



CISPR 12 OTS to ALSE/UTC Correlation for the
Elite Electronic Engineering Whole Vehicle
RF Shielded Test Facility

CLP-CCOTS-002

For Elite Electronic Engineering
1516 Centre Circle
Downers Grove, IL 60174

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Test Specification CISPR 12 Edition 6.0 January 2009 – Amendment 1

Written By

Tim Royer and
Stanley D. Dolecki
iNARTE® Certified: ALT-0151-E

Approved By

Craig Fanning
EMC Lab Manager
iNARTE® Certified: EMC-000296-NT
iNARTE® Certified: ALT-0188-E



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1. REPORT REVISION HISTORY

REVISIONS	DATE	DESCRIPTION
001	02/02/2010	INITIAL RELEASE
002	03/19/2010	ADDED HISTORICAL/PROFICIENCY DATA TO SHOW REPEATABILITY IN SECTION 7 AND ADJUSTED THE OTHER SECTION NUMBERING AS NEEDED.

2. INTRODUCTION

2.1. Purpose

In November of 2009, a series of measurements were made in order to determine the factor which correlates 3 meter radiated emissions measurements made in Elite's Vehicle Test Chamber (VTC) to 3 meter radiated emissions measurements made on a CISPR 12 Open Test Site (OTS). This document provides a description of the process, and the resulting data obtained, to meet the correlation requirement of CISPR 12 Edition 6.0 January 2009- Amendment 1, Clause 5.2.2 Absorber Lined Shielded Enclosure (ALSE) Requirements; Sub-clause "5.2.2.1 Correlation".

2.2. Requirement:

Per CISPR 12 Edition 6.0, Clause 5.2.2 Absorber Lined Shielded Enclosure (ALSE) requirements; Sub-clause 5.2.2.1 Correlation, an ALSE may be used for vehicle level radiated emissions testing provided that the results obtained can be correlated with the results obtained from measurements made using a OTS. The specification does not define a specific process, metrics, or other parameters.

2.3. Applicable Documents

CISPR 12 Edition 6.0 January 2009 – Amendment 1	“Vehicles, boats and combustion engines – Radio disturbances characteristics – Limits of methods of measurement for the protection of off-board receivers.”
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2.4. Equipment Needed:

- 1 ComPower CG515 Comb Generator
- 2 Rhode & Schwarz EMI Receiver, Model ESCI (or equivalent)
- 3 Chase Model CBL6112 Bilog antenna
- 4 2801 Type coax cable
- 5 Workstation or laptop with Field measurement and Universal Emissions applications

Note: The same equipment and noise generator must be used for the outdoor and indoor measurements.

2.5. Process Overview:

This procedure was used to gather data in order to establish correlation between the OTS and VTC. It is intended for initial characterization of the chamber and establishing new test points in the chamber.

- All radiated measurements, OTS and ALSE, shall be made at a 3m separation distance.
- A set of outdoor reference measurements are made in the required frequency range using a receive antenna, EMI receiver, and a stable noise source (Com Power CG-515 Comb Generator).
- Outdoor measurements are made over the frequency range of 30 MHz to 1 GHz in 5 MHz intervals.
- Measurements are made with the receive antenna in both the horizontal and vertical orientations. The artifact is oriented in the same polarity as the receive antenna. This OTS data is recorded and saved as the Reference Measurements.
- The VTC is laid out such that vehicles can be placed in one fixed location to utilize fixed receive antenna points for the vehicle test.
- The measurements are repeated inside the chamber at each reference point. The measurements are made using the same equipment and measurement parameters that were used for the OTS measurements.
- The Correlation Factor (CF) is the delta (in dB) between the OTS Reference Data and the measurements made on the artifact in the VTC. The CF is then applied to the measurements made on a vehicle when tested inside the VTC.
- The chamber characterization and CF shall be made once unless the test site, test facility, or equipment are changed or modified.

3. ALSE VTC DESCRIPTION

Elite Electronic Engineering Incorporated's whole vehicle shielded test enclosure measures 105ft. by 33ft. by 20ft. high. The enclosure is designed for vehicle testing and is equipped with an exhaust elimination system to remove vehicle emissions from the area. The enclosure is setup in a semi-anechoic configuration utilizing panels of anechoic material. The location of the anechoic panels is clearly marked on the floor of the chamber to ensure repeatable and consistent test setups. The chamber floor has been marked off for vehicle positioning, antenna locations, and reference points. There are currently two antenna reference points established in the chamber for radiated emissions measurements. See Figure 1.

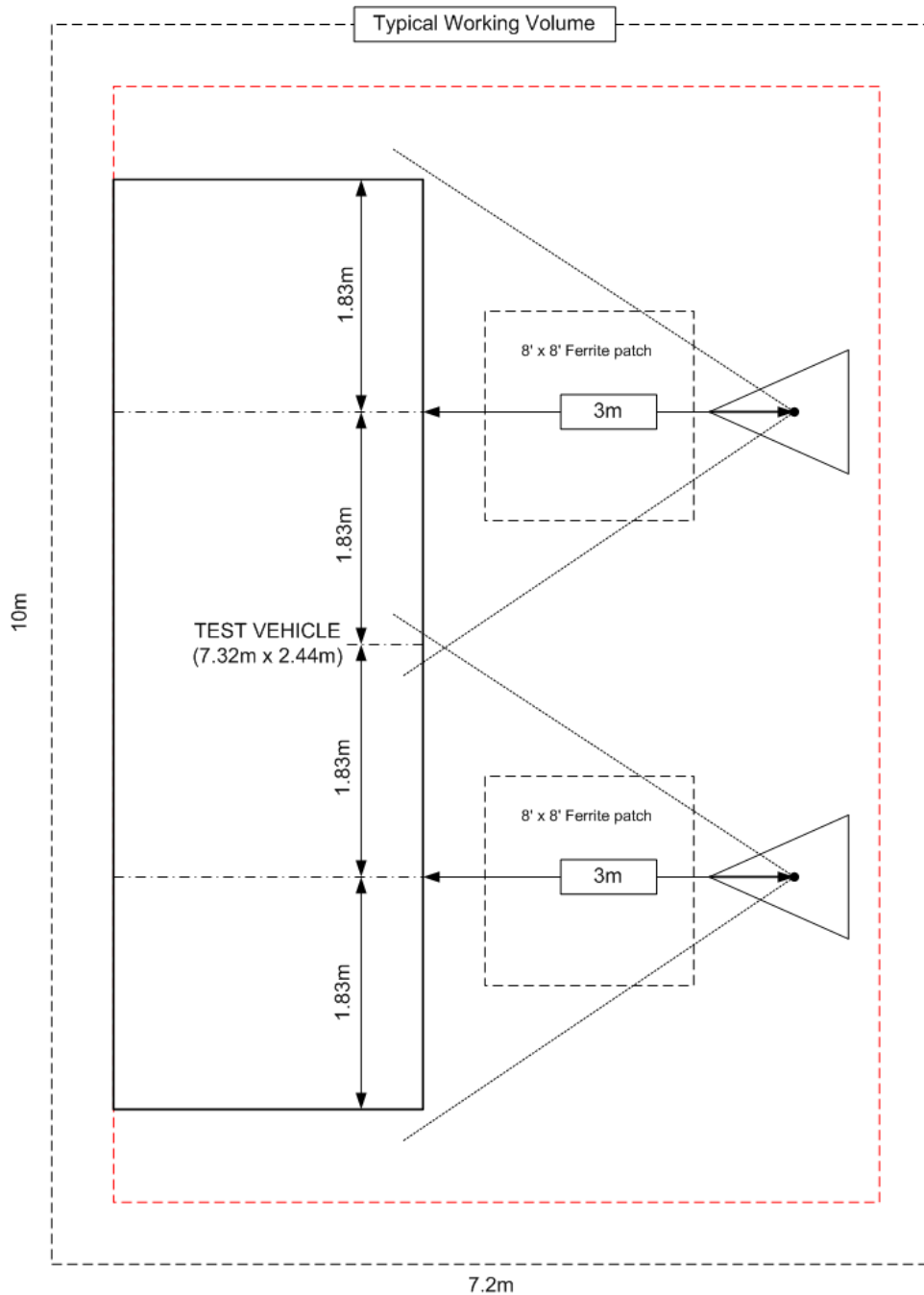


Figure 1 – CISPR ALSE Test Setup Diagram

4. CISPR 12 OTS AND ALSE VTC CORRELATION PROCEDURE

A Com Power CG515 comb generator was used as the reference standard for all measurements. The reference standard was configured with a 5 MHz output for all measurements. It was setup in the OTS, using the same setup as would be used for a vehicle radiated emissions test. The reference standard was placed at the same location and height as used for the vehicle reference point. All measurements were made at a 3 meter separation distance. The receive antenna and artifact heights were both 1.8 meters above the cement driveway.

All signals emanating from the reference standard were measured (narrowband signals at a 5 MHz interval) in the frequency range of 30 MHz to 1GHz. Measurements were made using both vertical and horizontal antenna polarization. These measurements were used as the "Reference Measurements". The measurements were repeated inside the VTC (ALSE) chamber for both vertical and horizontal antenna polarizations, and at both receive antenna reference points.

All measurements were performed using the peak detector function of an EMI receiver with 120 kHz BW that meets the measurement accuracy of CISPR 16. The measured data was used to derive correlation factors for each frequency, antenna polarization and antenna reference point. The factor was derived as noted below:

$$\text{Correlation Factor (dB) @ } f_x = \text{Ref Measurement (dBuV) @ } f_x - \text{Indoor Measured Value (dBuV) @ } f_x;$$

where the Ref Measurement = the measurement made on the OTS.

During a CISPR 12 radiated emissions test within the VTC, the emissions radiating from the vehicle are calculated as shown below:

$$\text{FI (dBuV/m) = Meter Reading (dBuV) + Antenna Factor (dB) + Cable Loss (dB) + Correlation Factor (dB)}$$

This FI is then compared to the radiated emissions limits specified in CISPR 12 to determine compliance.

5. SAMPLE DATA

The correlation factor data presented in this document is the actual reference data and chamber measurements used to derive the correction factors for testing. Comparison of the emissions measured from the artifact on the OTS and in the VTC are shown Figure 2 and Figure 3. The correlation data factors in tabular form are presented on pages 12 through 22.

Outdoor vs. Indoor Measurements: Vertical Positions 1 & 2 - w/ Ferrite

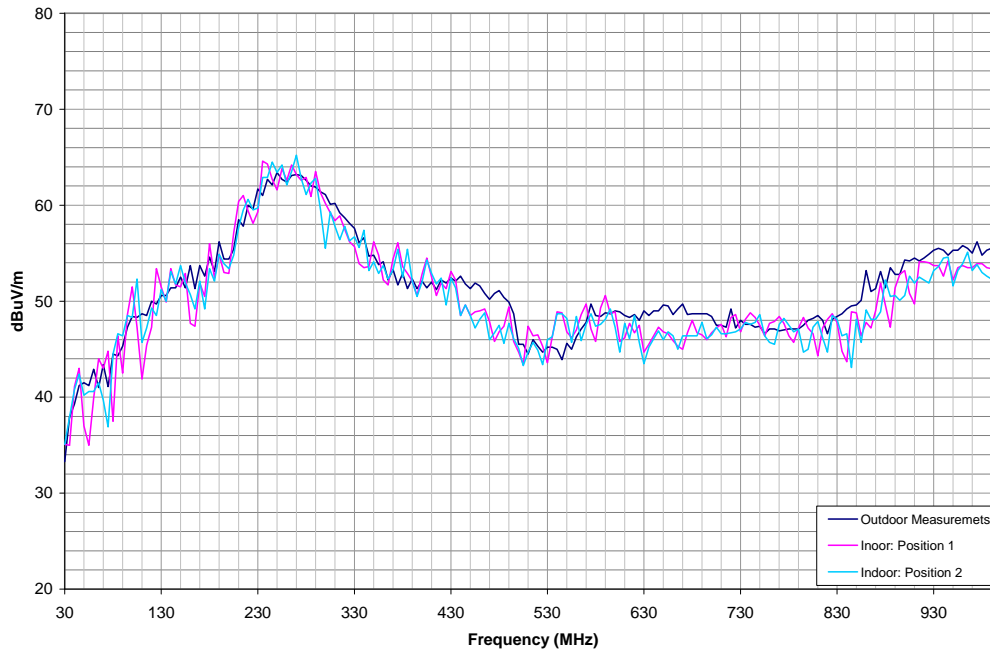


Figure 2 – Artifact Emissions OTS and VTC Vertical Polarization

Outdoor vs. Indoor Measurements: Horizontal - Positions 1 & 2 - w/ Ferrite

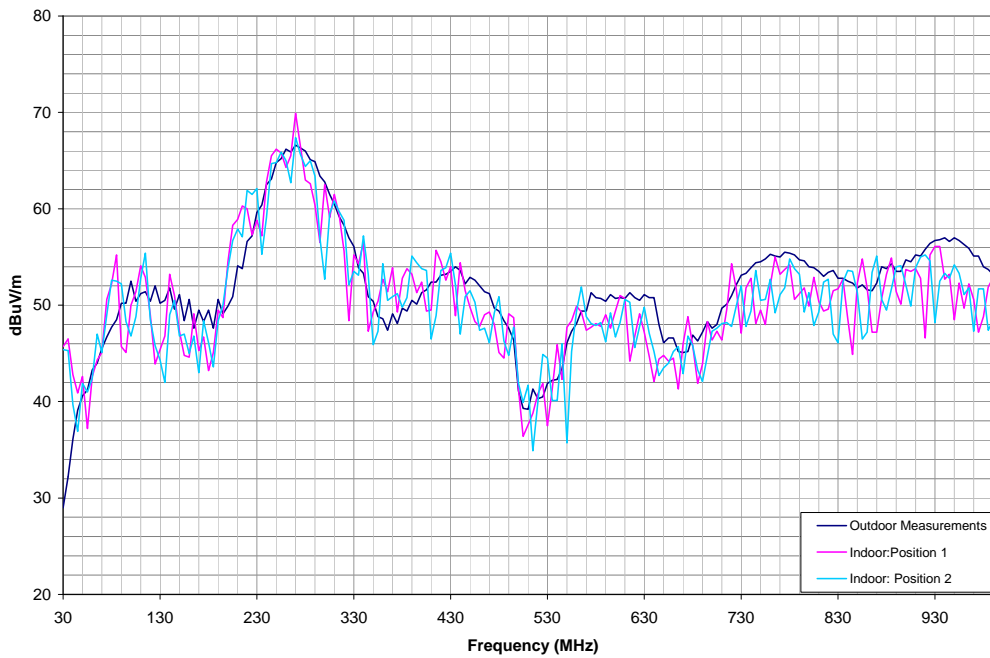


Figure 3 – Artifact Emissions OTS and VTC Horizontal Polarization

6. MEASUREMENT UNCERTAINTY:

Measurement Uncertainty is used by ISO 17025 Test Laboratories to calculate how accurate their measurements should be and in order to develop a confidence factor. Uncertainty guidelines are specified in CISPR 16-4-2: 2003. Uncertainty budgets take into consideration all of the pieces of the measurement system. The “weight” or probability distribution is applied to each piece of the measurement system per industry standards. The uncertainty budget then provides a measurement uncertainty with a confidence factor (usually 95%). Uncertainty is not applied to measurements in order to determine pass/fail. The 95% uncertainty budget for CISPR 12 radiated emissions measurements made at 3 meters are shown in Table 1.

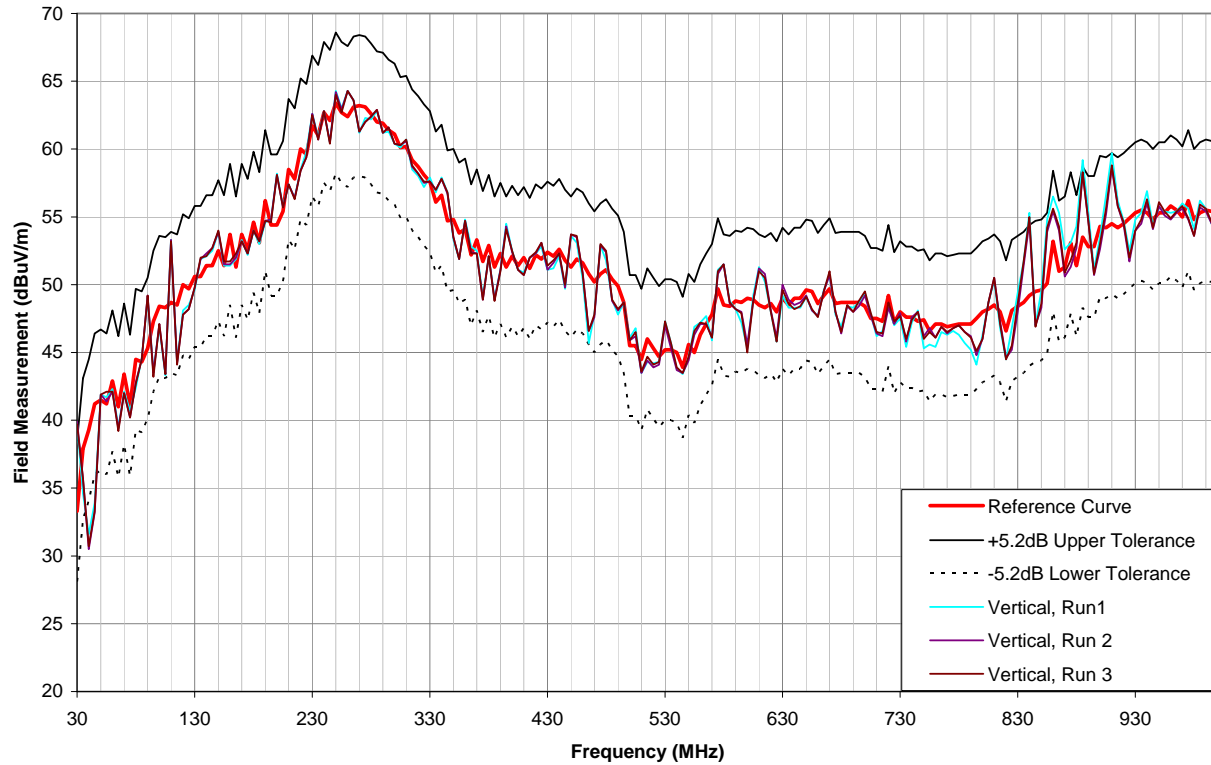
Quality Assurance Form QAF-27-01 Elite Electronic Engineering, Inc. Measurement Uncertainty Budget Worksheet 17025 Ref: QAP-27 Revision 1.1			
Description: Radiated Emissions in a 3 meter anechoic chamber Chase Bilog Antenna R&S EMC Receiver (Models ESIB and ESCI)			
Contributions	Probability Distribution Description	k-value	Uncertainty (dB) 30 - 1000MHz
Receiver Reading		1.73	2.00
Attenuation: antenna-receiver	Normal	2.00	0.50
Antenna Factor	Normal	2.00	2.00
Cable Factor	Normal	2.00	0.50
Receiver Corrections - sine wave voltage	Normal	2.00	1.00
Receiver Corrections - pulse amplitude response	Rectangular	1.73	0.87
Receiver Corrections - pulse repetition rate response	Rectangular	1.73	0.87
Receiver Corrections - noise floor proximity	Normal	1.40	0.50
Mismatch: antenna-receiver	U-shaped	1.41	1.00
Antenna Corrections - AF frequency interpolation	Rectangular	1.73	1.00
Antenna Corrections - AF height deviations	Rectangular	1.73	1.00
Antenna Corrections - directivity difference	Rectangular	1.73	1.00
Antenna Corrections - phase center location		1.00	0.75
Antenna Corrections - cross polarization		1.00	0.75
Antenna Corrections - balance	Rectangular	1.73	1.00
Site Corrections - site imperfections	Triangular	2.45	1.63
Site Corrections - separation distance	Rectangular	1.73	0.17
Site Corrections - table height	Normal	2.00	0.05
Combined Uncertainty			(+/-) 2.60
Expanded Uncertainty			(+/-) 5.20

Table 1 – Measurement Uncertainty Budget Worksheet for Radiated Emissions at 3 meters

7. HISTORICAL/ PROFICIENCY DATA TO SHOW REPEATABILITY

In March 2010, a series of measurements were made on the same artifact that was used for the VTC and OTS correlation measurements in order to show the repeatability of the measurements made in the VTC. The artifact and test equipment was setup and torn down between each run to show setup and test repeatability. The artifacts emissions were measured in the VTC and the correlation factors added to the measured values. The corrected emissions were then plotted along with the November 2009 measurements from the artifact on the OTS. The +/-5.2 dB uncertainty budget limits were also applied to the plots for reference. The uncertainty budget is based upon a 95% confidence factor. Therefore, at least 95% of the measurements made in the VTC shall be within +/- 5.2 dB of the OTS measurements. The data is shown on Figures 4 and 5. As can be seen from the data, at least 95% of the measured values (with correlation factor applied) were within the +/-5.2 dB uncertainty budget.

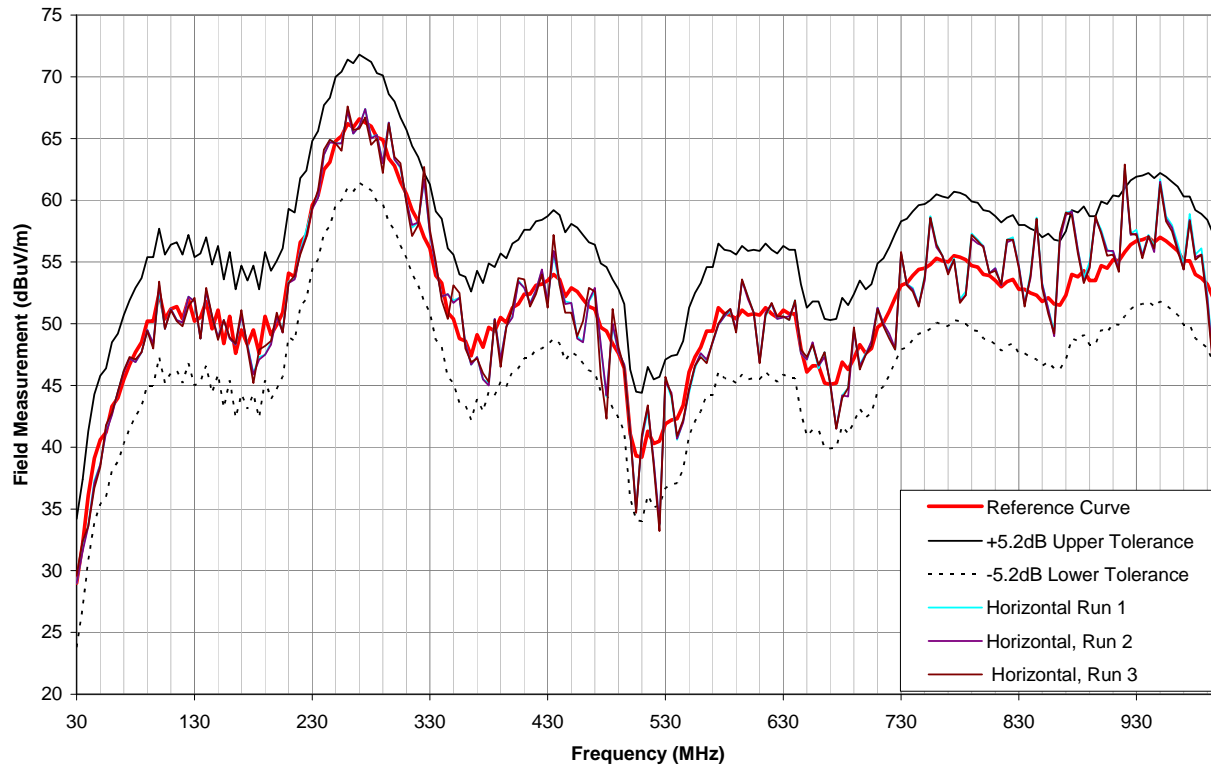
CISPR12 Indoor Repeatability: Actual Measurements vs Reference Curve - Vertical Antenna



Vertical:		
Run 1:		
>5.2dB	2 delta's	97.4 % of measured emissions within +/- 5.2 dB of the reference.
<-5.2dB	3 delta's	
Run 2:		
>5.2dB	2 delta's	97.9 % of measured emissions within +/- 5.2 dB of the reference.
<-5.2dB	2 delta's	
Run 3:		
>5.2dB	2 delta's	97.9 % of measured emissions within +/- 5.2 dB of the reference.
<-5.2dB	2 delta's	

Figure 4 – Artifact Emissions OTS and Corrected VTC Vertical Polarization

CISPR12 Indoor Repeatability: Actual Measurements vs Reference Curve - Horizontal Antenna



Horizontal:		
Run 1:		
>5.2dB	2 delta's	96.9 % of measured emissions within +/- 5.2 dB of the reference.
<-5.2dB	4 delta's	
Run 2:		
>5.2dB	1 delta's	97.4 % of measured emissions within +/- 5.2 dB of the reference.
<-5.2dB	4 delta's	
Run 3:		
>5.2dB	2 delta's	96.4 % of measured emissions within +/- 5.2 dB of the reference.
<-5.2dB	5 delta's	

Figure 5 – Artifact Emissions OTS and Corrected VTC Horizontal Polarization

It should be noted that during the March 2010 historical/proficiency artifact testing to show repeatability, the chamber absorber panels were not completely setup and torn down between sweeps. This was done for two reasons:

- 1) Absorber panel movement was not seen as an issue since the panels are labeled and placed in the same location every time the chamber is setup in the semi-anechoic configuration.
- 2) The chamber panels have been completely removed and replaced many times since the original OTS and VTC correlation work that was done in November 2009. The original OTS to VTC correlation factors are currently used for all 3 meter radiated emissions measurements made in the VTC. If at least 95% of the corrected VTC artifact measurements made in March 2010 are within ± 5.2 dB of the OATS artifact measurements made in November 2009 (within the 95% confidence measurement uncertainty), and after the chamber absorber panels have been moved in and out of the chamber many times, then the chamber absorber setup and teardown has sufficient repeatability.

Since at least 95% of the historical/proficiency artifact measurements did come out within ± 5.2 dB of the original OTS measurements, then good repeatability of the chamber absorber setup and the measurement equipment was shown. If the historical/proficiency measurements on the artifact in the VTC did not come out within the 95% confidence factor of the original OTS measurements, then further investigation would have been required to determine if the absorber panel movement would be the cause for excessive measurement deviation.

8. CONFIRMATION OF MEASUREMENTS MADE ON VEHICLES IN THE VTC

Since the OTS is the reference site for CISPR 12 emissions measurements, Elite believes that it is prudent to make additional measurements on any signals which are measured from the vehicle and in excess of the specification limits. As a general rule, any measurements made inside of the test chamber that are within 2 dB of the specification limit, or exceeding the limit, should be re-measured with the test vehicle setup on the OTS. Any outdoor measurements will be considered final and used in determining compliance with the applicable limits defined in the CISPR 12 standard. For reporting purposes, the data collected inside of the chamber and on the OTS will be included.

9. CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this document was obtained under conditions which meet or exceed those specified in CISPR 12 test specification. The data presented in this test report pertains to the OTS/VTC correlation on the test date specified.



Correlation Factors: OUTDOOR vs Whole Vehicle Chamber	
Artifact Orientation:	Vertical
Antenna Polarization:	Vertical
Test Distance:	3 meters
Test Height:	1.8 meters

	Reference	Position 1	Position 2
Freq (MHz)	Outdoor Peak (dBuV/m)	Indoor Measurement Facing West Run 1 (dBuV/m)	Indoor Measurement Facing West Run 2 (dBuV/m)
30	33.3	35.1	35.1
35	37.9	35	37.9
40	39.3	41.1	40.8
45	41.2	43	42.4
50	41.5	37	40.2
55	41.2	35	40.6
60	42.9	39.9	40.6
65	41	44	41.5
70	43.4	43	39.7
75	41.1	44.8	36.9
80	44.5	37.5	44.5
85	44.3	46.4	46.6
90	45.3	42.5	46.4
95	47.3	48.6	48.5
100	48.4	51.5	48.3
105	48.3	47.3	52.3
110	48.7	41.9	45.7
115	48.5	45.4	47.2
120	50	47.3	49.3
125	49.7	53.4	48.5

FACTORS	
(Outdoor) - (Indoor)	
Reference (outdoor) - Indoor Pos. 1 (dB)	Reference (outdoor) - Indoor Pos. 2 (dB)
-1.80	-1.80
2.90	0.00
-1.80	-1.50
-1.80	-1.20
4.50	1.30
6.20	0.60
3.00	2.30
-3.00	-0.50
0.40	3.70
-3.70	4.20
7.00	0.00
-2.10	-2.30
2.80	-1.10
-1.30	-1.20
-3.10	0.10
1.00	-4.00
6.80	3.00
3.10	1.30
2.70	0.70
-3.70	1.20



130	50.6	51.5		51.2
135	50.6	49.9		50
140	51.4	53.4		53.1
145	51.4	51.7		51.8
150	52.5	51.5		53.7
155	51.4	52.9		51.9
160	53.7	47.7		50.7
165	51.3	47.4		49.2
170	53.7	51.9		52.1
175	52.6	50.5		49.2
180	54.6	56		53.4
185	53.1	52.4		52.1
190	56.2	54.9		54.9
195	54.4	53		53.9
200	54.4	52.9		53.4
205	55.4	57.1		54.8
210	58.5	60.4		57.7
215	57.8	61		59.5
220	60	59.4		60.6
225	59.6	58.1		59.5
230	61.7	59.3		59.7
235	61	64.6		62.9
240	62.7	64.3		62.9
245	62.1	62.7		64.5
250	63.4	61.6		63.4
255	62.7	63.8		64.2
260	62.4	62.6		62.1
265	63.1	64.2		63.5
270	63.2	63.2		65.2
275	63.1	62.6		62.8
280	62.6	62.9		61.1
285	62	60.9		62.3
290	61.9	63.5		62.8
295	61.4	61.3		59.5
300	61.1	60.2		55.5
305	60.1	59.2		59.3
310	60.2	58.4		57.8
315	59.2	58.9		56.4
320	58.7	57.5		57.8
325	58.1	56.2		56.3
330	57.6	55.7		56.7
335	56.1	53.9		55.6

-0.90	-0.60
0.70	0.60
-2.00	-1.70
-0.30	-0.40
1.00	-1.20
-1.50	-0.50
6.00	3.00
3.90	2.10
1.80	1.60
2.10	3.40
-1.40	1.20
0.70	1.00
1.30	1.30
1.40	0.50
1.50	1.00
-1.70	0.60
-1.90	0.80
-3.20	-1.70
0.60	-0.60
1.50	0.10
2.40	2.00
-3.60	-1.90
-1.60	-0.20
-0.60	-2.40
1.80	0.00
-1.10	-1.50
-0.20	0.30
-1.10	-0.40
0.00	-2.00
0.50	0.30
-0.30	1.50
1.10	-0.30
-1.60	-0.90
0.10	1.90
0.90	5.60
0.90	0.80
1.80	2.40
0.30	2.80
1.20	0.90
1.90	1.80
1.90	0.90
2.20	0.50



340	56.6	53.5		57.4	3.10	-0.80
345	54.7	53.6		53.2	1.10	1.50
350	54.8	56.2		54.1	-1.40	0.70
355	53.8	54.8		52.9	-1.00	0.90
360	54.1	52.2		53.7	1.90	0.40
365	52.2	51.7		52.3	0.50	-0.10
370	53.3	54.4		53.3	-1.10	0.00
375	51.7	56.1		55.4	-4.40	-3.70
380	52.9	53.6		52.5	-0.70	0.40
385	51.3	52.9		55.4	-1.60	-4.10
390	52.3	52.1		52.1	0.20	0.20
395	51.3	50.6		50.5	0.70	0.80
400	52.1	52.8		52	-0.70	0.10
405	51.4	54.5		54.3	-3.10	-2.90
410	52	52.5		52.9	-0.50	-0.90
415	51.2	50.6		51.8	0.60	-0.60
420	52.2	51.9		52.4	0.30	-0.20
425	51.9	51.3		49.6	0.60	2.30
430	52.4	53.1		52.4	-0.70	0.00
435	52.1	52.2		51.4	-0.10	0.70
440	52.6	48.5		48.5	4.10	4.10
445	51.8	49.6		49.6	2.20	2.20
450	51.3	48.5		48.5	2.80	2.80
455	51.9	48.9		47.2	3.00	4.70
460	51.6	49		48.1	2.60	3.50
465	50.8	49.2		48.8	1.60	2.00
470	50.2	47.9		46	2.30	4.20
475	50.8	45.8		46.7	5.00	4.10
480	51.1	46.8		47.5	4.30	3.60
485	50.4	47.4		45.6	3.00	4.80
490	49.9	49.4		47.7	0.50	2.20
495	48.7	45.8		46.1	2.90	2.60
500	45.5	44.7		45.1	0.80	0.40
505	45.5	43.4		43.3	2.10	2.20
510	44.5	47.4		44.7	-2.90	-0.20
515	46	46.4		45.7	-0.40	0.30
520	45.3	46.5		44.9	-1.20	0.40
525	44.7	45.3		43.4	-0.60	1.30
530	45.2	43.6		46	1.60	-0.80
535	45.2	46.3		46.3	-1.10	-1.10
540	45	48.9		48.7	-3.90	-3.70
545	43.9	48.8		48.7	-4.90	-4.80



550	45.6	46.8		48.2	-1.20	-2.60
555	45	46.2		45.7	-1.20	-0.70
560	46.3	47		48.4	-0.70	-2.10
565	47.1	48.6		45.9	-1.50	1.20
570	47.8	49.7		47.6	-1.90	0.20
575	49.7	47.1		48.7	2.60	1.00
580	48.5	45.8		47.4	2.70	1.10
585	48.4	49.3		47.6	-0.90	0.80
590	48.8	50.6		48.1	-1.80	0.70
595	48.7	48.7		49.2	0.00	-0.50
600	49	48.9		47.3	0.10	1.70
605	48.9	45.8		44.7	3.10	4.20
610	48.5	46.2		47.7	2.30	0.80
615	48.3	47.7		46.1	0.60	2.20
620	48.6	46.7		48.5	1.90	0.10
625	48	47.5		45.7	0.50	2.30
630	49	44.7		43.5	4.30	5.50
635	48.5	45.5		45.2	3.00	3.30
640	49	46.4		46.1	2.60	2.90
645	49	47.3		46.9	1.70	2.10
650	49.6	46.8		46	2.80	3.60
655	49.5	46.6		46.8	2.90	2.70
660	48.6	45.9		46.4	2.70	2.20
665	49.2	45.3		45	3.90	4.20
670	49.7	45		46.4	4.70	3.30
675	48.6	46.7		46.4	1.90	2.20
680	48.7	48		46.4	0.70	2.30
685	48.7	46.7		46.4	2.00	2.30
690	48.7	46.5		47.8	2.20	0.90
695	48.7	46		46.1	2.70	2.60
700	48.4	46.7		46.5	1.70	1.90
705	47.5	47.2		47.3	0.30	0.20
710	47.5	47.6		46.6	-0.10	0.90
715	47.3	46.3		46.6	1.00	0.70
720	49.2	48.3		46.7	0.90	2.50
725	47.2	48.6		46.8	-1.40	0.40
730	48	46.8		47.1	1.20	0.90
735	47.6	48.1		47.8	-0.50	-0.20
740	47.6	48.8		47.6	-1.20	0.00
745	47.3	48.3		47.8	-1.00	-0.50
750	47.4	47.5		48.6	-0.10	-1.20
755	46.6	46.4		46.4	0.20	0.20



760	47.1	47.7		45.7	-0.60	1.40
765	47.1	47.9		45.5	-0.80	1.60
770	46.9	48.4		47.6	-1.50	-0.70
775	47	47.7		48.2	-0.70	-1.20
780	47.1	46.4		47.5	0.70	-0.40
785	47.1	45.7		46.8	1.40	0.30
790	47.1	47.2		47.1	-0.10	0.00
795	47.5	48.3		44.7	-0.80	2.80
800	48	47.2		45	0.80	3.00
805	48.2	46.6		47.3	1.60	0.90
810	48.5	44.3		47.9	4.20	0.60
815	48	47.2		46.2	0.80	1.80
820	46.6	48.1		44.7	-1.50	1.90
825	48.1	48.7		48.5	-0.60	-0.40
830	48.4	47.8		48.1	0.60	0.30
835	48.7	44.8		46.4	3.90	2.30
840	49.2	43.7		46.6	5.50	2.60
845	49.5	48.9		43.1	0.60	6.40
850	49.6	48.8		48.1	0.80	1.50
855	50.1	46.4		45.7	3.70	4.40
860	53.2	47.8		49.1	5.40	4.10
865	51	47.2		48.1	3.80	2.90
870	51.3	49		48.1	2.30	3.20
875	53.1	51.9		48.9	1.20	4.20
880	51.4	49.6		52.2	1.80	-0.80
885	53.5	47.3		50.5	6.20	3.00
890	52.8	51.4		50.6	1.40	2.20
895	52.8	52.8		50.1	0.00	2.70
900	54.3	53.2		50.6	1.10	3.70
905	54.2	50.8		52.6	3.40	1.60
910	54.5	49.7		51.9	4.80	2.60
915	54.2	54.1		52.5	0.10	1.70
920	54.5	54.1		52.2	0.40	2.30
925	54.9	54		51.9	0.90	3.00
930	55.3	53.7		53.2	1.60	2.10
935	55.5	53.7		53.6	1.80	1.90
940	55.3	52.6		54.5	2.70	0.80
945	54.8	54.2		54.6	0.60	0.20
950	55.3	52.2		51.6	3.10	3.70
955	55.3	53.5		53.2	1.80	2.10
960	55.8	53.7		53.9	2.10	1.90
965	55.5	53.5		55.1	2.00	0.40



970	55	53.5	53.2
975	56.2	53.9	53.8
980	54.8	53.9	53
985	55.3	53.5	52.6
990	55.5	53.4	52.3
995	55.4	52.7	53.9
1000	55.5	53.6	53.9

1.50	1.80
2.30	2.40
0.90	1.80
1.80	2.70
2.10	3.20
2.70	1.50
1.90	1.60

Correlation Factors: OUTDOOR vs Whole Vehicle Chamber	
Artifact Orientation:	Horizontal
Antenna Polarization:	Horizontal
Test Distance:	3 meters
Test Height:	1.8 meters

FACTORS

	Reference	Position 1	Position 2
Freq (MHz)	Outdoor Peak (dBuV/m)	Indoor Measurement Facing West Run 1 (dBuV/m)	Indoor Measurement Facing West Run 2 (dBuV/m)
30	29	45.7	45.4
35	32.2	46.5	45.3
40	36.1	42.8	39.7
45	39.1	40.9	36.9
50	40.6	42.6	41.9
55	41.2	37.2	41
60	43.3	42.6	42.4
65	44	44.3	47
70	45.5	45.1	45.1
75	46.7	50.6	49
80	47.7	52.2	52.6
85	48.5	55.2	52.5
90	50.2	45.7	52.2

(Outdoor) - (Indoor)	
Reference (outdoor) - Indoor Position 1 (dB)	Reference (outdoor) - Indoor Position 2 (dB)
-16.70	-16.40
-14.30	-13.10
-6.70	-3.60
-1.80	2.20
-2.00	-1.30
4.00	0.20
0.70	0.90
-0.30	-3.00
0.40	0.40
-3.90	-2.30
-4.50	-4.90
-6.70	-4.00
4.50	-2.00



95	50.2	45.1		48.3	5.10	1.90
100	52.5	50		46.8	2.50	5.70
105	50.4	51.4		48.8	-1.00	1.60
110	51.2	54.1		52.8	-2.90	-1.60
115	51.4	52.9		55.4	-1.50	-4.00
120	50.4	49		48.5	1.40	1.90
125	52	43.9		45.8	8.10	6.20
130	50.2	45.4		44.3	4.80	5.90
135	50.5	46.8		42	3.70	8.50
140	51.8	53.2		49	-1.40	2.80
145	49.6	51		50.5	-1.40	-0.90
150	51.1	47.3		46.8	3.80	4.30
155	48.4	44.8		47	3.60	1.40
160	50.6	44.6		45	6.00	5.60
165	47.6	49.1		46.8	-1.50	0.80
170	49.5	45.3		43	4.20	6.50
175	48.3	46.7		48.4	1.60	-0.10
180	49.5	43.2		46.1	6.30	3.40
185	47.6	45.1		43.6	2.50	4.00
190	50.6	49.5		48.4	1.10	2.20
195	49.1	48.7		50	0.40	-0.90
200	49.9	54.5		53.8	-4.60	-3.90
205	50.9	58.3		56.7	-7.40	-5.80
210	54.1	58.9		57.9	-4.80	-3.80
215	53.8	60.3		57.1	-6.50	-3.30
220	56.6	60		61.9	-3.40	-5.30
225	57.2	57.3		61.5	-0.10	-4.30
230	59.6	58.8		62.1	0.80	-2.50
235	60.4	57.2		55.3	3.20	5.10
240	62.5	62.8		59.1	-0.30	3.40
245	63.1	65.5		64.7	-2.40	-1.60
250	64.8	66.2		64.8	-1.40	0.00
255	65.2	65.8		65.9	-0.60	-0.70
260	66.2	64.3		65	1.90	1.20
265	65.9	65.5		62.7	0.40	3.20
270	66.6	69.9		67.4	-3.30	-0.80
275	66.3	66.4		65.6	-0.10	0.70
280	66	63		64.4	3.00	1.60
285	65.1	62.6		65	2.50	0.10
290	64.9	60.4		63.4	4.50	1.50
295	63.4	56.5		57	6.90	6.40
300	62.8	62.5		52.7	0.30	10.10



305	61.5	59.1		59.5	2.40	2.00
310	60.5	61.5		60.8	-1.00	-0.30
315	59.2	59.4		59.7	-0.20	-0.50
320	58.3	55.6		58.8	2.70	-0.50
325	57	48.4		52.1	8.60	4.90
330	56.1	55.2		53.5	0.90	2.60
335	53.9	54.3		53.1	-0.40	0.80
340	53.3	56.5		57.2	-3.20	-3.90
345	50.9	47.3		53.2	3.60	-2.30
350	50.4	49.3		45.9	1.10	4.50
355	48.8	50.4		47.3	-1.60	1.50
360	48.6	52.7		54.3	-4.10	-5.70
365	47.4	51.4		50.5	-4.00	-3.10
370	49.1	53.9		50.9	-4.80	-1.80
375	48.1	49.3		51.2	-1.20	-3.10
380	49.7	52.8		49.8	-3.10	-0.10
385	49.4	53.8		50.8	-4.40	-1.40
390	50.5	53.2		55.1	-2.70	-4.60
395	50.1	51.3		54.4	-1.20	-4.30
400	51.3	52.4		53.8	-1.10	-2.50
405	51.6	49.4		53.6	2.20	-2.00
410	52.4	49.5		46.5	2.90	5.90
415	52.4	55.7		48.9	-3.30	3.50
420	53.1	54.5		53.6	-1.40	-0.50
425	53.2	52.6		53.9	0.60	-0.70
430	53.5	54		55.4	-0.50	-1.90
435	54	48.9		52.1	5.10	1.90
440	53.6	54.4		47	-0.80	6.60
445	52.2	51.5		50.9	0.70	1.30
450	52.9	49.8		51.5	3.10	1.40
455	52.6	48.3		50.3	4.30	2.30
460	52	44		47.4	8.00	4.60
465	51.4	49		47.6	2.40	3.80
470	51.2	49.3		46.1	1.90	5.10
475	49.7	48		49.2	1.70	0.50
480	49.4	38.3		50.9	11.10	-1.50
485	48.4	44.5		38.7	3.90	9.70
490	47.6	49.1		44.8	-1.50	2.80
495	46.4	48.7		47.7	-2.30	-1.30
500	41.1	41.3		41.9	-0.20	-0.80
505	39.3	36.4		39.9	2.90	-0.60
510	39.2	37.6		41.7	1.60	-2.50



515	41.3	38.8		34.9	2.50	6.40
520	40.3	40.8		39.9	-0.50	0.40
525	40.5	41.9		44.9	-1.40	-4.40
530	41.9	37.5		44.5	4.40	-2.60
535	42.2	41.3		40.1	0.90	2.10
540	42.3	45.9		40.1	-3.60	2.20
545	43.4	42.3		46	1.10	-2.60
550	46.1	47.7		35.7	-1.60	10.40
555	47.3	48.4		45.2	-1.10	2.10
560	48.1	49.9		49.4	-1.80	-1.30
565	49.4	49.3		51.9	0.10	-2.50
570	49.4	47.4		48.8	2.00	0.60
575	51.3	47.7		48.1	3.60	3.20
580	50.8	48.1		47.9	2.70	2.90
585	50.7	47.8		48.2	2.90	2.50
590	50.4	49		46.2	1.40	4.20
595	51.1	47.6		49.2	3.50	1.90
600	50.7	49.4		46.7	1.30	4.00
605	50.8	51		48.2	-0.20	2.60
610	50.7	50.7		50.6	0.00	0.10
615	51.3	44.2		50.3	7.10	1.00
620	50.8	46.8		45.6	4.00	5.20
625	50.5	49.1		47.8	1.40	2.70
630	51.1	47.2		49.8	3.90	1.30
635	50.8	44.7		47.1	6.10	3.70
640	50.8	42.1		45.2	8.70	5.60
645	48	44.4		42.7	3.60	5.30
650	46.1	44.8		43.5	1.30	2.60
655	46.6	44.2		44	2.40	2.60
660	46.6	44.5		45.2	2.10	1.40
665	45.2	41.3		45.7	3.90	-0.50
670	45.1	46		42.9	-0.90	2.20
675	45.2	48.8		46.8	-3.60	-1.60
680	46.9	45.8		45.8	1.10	1.10
685	46.3	41.9		43.3	4.40	3.00
690	47.2	43.9		42.1	3.30	5.10
695	48.3	48.3		44.8	0.00	3.50
700	47.6	46.4		47.3	1.20	0.30
705	48	47.3		47.6	0.70	0.40
710	49.7	46.4		48.1	3.30	1.60
715	50.1	49.6		48.2	0.50	1.90
720	51	54.3		47.8	-3.30	3.20



725	52.1	51.7		49.9	0.40	2.20
730	53.1	47.1		52	6.00	1.10
735	53.3	51.8		47.8	1.50	5.50
740	53.9	52.8		49.4	1.10	4.50
745	54.4	48.1		53.6	6.30	0.80
750	54.5	49.5		50.5	5.00	4.00
755	54.8	48		50.6	6.80	4.20
760	55.3	52.1		52.7	3.20	2.60
765	55.1	55		49.2	0.10	5.90
770	55	53.2		51.1	1.80	3.90
775	55.5	53.7		51.8	1.80	3.70
780	55.4	54.2		54.8	1.20	0.60
785	55.2	50.6		53.8	4.60	1.40
790	54.7	51.2		53.2	3.50	1.50
795	54.6	51.8		49.3	2.80	5.30
800	54	49.9		51.3	4.10	2.70
805	53.9	52.9		47.9	1.00	6.00
810	53.5	50.4		49.3	3.10	4.20
815	53	49.4		52.4	3.60	0.60
820	53.4	49.6		52.7	3.80	0.70
825	53.6	51.5		47	2.10	6.60
830	52.8	51.7		46.1	1.10	6.70
835	52.8	52.7		52.4	0.10	0.40
840	52.5	48.6		53.6	3.90	-1.10
845	52.3	44.9		53.5	7.40	-1.20
850	51.8	52.3		51.3	-0.50	0.50
855	52.1	54.8		46.5	-2.70	5.60
860	51.6	51.8		47.2	-0.20	4.40
865	51.5	47.2		53.4	4.30	-1.90
870	52.3	47.2		55.1	5.10	-2.80
875	54	50.7		50.6	3.30	3.40
880	53.8	53.2		49.5	0.60	4.30
885	54.3	54.9		51.7	-0.60	2.60
890	53.5	51.4		54	2.10	-0.50
895	53.5	50.1		54.1	3.40	-0.60
900	54.7	53.7		52.1	1.00	2.60
905	54.5	53.5		49.9	1.00	4.60
910	55.2	53.8		53.9	1.40	1.30
915	55.1	52.8		55	2.30	0.10
920	55.8	46.6		55.2	9.20	0.60
925	56.4	55.2		54.6	1.20	1.80
930	56.7	56.1		48.2	0.60	8.50



935	56.8	56.1		52.5	0.70	4.30
940	57	52.7		53.3	4.30	3.70
945	56.6	53.2		52.8	3.40	3.80
950	57	48.5		54.2	8.50	2.80
955	56.7	52.3		53.3	4.40	3.40
960	56.3	49.7		51.1	6.60	5.20
965	55.9	52.2		51.8	3.70	4.10
970	55.1	50.6		47.3	4.50	7.80
975	55.1	47.2		51.7	7.90	3.40
980	54	48.8		51.7	5.20	2.30
985	53.7	51.9		47.4	1.80	6.30
990	53.2	52.8		48.4	0.40	4.80
995	52.1	50.5		49.8	1.60	2.30
1000	48.5	46.4		51.6	2.10	-3.10

<END>