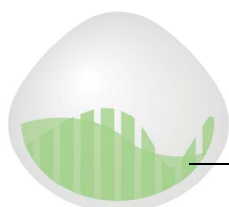


FIGURE 4: VERTICAL REQUIRED RESPONSE SPECTRUM,
RRS (UBC 1997 Zone 4, I_p 1,5)



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ANNEX II

INSTALLATION DIAGRAM AND MEASURING AND CONTROL EQUIPMENT OF THE DYNAMIC TEST PLATFORM.

