DAT-P-002/91-02

# Center for Quality Engineering

# Test Report No.: B0AL0001

| **Order No.:** B0AL | **Pages:** 32 | **Munich,** Jun 23, 2008 |
|---|---|---|

| | |
|---|---|
| Client: | Bosco S.r.l. |
| Equipment Under Test: | BOSCO Cabinet<br>Series: BTDA completed with weigth dummys |
| Manufacturer: | Bosco S.r.l. |
| Task: | Earthquake test with acceleration-time history waveform<br>VERTEQII |
| Test Specification(s):<br>[covered by accreditation] | Telcordia Technologies Generic Requirements<br>**GR 63 CORE , Issue 3,** March 2006<br>NEBS Requirements : Physical Protection<br>Section(s) 4.4 , 5.4 , Earthquake |
| Result: | The EUT complies with the requirements listed in detail in sec.6.1 |



The results relate only to the items tested as described in this test report.

| **approved by:** | **Date** | **Signature** |
|---|---|---|
| Alt<br>Manager Environmental Engineering Systems | Jun 23, 2008 | |

This document was signed electronically.

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# 1 Summary

The report contains the results from the environmental compatibility technical analysis of the Bosco equipment:

Cabinet series BTDA with Bellcore kit, completed with dummy weights (270kg)

with regard to

Telcordia Technologies Generic Requirements
**GR 63 CORE , Issue 3,** March 2006
NEBS Requirements : Physical Protection
Section(s) 4.4 , 5.4 , Earthquake

Testing was performed by SGS Deutschland GmbH, Center for Quality Engineering, CTS CQE at their test-facilities.

| **Requirement** | **Criteria met (yes/no)** | **Remark** |
|---|---|---|
| R 4-68 Earthquake: Structural / Mechanical Damage | y | Test performed without cable load |
| R 4-69 Earthquake : Deflection Criterion (3 in.) | y | Test performed without cable load |
| R 4-70 Earthquake : Natural frequency > 2 Hz | y | |
| O 4-71 Earthquake : Natural frequency > 6 Hz | y | |
| R 4-72 Earthquake : Functional performance | - | Cabinet was completed with weight dummys, therefore no function are possible |
| O 4-73 Earthquake : Functional performance | - | Cabinet was completed with weight dummys, therefore no function are possible |
| O 4-74 Earthquake : Framework and Anchor Criteria | n | |
| R 4-75 Earthquake : Framework and Anchor Criteria | y | |
| O 4-76 Earthquake : Framework and Anchor Criteria | - | Not performed. O 4-76 is coverd by Test acc. R 4-69 |
| R 4-77 Earthquake : Framework and Anchor Criteria | - | The anchors are unknown and therefore omitted from the test configuration |
| O 4-78 Earthquake : Framework and Anchor Criteria | - | The anchors are unknown and therefore omitted from the test configuration |
| O 4-79 Earthquake : Framework and Anchor Criteria | - | The anchors are unknown and therefore omitted from the test configuration |

# 2 References

## 2.1 Specifications

Telcordia Technologies Generic Requirements
**GR 63 CORE , Issue 2 (2002),** April 2002
NEBS Requirements : Physical Protection
Section(s) 4.4 , 5.4 , Earthquake

# 3 General Information

## 3.1 Identification of Client

Bosco S.r.l.
Via Montale, 2b
22070 Bulgarograsso - (CO)
Vincenzo Bosco

## 3.2 Test Laboratory

Center for Quality Engineering
SGS Germany GmbH
CTS CoC3
Hofmannstraße 51
81379 München

## 3.3 Time Schedule

Delivery of EUT: Jun 03, 2008
Start of test: Jun 11, 2008
End of test: Jun 12, 2008

## 3.4 Participants

| Name | Function | Phone | E-Mail |
|---|---|---|---|
| Alfred Knier | Accredited testing, Editor | +49 89 722-48726 | alfred.knier@nsn.com |
| Vincenzo Bosco | Client | +39 0319 891449 | vincenzo.bosco@elttrobosco.it |
| Francesco Bosco | Client | +39 0319 891449 | francesco.bosco@elttrobosco.it |
| Alberto Drei | External consulting | | |

# 4 Equipment Under Test

Cabinet series BTDA with KIT Bellcore 4

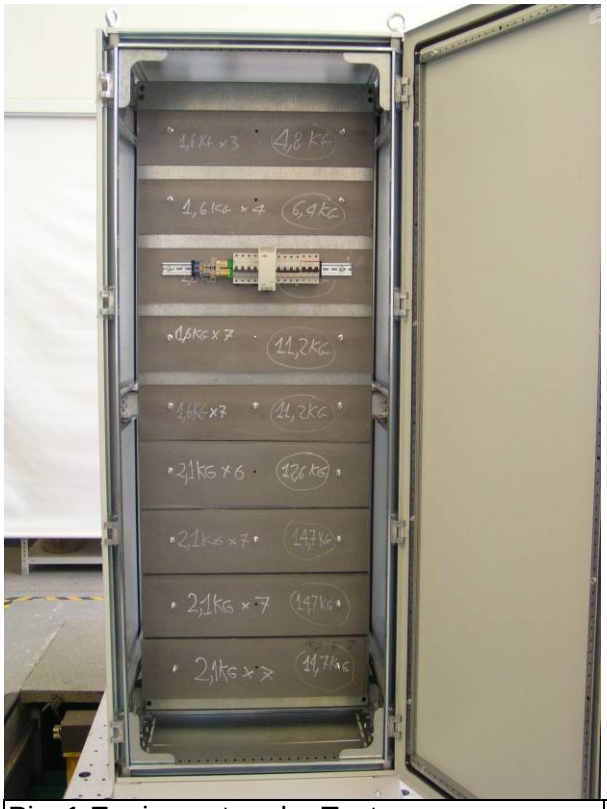
## 4.1 Configuration of EUT

| | |
|---|---|
| Cabinet: | Width 800mm, length 800mm, height 2200mm |
| Doors: | N°2 , Frontal door and door on back |
| Panel side: | N°2 Left, right |
| Base height: | 200mm |
| | |
| Total inside load: | 270kg |
| Internal mounting plate: | N° 2 (total 70kg) |
| Total weight: | 492 kg |

Disposition weight on the mounting plate

| | |
|---|---|
| 200mm From the top | 4,8kg (for 2 pcs, front and rear) |
| 400mm From the top | 6,4kg (for 2 pcs, front and rear) |
| 600mm From the top | 9,6kg (for 2 pcs, front and rear) |
| 800mm From the top | 11,2kg (for 2 pcs, front and rear) |
| 1000mm From the top | 11,2kg (for 2 pcs, front and rear) |
| 1200mm From the top | 12,6kg (for 2 pcs, front and rear) |
| 1400mm From the top | 14,7kg (for 2 pcs, front and rear) |
| 1600mm From the top | 14,7kg (for 2 pcs, front and rear) |
| 1800mm From the top | 14,7kg (for 2 pcs, front and rear) |






Pic. 1 Equipment under Test

Pic. 2 Equipment under Test

# 5 Test Equipment

## 5.1 Test Facility

The measurements were carried out in the testlabs of SGS Germany GmbH, Center for Quality Engineering, CTS CoC3, Hofmannstraße 50, 81379 München, Germany.

## 5.2 Measuring Equipment

Resonance search

| ID No. | Equipment | Manufacturer | Status | Calibration date | Calibration due |
|---|---|---|---|---|---|
| S0795 | Frequency Counter | Newport | ind | | |
| S0854 | Frequency Display | Newport | ind | | |
| S1406 | Charge Amplifier (VIB9000) | Unholtz Dickie | cal | Feb 19, 2008 | Feb 28, 2009 |
| S1407 | Charge Amplifier (VIB9000) | Unholtz Dickie | cal | Feb 19, 2008 | Feb 28, 2009 |
| S1408 | Charge Amplifier (VIB9000) | Unholtz Dickie | cal | Feb 19, 2008 | Feb 28, 2009 |
| S1419 | 80A Vibration Exciter VIB9000 | RMS | cal | Feb 19, 2008 | Feb 28, 2009 |
| S5004 | Oscilloscope | Siemens | ind | | |
| S5452 | Software Version 2.9.0 | M&P | cnn | | |
| S5528 | Personal Computer (VIB9000) | Fujitsu Siemens | cnn | | |
| S5662 | Vibration Control and Analysis System (VIB9000) | Agilent | cal | Feb 19, 2008 | Feb 28, 2009 |
| S5137 | Accelerometer | Endevco | cal | Dec 13, 2006 | Dec 31, 2008 |
| S5282 | Accelerometer | Bruel & Kjaer | cal | Jan 21, 2008 | Jan 31, 2010 |
| S5284 | Accelerometer | Bruel & Kjaer | cal | Jan 22, 2008 | Jan 31, 2010 |

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, cnn = Calibration not necessary, ind = for indication only

Earthquake

| ID No. | Equipment | Manufacturer | Status | Calibration date | Calibration due |
|---|---|---|---|---|---|
| S0353 | Earthquake Test System | MTS | cnn | | |
| S0896 | Control System for Earthquake | | cnn | | |
| S0919 | Amplifier | Endevco | cal | Feb 12, 2008 | Feb 28, 2009 |
| S0922 | Power Supply | Endevco | cnn | | |
| S5398 | Accelerometer | Endevco | cal | Feb 12, 2008 | Feb 28, 2009 |
| S5453 | Software Version 3.3A | MTS | cnn | | |
| S5482 | Power Supply | TET Electronic | ind | | |
| S5544 | Position Transducer | National Oilwell | chk | Jun 16, 2008 | Jun 30, 2009 |
| S5841 | 3 CH DC Signal Conditioner | PCB | cal | Mar 07, 2008 | Mar 31, 2009 |
| S5843 | Accelerometer | Honeywell | cal | Aug 28, 2007 | Aug 31, 2009 |
| S5844 | Accelerometer | Honeywell | cal | Aug 28, 2007 | Aug 31, 2009 |

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, cnn = Calibration not necessary, ind = for indication only

# 6 Test Specifications and Results

The test results in the report refer exclusively to the test object described in section 4 and the test period in section 3.3.

## 6.1 Requirements Specification

### 6.1.1 Earthquake Criteria (Zone 4)

**R 4-68** All equipment shall be constructed to sustain the waveform testing of **GR-63-CORE Section 5.4.1** without permanent structural or mechanical damage

**R 4-69** Frame level equipment shall be constructed so that during the waveform testing of **GR-63-CORE Section 5.4.1.**, the maximum single-amplitude deflection at the top of the framework, relative to the base, does not exceed 75 mm.

**R 4-70** Frame level equipment shall have a natural mechanical frequency greater than 2.0 Hz as determined by the swept sine survey of **GR-63-CORE Section 5.4.1.**

**O 4-71** Frame level equipment should have a natural mechanical frequency greater than 6.0 Hz as determined by the swept sine survey of **GR-63-CORE Section 5.4.1.**

**R 4-72** All equipment shall be constructed to meet aplicable functionality requirements immediately before and after each axis of waveform testing of Section 5.4.1. The equipment shall sustain operation without replacement of components, manual rebooting, or human intervention.

**O 4-73** All equipment shall be constructed to meet aplicable functionality requirements continuously during waveform testing of Section 5.4.1. These functionality criteria shall demonstrate thet the equipment has sustained operation without loss of service during the testing.

### 6.1.2 Framework and Anchor Criteria

**O4-74** Framework should be of welded construction.

**R4-75** Framework shall be constructed for base mounting to the floor without auxiliary support or bracing from the building walls or ceilings.

**O4-76** For framework used in earthquake risk zones, the static pull testing procedures of Section 5.4.1.4 should be followed, meeting these objectives:

- The maximum single amplitude deflection at the top of the framework should not exceed 75 mm (3 in).
- The top of the framework should return to its original position, within 6 mm (0.24 In) when the load is removed.
- The framework should sustain no permanent structural damage during static framework testing.

**R4-77** Concrete expansion anchors used to base mount framework to the floor shall meet the following requirements:

- Maximum embedment depth of 90 mm (3.5 in)
- Maximum bolt diameter of 13 mm (0.5 in).

**O4-78** Concrete expansion anchors used to base mount the framework to the floor should be suitable for earthquake (dynamic) applications, as specified by the manufacturer.

**O4-79** Concrete expansion anchors should use steel construction to minimize creep.

## 6.2 Test Specification

The tests were performed in accordance to GR – 63 – CORE , Section 5.4 : Earthquake.

Remarks:
1. The Earthquake test was performed with acceleration-time history waveform VERTEQII.
2. The EUT was mounted during the tests on a 40mm aluminium adapter plate. The plinth is secured to the aluminum plate using four M12 screws and washers.
3. The EUT was completed with weight dummys, therefore no function are possible
4. The mounting on the floor and anchors are unknown and therefore omitted from the test configuration.
5. The resonance sweep was performed on an electro-dynamic shaker. Due to its performance, the applied acceleration was 0,13 g (instead of 0,2g).
6. Test performed without cable load.



**Table 6.2.1 - Earthquake Test conditions**

| Environmental parameter | Test Severity | | Duration | Method |
|---|---|---|---|---|
| Earthquake time-history | RRS | see Table 6.3 | 30 s | Time-history VERTEQII |
| | ZPA* | 15 m/s$^2$ | | |
| | frequency range | 1 – 50 Hz | | |
| | axes | 3 | | |
| | damping ratio | 2 % | | |

* Zero Period Acceleration

**Table 6.2.2 - Earthquake Required Response Spectrum for Zone 4 according to Telcordia Technologies GR-63-CORE Section 5.4.1**

| Coordinate Point | Frequency (Hz) | Values for Upper Floor Acceleration (g) |
|---|---|---|
| 1 | 0.3 | 0.2 |
| 2 | 0.6 | 2.0 |
| 3 | 2.0 | 5.0 |
| 4 | 5.0 | 5.0 |
| 5 | 15.0 | 1.6 |
| 6 | 50.0 | 1.6 |

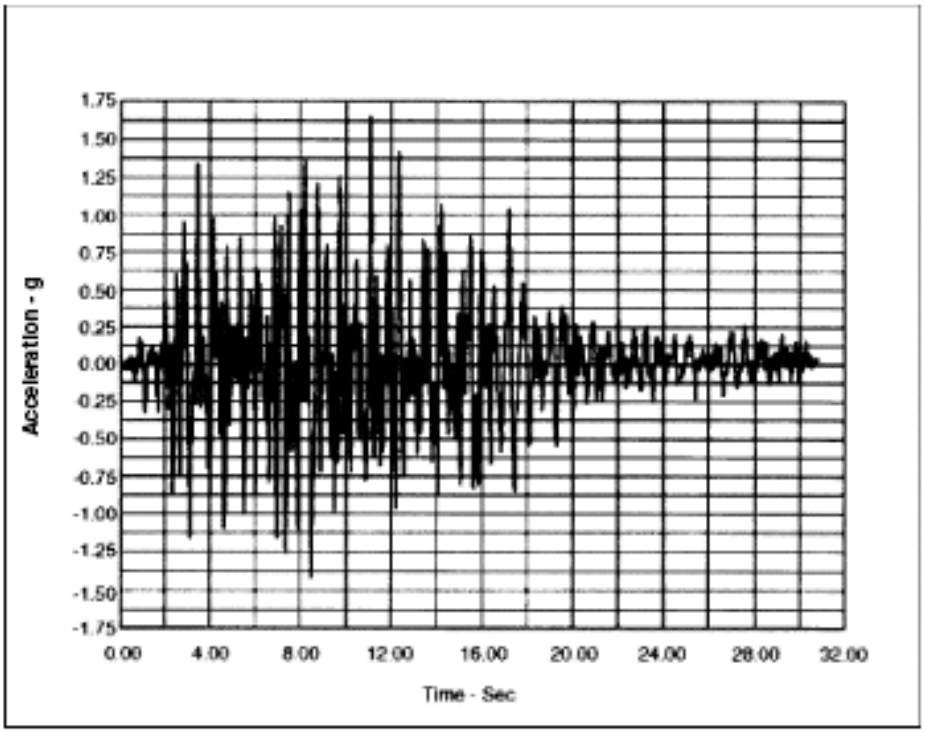



Figure 6.1: Earthquake Synthesized Waveform VERTEQ II Zone4

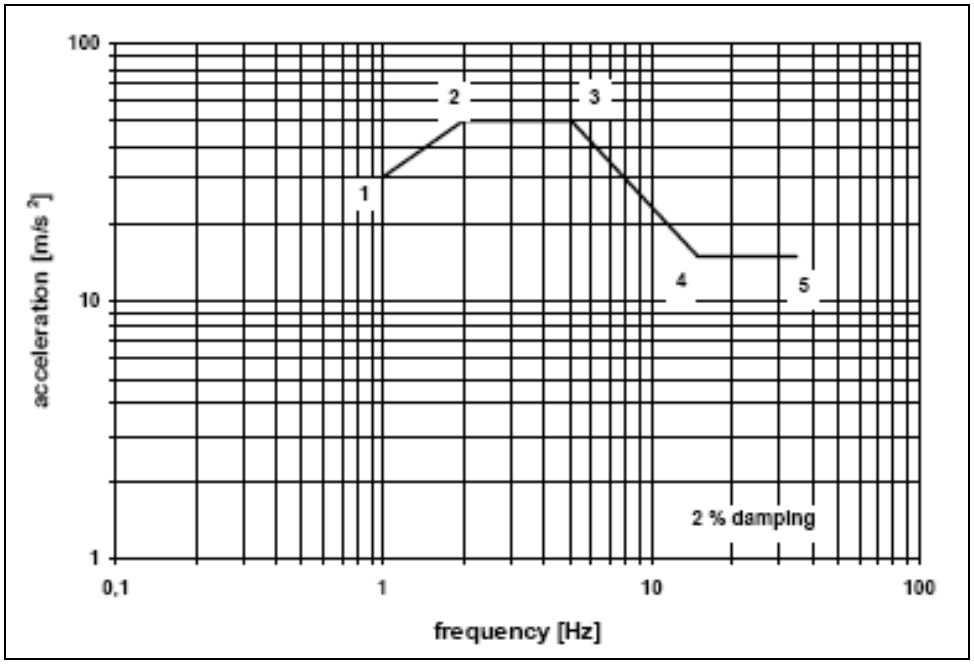



Figure 6.2: Earthquake Requiered Response Spectrum

### 6.3 Test Performance

For the tests the EUT were mounted on a 40 mm aluminium plate. The plinth of the EUT is secured to the aluminum plate using eight M12 screws and washers.
No function at the EUT is possible, because the cabinet was only completed with weight dummys.

For the time-history testing on the seismic table, the buildup “EUT – aluminium plate” remained unchanged.

#### 6.3.1 Vibration Response Investigation

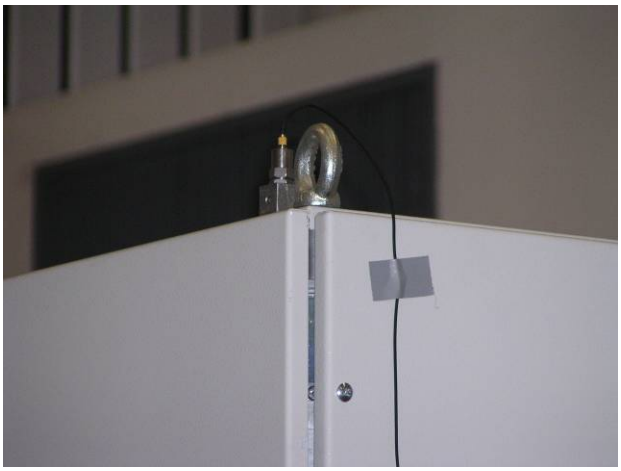
Before execution of the main earthquake tests a vibration response investigation (resonance search) was performed on the electro dynamic vibration system VIB 9000 in 3 mutually perpendicular axes with the following parameters:

| | |
|---|---|
| Frequency Range: | 1.25 to 50 Hz |
| Acceleration: | 1.3 m/s$^2$ |

Two accelerometers were attached to the middle and top of the cabinet.
Diagrams are shown in section 6.4.1.

The tests were performed in normal use attitude.

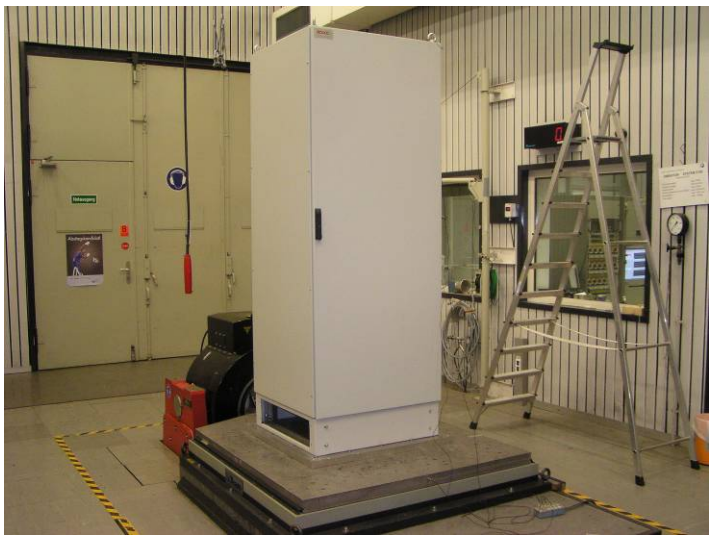
Pic. 3 Measuring point middle



Pic. 4 Measuring point top

Pic. 5 Mounting of EUT for Z-axis test

Pic. 6 Mounting of EUT for X-axis test



Pic. 7 Mounting of EUT for Y-axis test

### 6.3.2 Time-History

The EUT was mounted on the seismic table over a 40mm aluminum plate. The plinth of the EUT is secured to the aluminum plate using eight M12 screws and washers. No cable load was mounted at the top of the cabinet. All cables enter or leave the cabinet via the cabinet base

Two single-axis accelerometers are positioned at the middle and on top of the EUT to record the acceleration.

A LVDT was attached to the top of the EUT.

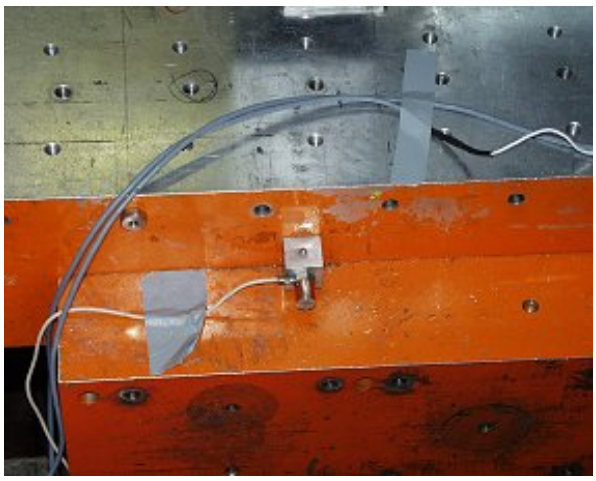
A video taken from tests in all three axes is part of the documentation.

The test was performed in 3 mutually perpendicular axes.

horizontal longitudinal front to back = Y-axis
horizontal lateral side to side = X-axis
vertical = Z-axis

Diagrams are shown in section 6.4.2 + 6.4.3





Pic. 8 Measuring point for time history at earthquake table


Pic. 9 Measuring Equipment for displacement

Pic. 10 Measuring point middle of EUT

Pic. 11 Measuring point top of EUT


Pic. 12 Mounting of EUT for Z-axis test


Pic. 13 Mounting of EUT for Y -axis test


Pic. 14 Mounting of EUT for X -axis test

## 6.4 Test Results

### 6.4.1 Vibration Response Investigation

The measured resonance frequencies are:

**Table 6.3: Results - Resonance Frequencies**

| Axis | Frequency [Hz] |
|---|---|
| X | 9.0 |
| Y | 6.4 |
| Z | 47.5 |

#### 6.4.1.1 Vibration Response Investigation X-axis

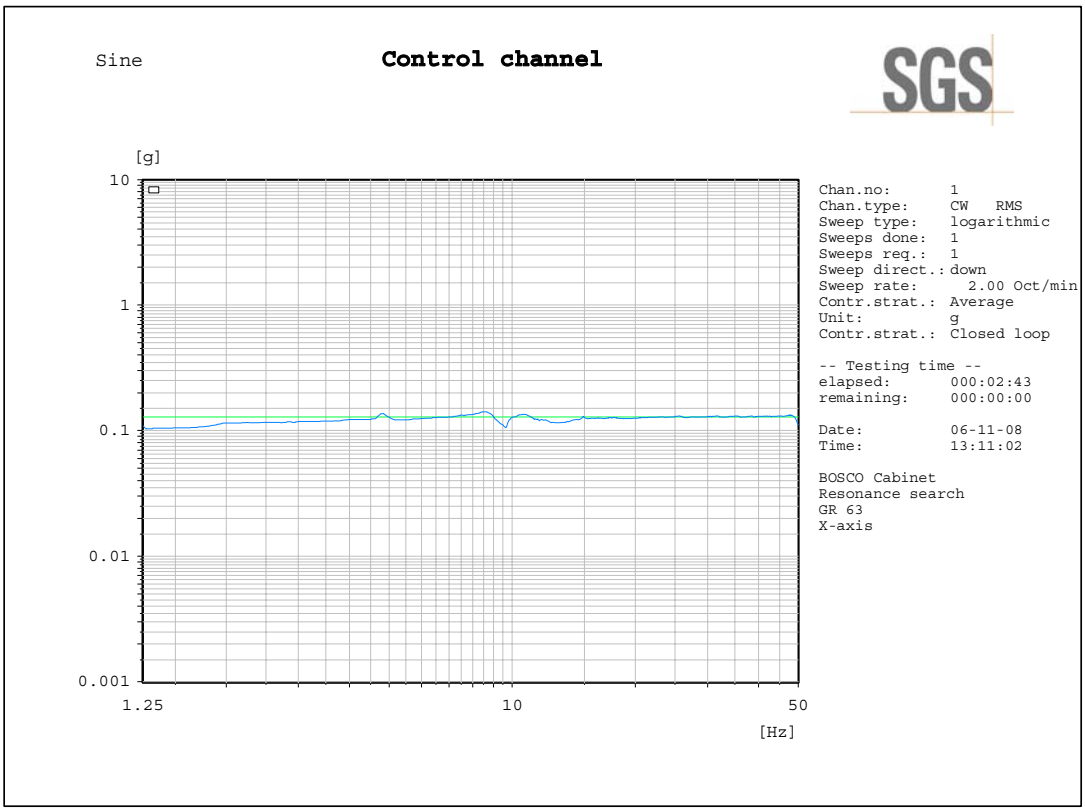



Figure 6.3: Res. Search: acceleration at Vibration Table, X-Axis

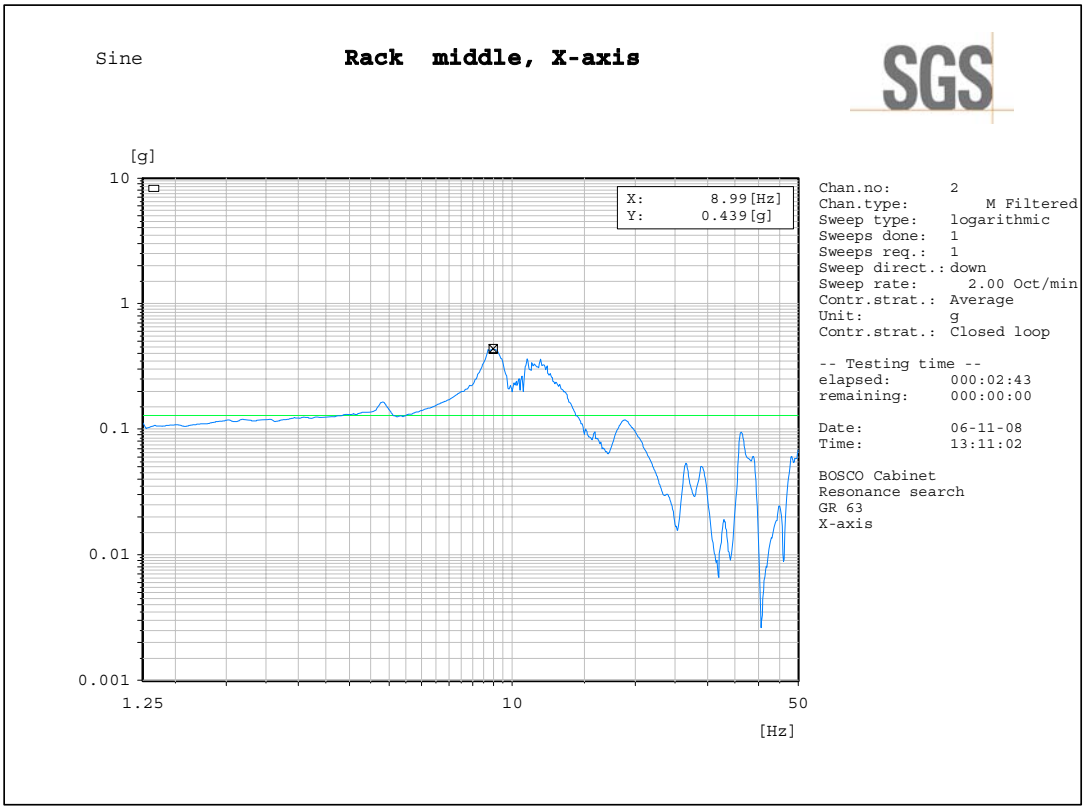



Figure 6.4: Res. search: excitation in x-dir.; middle of the rack

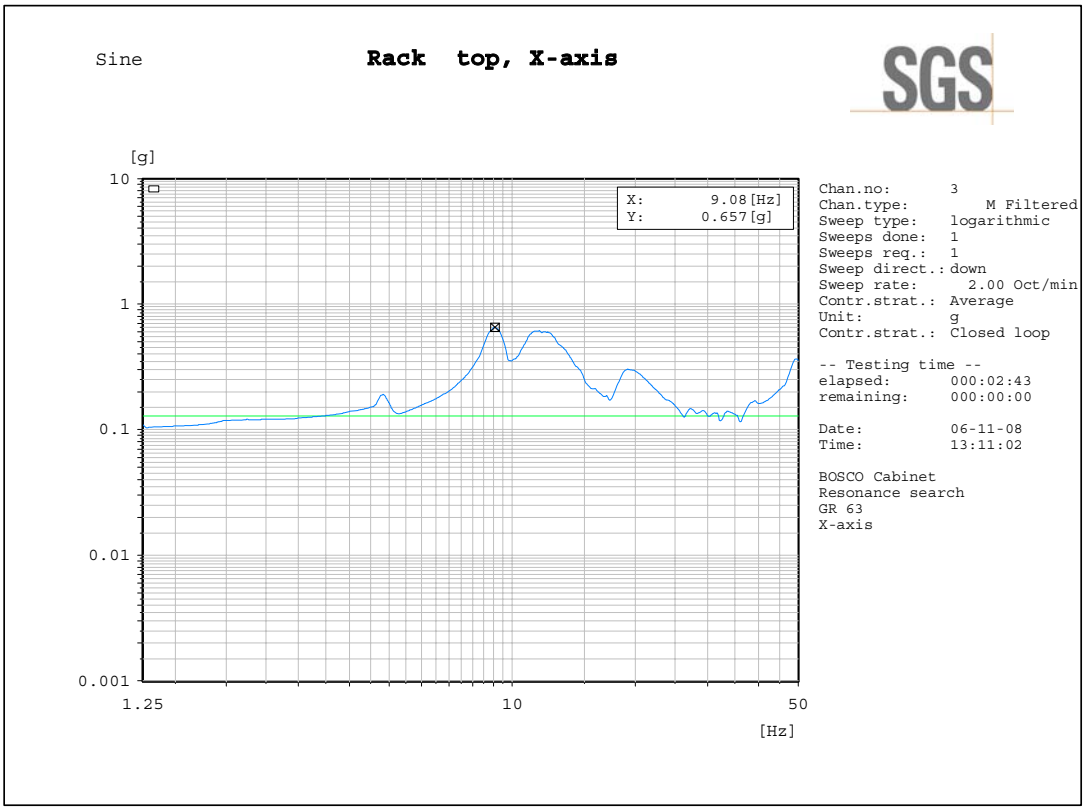



Figure 6.5: Res. search: excitation in x-dir.; top of the rack

### 6.4.1.2 Vibration Response Investigation Y-axis

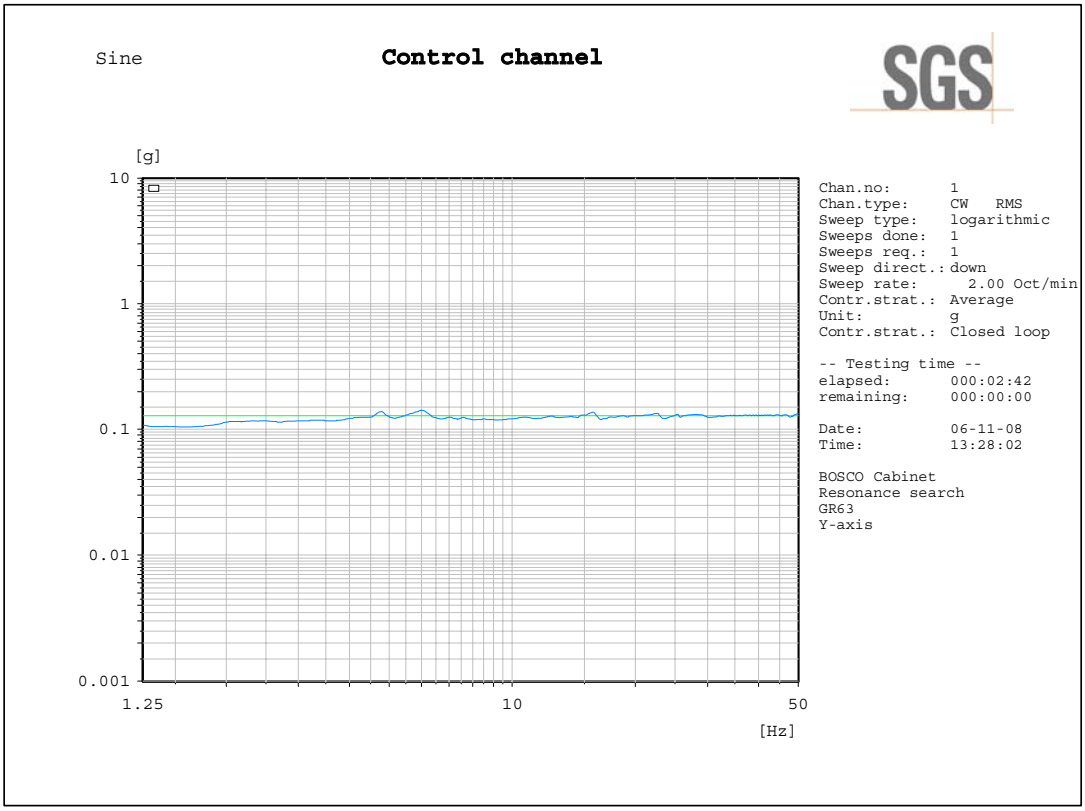



Figure 6.6: Res. Search: acceleration at Vibration Table, Y-Axis

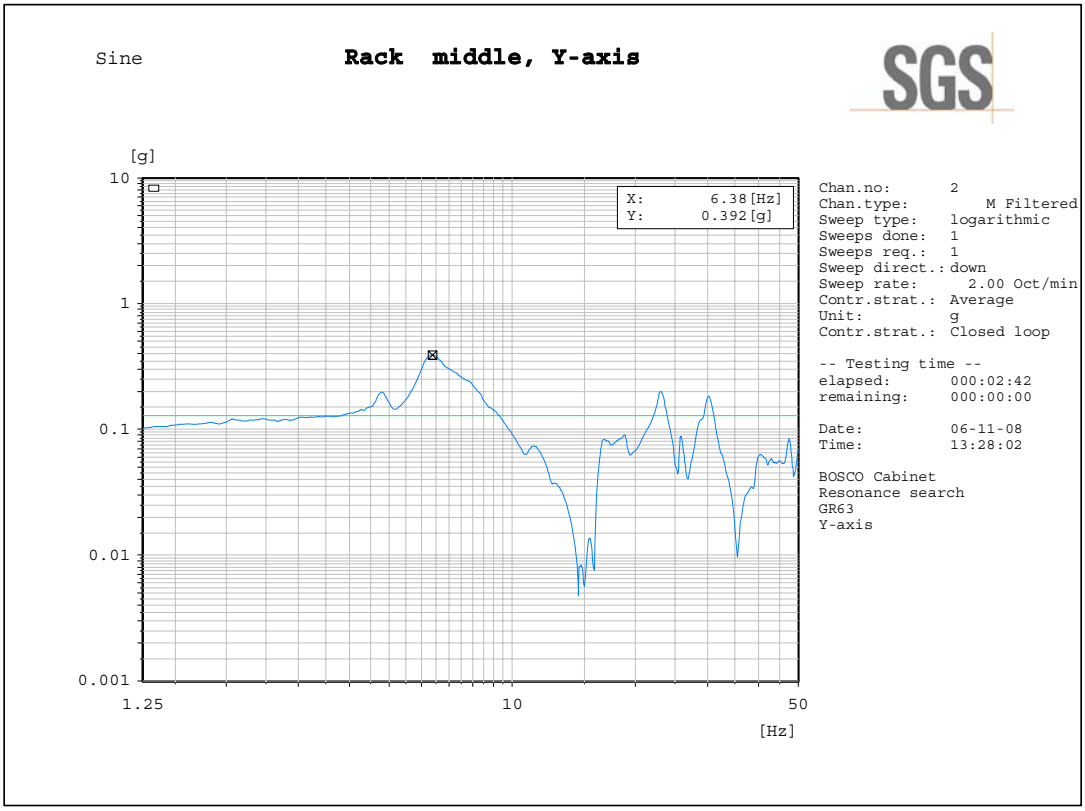



Figure 6.7: Res. search: excitation in y-dir.; middle of the rack


Figure 6.8: Res. search: excitation in y-dir.; top of the rack

### 6.4.1.3 Vibration Response Investigation Z-axis

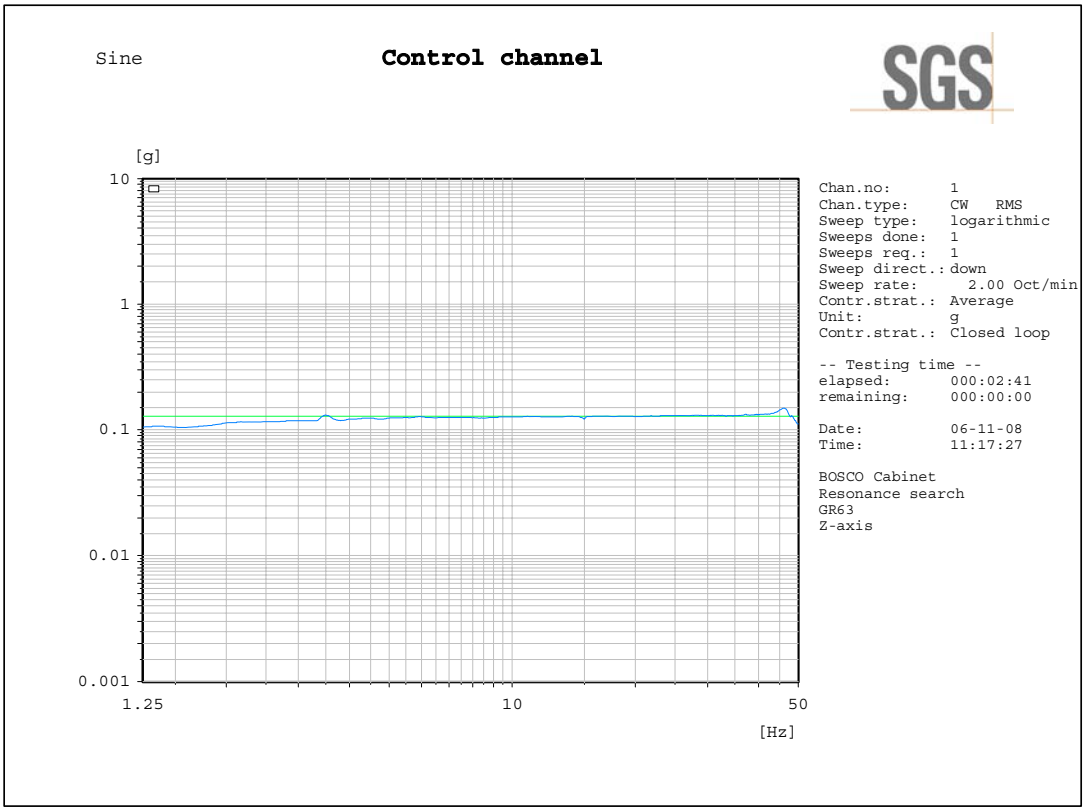



Figure 6.9: Res. Search: acceleration at Vibration Table, Z-Axis

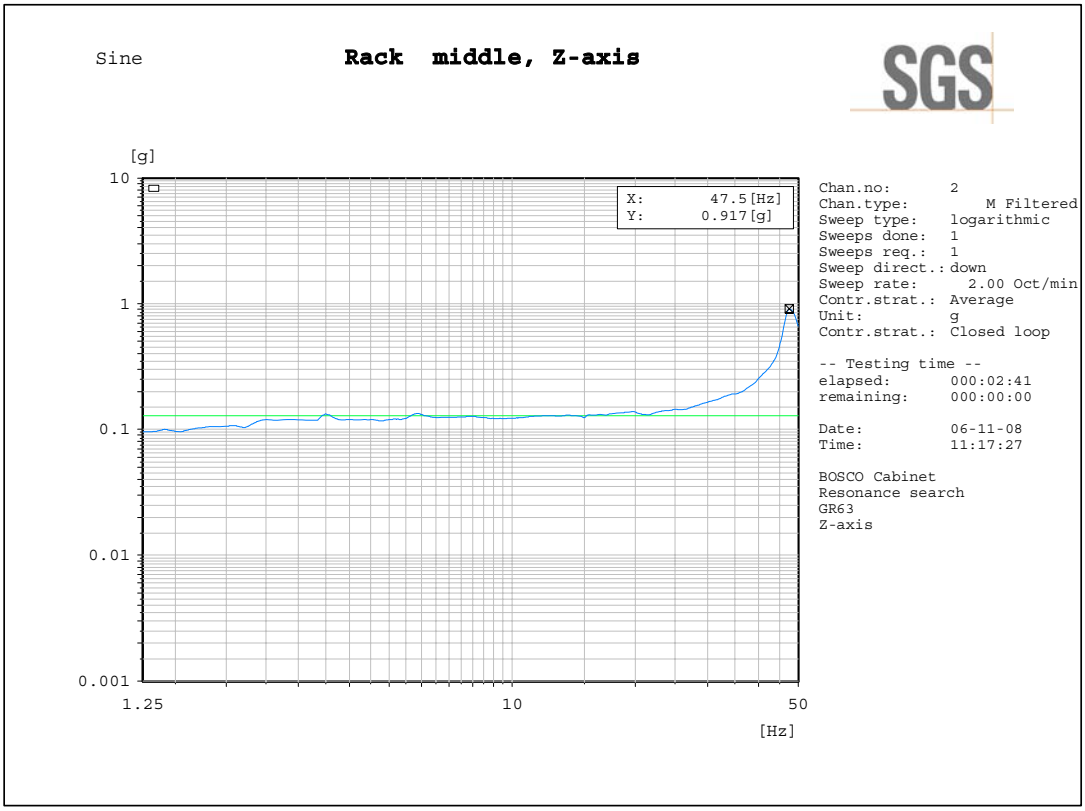



Figure 6.10: Res. search: excitation in z-dir.; middle of the rack

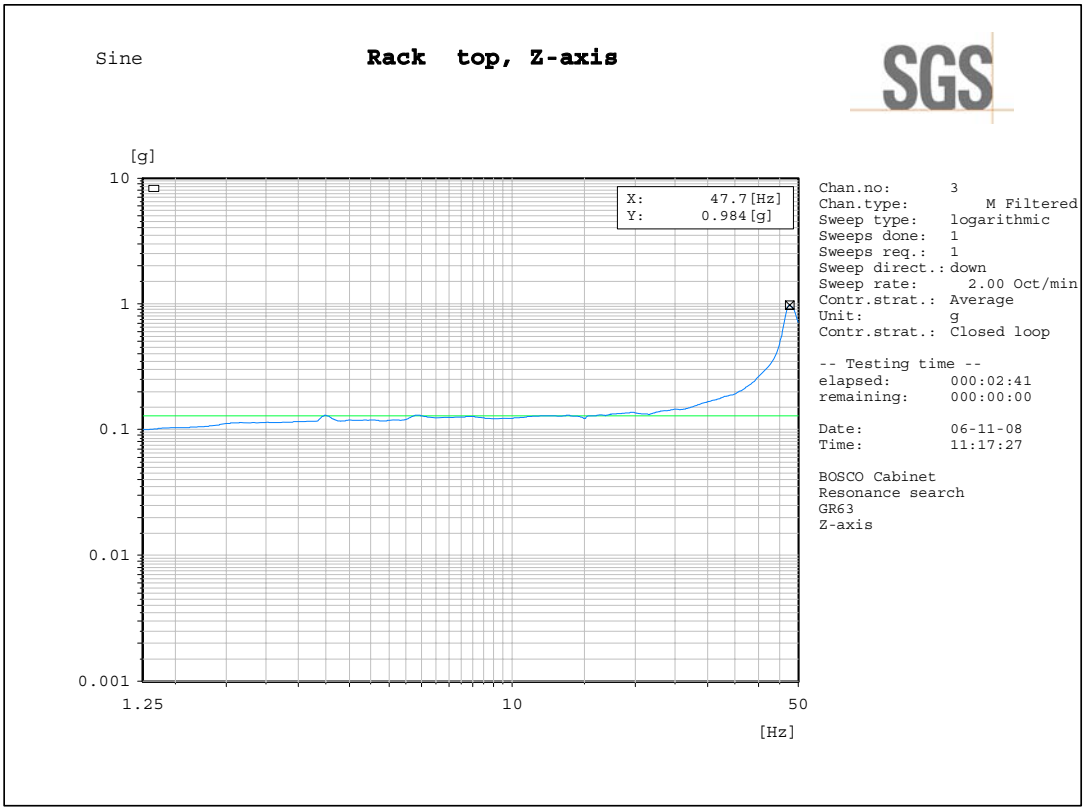



Figure 6.11: Res. search: excitation in z-dir.; top of the rack

### 6.4.2 Results Earthquake Test

In detail:

- R4-68 : No structural damages occurred
- R4-69 : The deflection on top was:
  X-axis: 10,6 mm
  Y-axis: 26,5 mm
  Z-axis: no LVDT-measurement was performed
- R4-70, O4-71: The lowest natural gross frequency was 6.4 Hz
- R4-72, O4-73: The EUT was completed with weight dummys, therefore no function are possible
- R4-74: Framework is not a welded construction.
- O4-75: Framework is constructed fore base mounting.
- O4-76: Static pull test not performed, because Framework is synthesized waveform tested.
- R4-77: O4-78: O4-79: The anchors are unknown and therefore omitted from the test configuration.



**Results Earthquake TRS vs. RRS and Acceleration at EUT**

The shaker table's analysed acceleration, known as Test Response Spectrum (TRS, red line), must meet or exceed the Required Response Spectrum (RRS, blue line) for the Earthquake Risk Zone 4 in the range from 1.0 to 35 Hz.

The following diagrams show the recorded plots for each axis.

**X-axis (horizontal)**

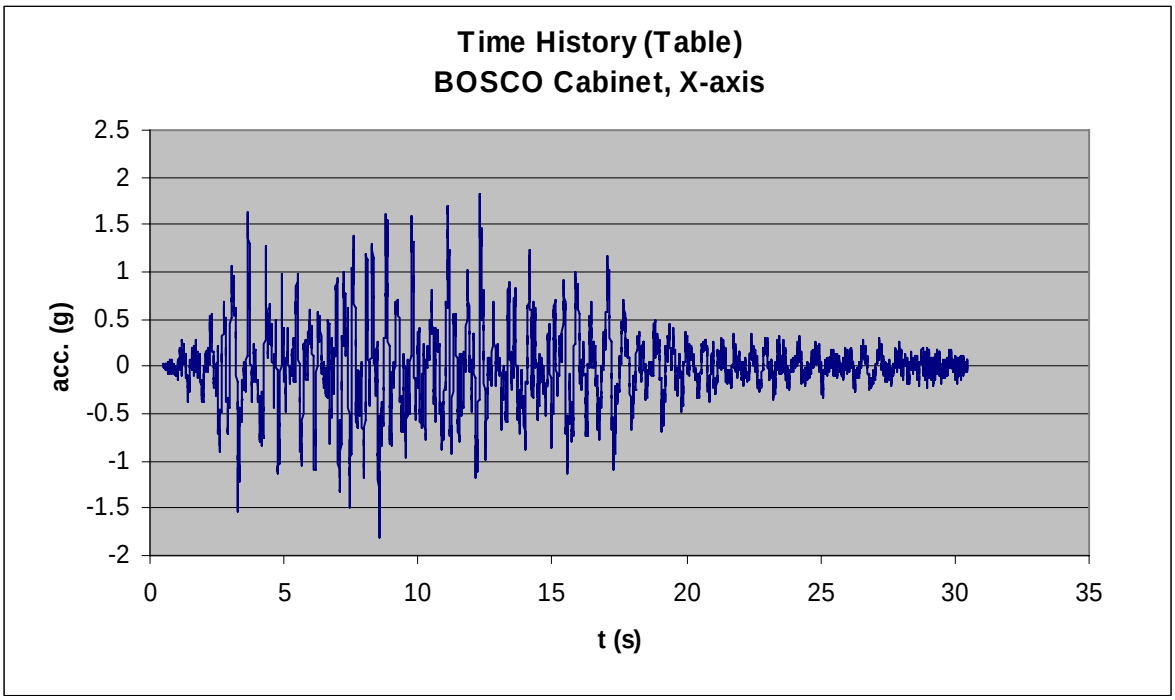



Figure 6.12: Acceleration at Earthquake Table (X-Axis)

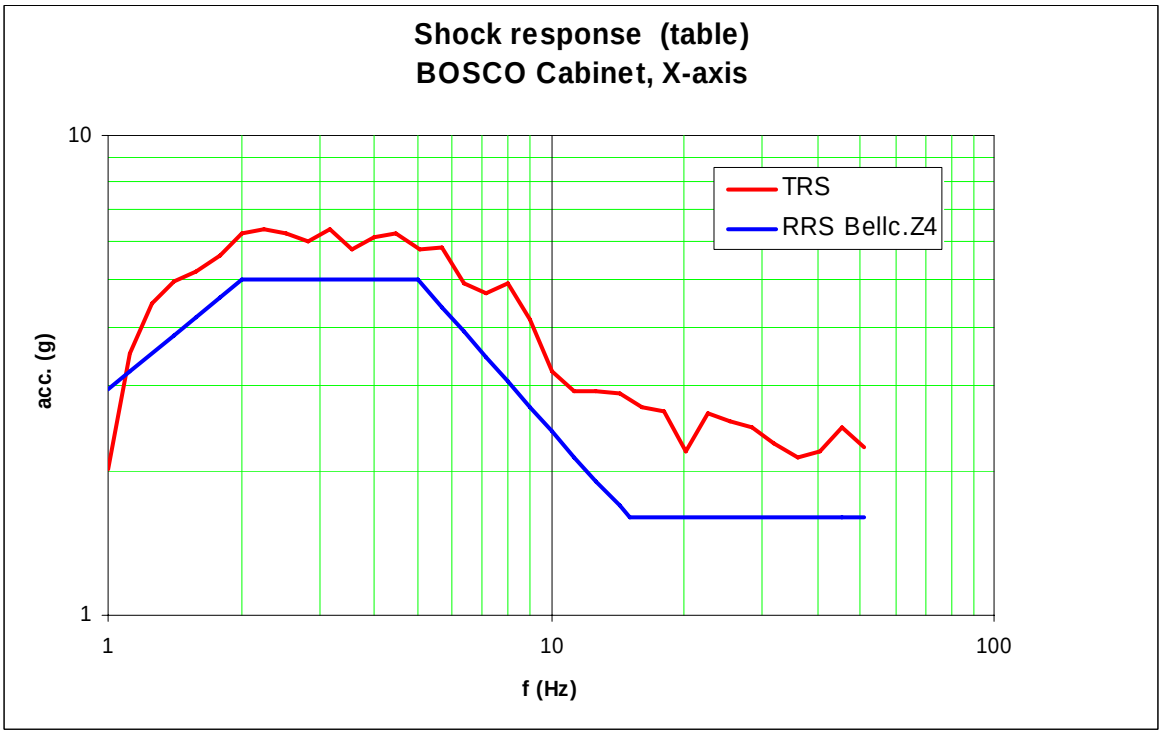



Figure 6.13: Test Response Spectrum – Earthquake table (X-Axis)

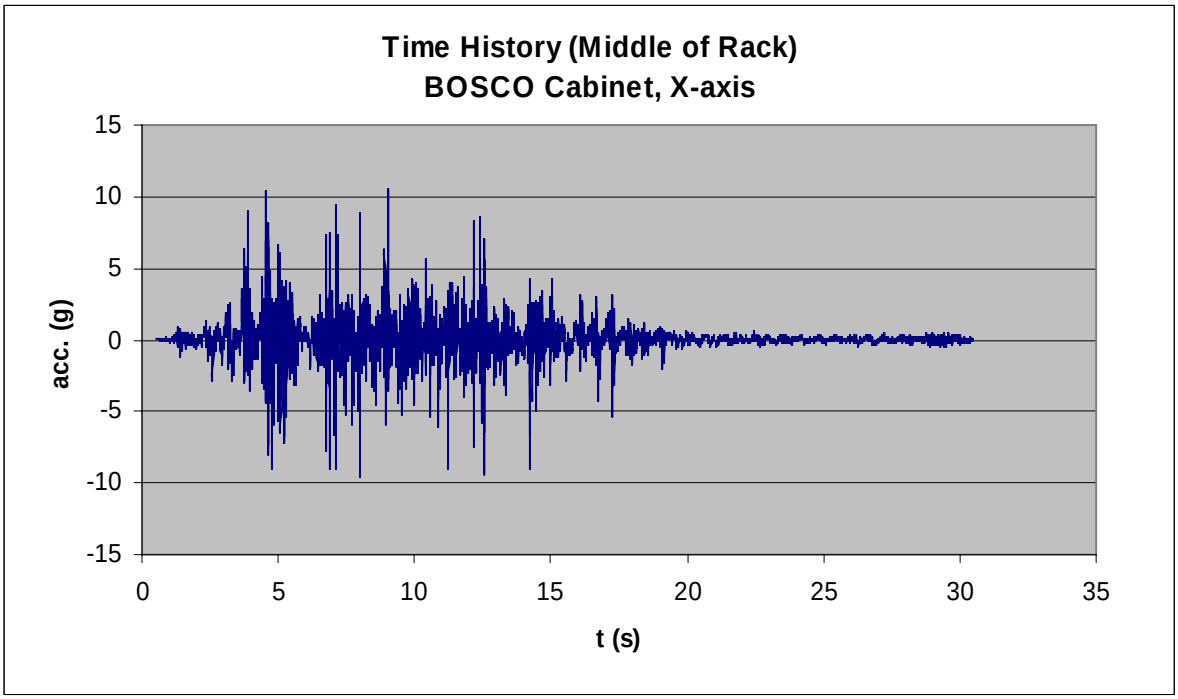



Figure 6.14: Acceleration at middle of Cabinet (X-Axis)

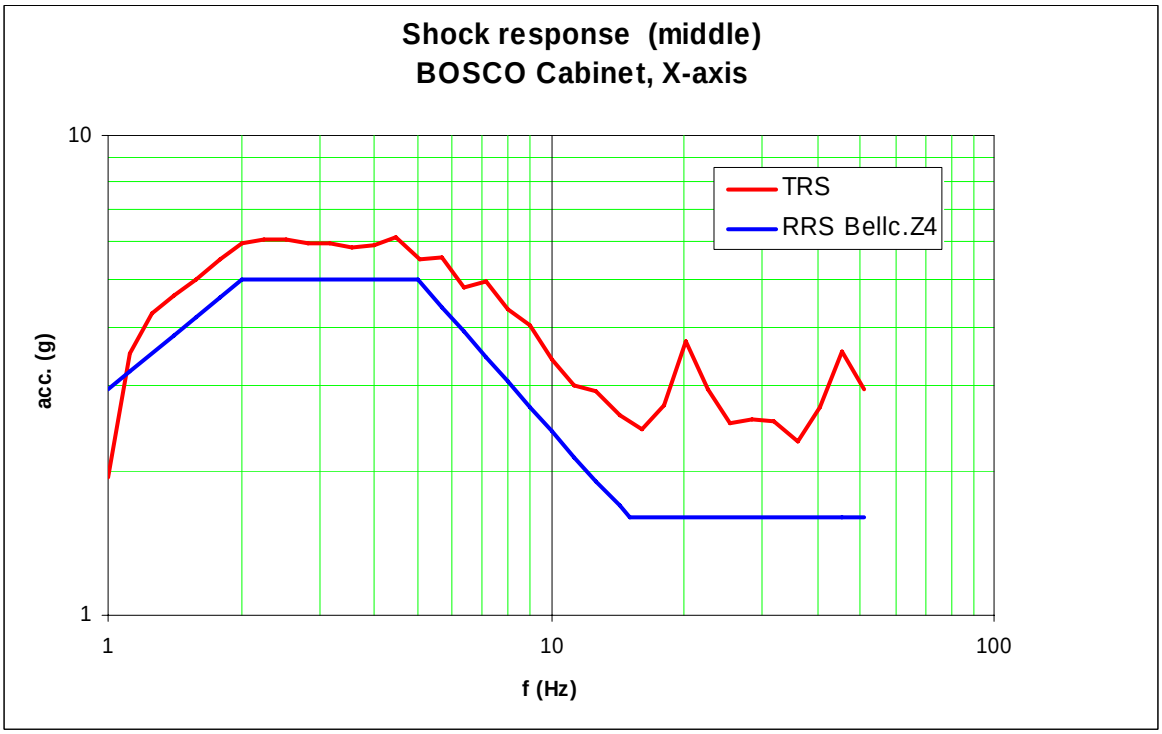



Figure 6.15: Test Response Spectrum – middle of Cabinet (X-Axis)

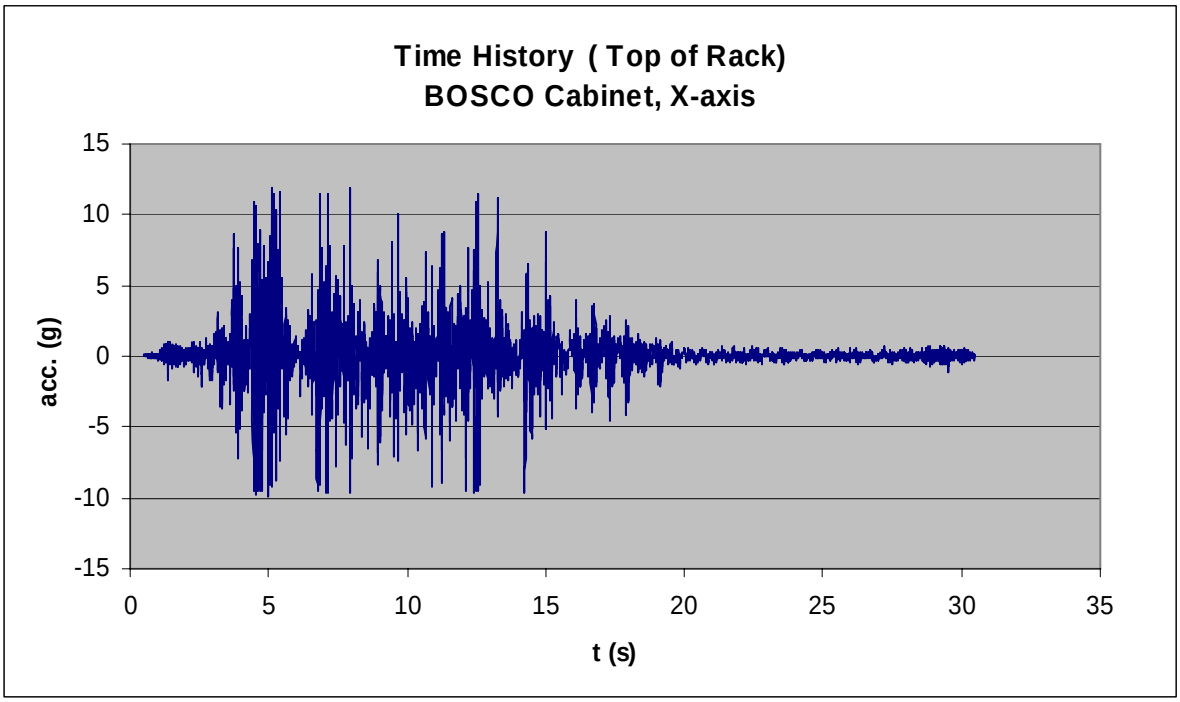



Figure 6.16: Acceleration at Top of Cabinet (X-Axis)

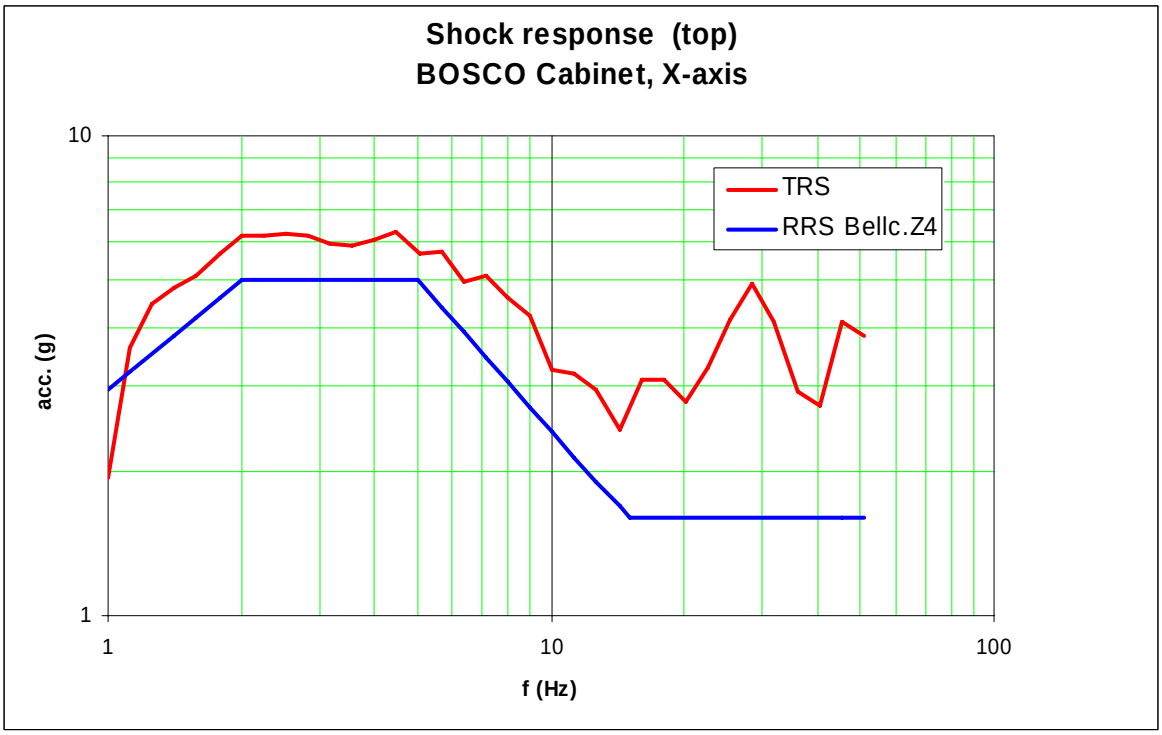



Figure 6.17: Test Response Spectrum – Top of Cabinet (X-Axis)

**Y-axis (horizontal)**

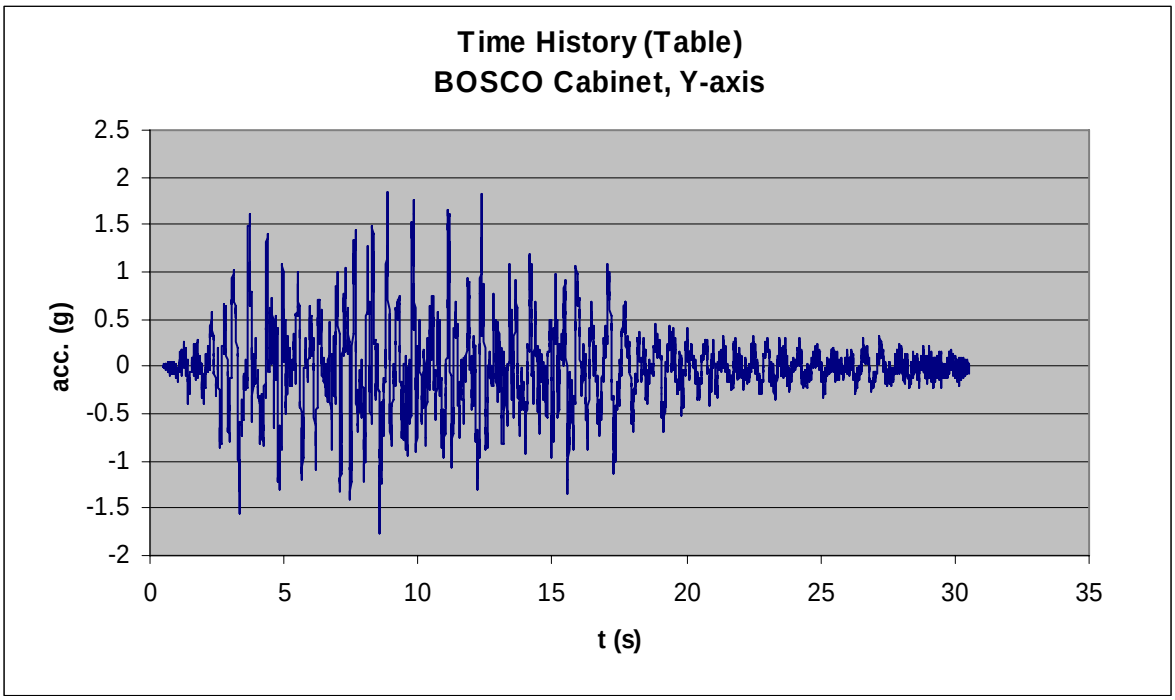



Figure 6.18: Acceleration at Earthquake Table (Y-Axis)

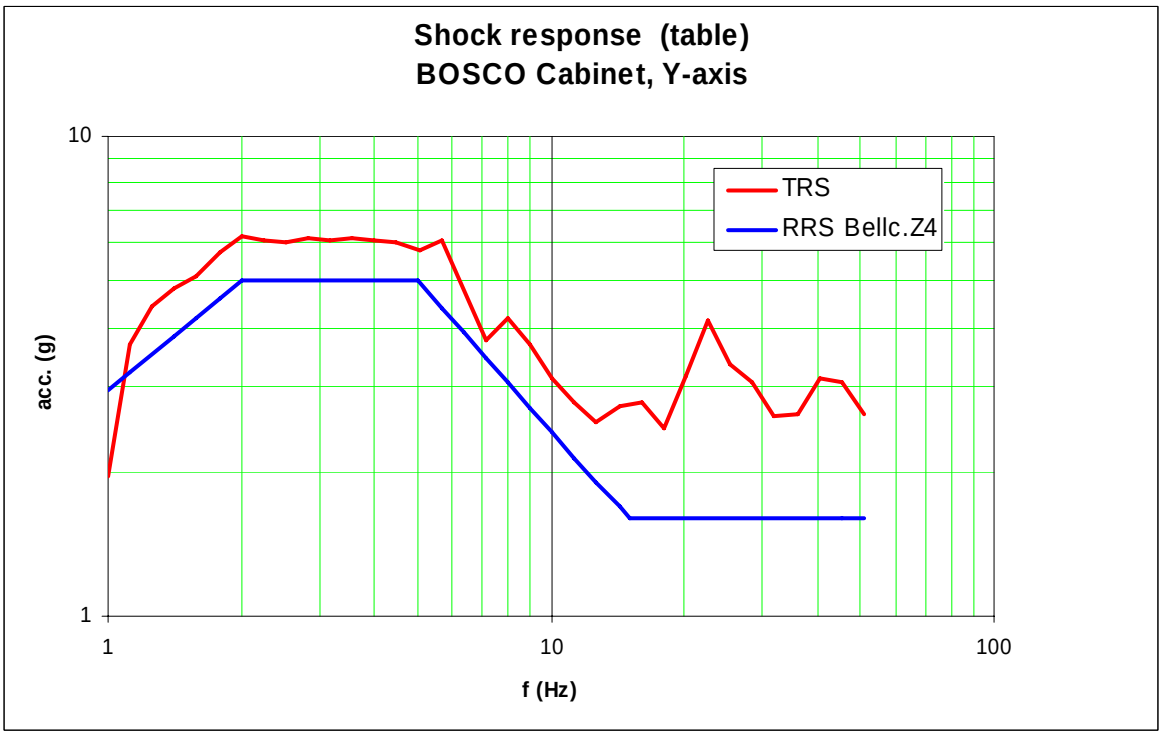



Figure 6.19: Test Response Spectrum – Earthquake table (Y-Axis)

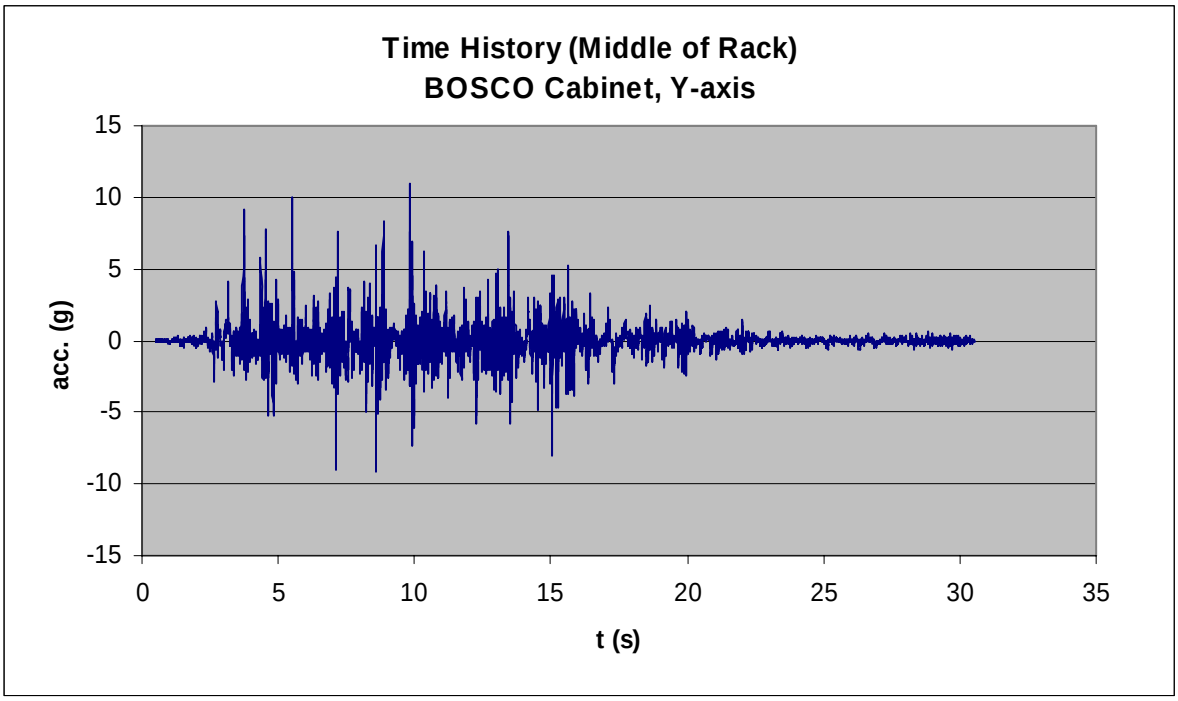



Figure 6.20: Acceleration at middle of Cabinet (Y-Axis)

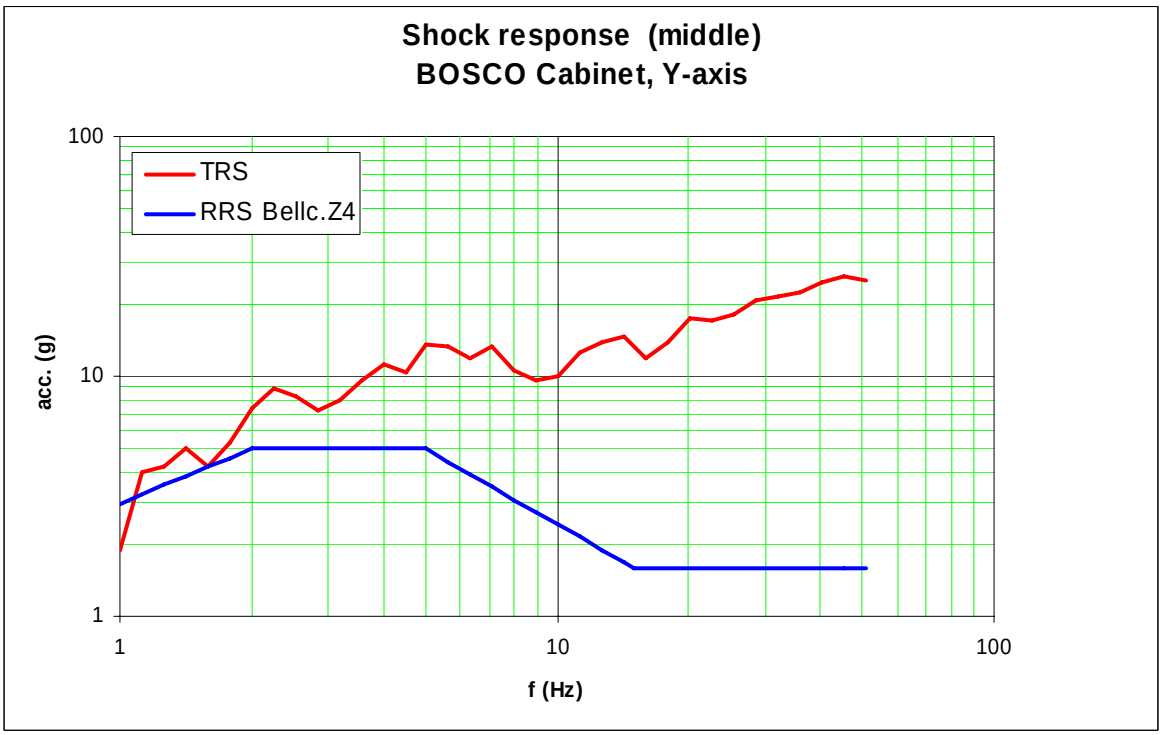



Figure 6.21: Test Response Spectrum – middle of Cabinet (Y-Axis)

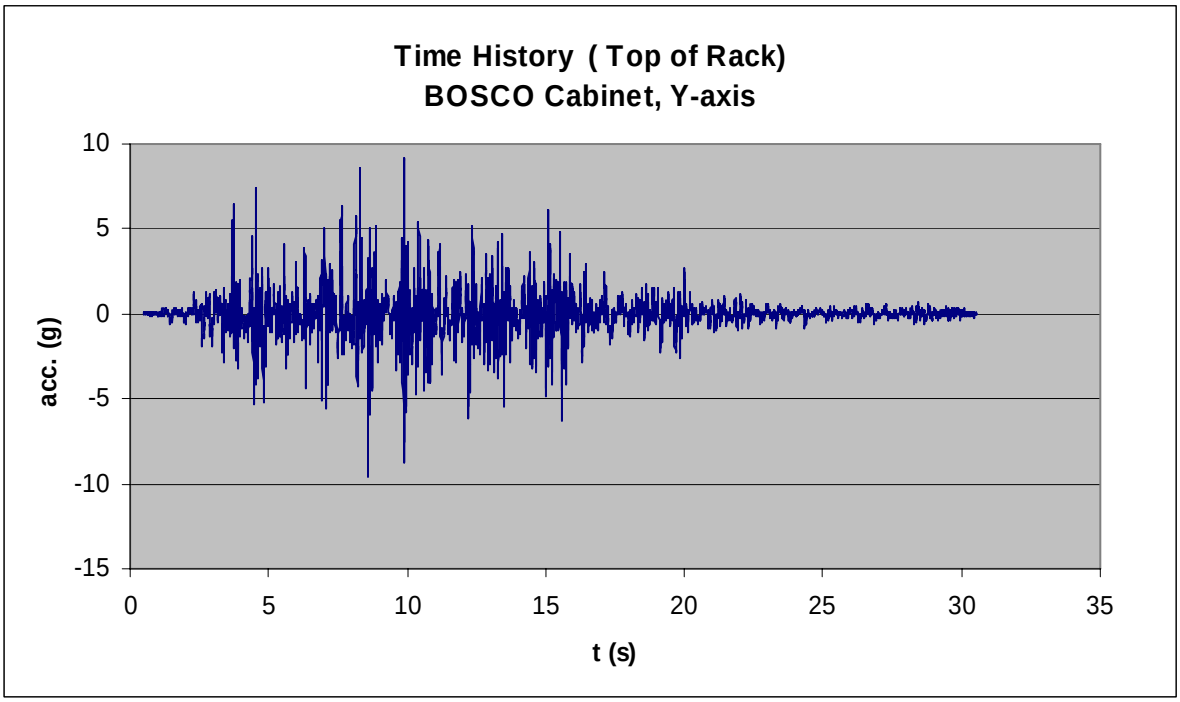



Figure 6.22: Acceleration at Top of Cabinet (Y-Axis)

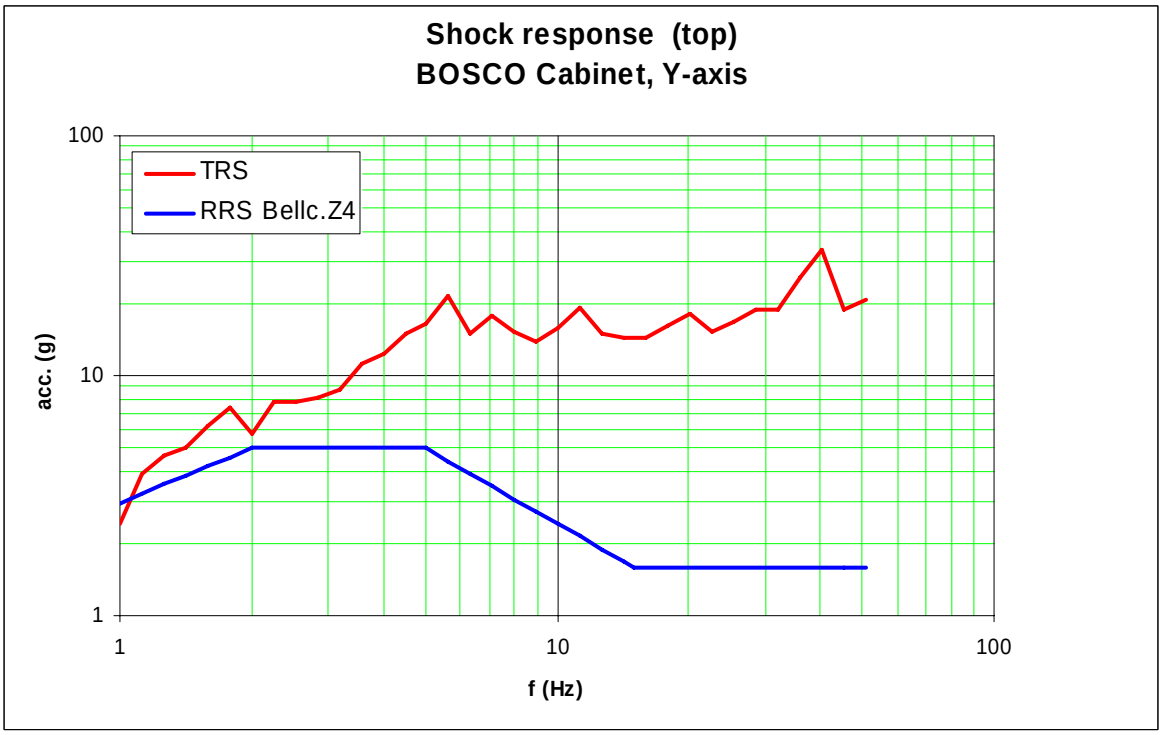



Figure 6.23: Test Response Spectrum – Top of Cabinet (Y-Axis)

**Z-axis (vertical)**

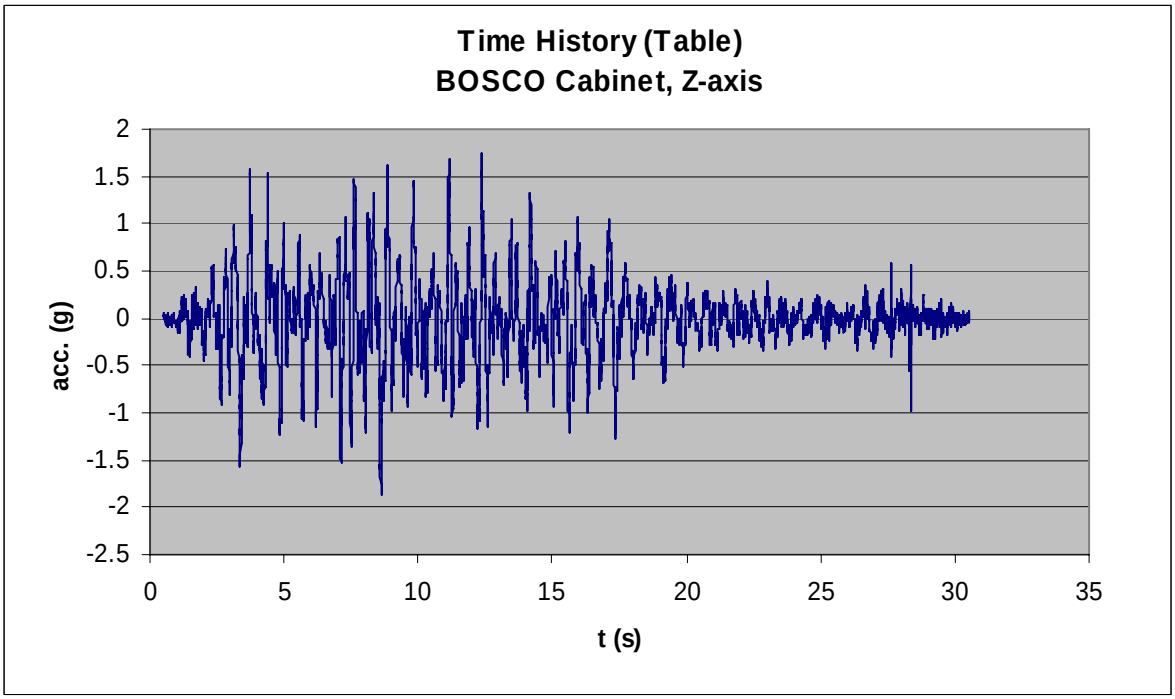



Figure 6.24: Acceleration at Earthquake Table (Z-Axis)

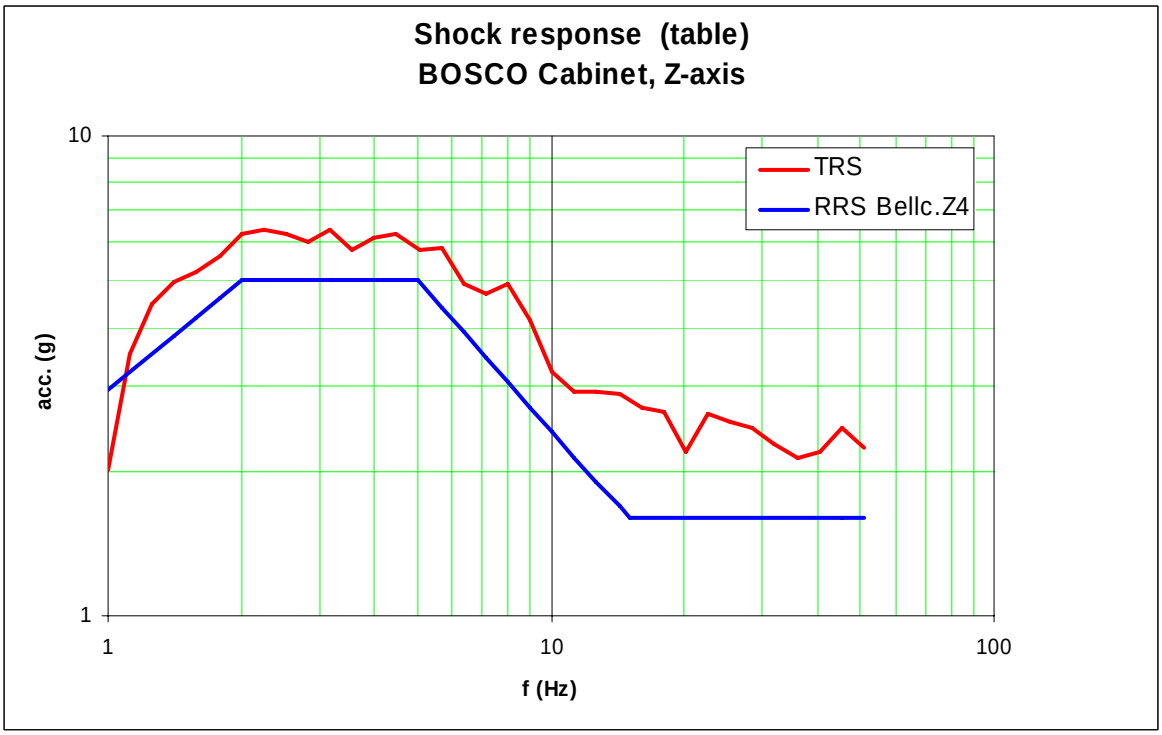



Figure 6.25: Test Response Spectrum – Earthquake table (Z-Axis)

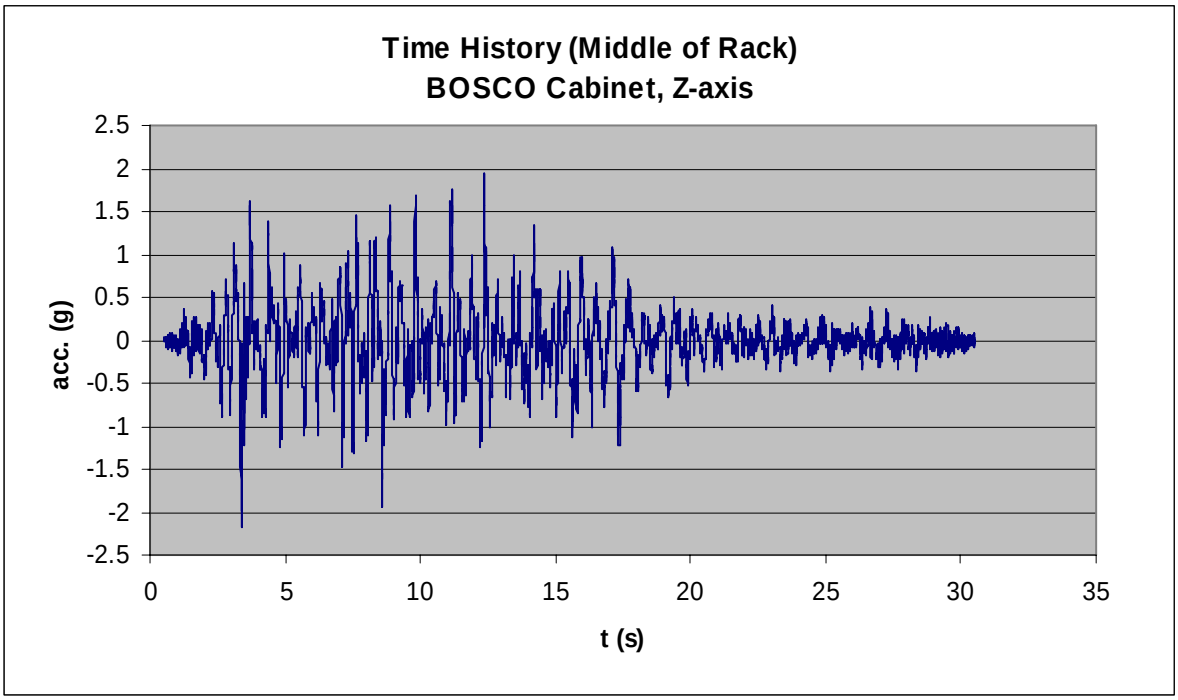



Figure 6.26: Acceleration at middle of Cabinet (Y-Axis)

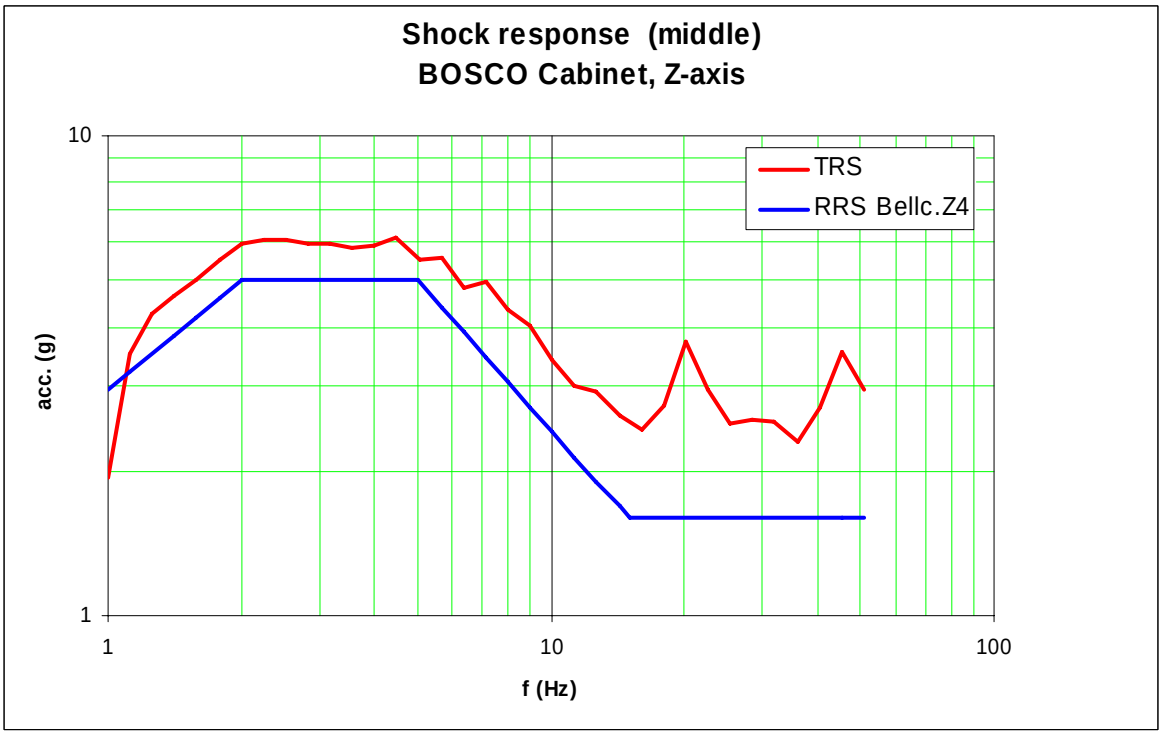



Figure 6.27: Test Response Spectrum – middle of Cabinet (Y-Axis)

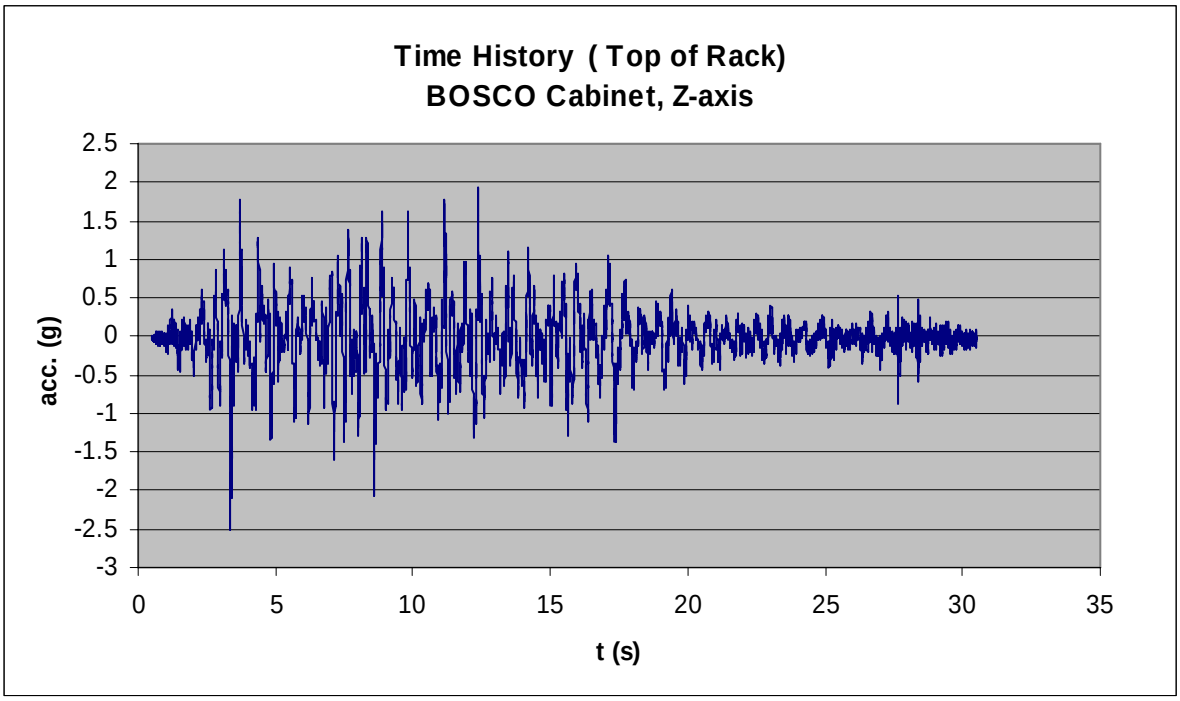



Figure 6.28: Acceleration at Top of Cabinet (Z-Axis)

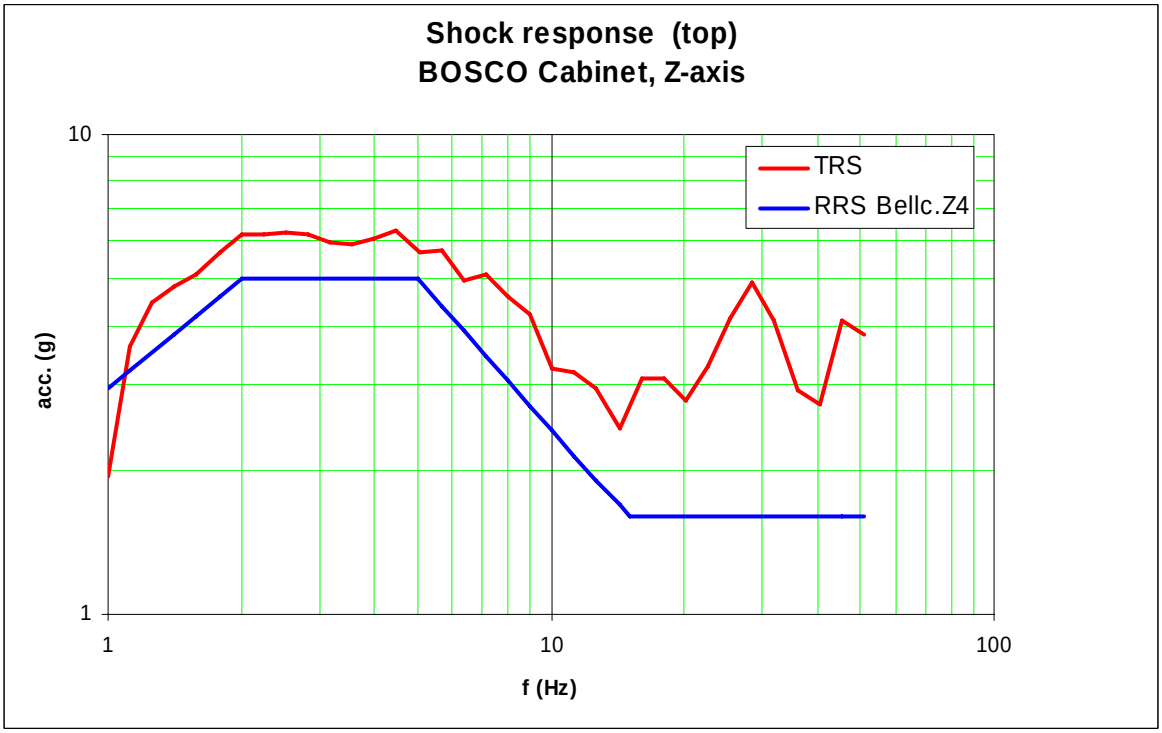



Figure 6.29: Test Response Spectrum – Top of Cabinet (Z-Axis)

### 6.4.3 Results of Displacement measurement

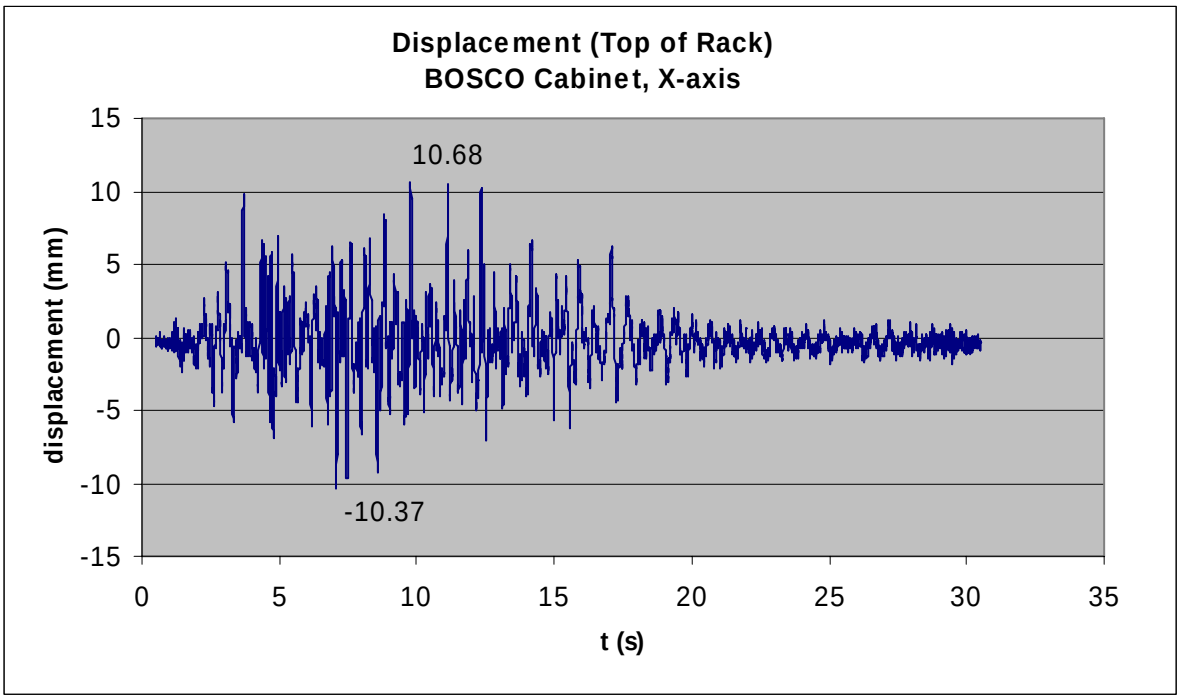



Figure 6.30: illustrates the displacement at top of EUT X-axis

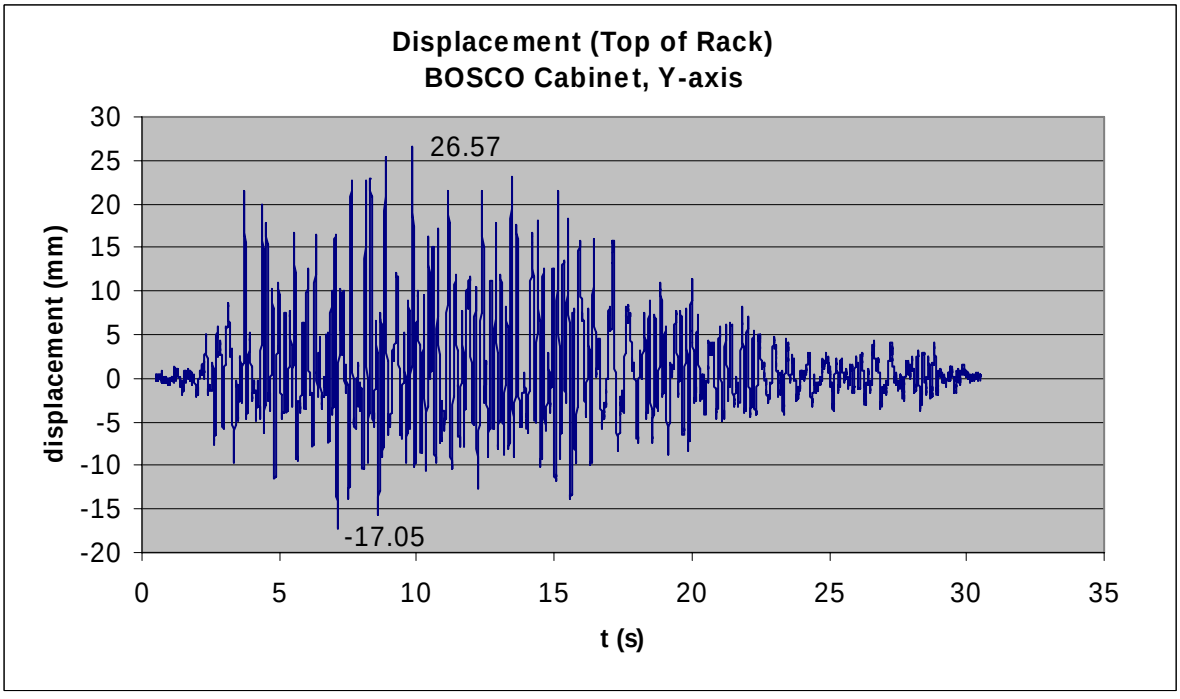



Figure 6.31: illustrates the displacement at top of EUT Y-axis

In **vibration direction vertical (Z-axis)** no displacement was measured.