

# V A R I S T A R

## Test report



### Earthquake resistance tests on Heavy-Duty cabinets

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## TESTS REPORT

LH 34040

Issue 1

*This test report supersedes our report LH 34040*

### EARTHQUAKE RESISTANCE TESTS ON TWO CABINETS

Company :  
**SCHROFF**

Copy N° 1

Project Engineer : **D. TAUZIN**

Number of pages, appendices not included : 51

Number of appendices : 1

Number of pages in appendices : 60

Certified accurate for SOPEMEA  
Villacoublay, 21 December, 2004

This test report only concerns objects submitted to testing.

**O. GAGEONNET**  
Test Engineer

## 1 - GENERAL PART

### 1.1. ADMINISTRATIVE INFORMATION

#### 1.1.1. ORDER ISSUER

SCHROFF Company  
ZI - 4, rue du Marais  
BP 16  
67660 BETSCHDORF

#### 1.1.2. ORDER NUMBER

SCHROFF ref. : Order No. 4029965/OP of 20 July, 2004

#### 1.1.3. PURPOSE OF THE ORDER

Earthquake resistances on two cabinets.

#### 1.1.4. SOPEMEA REFERENCE

In-house reference number : LH 34040

#### 1.1.5. TEST PERFORMANCE DATE

The tests were performed from 09 to 12 August, 2004

### 1.2. SOPEMEA PERSONNEL

H. DORDET - P. CALMELS

### 1.3. TEST ATTENDANT

Name

Company

Mr. FISCHER

SCHROFF

## 2 - TEST RESOURCES

### 2.1. TEST EQUIPMENT USED

#### 2.1.1. TEST FACILITIES

Character	Manufacturer	Type	Periodicity ± 1 month	Date of last verification
Hydraulic vibration exciter	SOPEMEA JACOTTET	HOR 300KN	1 year	11/06/2003
Hydraulic vibration exciter	SOPEMEA	Biaxis 300KN	1 year	02/06/2003

## 2.1.2. CONTROL

### - Control systems

Character	Manufacturer	Type	Serial n°	Periodicity ± 1 month	Date of last verification
Digital servo-system	CONCURRENT COMPUTER	MVME	DV374	2 years	04/07/2002
Digital servo-system	HP-LMS	3565	3132G01149	2 years	15/12/2003

### - Control channels

SENSORS : Piezoelectric accelerometers					CONDITIONING MODULE : Load amplifiers				
Manu- facturer	Type	Serial n°	Periodicity ± 1 month	Date of last calibration	Manu- facturer	Type	Serial n°	Periodicity ± 1 month	Date of last calibration
B-K	4370	1578661	6 months	25/05/2004	KISTLER	5011-SK10	1030A-6622/4-V1	6 months	25/05/2004
B-K	4370	1578662	6 months	25/05/2004	KISTLER	5011-SK10	1030A-6622/4-V2	6 months	25/05/2004
B-K V2	4370	1622974	6 months	25/05/2004	KISTLER	5011-SK10	1030A-6622/6-V2	6 months	25/05/2004
B-K V1	4370	1622973	6 months	25/05/2004	KISTLER	5011-SK10	1030A-6622/6-V1	6 months	25/05/2004
JPB	J505-10	1637	1 year	30/10/2003	VISHAY	2120A	116277V1	1 year	30/10/2003
JPB	J505-10	3254	1 year	30/10/2003	VISHAY	2120A	116277V3	1 year	30/10/2003

## 2.2. MEASUREMENT EQUIPMENT USED

### MEASURING CHANNELS

SENSORS : Piezoelectric accelerometers					CASING MODULE : Load amplifiers				
Manu- facturer	Type	Serial n°	Periodicity ± 1 month	Date of last calibration	Manu- facturer	Type	Serial n°	Periodicity ± 1 month	Date of last calibration
B-K	4383	1745281/1	1 year	4/05/2004	BK	2692	2078970/1	1 year	30/04/2004
B-K	4367	1074053/2	1 year	4/05/2004	BK	2692	2078970/2	1 year	30/04/2004
B-K	4367	0932193/3	1 year	4/05/2004	BK	2692	2078970/3	1 year	30/04/2004
B-K	4367	0627959/4	1 year	4/05/2004	BK	2692	2078970/4	1 year	30/04/2004
B-K	4367	0627966/5	1 year	4/05/2004	BK	2692	2078971/5	1 year	30/04/2004
B-K	4367	1074123/6	1 year	4/05/2004	BK	2692	2078971/6	1 year	30/04/2004
B-K	4367	932213/7	1 year	4/05/2004	BK	2692	2078971/7	1 year	30/04/2004
B-K	4367	1074122/8	1 year	4/05/2004	BK	2692	2078971/8	1 year	30/04/2004



## 3 - TECHNICAL PART

### **3.1. EQUIPMENT PRESENTED FOR TESTS**

SCHROFF submitted testing for :

- a standard cabinet, P/N : F15053-126, prototype,
- a reinforced cabinet, P/N : F15053-127, prototype

### **3.2. TEST PROGRAM**

The test program, communicated by SCHROFF's representatives, is defined in accordance with the IEC 61587 standard.

The tests carried out were monoaxial type.

The test program is executed as indicated hereafter :

#### **3.2.1. SEARCH FOR RESONANCE FREQUENCIES**

##### **Excitation mode**

Monoaxial excitation

Sinusoidal vibrations maintained with exponential frequency excursion

##### **Frequency excursion**

Sweep rate : 1 oct/min

Sweep to rising, then decreasing frequency

##### **Frequency range**

1 to 50 Hz

##### **Excitation level**

Excitation at constant acceleration of 0.2 g.

Configuration : equipment powered OFF.

### 3.2.2. EARTHQUAKE RESISTANCE TESTS

#### 3.4.2.1. Tests on the standard cabinet

##### **Excitation mode**

Monoaxial excitation

Synthesized time histories based on spectra from the IEC 61587-2 (equal to Bellcore, zones 2 and 3).

Damping value pertaining to spectra : 2 %

Time history duration : 30 s

See RRS reference spectrum, pages 8 to 11 and reference time history pages 14 to 17.

##### **Frequency range**

1 to 50 Hz

##### **Test level**

The time history applied to the test table must produce a TRS test response spectrum comparable to the RRS reference spectrum.

##### **Sequence of the tests**

An earthquake is simulated by a 30 s time history.

The specimen is subjected to 1 earthquake, according to the three axes configurations OX, OY and OZ.

Check : mechanical resistance check



### 3.4.2.2. Tests on the reinforced cabinet

#### **Excitation mode**

Monoaxial excitation

Synthesized time histories based on spectra of zone 4 from the BELLCORE specification ref. GR-63-CORE.

Damping value pertaining to spectra : 2 %

Time history duration : 30 s

See RRS reference spectrum, pages 12 and 13 and reference time history pages 18 and 19.

#### **Frequency range**

1 to 50 Hz

#### **Test level**

The time history applied to the test table must produce a TRS test response spectrum comparable to the RRS reference spectrum.

#### **Sequence of the tests**

An earthquake is simulated by a 30 s time history.

The specimen is subjected to 1 earthquake, according to the three axes configurations OX, OY and OZ.

Check : mechanical resistance check

#### **Notations :**

RRS : Required Response Spectrum

TRS : Test Response Spectrum

### 3.3. OPERATING PROCEDURE

#### 3.3.1. ORIENTATION REFERENCE

The position of equipment is defined in relation to the axes of the trirectangular reference system shown on photographs No. 1 to 3, pages 25 and 26.

#### 3.3.2. TEST CONDITIONS

##### 3.3.2.1. Mounting

Each cabinet is fastened by 16 M12 screws on an interface plate.

##### 3.3.2.2. Vibration method

##### ☐ Search for resonance frequencies

##### **Sinusoidal vibrations**

The tests are carried out with an electrohydraulic vibration installation controlled by a digital control console.

The rectilinear and sinusoidal vibrations transmitted are defined by their amplitude of displacement  $a$  and their frequency  $f$ .

The amplitude of acceleration obtained is :

$$\Gamma = \frac{1}{g} 4\pi^2 f^2 a \quad \text{with : } \begin{array}{l} \Gamma \text{ in number of } g \\ f \text{ in Hz} \\ a \text{ in m} \end{array}$$

( $g$  : acceleration of normalized gravity)

Control is made at 2 points, on the filtered signal of reference sensors, on the highest signal.

### □ Earthquake resistance tests

The tests were controlled with a digital control console using a calculation program in transient mode.

The program enabled :

- The synthesis of a time history based on the RRS reference spectrum. This time history is used to excite the specimen during the test.
- The analysis of the TRS spectrum of this time history after the test to validate program realization. The TRS spectrum must be equal or more than the RRS spectrum at all points.  
The functions of synthesis and analysis were programmed according to the data hereafter.

#### Synthesis

- Generation of a synthesized time history
- Characteristics of a time history.

RRS spectra pages	8 to 13
Damping (%)	2
Frequency range (Hz)	1 – 50
Resolution (1/n octave)	1/6
Time history duration (s)	30

#### Analysis

The excitation movement of the cabinet during the test is measured using an accelerometric chain and recorded (see paragraph 3.3.3.3).

#### Analysis of TRS spectrum

Characteristic of the spectrum

Response	Absolute
Spectrum	Composite
Frequency range (Hz)	1 – 50
Resolution (1/n octave)	1/6
Damping (%)	2

Graphic plotting :  
acceleration in relation to frequency

### Analysis of test time history

#### Characteristics of the analysis

Response	Absolute
Definition	6144
Duration of basic time history (s)	30

Graphic plotting : acceleration in relation to time.

Absolute response : signal processing is carried from the absolute value of the time history.

Composed spectrum : spectrum calculation is carried on the total duration of the time history and on the entirety of frequential content.

### **3.3.3. ACCELERATION MEASUREMENTS**

#### 3.3.3.1. Measuring points

Accelerometers were installed on the cabinet.

Their location and photographs number are given in the table below.

Point n°	Location description	Photograph	
		No.	page
1	At the base of the structure, near a	12	30
2	On the front of the ballast of 90 kg	12	30
3	At the center of the ballast of 60 kg	13	31
4	On the front side of the lower ballast of 25 kg	14	31
5	On the front side of the upper ballast	15	32
6	On the top of the cabinet, right-hand front side	16	32
Pilots 1 and 2	At the base of the cabinet, between the attachments, right and left side	17 - 18	33



### 3.3.3.2. Measurements acquisition

#### ☐ Sinusoidal vibrations

The signals delivered by the accelerometric measurement channels are recorded and directly restored by the digital control console.

The signal digitized are stored on hard disk.

Acquisition is made through 10 channels multiplexer and low-pass filters. These filters were effective in the frequency range 1 – 50 Hz with a slope of 48 dB/octave at the cut-off frequency.

The acquisition characteristics are given in paragraph 3.3.3.4.

#### ☐ Earthquake resistance tests

The signals delivered by the accelerometers are recorded and restored by the data processing device.

Acquisition is made through 10 channels multiplexer and low-pass filters. These filters were effective in the frequency range 1 – 50 Hz with a slope of 48 dB/octave at the cut-off frequency.

### 3.3.3.3. Measurements processing

#### ☐ Sinusoidal vibrations

##### **Restoration of filtered signals**

The signals are filtered digitally.

Filtering enables restoring of the fundamental signal alone, excluding any others (harmonics, impacts, etc...)

The curves give the level of acceleration  $\Gamma$  in g (peak), in relation to frequency.

#### ☐ Earthquake resistance tests

The time histories relative to the different measurements points were processed on the computer to obtain their respective response spectrum.

The characteristics of the response spectrum analysis were as follows :

Response	Absolute
Spectrum	Composite
Frequency range (Hz)	1 – 50
Resolution (1/n octave)	1/6
Damping (%)	2

#### Remarks :

Analysis of response spectrum of reference accelerometer (TRS) is carried out with the data processing device

#### 3.3.3.4. Parameters of acquisition

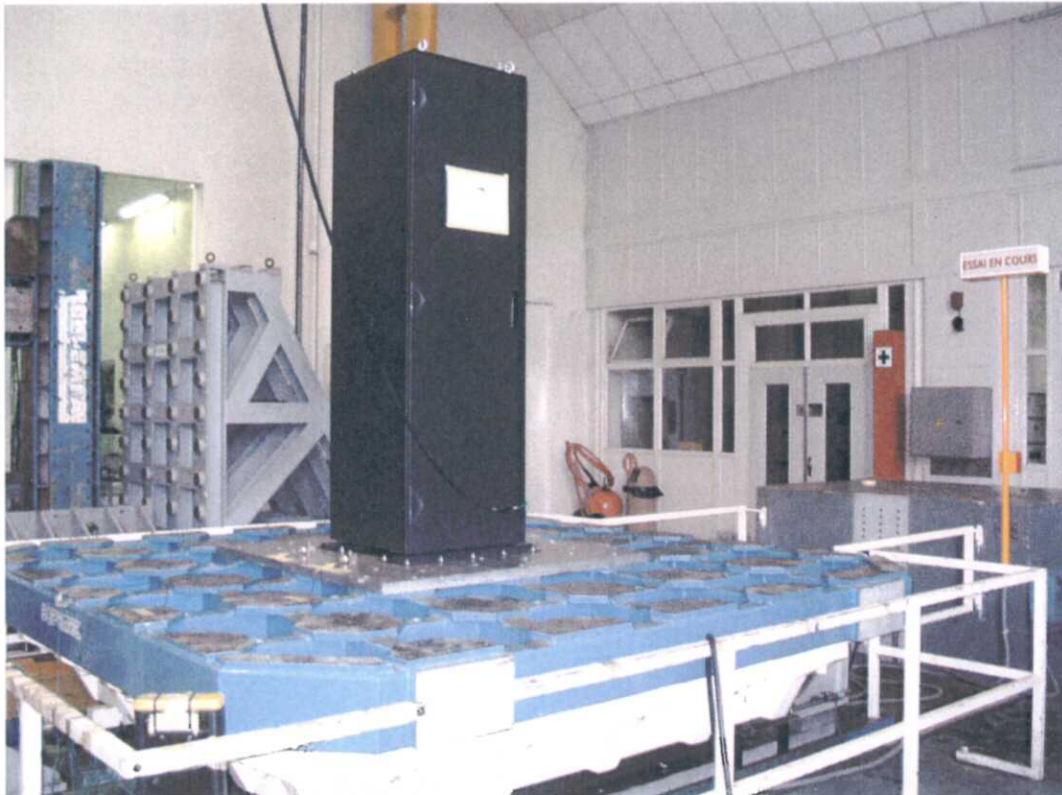
##### ☐ Sinusoidal vibrations

- Minimum frequency : 1 Hz
- Maximum frequency : 50 Hz
- Number of channels : 10
- Number of frequency points : 200 by octave



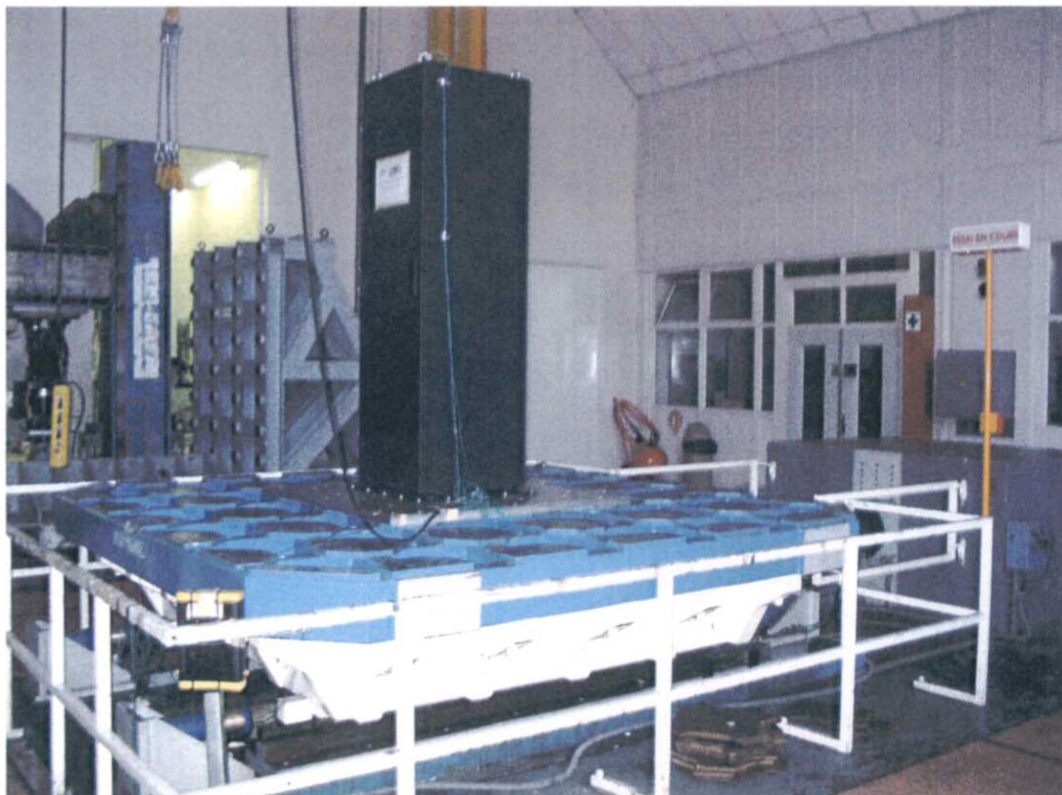
**PHOTOGRAPH No. 1**

**STANDARD CABINET - OVERALL VIEW ALONG THE OX AXIS**



**PHOTOGRAPH No. 2**

**REINFORCED CABINET - OVERALL VIEW ALONG THE OY AXIS**



**PHOTOGRAPH No. 3**

**STANDARD CABINET - OVERALL VIEW ALONG THE OZ AXIS**



**PHOTOGRAPH No. 4**

**VIEW OF THE STANDARD CABINET WITHOUT THE REAR PANEL**





**PHOTOGRAPH No. 5**

**VIEW OF THE STANDARD CABINET WITHOUT THE REAR PANEL**



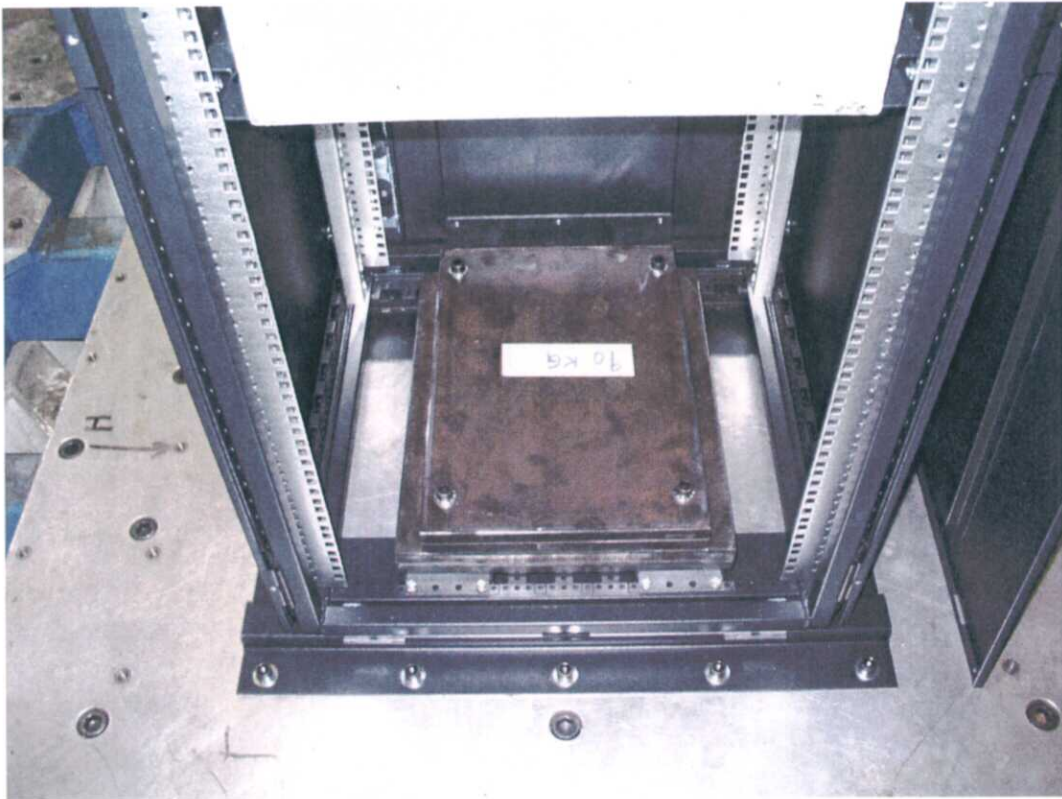
**PHOTOGRAPH No. 6**

**VIEW OF THE STANDARD CABINET WITHOUT THE REAR PANEL**



**PHOTOGRAPH No. 7**

**VIEW OF THE STANDARD CABINET WITHOUT THE REAR PANEL**



**PHOTOGRAPH No. 8**

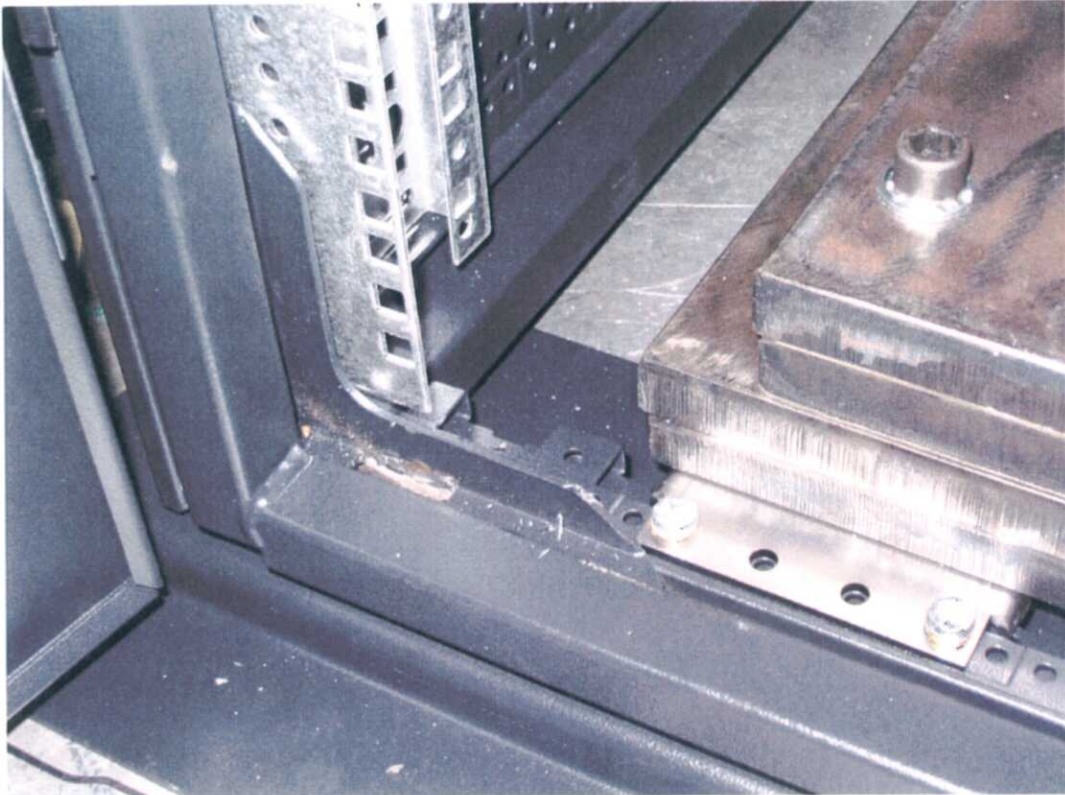
**REINFORCED CABINET – VIEW OF THE UPPER REINFORCEMENT**





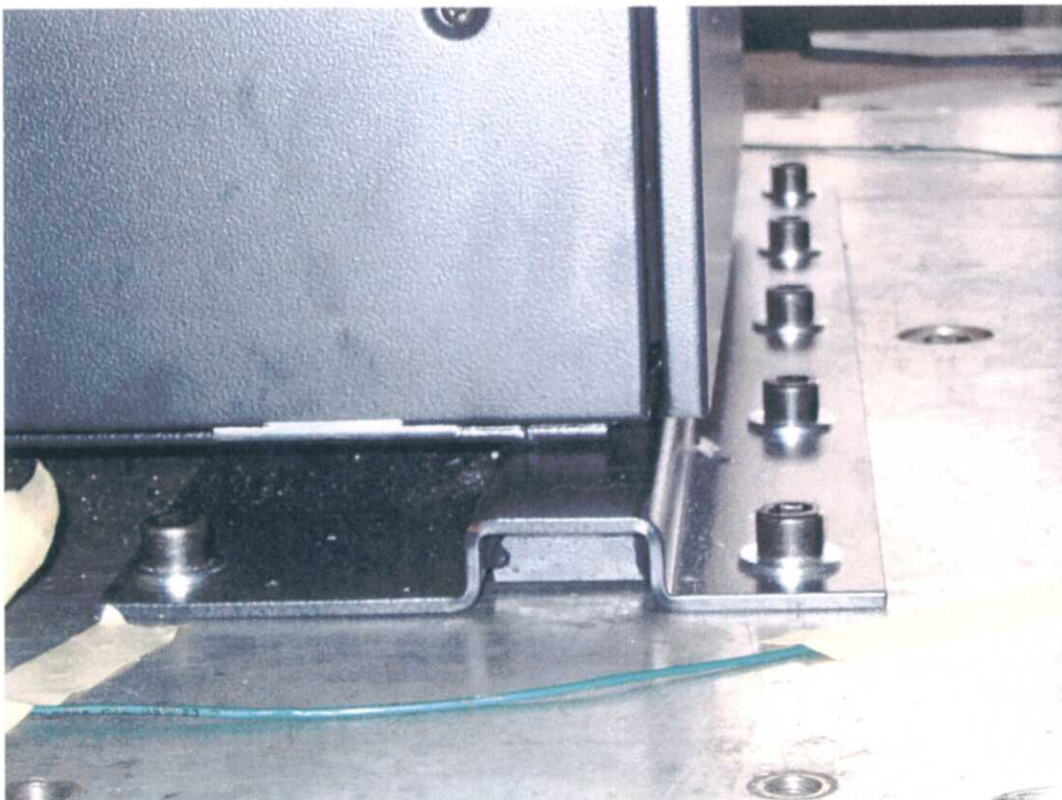
**PHOTOGRAPH No. 9**

**REINFORCED CABINET – VIEW OF THE LOWER REINFORCEMENT**



**PHOTOGRAPH No. 10**

**STANDARD CABINET – VIEW OF ATTACHMENTS**



### 3.3.4. CHECKS

Functional checks are carried by SCHROFF's representative and SOPEMEA's technicians.

### 3.4. TEST SCHEDULES AND RESULTS

The tests were carried out in accordance with the conditions defined in paragraphs 3.2 and 3.3. Schedules and results are set out in :

- the tables hereafter, for the tests,
- the appendix for the acceleration recordings

#### 3.4.1. SEARCH FOR RESONANCE FREQUENCIES

##### 3.4.1.1. Tests carried out on the standard cabinet

Sweep rate : 1 oct/min (logarithmic)

Date	Axis	Program		Duration	Graphs No.	Remarks
		Frequency Hz	$\Gamma$ g			
09/08/2004	OY	1 to 50	0.2	5 min 38 s	11 to 20	Frequency at 8.5 Hz. Functional checks after the tests : nothing to report. Recording of 8 measurement channels
	OX	1 to 50	0.2	5 min 38 s	21 to 30	Frequency at 4 Hz. Functional checks : nothing to report.
10/08/2004	OZ	1 to 50	0.2	5 min 38 s	31 to 40	Nothing to report.



### 3.4.1.2. Tests carried out on the reinforced cabinet

Sweep rate : 1 oct/min (logarithmic)

Date	Axis	Program		Duration	Graphs No.	Remarks
		Frequency Hz	$\Gamma_g$			
10/08/2004	OY	1 to 50	0.2	5 min 38 s	41 to 50	The location of measurement point is identical to the standard cabinet Frequency at 8 Hz.
	OX	1 to 50	0.2	5 min 38 s	51 to 60	Frequency at 4.5 Hz. Mechanical resistance : nothing to report.
	OZ	1 to 50	0.2	5 min 38 s	61 to 70	Nothing to report after the tests.

### 3.4.2. EARTHQUAKE RESISTANCE TESTS

#### 3.4.2.1. Tests carried out on the standard cabinet

Date	Axis	Program				Remarks
		Level	TRS spectra graphs no.	Number of tests	Time/ test s	
11/08/2004	OZ	Zone 2	1	1	30	<u>Application of 1 earthquake, zone 2 level</u> Nothing to report. No accelerometric measurement for earthquake resistance tests
	OX	Zone 2	2	1	30	<u>Application of 1 earthquake, zone 2 level</u> Nothing to report
	OY	Zone 2	3	1	30	<u>Application of 1 earthquake, zone 2 level</u> Nothing to report
	OZ	Zone 3	4	1	30	<u>Application of 1 earthquake, zone 3 level</u> Nothing to report.
	OY	Zone 3	5	1	30	<u>Application of 1 earthquake, zone 3 level</u> Nothing to report
12/08/2004	OX	Zone 3	6	1	30	<u>Application of 1 earthquake, zone 3 level</u> Nothing to report

### 3.4.2.2. Tests carried out on the reinforced cabinet

Date	Axis	Program				Remarks
		Level	TRS spectra graphs no.	Number of tests	Time/ tests	
12/08/2004	OZ	Zone 4	7	1	30	<u>Application of 1 earthquake, zone 4 level</u> Little low level. Nothing to report.
		Zone 4	8	1	30	<u>Application of 1 earthquake, zone 4 level</u> Resumption of the tests after correction. Nothing to report
	OX	Zone 4	9	1	30	<u>Application of 1 earthquake, zone 4 level</u> Nothing to report
	OY	Zone 4	10	1	30	<u>Application of 1 earthquake, zone 4 level</u> Nothing to report.