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DELTA Test Report

TEST Reg. no. 19

Seismic Test of Test Tavle

Performed for Løgstrup A/S

DANAK-19/14413
Project no.: T208221-2
Page 1 of 48
including 5 annexes

19 August 2014

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Title	Seismic Test of Test Tavle
Test object	1 pc. “Vibrations_testtavle_2014” Detailed information is given in Section 1. The test object was received 16 June 2014.
Report no.	DANAK-19/14413
Project no.	T208221-2
Test period	18 June – 19 June 2014
Client	Løgstrup A/S Egeskovvej 16 -18 - 20 Postboks 1009 DK 3490 Denmark
Contact person	Mr Rasmus Kirkegaard E-mail: rki@logstrup.dk
Manufacturer	Løgstrup Steel
Specifications	IEC 60068-3-3 ed. 1.0, 1991 “Guidance – Sesmic test methods for equipment” IEC 60068-2-6, ed. 7.0, 2007 “Test Fc Vibration (sinusoidal)”
Results	No major deteriorations were detected except around the bottom frame and some minor issues were found during and after the seismic testing. The criteria for compliance are listed in Section 3.2.
Test personnel	Carsten Kiørboe Kim A. Schmidt
Date	19 August 2014
Responsible	 Kim A. Schmidt, B.Sc.M.E. DELTA

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1. Test object

1.1 Test object

Test object 1.1.1

Name of test object	Vibrations_testtavle_2014
Model / type	Mixed configurations
Part no.	-
Serial no.	-
Manufacturer	Løgstrup Steel
Supply voltage	-
Comments	The test object is made from several different Løgstrup modules/parts in order to cover many different Løgstrup parts and to represent a typical configuration. Mass: Approx. 960 kg Size: 2191 x 840 x 1776 mm or 11 x 4 x 9 modules The test object was fitted with standard Earthquake reinforcement bracket supplied by Løgstrup A/S. Note that the same test object has been subjected to a full vibration marine type approval test before the seismic testing, and that some minor damages thus were present in the test object before the seismic testing. The door locking means was changed to “T-wing handles” during the seismic testing.

Figure 1 Test object with initial door locking means (door at large circuit breaker not closed on this photo).

Figure 2 Test object with final door locking means.

1.2 Auxiliary equipment

Auxiliary equipment 1.2.1

Name of auxiliary equipment	Insulation Resistance Tester
Model / type	MI 3201 / TeraOhm 5 kV Plus
Part no.	-
Serial no.	Trescal 239405
Manufacturer	Metrel
Supply voltage	-
Comments	Supplied and operated by Løgstrup A/S. Used for High Voltage test / Insulation resistance test before and after vibration test

2. General test conditions

2.1 Introduction

This test report concerns the seismic testing of Test Tavle manufactured by Løgstrup A/S.

The testing was performed according to the seismic test guidance and requirements given in the following document:


NORME INTERNATIONALE
INTERNATIONAL STANDARD

CEI
IEC
68-3-3

Première édition
First edition
1991-02

Essais d'environnement

Troisième partie:
Guide
Méthodes d'essais sismiques applicables aux matériels

Environmental testing

Part 3:
Guidance
Seismic test methods for equipments

Now designated IEC 60068-3-3 (still ed. 1.0).

The actual test parameters were selected to be:

Test wave:	Sine sweep
Test type:	Single-axis test
Test method:	Standard amplitude conventional test
Performance level:	II

The detailed test parameters are described in section 3.

2.2 Test setup

The test object was attached to a rigid, horizontal vibration fixture via its normal mounting holes in the bottom. The vibration fixture was partly supplied by Løgstrup A/S (the part in direct contact with the test object) and by DELTA (all other parts of the fixture).

As the test object was not designed for a specific purpose, it did not have a specific electrical function. Thus no electrical function test was performed at DELTA.

An electrical insulation resistance test was performed before and after the seismic test. The test was performed by personnel from Løgstrup A/S and witnessed by DELTA. The test was performed with 2500 VAC applied between the 3 phases and between the phases and earth/ground for 1 minute per test point. See details from the insulation resistance tests in Annex 4.

2.3 Criteria for compliance

The following acceptance criteria were relevant for the actual test object:

- No mechanical degradation of the test object's major structural parts is allowed. The overall frame, electrical conductors ("cupper bars") and the attachment of these, attachment of large components ("circuit breakers") and electrical safety barriers are considered to be major structural parts.
- No major change in insulation resistance.
- No electrical flashovers etc. are to be observed during the insulation resistance testing.

2.4 Standard environment

Normal environmental condition:

Temperature	:	15 °C - 35 °C
Humidity	:	25 %RH - 75 %RH
Air pressure	:	86 kPa - 106 kPa (860 mbar - 1060 mbar)
Power supply voltage	:	U_{nom}. ±3 %

3. Test and results

3.1 General

The following tests were carried out as agreed with the client.

Sweep sine, single axis seismic test

The vibration response of 4 selected measuring points was measured during the sweep sine seismic exposure in each axis.

An Insulation resistance test was also performed before and after the seismic testing.

The designation of exposure axes are defined as follows:

X-axis Horizontal, perpendicular to front doors (“front-back”)

Y-axis Horizontal, perpendicular to sides (“side-side”)

Z-axis Vertical, perpendicular to the bottom (“up-down”)

The tests and the results are described in details in the following sections.

3.2 Seismic test, vertical (4.5 m/s^2)

Specifications

IEC 60068-3-3: ed. 1.0, 1991, “Guidance, Seismic test methods for equipment”

Test method

IEC 60068-2-6: ed. 7.0, 2007, Test Fc: Vibration (sinusoidal).

Severity and procedure

Frequency range	:	1 - 35 Hz		
Frequency / amplitude	:	1 - 35 Hz	:	±4.5 m/s^2 (±0.46 g)
Sweep rate	:	1 octave/min.		
Number of axes	:	1 (vertical)		
Duration	:	One sweep (nominal duration 5 min. 8 sec.)		

The test object is de-energised during the exposure.

During the resonance search, the resonance frequencies are determined by means of accelerometer measurements of the amplification factors (Q).

The absolute acceleration response of the selected measuring point is presented as curves with response acceleration as function of frequency.

The test was performed on an electro dynamical vibration system with a limited displacement at lower frequencies and it was thus not possible to run test all down to the specified 1 Hz. It was thus decided to perform the test as a sweep starting from 35 Hz and continue the sweeping down in frequency until the displacement limit of the test system was tripped. The actual reached lower frequency was recorded for each axis.

Results

See section 3.4.

3.3 Seismic test, horizontal (9 m/s²)

Specifications

IEC 60068-3-3: ed. 1.0, 1991, “Guidance, Seismic test methods for equipment”

Test method

IEC 60068-2-6: ed. 7.0, 2007, Test Fc: Vibration (sinusoidal).

Severity and procedure

Frequency range	:	1 - 35 Hz		
Frequency / amplitude	:	1 - 35 Hz	:	±9 m/s^2 (±0.92 g)
Sweep rate	:	1 octave/min.		
Number of axes	:	2 mutually perpendicular horizontal axes		
Duration	:	One sweep in each axis		

The test object is de-energised during the exposure.

During the resonance search, the resonance frequencies are determined by means of accelerometer measurements of the amplification factors (Q).

The absolute acceleration response of the selected measuring point is presented as curves with response acceleration as function of frequency.

The test was performed on an electro dynamical vibration system with a limited displacement at lower frequencies and it was thus not possible to run test all down to the specified 1 Hz. It was thus decided to perform the test as a sweep starting from 35 Hz and continue the sweeping down in frequency until the displacement limit of the test system was tripped. The actual reached lower frequency was recorded for each axis.

Results

See section 3.4.

3.4 Test results

4 response measuring points were selected as representative for the major structural parts of the test object. The measuring points are described below and shown on photos in Annex 2.

Description of measuring points

A1 Upper left front corner of cabinet

A2 Lower right back corner of cabinet

A3 Middle of left front edge of cabinet

A4 Upper right front corner of cabinet

The recorded test levels and the recorded measurement curves with the response acceleration as function of frequency are given in Annex 3.

The actual sequence of testing and results of the testing were as follows:

Axis	Activity	Results
-	Insulation resistance test	Performed by Løgstrup A/S. See results in Annex 4
Z	Seismic sine sweep	Performed as specified except that the lower frequency limit was 2.5 Hz (specified to 1 Hz). At frequencies below 3 Hz, the input vibration level was oscillating due to interference with the vibration system flexible suspension. This resulted in a higher test level. No damaged to the test object observed during the exposure
-	Brief external visual inspection	No remarks
Y	Seismic sine sweep	Performed as specified except that the lower frequency limit was 3.6 Hz (specified to 1 Hz) No damaged to the test object observed during the exposure except that 2 of the front doors opened during the exposure (see photo 9)
-	Brief visual inspection	Back and sides: OK 2 hinges at lower left front door loose (see photo 10) Large circuit breaker and mounting: OK Small circuit breaker and mounting OK Large cassette: One hinge partly defect (lower “pin” partly fallen out, see photo 11) No remarks to other parts
-	Modification	All front door “Wing knob” handles changed to “T-wing handles” (see photo 12)
X	Seismic sine sweep	Performed as specified except that the lower frequency limit was 3.2 Hz (specified to 1 Hz) The black bottom frame was partly torn apart and one of the mounting screws at the right side plate fell off during the exposure (see photo 13+14)

Axis	Activity	Results
-	Brief visual inspection	Both corners of the black bottom frame partly torn apart in the left side.
-	Insulation resistance test	Performed by Løgstrup A/S. See results in Annex 4
-	Detailed visual inspection	See details below

The results of the detailed visual inspections are (see also photos in Annex 3):

Outside

General appearance OK

No doors open and all “T-wing” knobs in correct position

No loose side panel mounting screws at left side

No loose side panel mounting screws at right left side (except the one that fell off during the exposure)

No loose front panels mounting screws at front

No loose back plate mounting screws (at back)

General “frame”

Earthquake brackets and mounting OK

Main structural frame including corners: OK

Black bottom frame partly torn apart at corners in the left side

Left front panels

Large cupper bars and mounting: OK

Large circuit breaker and mounting: OK

Buckling of lower right intermediate plate at front (near earth cupper bars, see photo 16)

Middle front panels

3 small cassettes: OK

Large cassette: OK

Small circuit breaker and mounting: OK

Buckling of lower cassette right side plate (in room with small circuit breaker, see photo 24)

Rigth front panel

No remarks

Back plates removed

No remarks

2 side panels removed

No remarks

Summary of test results

No deteriorations, damages etc. was observed on any structural frame parts, main cupper conductors, earthquake brackets and large dummy loads.

The black bottom frame was partly torn apart.

Some minor issues were seen on secondary parts.

The insulation resistance tests performed before and after test were OK.

Annex 1

List of instruments

List of instruments

NO.	DESCRIPTION	MANUFACTURER	TYPE NO.
EVFGT-50	EL.DYN SHAKER	LING DYNAMICS	V875-440 LS
96	ACCELEROMETER	BRÜEL & KJÆR	4371
71a	ACCELEROMETER	BRÜEL & KJÆR	4393
72a	ACCELEROMETER	BRÜEL & KJÆR	4393
73	ACCELEROMETER	BRÜEL & KJÆR	4393
78	ACCELEROMETER	BRÜEL & KJÆR	4393
22575	ACC. PRE-AMP.	BRÜEL & KJÆR	2626
22630	ACC. PRE-AMP. 4-CHAN.	BRÜEL & KJÆR	2692
43236	VIBR. CONTROLLER	LDS DACTRON	LAS 200
22610	OSCILLOSCOPE /METER	FLUKE	123
22599	STROBOSCOPE/COUNTER	BRÜEL & KJÆR	4913

The Insulation resistance test was performed by use of the following instrument supplied by Løgstrup A/S:


18.Jun.2014 08:20
METREL
MI 3201
SELECT
START
STOP
Trescal
DANAK
Reg. nr. 22
Trescal No.: 239405
Cal. Date: 04-06-2014
Next Cal.: 04-06-2015
Cert.No.: 22 - 442394
Equip.No.:
Trescal 239405

Annex 2

Photos

Photo 1 Test object before test (door at large circuit breaker not closed on this photo).

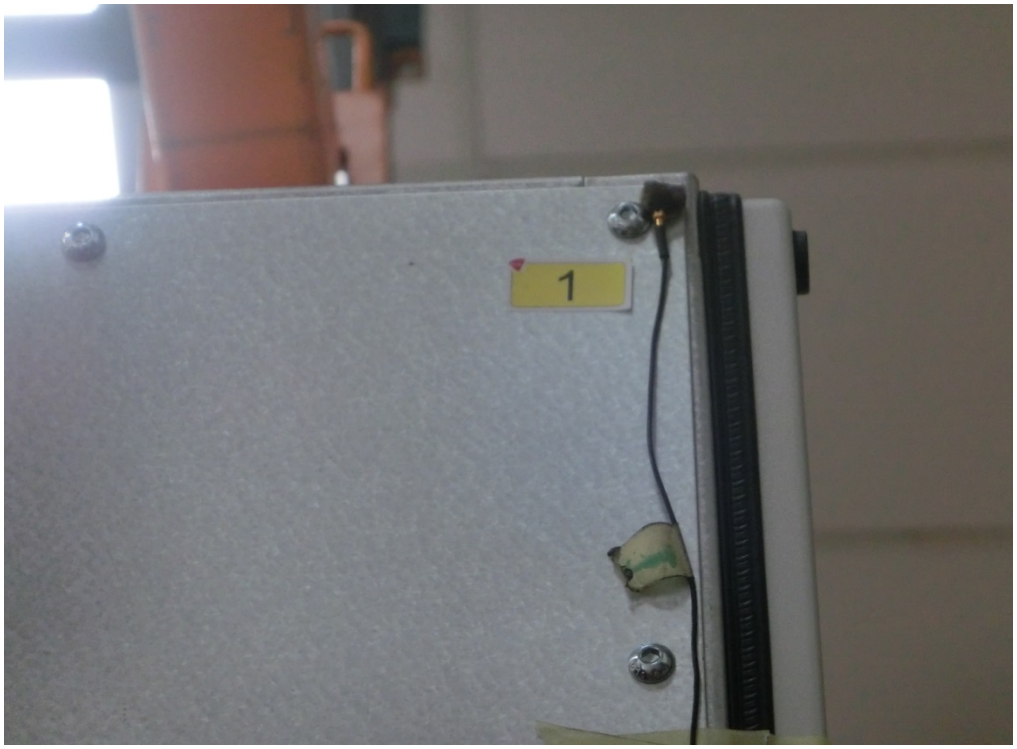


Photo 2 Measuring point A1: Upper left front corner of cabinet (Y-axis shown).

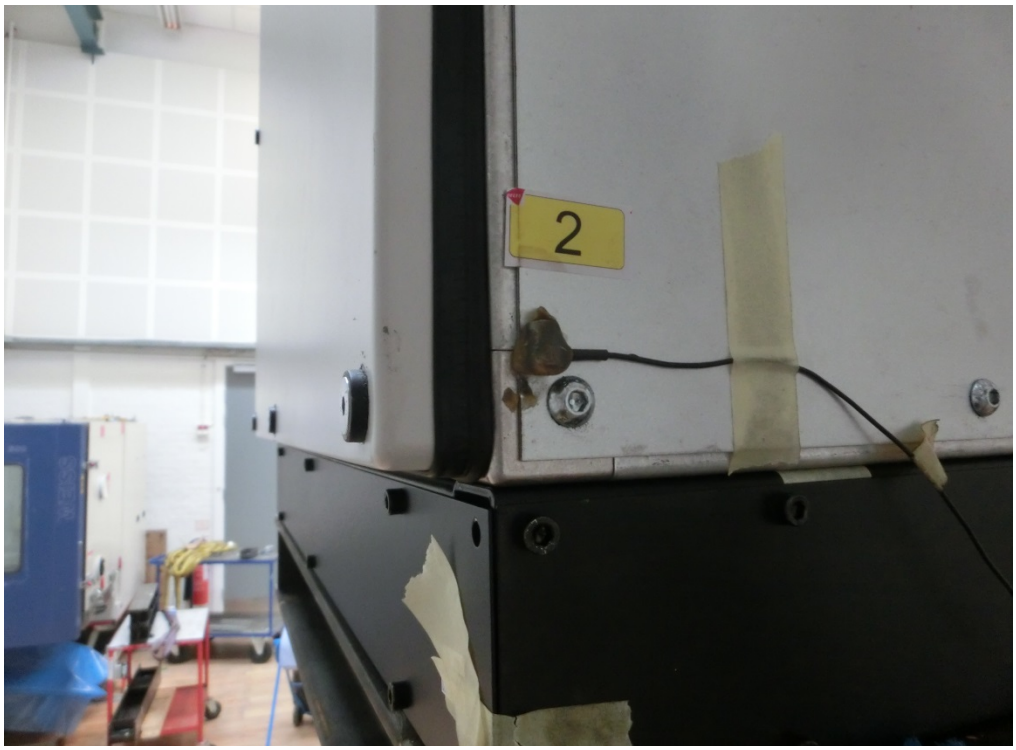


Photo 3 Measuring point A2: Lower right back corner of cabinet (Z-axis shown).

Photo 4 Measuring point A3: Middle of left front edge of cabinet (Y-axis shown).

Photo 5 Measuring point A4: Upper right front corner of cabinet (Y-axis shown).

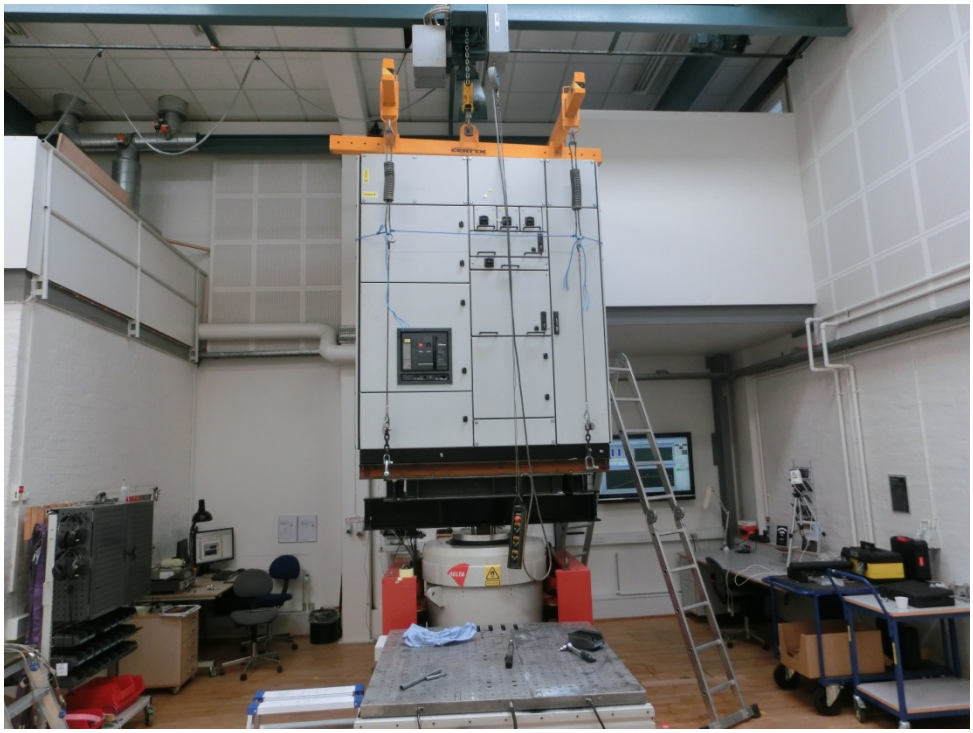


Photo 6 Test setup for Z-axis (note that the steel wires are used for carrying some of the weight via the fixture and are not attached to/supporting the test object.

Photo 7 Test setup for Y-axis.

Photo 8 Test setup for X-axis.

Photo 9 Visual Inspection after Y-axis: 2 front doors opened during exposure.

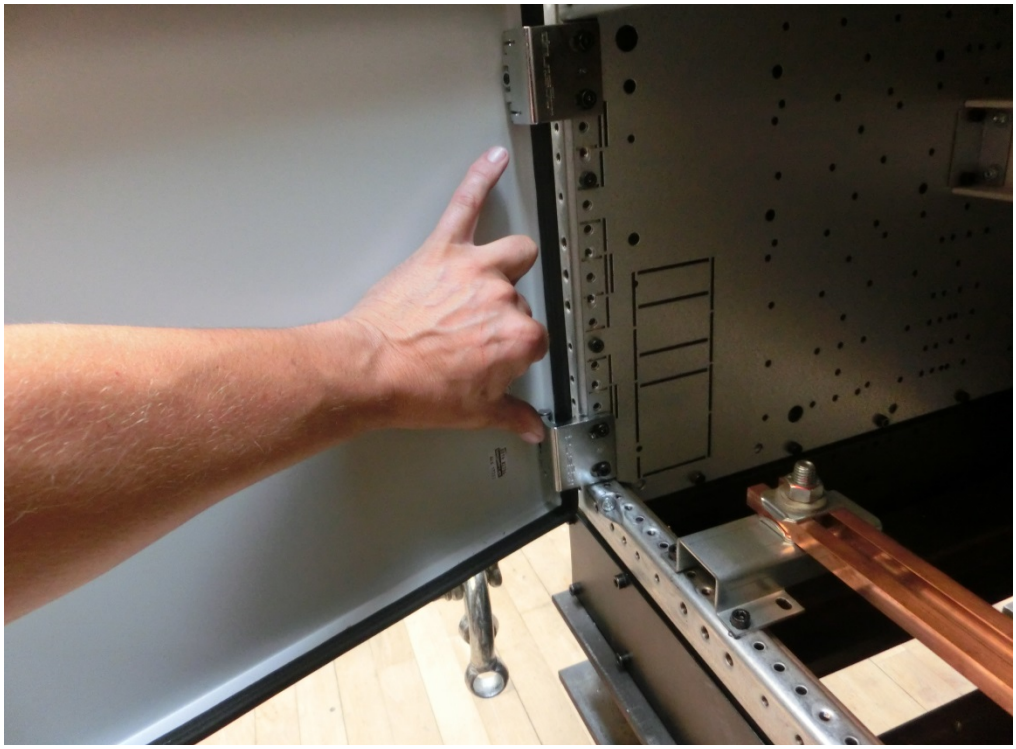


Photo 10 Visual Inspection after Y-axis: 2 front doors hinges loose.

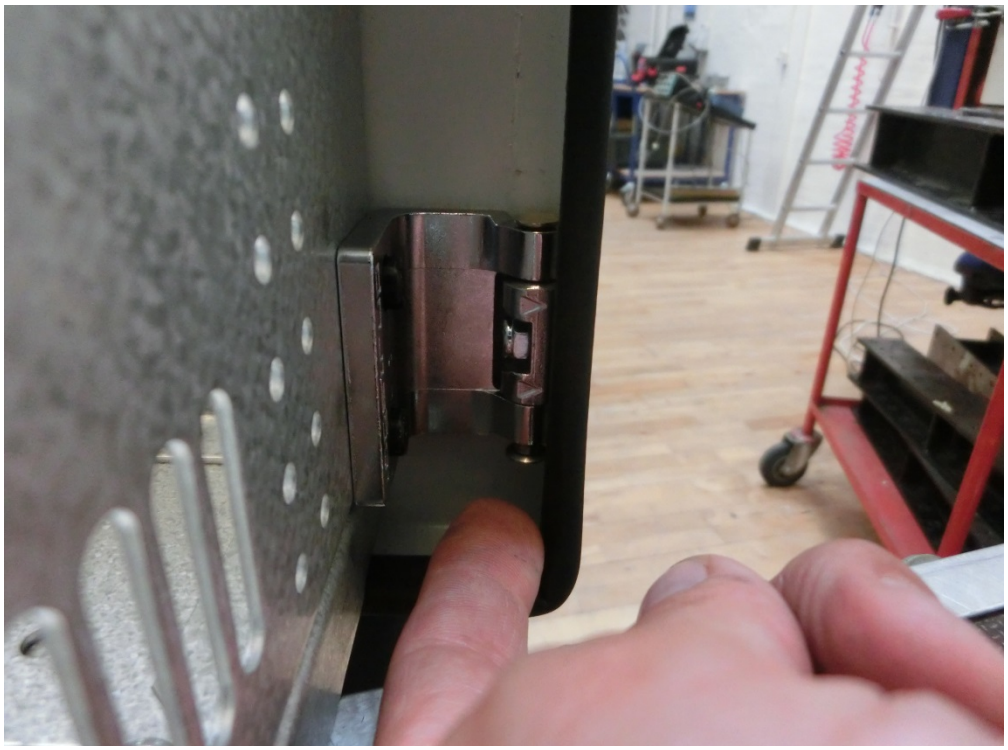


Photo 11 Visual Inspection after Y-axis: One hinge partly defect (lower “pin” fallen partly out).

Photo 12 Modification: All front door handles changed to “T-wing” types.

Photo 13 Visual Inspection: Black bottom frame broken at left side.

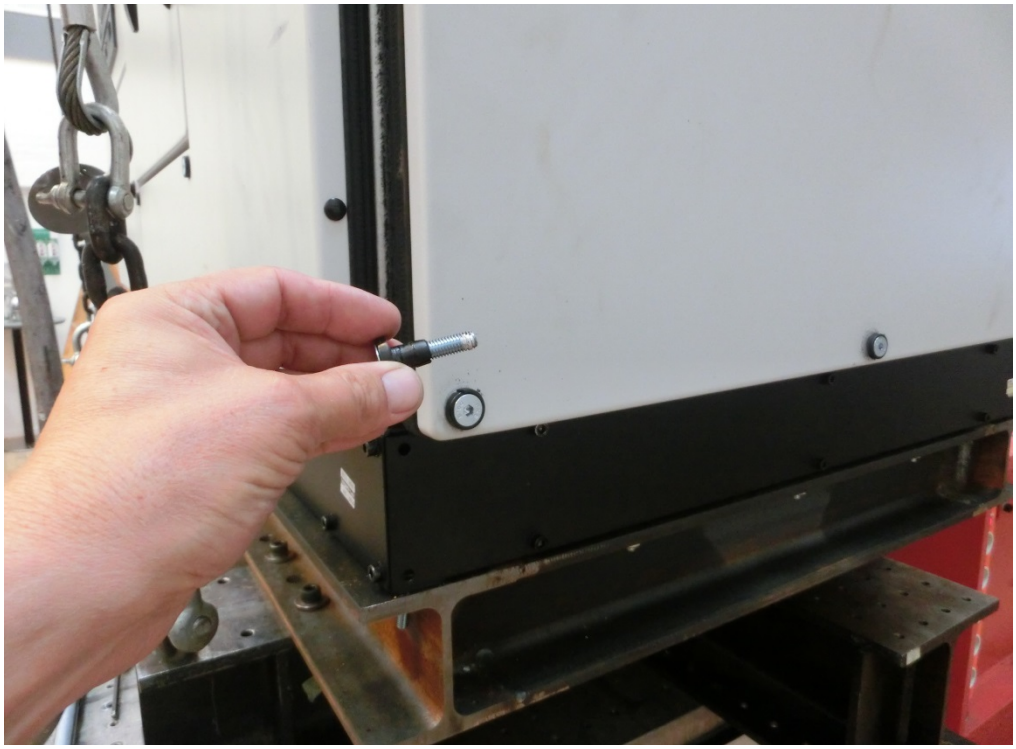


Photo 14 Visual Inspection: One mounting screw for right side plate fallen out.

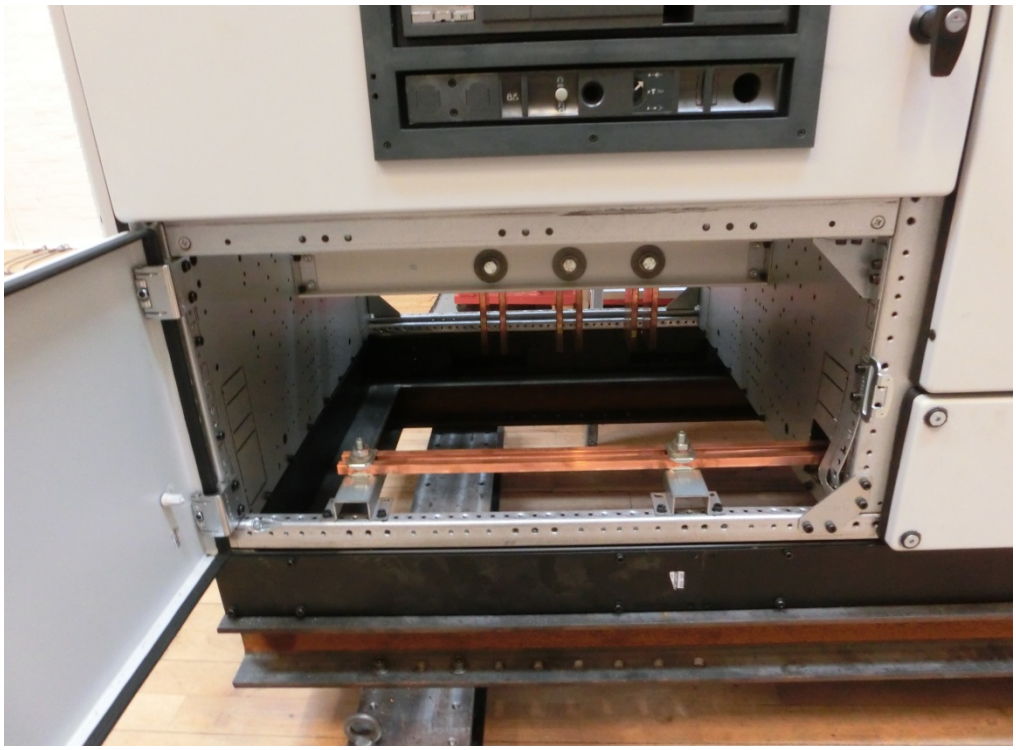


Photo 15 Visual Inspection: Large cupper bars and mounting OK.

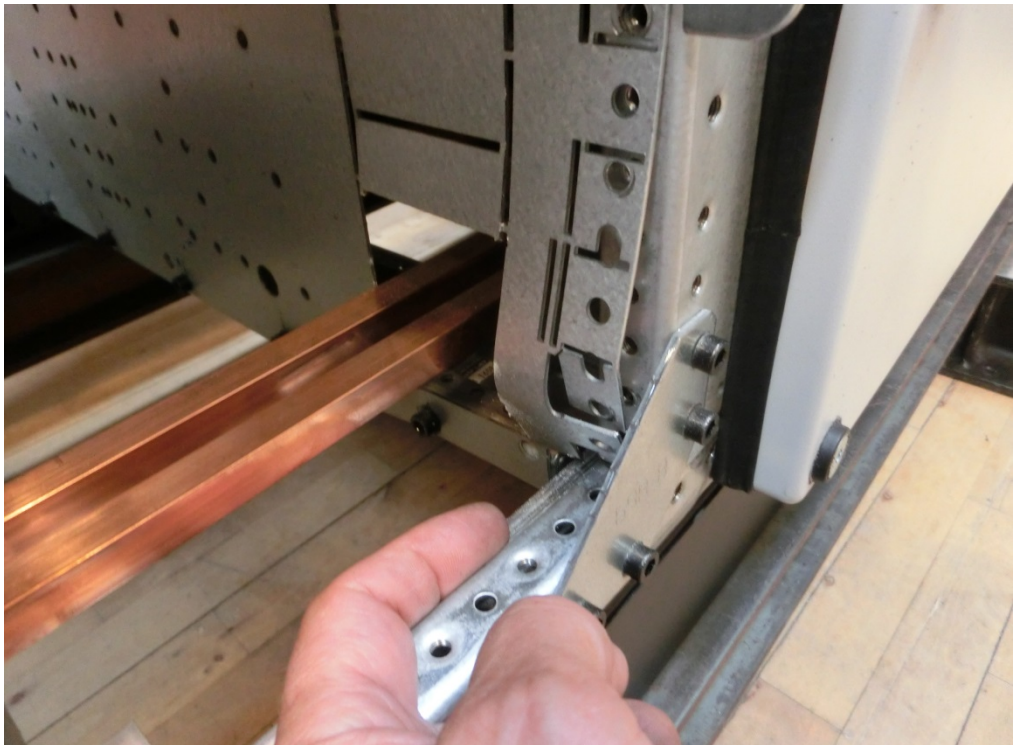


Photo 16 Visual Inspection: Buckling of lower right intermediate plate at front (near earth cupper bars).

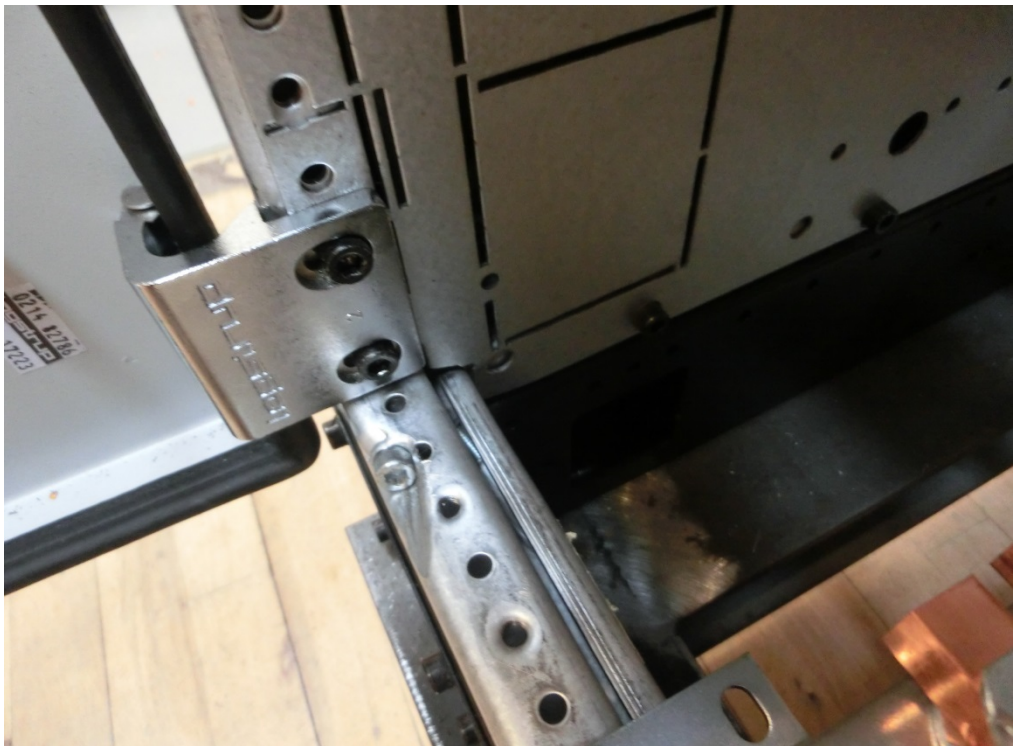


Photo 17 Visual Inspection: Structural corner OK.

Photo 18 Visual Inspection: Large cupper bars and mounting OK.

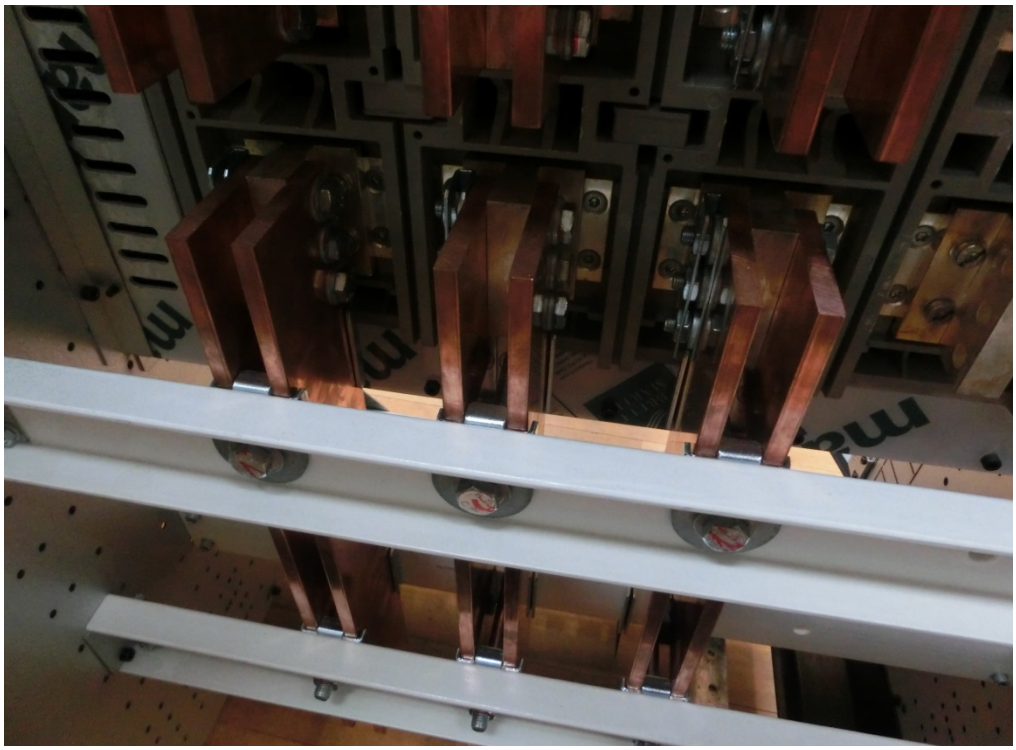


Photo 19 Visual Inspection: Large cupper bars and mounting OK.

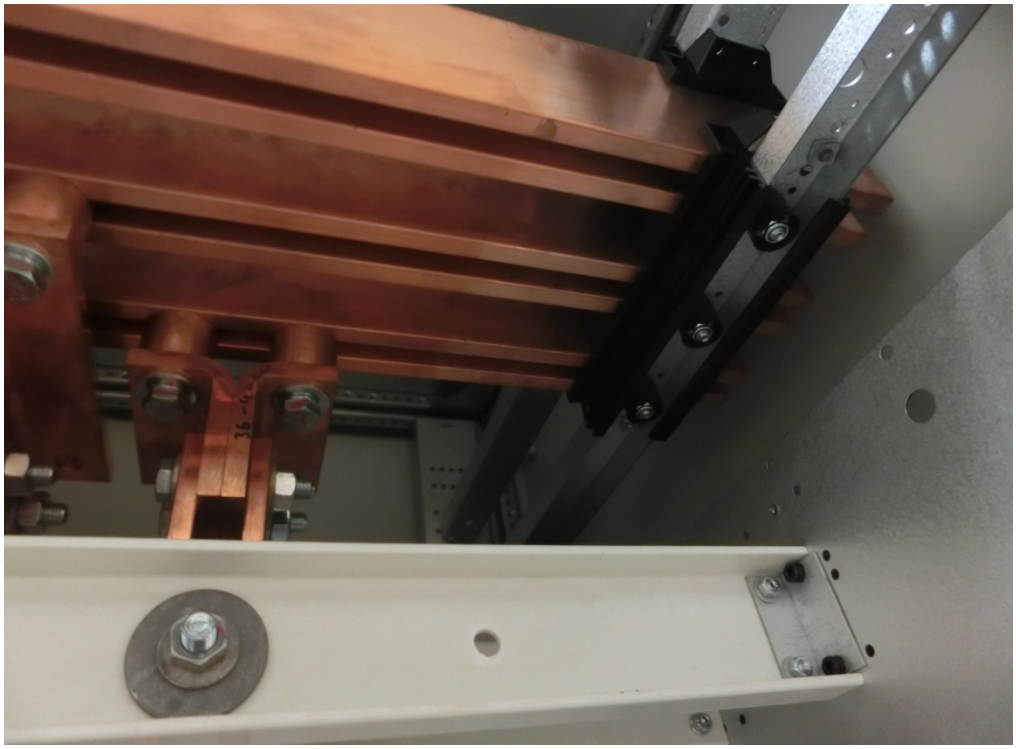


Photo 20 Visual Inspection: Large cupper bars and mounting OK.

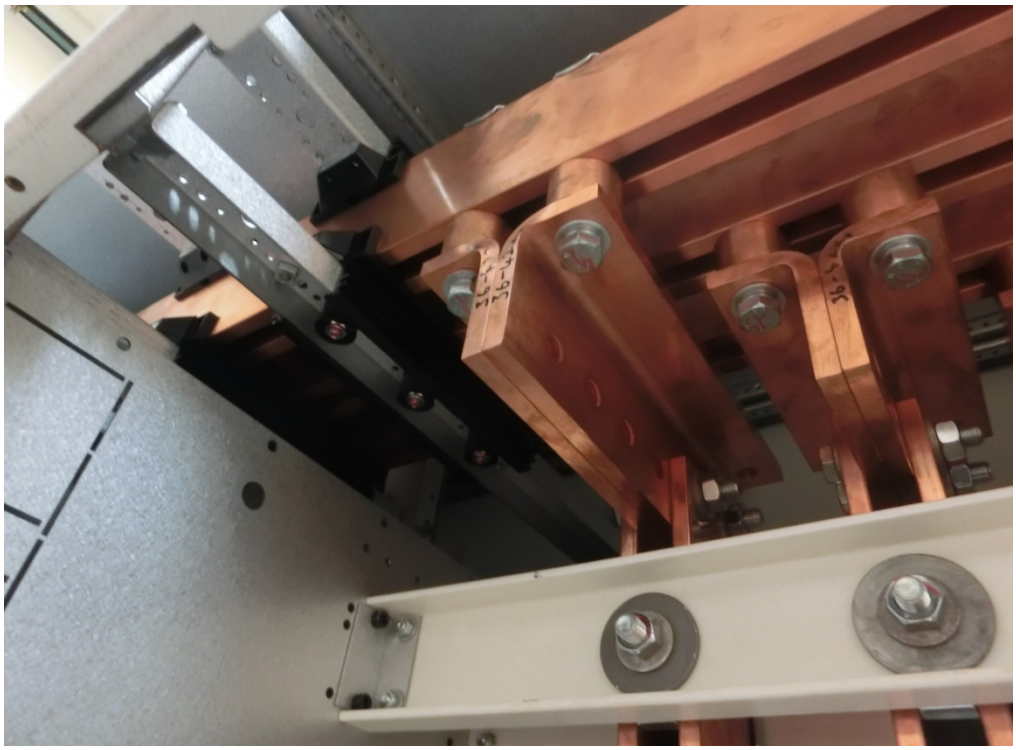


Photo 21 Visual Inspection: Large cupper bars and mounting OK.

Photo 22 Visual Inspection: Large circuit breaker and mounting OK.

Photo 23 Visual Inspection: Small circuit breaker and mounting OK.

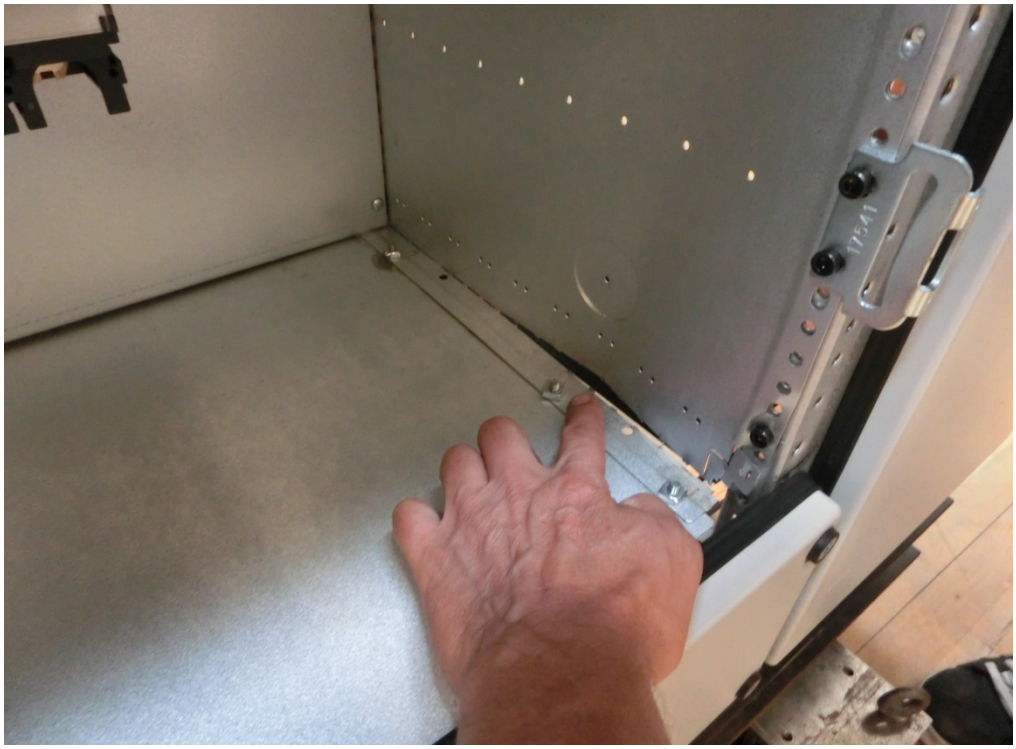


Photo 24 Visual Inspection: Buckling of lower cassette right side plate.

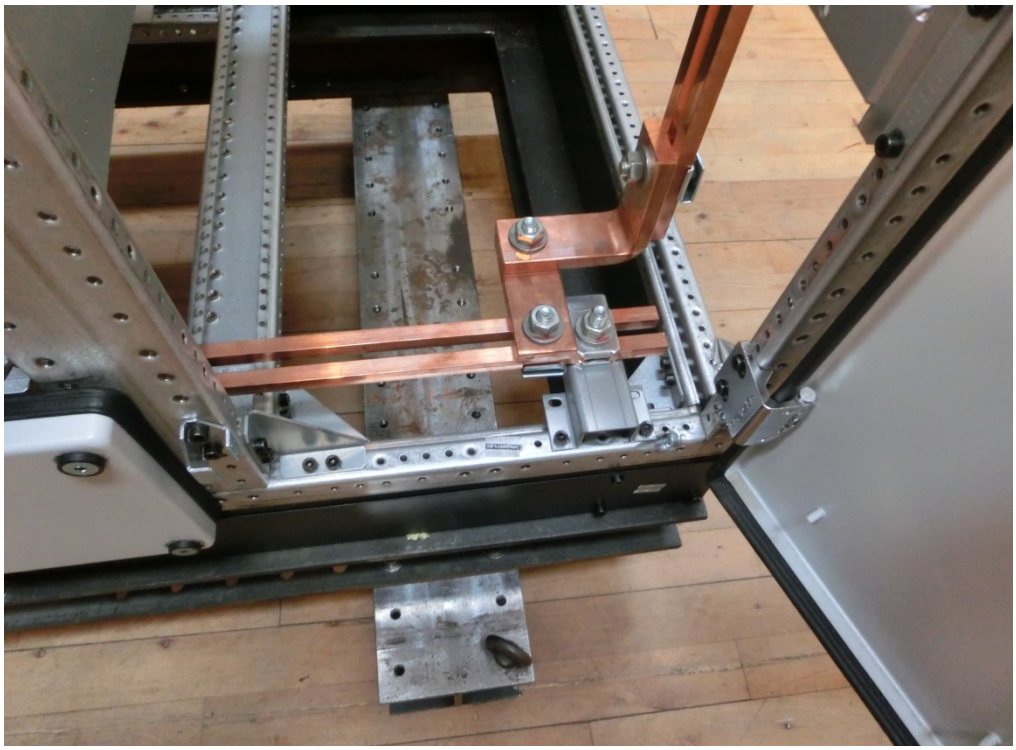


Photo 25 Visual Inspection: Large cupper bars and mounting OK.

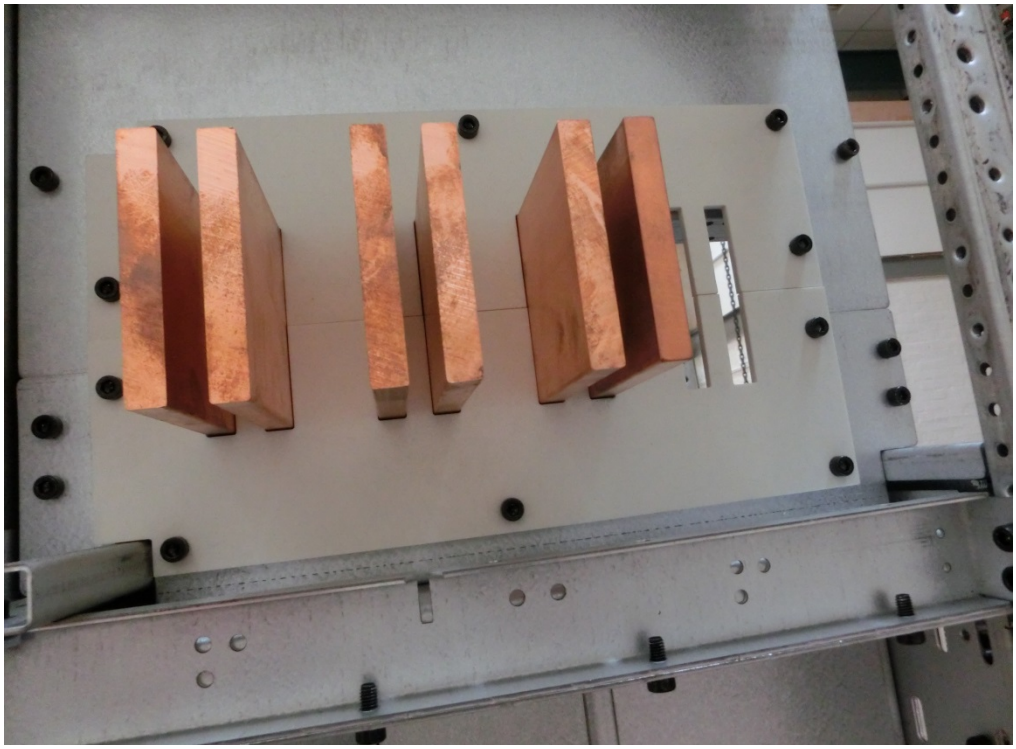


Photo 26 Visual Inspection: Large cupper bars and mounting OK.

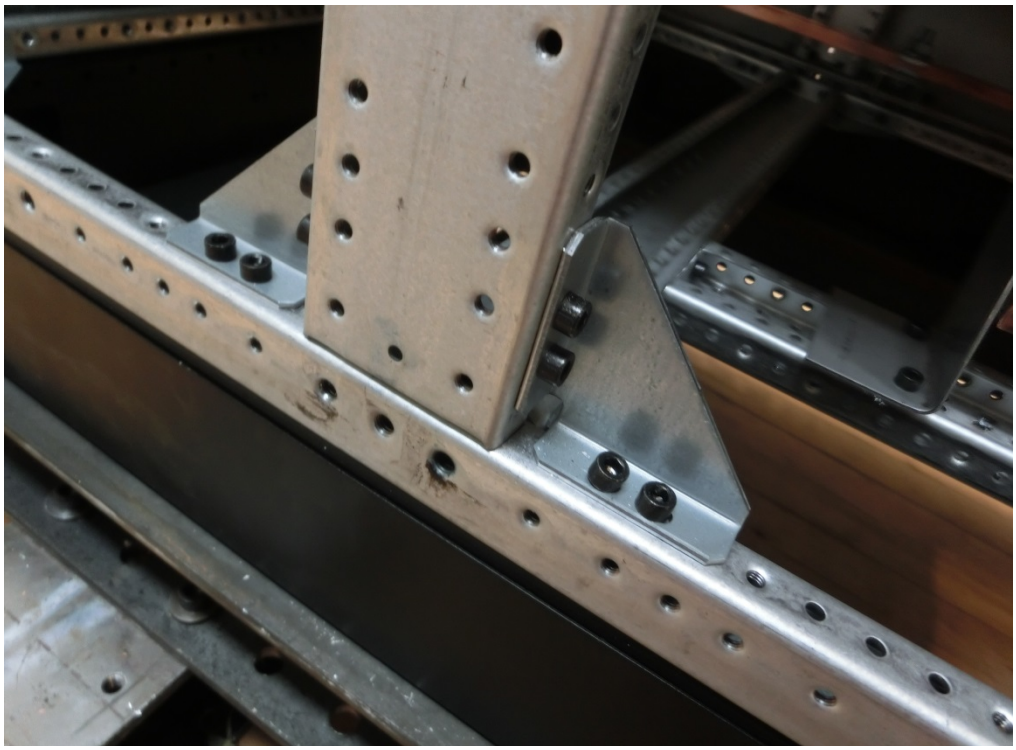


Photo 27 Visual Inspection: “Earthquake brackets” OK.

Photo 28 Visual Inspection: “Earthquake brackets” OK (black frame broken).

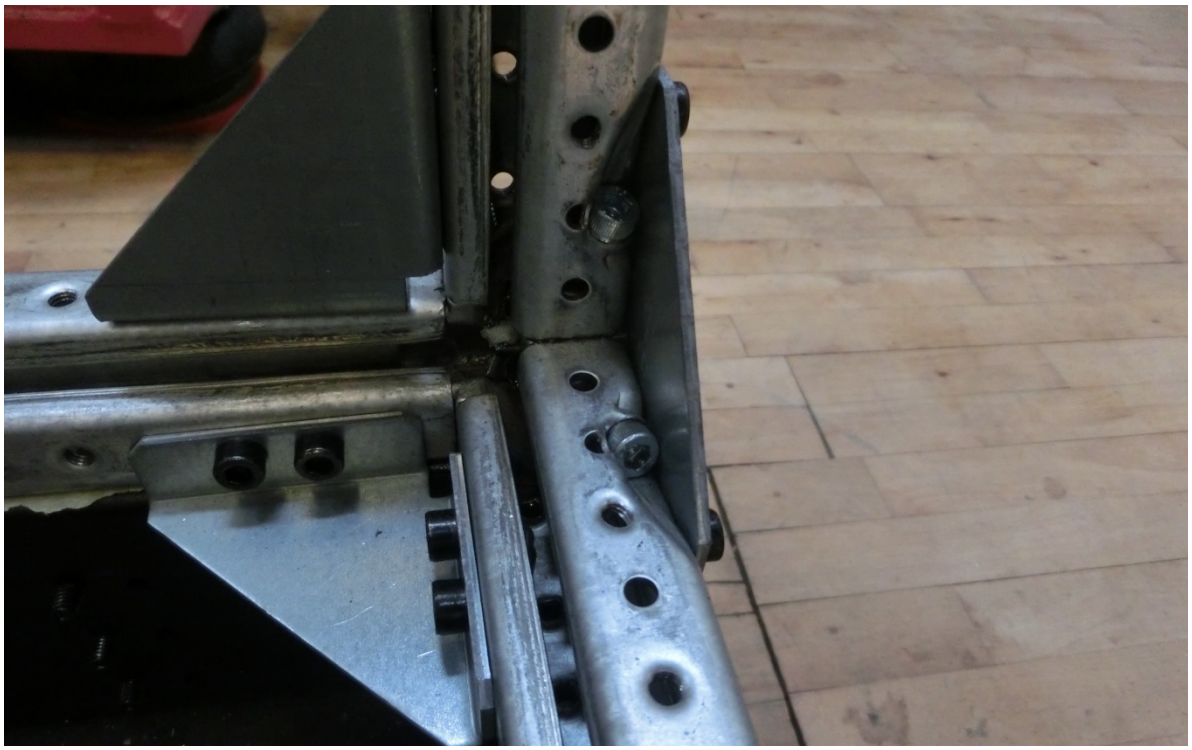


Photo 29 Visual Inspection: “Earthquake brackets” OK.

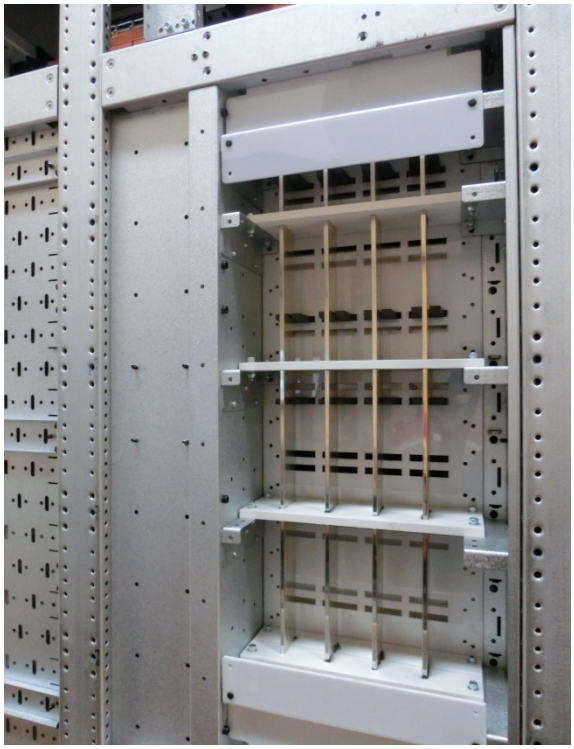


Photo 30 Visual Inspection: Medium size cupper bars and mounting OK.

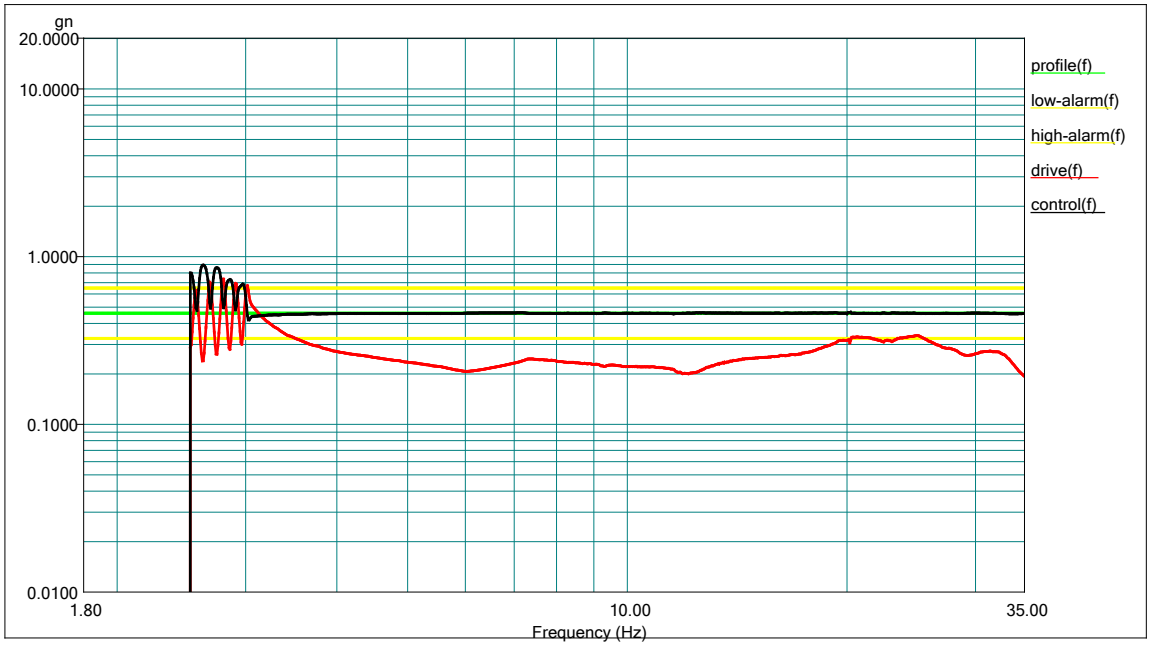
Photo 31 Visual Inspection: General external (without covers) OK.

Photo 32 Visual Inspection: General external (without covers) OK.

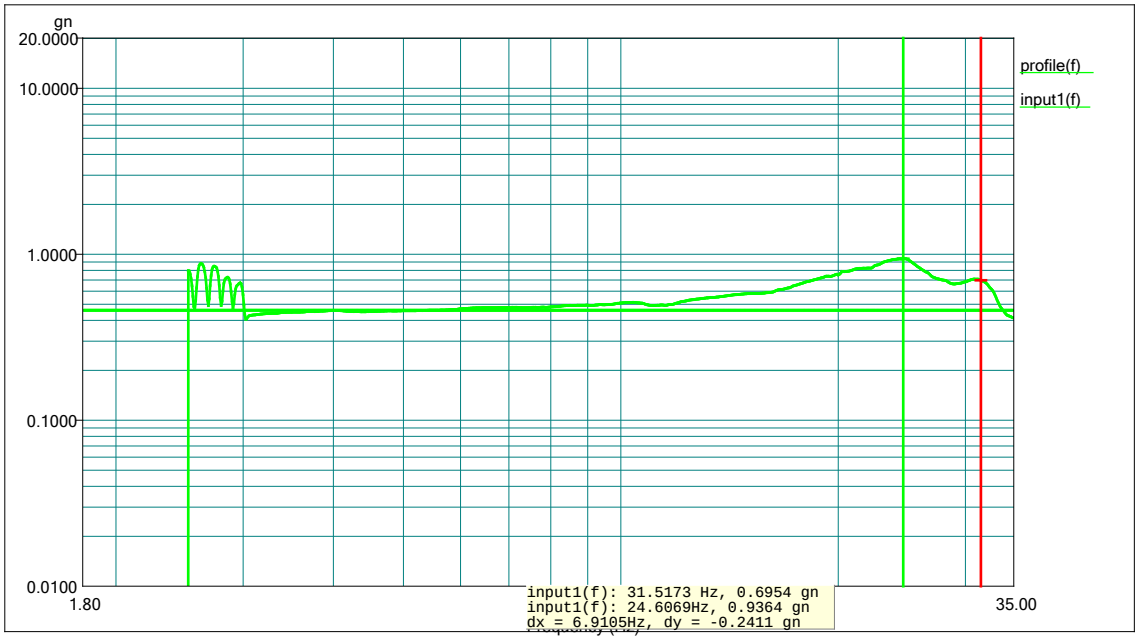
Photo 33 Visual Inspection: General external (without covers) OK.

Annex 3

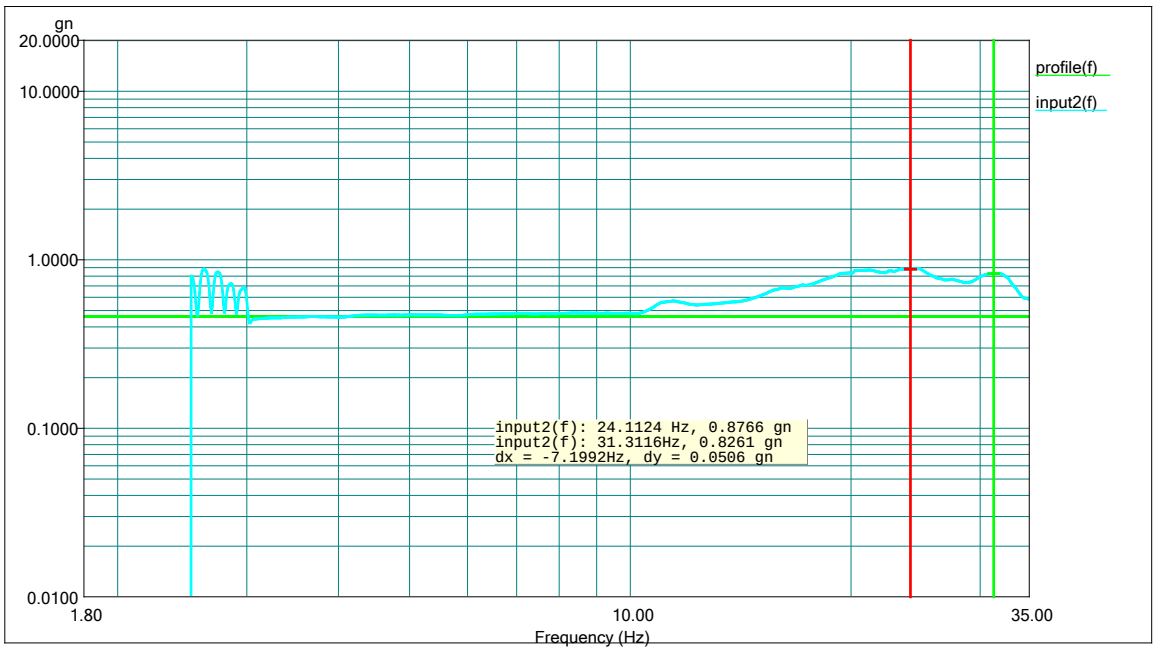
Measurement curves



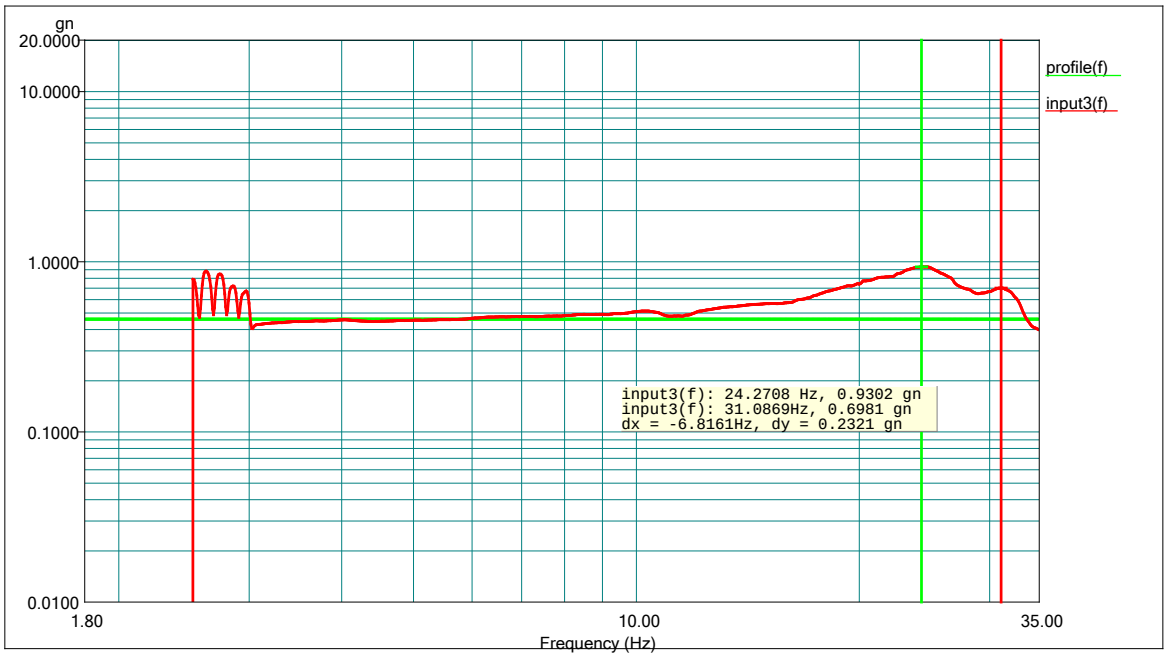
Curve 1 Recorded test level, Z-axis, black curve (the red curve is an internal vibration control channel).



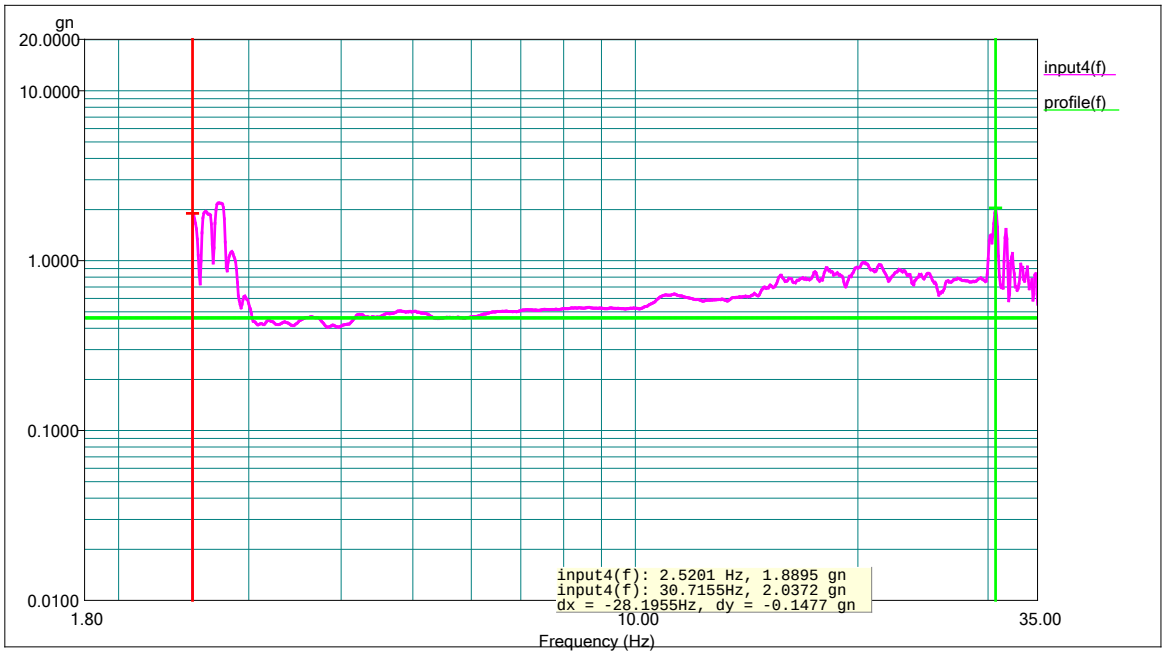
Curve 2 Recorded response, Z-axis, A1.



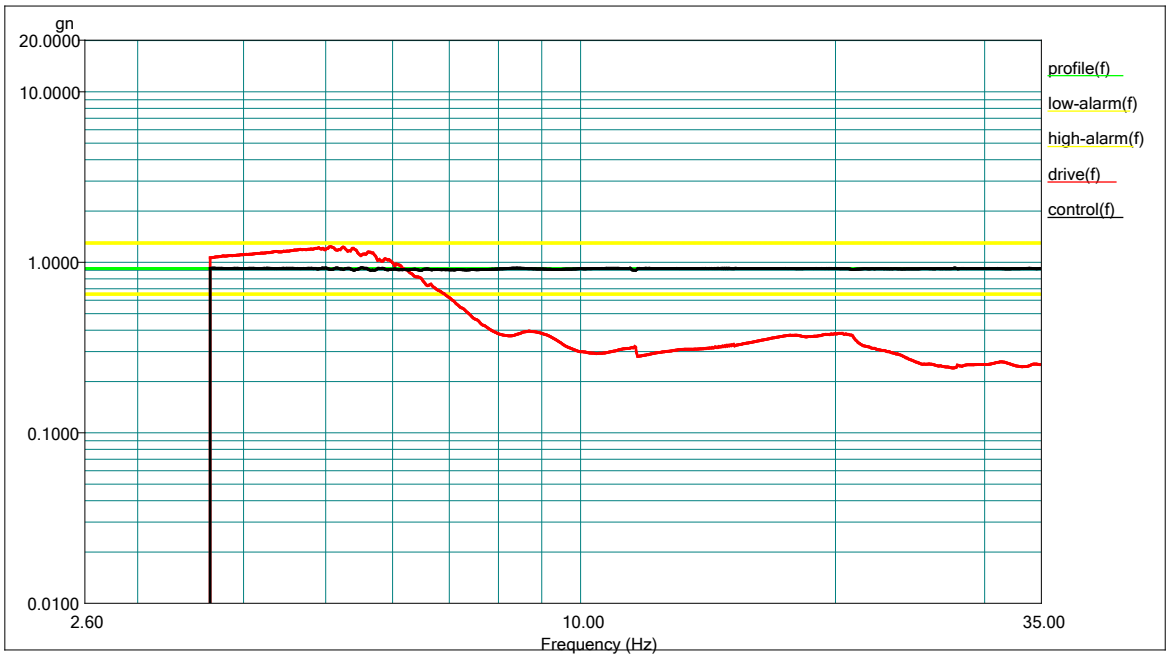
Curve 3 Recorded response, Z-axis, A2.



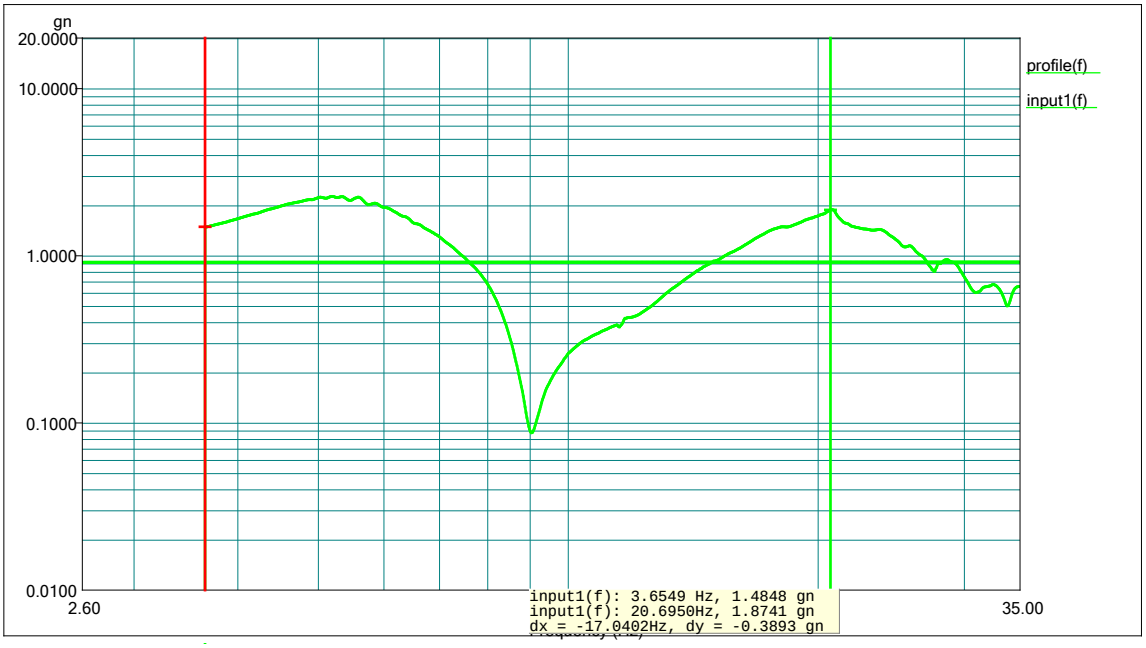
Curve 4 Recorded response, Z-axis, A3.



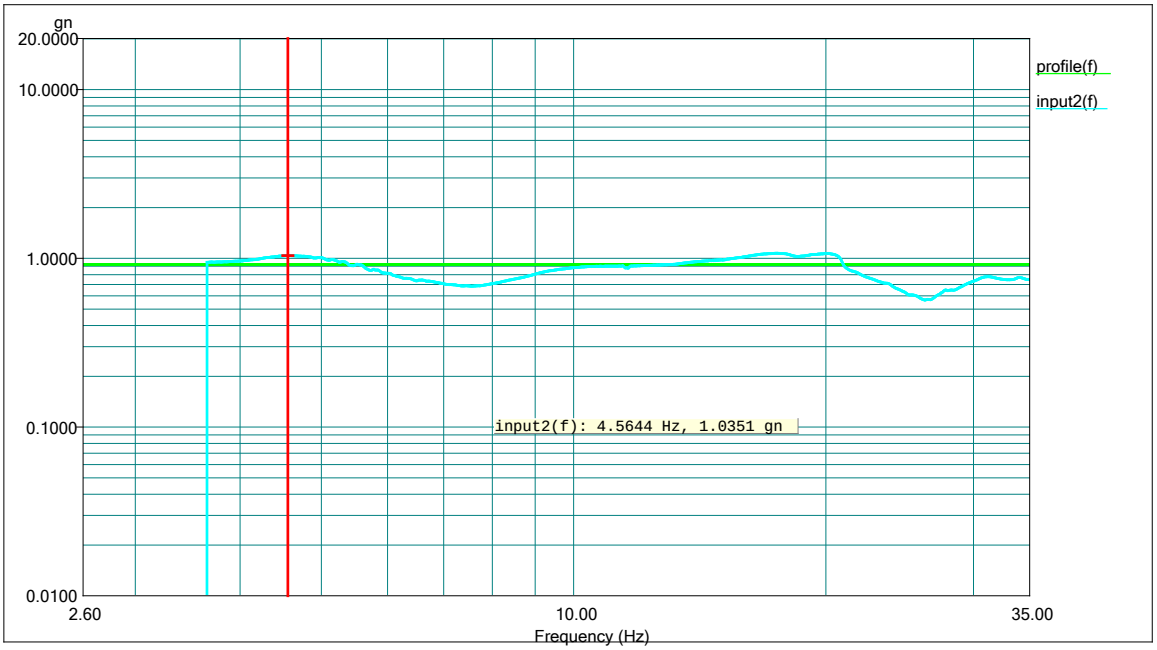
Curve 5 Recorded response, Z-axis, A4.



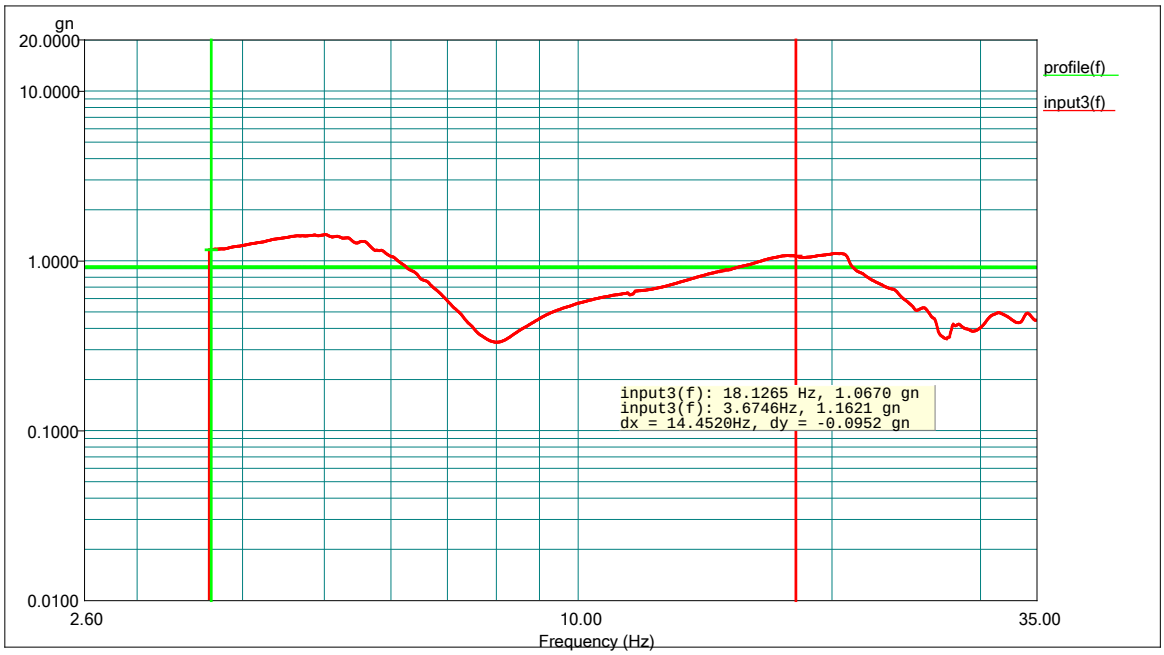
Curve 6 Recorded test level, Y-axis (black curve).



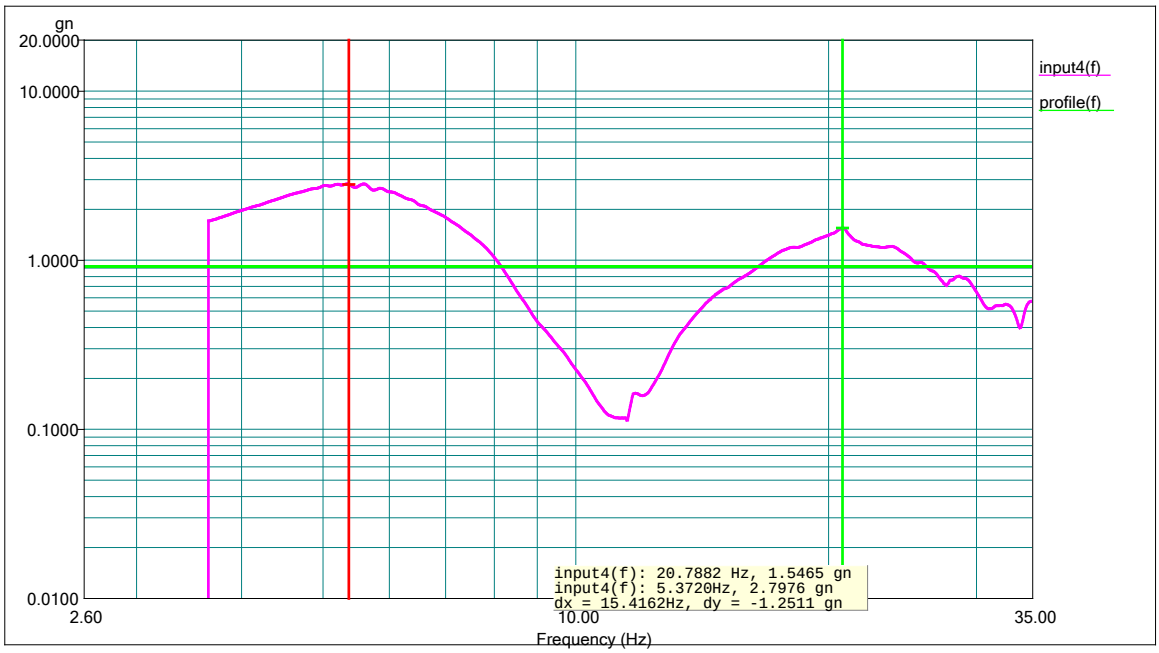
Curve 7 Recorded response, Y-axis, A1.



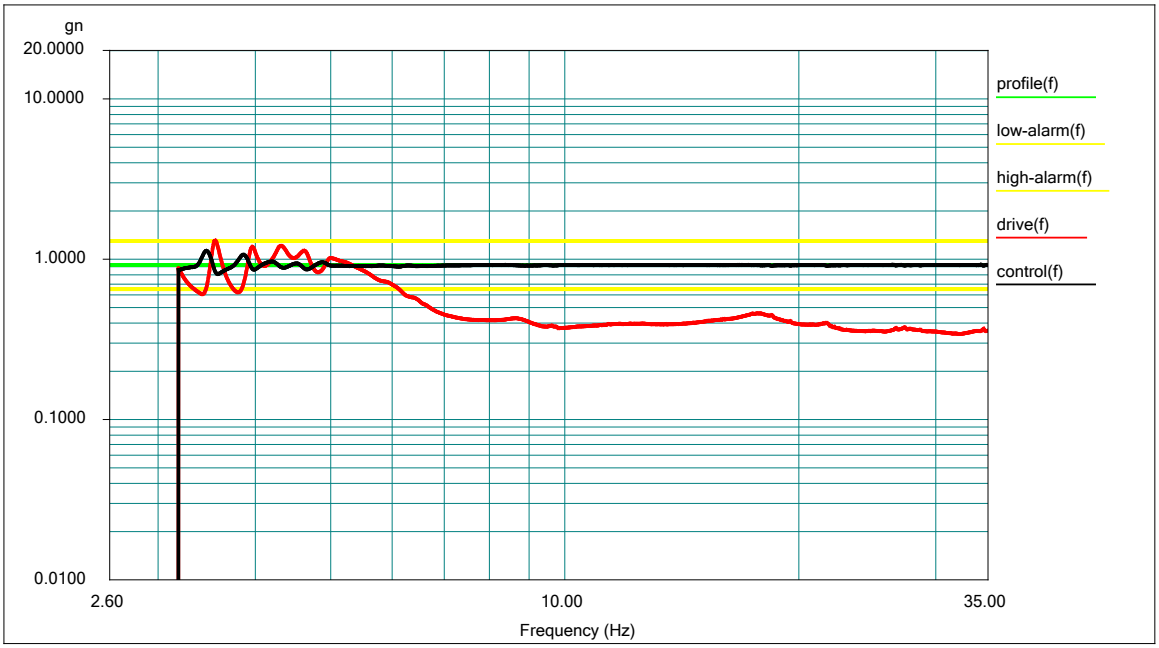
Curve 8 Recorded response, Y-axis, A2.



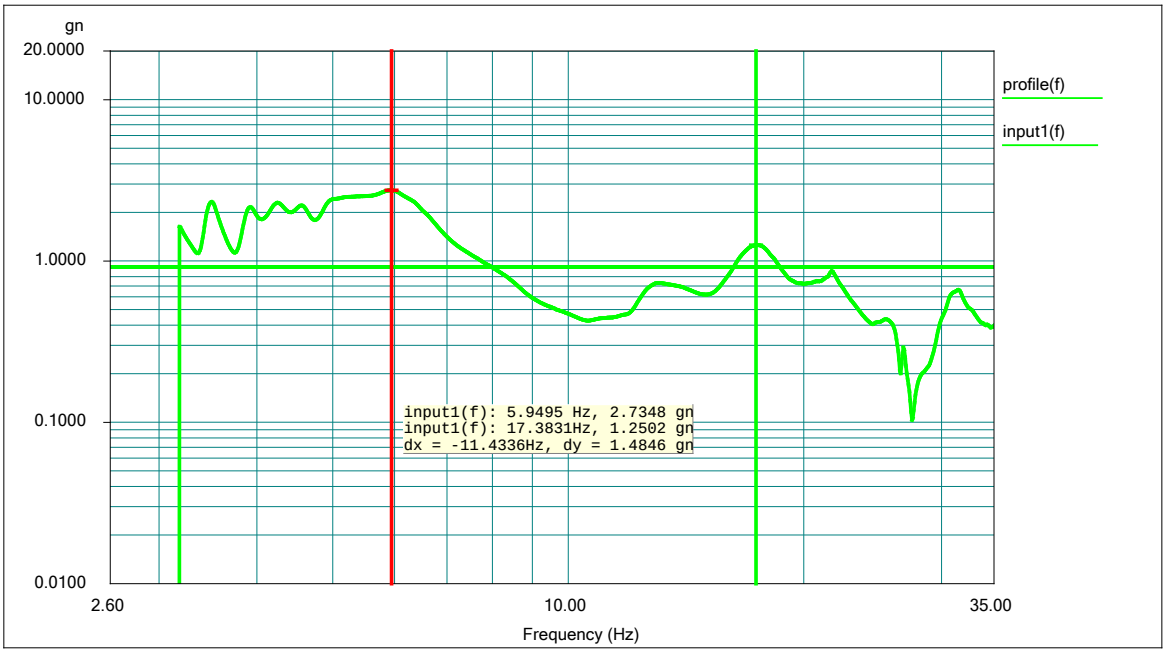
Curve 9 Recorded response, Y-axis, A3.



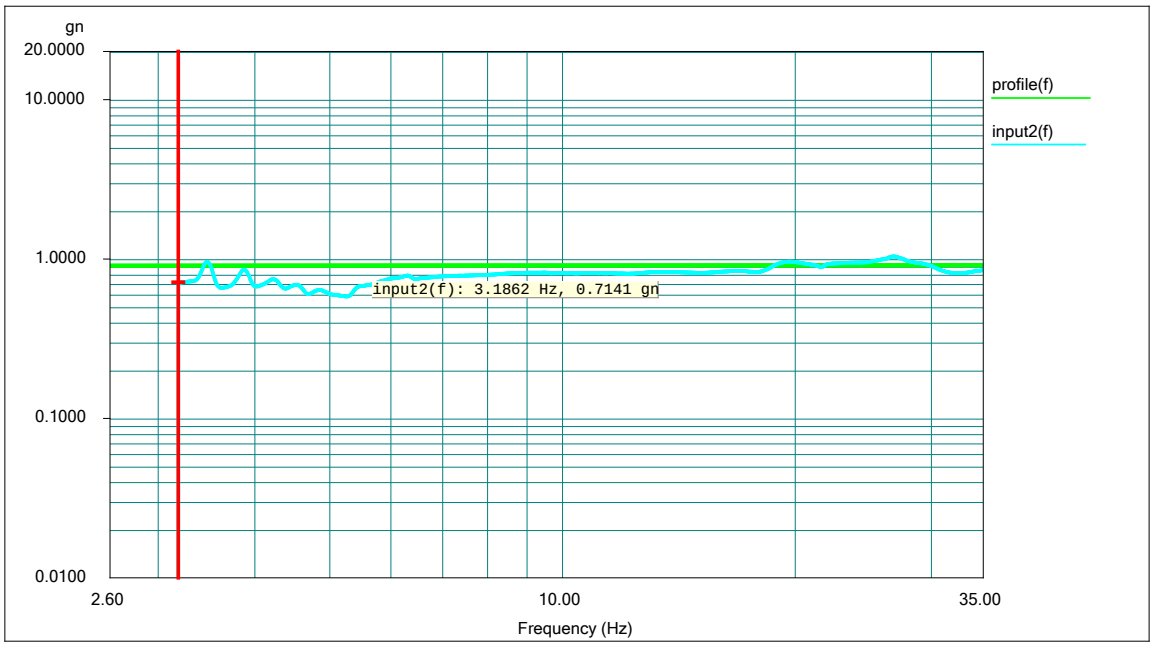
Curve 10 Recorded response, Y-axis, A4.



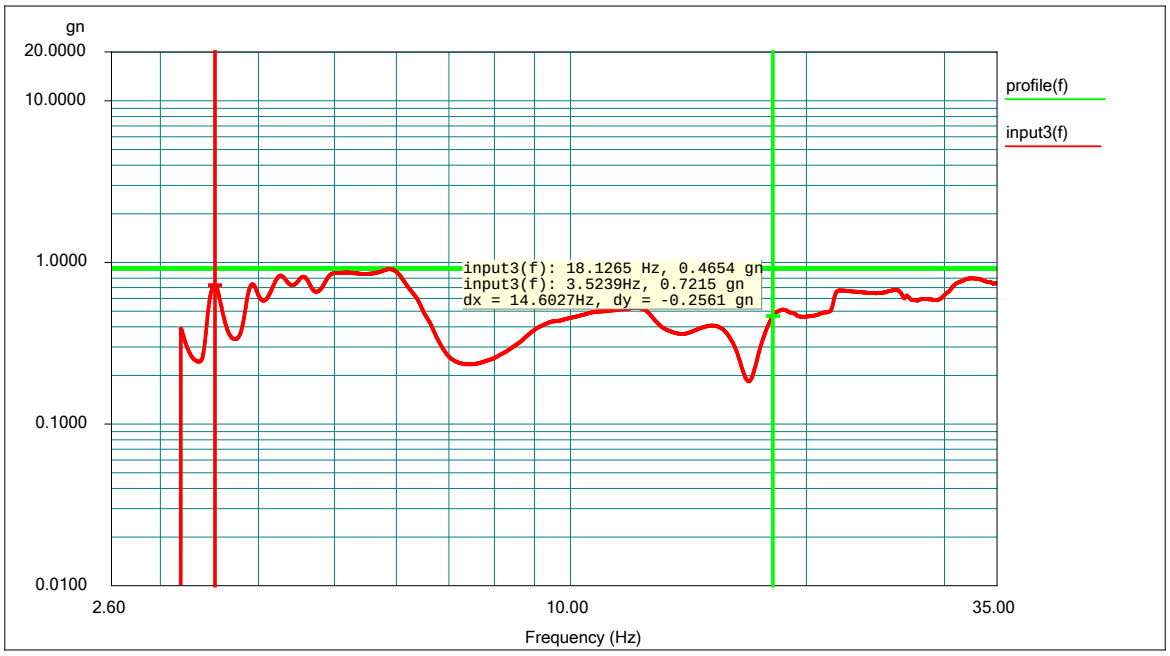
Curve 11 Recorded test level, X-axis (black curve).



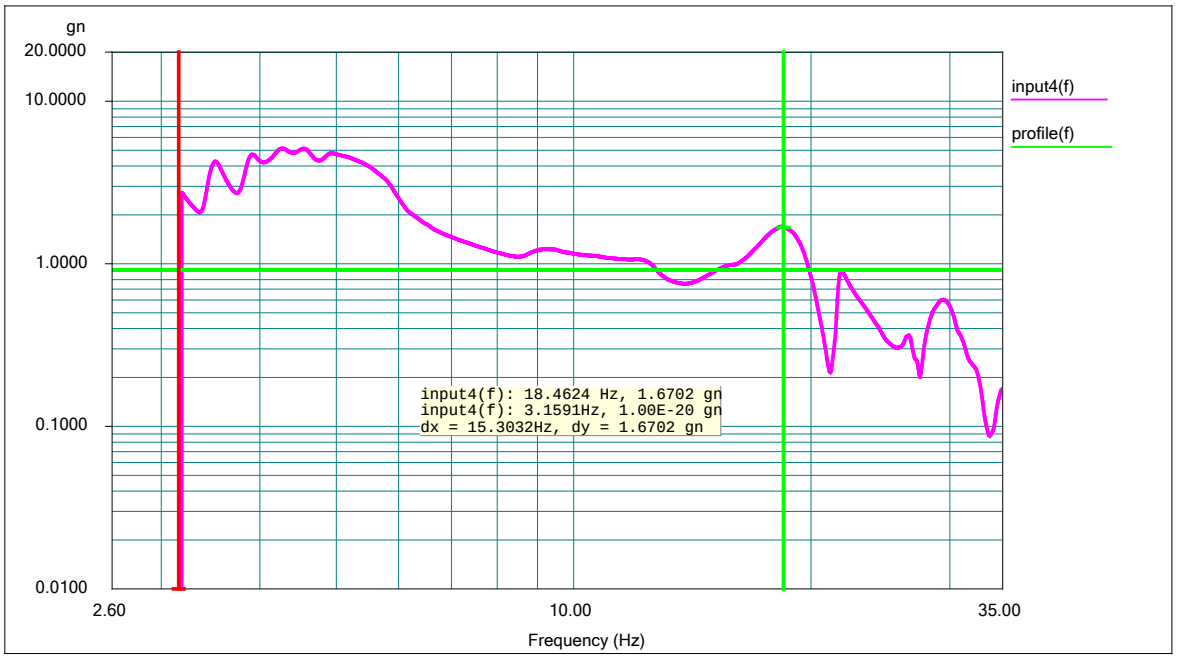
Curve 12 Recorded response, X-axis, A1.



Curve 13 Recorded response, X-axis, A2.



Curve 14 Recorded response, X-axis, A3.



Curve 15 Recorded response, X-axis, A4.

Annex 4

Insulation resistance test results

(Provided by the client)

logstrup

F 4.7.2.1 Slutinspektion AFD72

SLUTINSPEKTION	
KUNDE	DATO: 18/6-2014
OPSTILLING	
ORDRE NR.	TEGN. NR.

	MEGGER	HØJSPÆNDING		Initialer test:
AC-Test	M Ohm	KV 2,5	Sec 60	
PEN - L1+L2+L3				
L3 - L1+L2				
L2 – L1				
PE – L1+L2+L3+~~N~~		18,8 GΩ		BBA
N – L1+L2+L3				
L3 – L1+L2		30,8 GΩ		BBA
~~DC-Test~~ L1-L2		36,1 GΩ		BBA
PE – PLUS+MINUS				
PLUS - MINUS				
Styrekreds				

Systemjording:TN-S ☐ TN-C-S ☐ TN-C ☐ TT ☐ Andet ☐		
Megger udslag ved kortslutning	M Ohm	
Modstand i beskyttelseskreds	Ohm	

Kundeinspektion Underskrift	Dato:
Tavle godkendt BBA. Initialer	Dato: 18/6-14

DELTA

F 4.7.2.1 Slutinspektion AFD72

SLUTINSPEKTION	
KUNDE	DATO: 19/06 – 2014
OPSTILLING	
ORDRE NR.	TEGN. NR.

	MEGGER	HØJSPÆNDING		Initialer test:
AC-Test	M Ohm	KV 2,5	Sec 2,5	
PEN - L1+L2+L3				
L3 - L1+L2				
L2 – L1				
PE – L1+L2+L3+~~N~~		22,6 GΩ		RKI
N – L1+L2+L3				
L3 – L1+L2		34,3 GΩ		RKI
~~DC-Test~~ L1 – L2		40,2 GΩ		RKI
PE – PLUS+MINUS				
PLUS - MINUS				
Styrekreds				

Systemjording: TN-S ☐ TN-C-S ☐ TN-C ☐ TT ☐ Andet ☐		
Megger udslag ved kortslutning	M Ohm	
Modstand i beskyttelseskreds	Ohm	

Kundeinspektion Underskrift	Dato:
Tavle godkendt RKI Initialer	Dato: 19/06 2014

Annex 5

SRS analysis

(This annex is informative and not a part of the accredited report)

A Shock Response Spectrum, SRS, have been calculated on basis of the nominal input test level and the actual frequency range used during the seismic testing

The nominal input test levels are:

Vertical: ±4.5 m/s^2 (±0.46 g)

Horizontal: ±9 m/s^2 (±0.92 g)

The actual frequency range was:

3.6 – 35 Hz (lower frequency slightly lower in 2 out of 3 axes)

Below are the SRS spectrum calculated for the above mentioned test conditions for a damping coefficient of 5% (equal Q-factor is 10)

Note that the SRS level for a slow sine sweep (as this test) is equal to the input test level multiplied by the Q-factor.