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December 12, 2000

Chief, Equipment Authorization Branch,
Authorization and Evaluation Division,
Office of Engineering and Technology
FEDERAL COMMUNICATIONS COMMISSION
P.O. Box 358315
Pittsburgh, PA 15251-5315

Gentlemen:

The enclosed documents constitute a formal submittal and application for a Grant of Equipment Authorization pursuant to Subpart C of Part 15 of FCC Rules (CFR 47) regarding intentional radiators. Data within this report demonstrates that the equipment tested complies with the FCC limits for intentional radiators.

Elliott Laboratories, as duly authorized agent prepared this submittal. A copy of the letter of our appointment as agent is enclosed.
If there are any questions or if further information is needed, please contact Elliott Laboratories for assistance.

Sincerely,

Mark Briggs

Mark R. Briggs
Manager, EMC Consulting Services

MRB/dmg
Enclosures: Agent Authorization Letter
Emissions Test Report with Exhibits

Electromagnetic Emissions Test Report
and
Application for Grant of Equipment Authorization
pursuant to
FCC Part 15, Subpart C Specifications for an Intentional Radiator on the
Nokia Networks
Model: Presidio

FCC ID:	NPD-R242-V02
GRANTEE:	Nokia Networks Nokia Networks Mountain View, CA. 94043
TEST SITE:	Elliott Laboratories, Inc. 684 W. Maude Avenue Sunnyvale, CA 94086
REPORT DATE:	December 12, 2000
FINAL TEST DATE:	June 15, June 19, June 22 and July 20, 2000
AUTHORIZED SIGNATORY:	Mark Briggs ________________________ Mark R. Briggs Manager, EMC Consulting Services

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SCOPE

An electromagnetic emissions test has been performed on the Nokia Networks model Presidio pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Nokia Networks model Presidio and therefore apply only to the tested sample. The sample was selected and prepared by Darren Lancaster of Nokia Networks.

OBJECTIVE

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units which are subsequently manufactured.

STATEMENT OF COMPLIANCE

The tested sample of Nokia Networks model Presidio complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

EMISSION TEST RESULTS

The following emissions tests were performed on the Nokia Networks model Presidio. The actual test results are contained in an exhibit of this report.

LIMITS OF CONDUCTED INTERFERENCE VOLTAGE

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.207.

The following measurement was extracted from the data recorded during the conducted emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

0.45 – 30.00 MHz, 120V/ 60Hz, with modification, Main Radio Unit

Frequency	Level	Power	FCC 15.207(a)		Detector	Comments
MHz	dBuV	Lead	Limit	Margin	QP/Ave	
28.227	42.4	Line1	48.0	-5.6	QP	

0.45 – 30.00 MHz, 120V/ 60Hz, AC-DC adapter of DC Injector

Frequency	Level	Power	FCC 15.207(a)		Detector	Comments
MHz	dBuV	Lead	Limit	Margin	QP/Ave	
0.5219	35.7	Line	48.0	-12.3	QP	Note 1

Note 1: Signal is broadband, QP reading corrected by -13dB

LIMITS OF ANTENNA CONDUCTED SPURIOUS EMISSIONS – Presidio without amplifier

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247. All out-of-band emissions recorded in any 100 kHz band were more than 20 dB below the highest in-band level. The actual test data and any correction factors are contained an exhibit of this report.

LIMITS OF ANTENNA CONDUCTED SPURIOUS EMISSIONS – Presidio with amplifier

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247. All out-of-band emissions recorded in any 100 kHz band were more than 20 dB below the highest in-band level. The actual test data and any correction factors are contained an exhibit of this report.

LIMITS OF POWER AND BANDWIDTH – Presidio without amplifier

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247.

The maximum power output was 24.4 dBm on the center channel. The actual test data and any correction factors are contained in an exhibit of this report. Refer to the following section for the 20 dB bandwidth measurement data.

LIMITS OF POWER AND BANDWIDTH – Presidio with amplifier

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247.

The maximum power output was 29.2 dBm on the low channel. The 20 dB bandwidth was 995kHz. The actual test data and any correction factors are contained in an exhibit of this report.

CHANNEL OCCUPANCY TESTS

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247.

There were a total of 79 channels between 2.401 and 2.479 MHz, with channel spacing of 1000 kHz. The time of occupancy of 130mS seconds every 10 seconds (390mS every 30 seconds).

LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247 and 15.209 in the case of emissions falling within the frequency bands specified in Section 15.205.

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit for all of the configurations of Presidio Radio without the optional amplifier. The actual test data and any correction factors are contained in an exhibit of this report.

Radiated Emissions In Restricted Bands, 30 – 24000 MHz
Low Channel @2401 MHz, Base Unit without Amplifier, 12dBi Sector Antenna

Frequency	Level	Pol	FCC 15.207(a)		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7202.910	40.7	H	54.0	-13.3	Avg	186	1.8	

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit for all of the configurations of Presidio Radio with the optional amplifier. The actual test data and any correction factors are contained in an exhibit of this report.

Radiated Emissions In Restricted Bands, 30 – 24000 MHz
Low Channel @2401 MHz, Base Unit with Amplifier, 10 dBi Omni Antenna

Frequency	Level	Pol	FCC 15.207(a)		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4802.000	52.7	V	54.0	-1.3	Avg	200	1.0	

MEASUREMENT UNCERTAINTIES

ISO Guide 25 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	± 2.4
Radiated Emissions	30 to 1000	± 3.2

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Nokia Networks model Presidio is a 2.4 – 2.4835 GHz frequency-hopping spread spectrum (FHSS) transceiver that is designed for multipoint operation. The device incorporates a Symbol Spread Spectrum Radio PCMCIA card and can be configured with different antennas and an optional amplifier as shown in the table below:

Antenna Type and Manufacturer	Antenna Model Number	Gain dBi	Minimum Feeder Cable Length (ft)[1]	Cable Loss (dB)[2]	Amp (Y/N)	Max. EIRP (dBm)
8 dBi omni Maxrad	MFB24008	8	0	0.62	N	33.88
8 dBi omni with 7 degree downtilt Maxrad	MFB24008	8	0	0.62	N	33.88
10 dBi omni Maxrad	MFB24010	10	50	2.52	N	33.98
8 dBi panel Maxrad	MP24008PT	7.7	0	0.62	N	33.58
10 dBi sector Til-Tek Maxrad	TA-2404-2-90	10	50	2.52	N	33.98
12 dBi sector Til-Tek Maxrad	TA-2304	12	50	2.52	N	35.98
8 dBi omni with amplifier Maxrad	MFB24008	8	0	0.62	Y	36
15 dBi panel[3] Maxrad	MP24015PT	15	0	0.62	N	40.88
17 dBi panel[3] Til-Tek	TA-2408	17	0	0.62	N	42.88

[1] Feeder cable loss is 0.038 dB/ft.
[2] Default cable loss for all deployments includes 6 ft. jumper cable (0.095 dB/ft attenuation) plus 0.05 dB connector losses.
[3] These configurations are only legal on systems that are 1 hop from the AirHead and not amplified (i.e. point-to-point operation)

The actual configurations tested for radiated spurious emissions were:

1. Un-amplified system with Omni 10dBi
2. Un-amplified system with Panel to 17dBi
3. Un-amplified system with Sector to 12dBi
4. Amplified system with Omni 8dBi antenna

The configurations chosen were selected since they represent the highest gain antennas of each antenna type for the amplified and un-amplified configurations.

The antenna connector is a standard N-type connector. This is considered acceptable since the maneer in which the system is marketed and the location of the antennae is such that professional installation is always required.

The sample was received on June 15, 2000 and tested on June 15, June 19, June 22 and July 20, 2000. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number
Nokia	-	PCB	792924
Nokia	-	Radio	0G3UH3
Young Design	2441-E1	2.4 GHz bi-directional antenna amplifier with dc injector	None
Maxrad	MFB24010	10 dBi Omni Antenna	N/A
Til-Tek	TA-2408	17dBi Panel Antenna	N/A
Til-Tek	TA-2304	12 dBi Sector Antenna	N/A
Maxrad	MFB24008	8 dBi Omni Antenna	N/A

ENCLOSURE

It measures approximately 13.7 cm wide by 11.4 cm deep by 3.4 cm high. It is primarily constructed of plastic with an internal conductive coating.

MODIFICATIONS

The EUT required the following modifications in order to comply with the conducted emission specifications:

Added copper foil tape to edge of radio module inside EUT during conducted emissions testing.

SUPPORT EQUIPMENT

The following equipment was used as remote support equipment for emissions testing:

Manufacturer	Model	Description	Serial Number
IBM	-	Laptop	78-LZ070
IBM	-	AC Adapter	J15JR533PB4

The laptop was located on the table during conducted emissions measurements to facilitate changing the operating frequency quickly.

EUT INTERFACE PORTS

The I/O cabling configuration during emissions testing was as follows:

-	-	Cable(s)		
EUT Port	Connected To	Description	Shielded or Unshielded	Length(m)
Antenna Output	Antenna	Coax (Andrew)	Shielded	1.5

EUT OPERATION

EUT was set to transmit continuously on a single channel for radiated emissions, power and bandwidth tests. For Channel occupancy measurements the EUT was set to transmit in hopping mode.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken on June 15, June 19, June 22 and July 20, 2000 at the Elliott Laboratories Open Area Test Site #1, 2, 3, and CCA1 located at 684 West Maude Avenue, Sunnyvale, California. The test sites contain separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde and Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors programmed into the test receivers.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table-mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The FCC requires that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

RADIATED EMISSIONS

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit.

A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth which results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207

Frequency Range (MHz)	Limit (uV)	Limit (dBuV)
0.450 to 30.000	250	48

RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - B = C$$

and

$$C - S = M$$

where:

R_r = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level - Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20*LOG_{10}(D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

EXHIBIT 1: Test Equipment Calibration Data

EXHIBIT 2: Test Data Log Sheets

ELECTROMAGNETIC EMISSIONS

TEST LOG SHEETS

AND

MEASUREMENT DATA

Filename	Pages
T38016	14 Pages
T38016 Graphs	11 Pages
T38457	9 Pages
T38457 Graphs	13 Pages

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

Sector Antenna

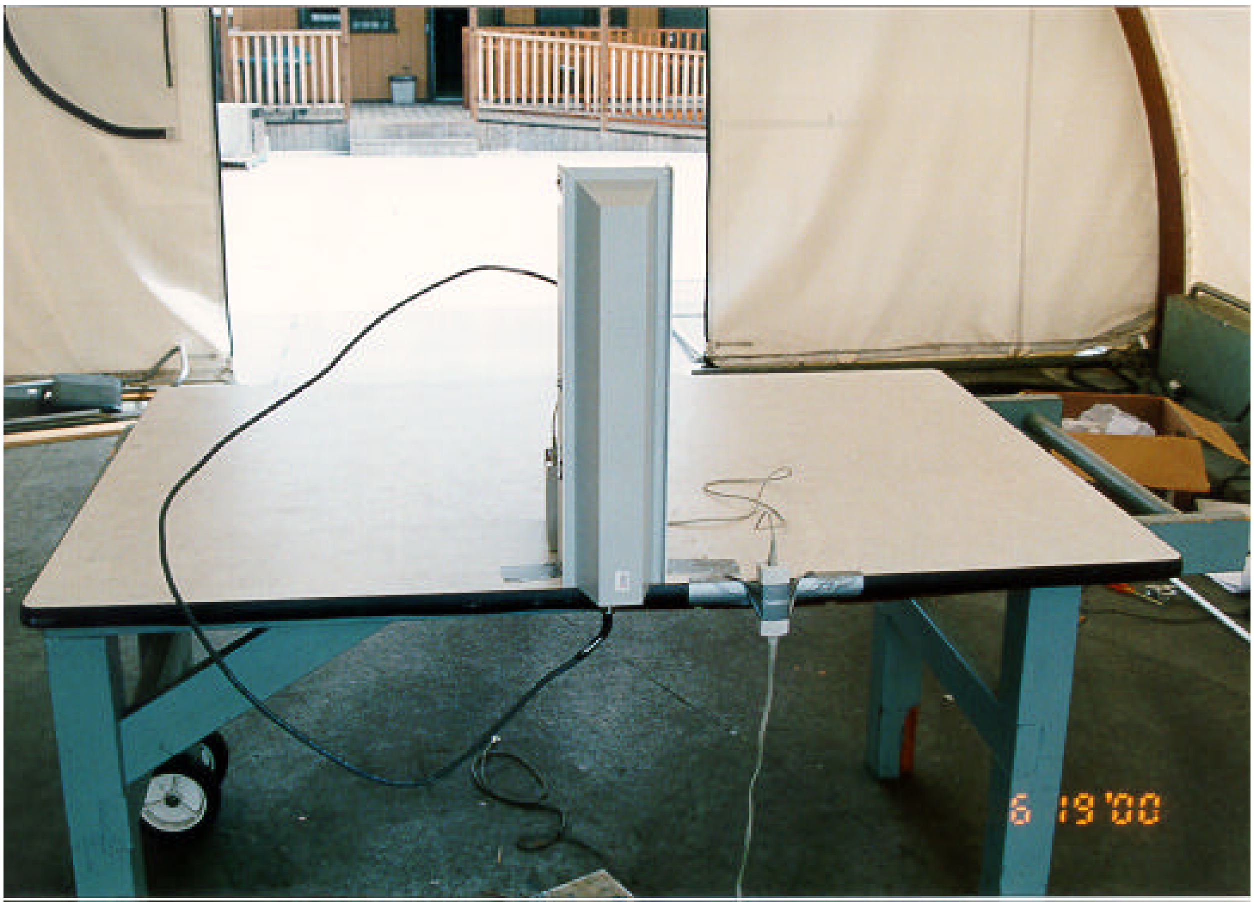

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

Panel Antenna

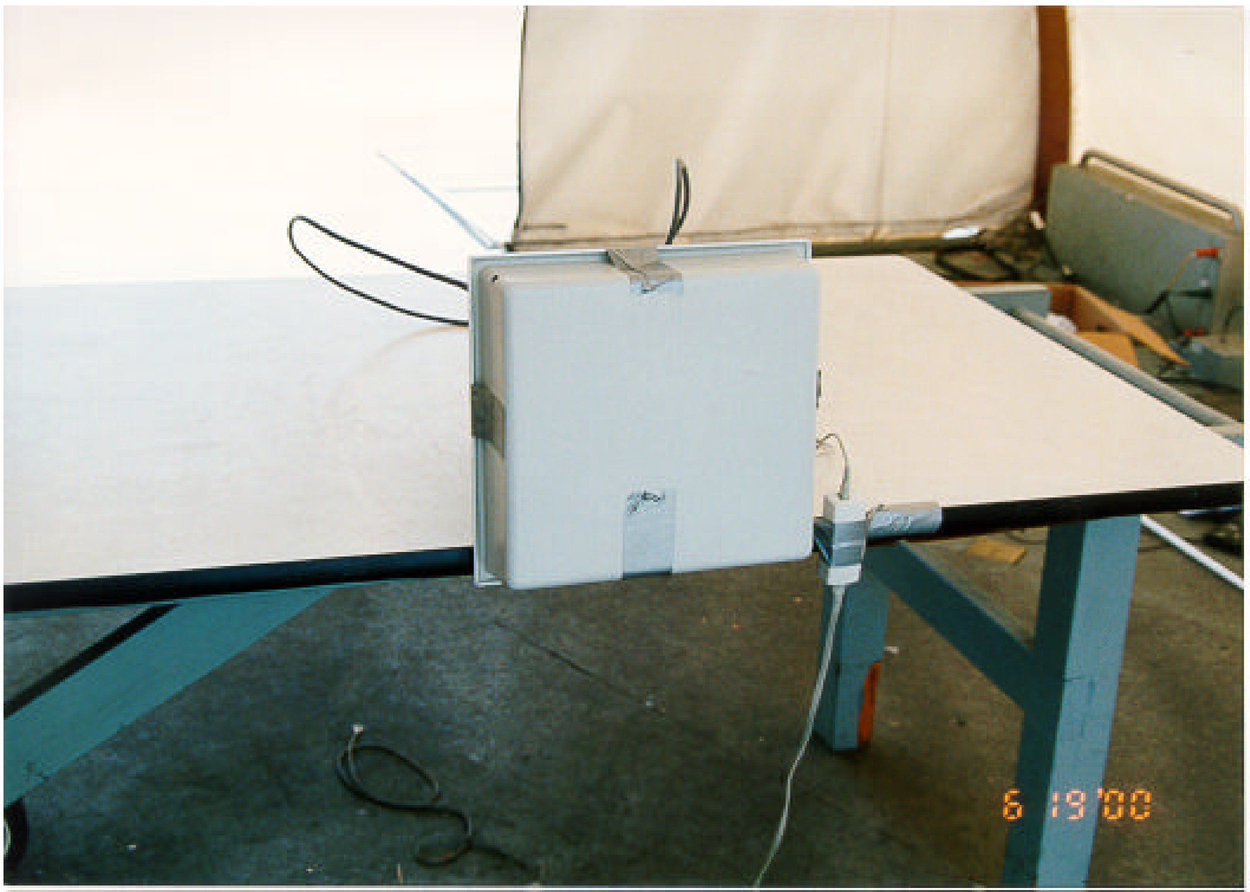

EXHIBIT 3: Radiated Emissions Test Configuration Photographs

Omni Antenna

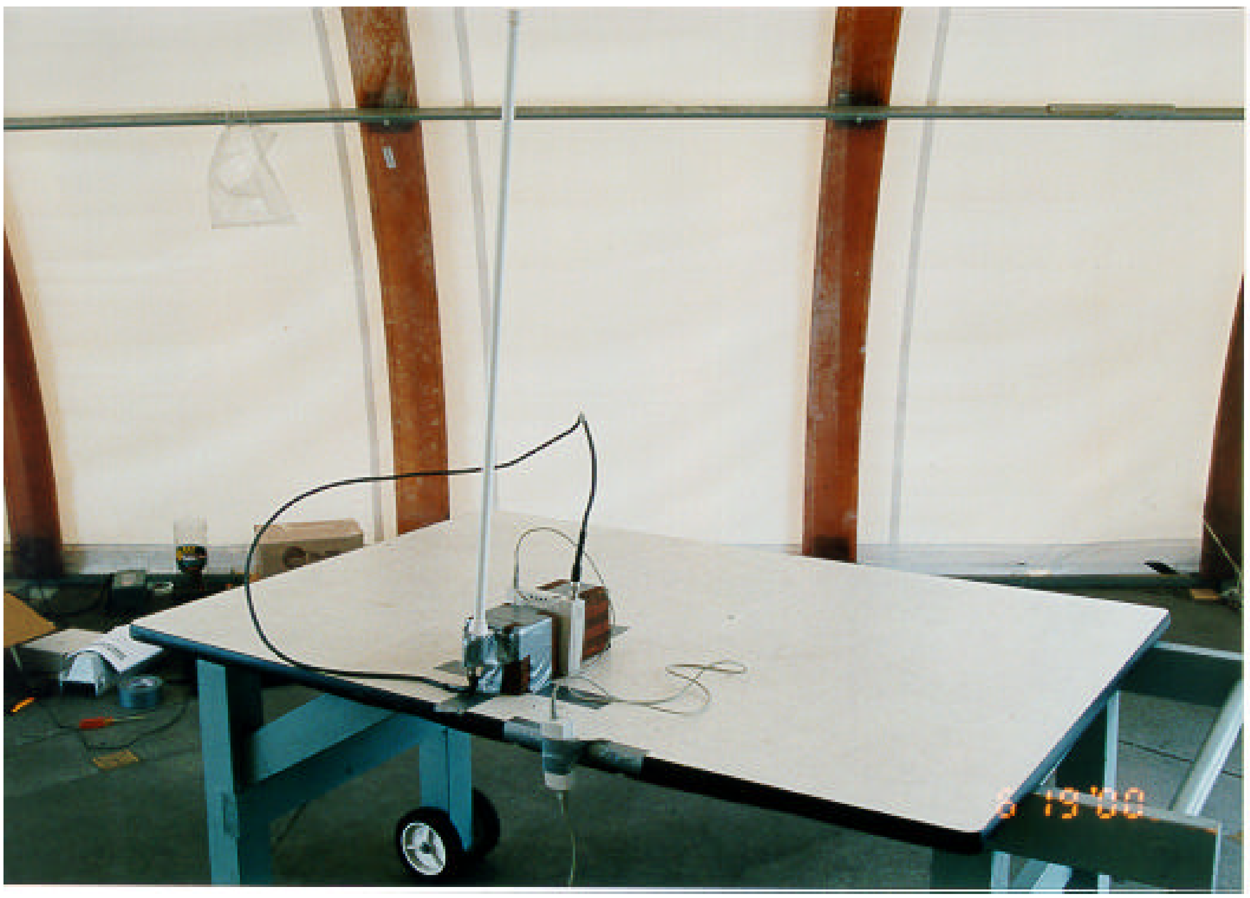

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

System Without Amplifier

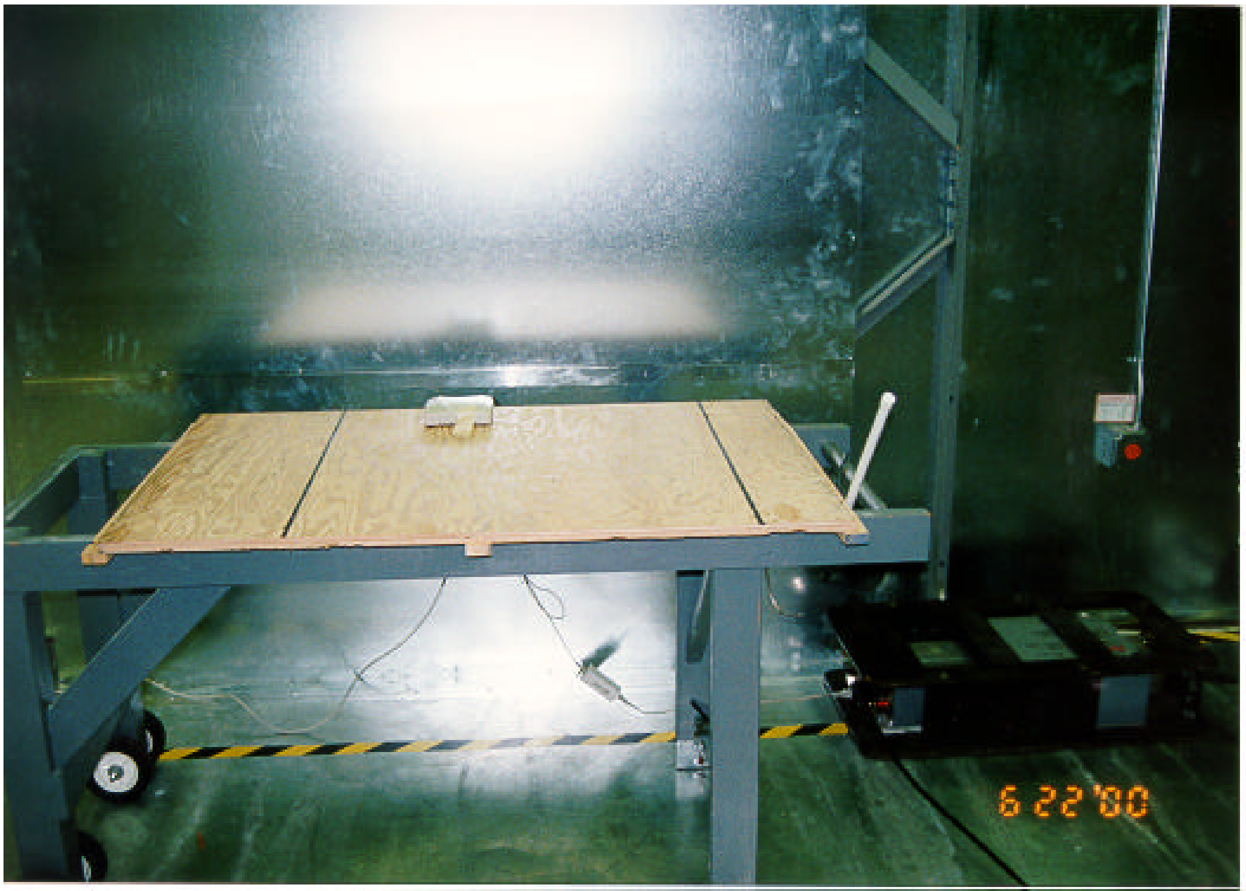

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

System Without Amplifier

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

System With Amplifier

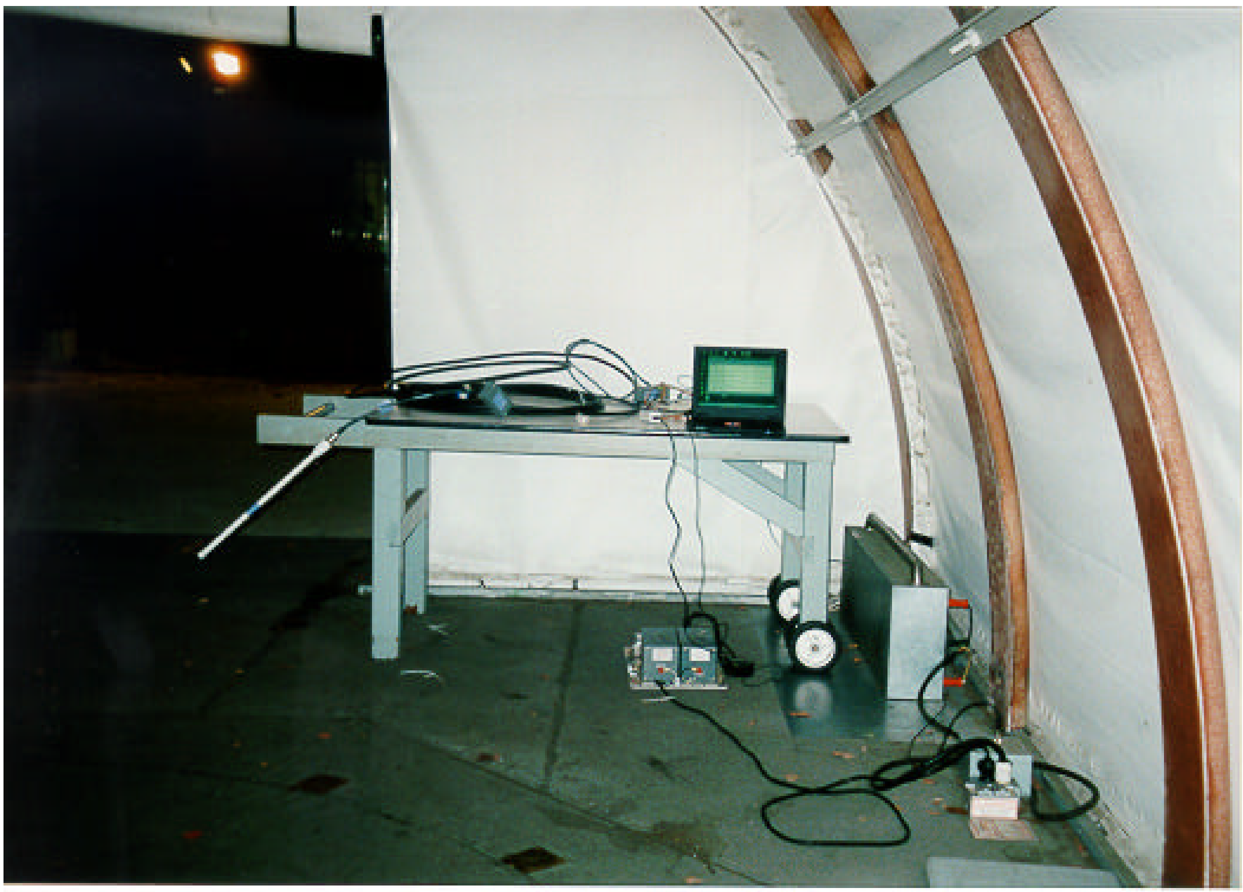

EXHIBIT 4: Conducted Emissions Test Configuration Photographs

System With Amplifier

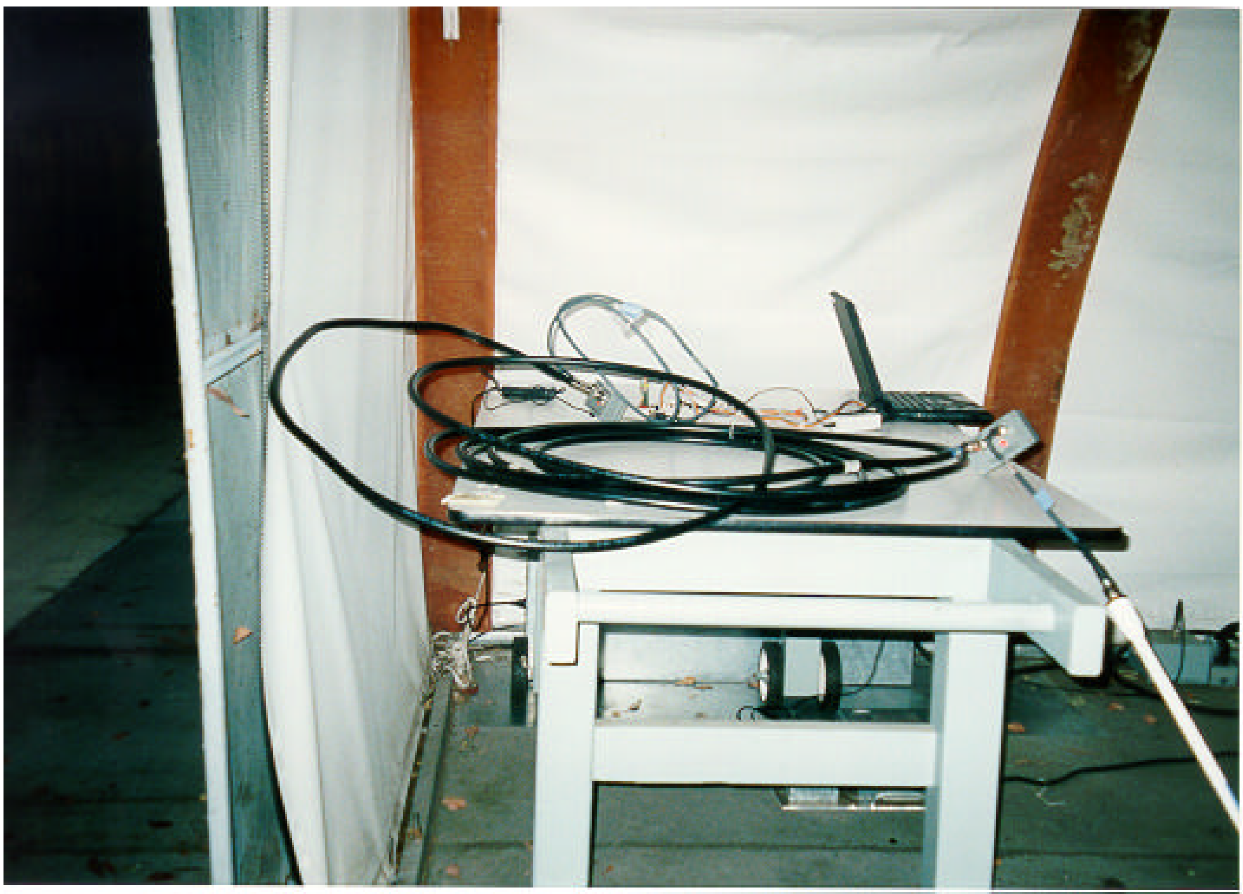

EXHIBIT 5: Proposed FCC ID Label & Label Location

Filename
label and location.PDF

EXHIBIT 6: Detailed Photographs of Nokia Networks Model Presidio Construction

Filename
Internal photos.pdf
External photos.pdf

EXHIBIT 7: Operator's and Installation Manual for Nokia Networks Model Presidio

Filename
Installation Manual.pdf
User Manual.pdf

EXHIBIT 8: Block Diagram of Nokia Networks Model Presidio

Filename
Block Diagram

EXHIBIT 9: Schematic Diagrams for Nokia Networks Model Presidio

Filename
Schematics

EXHIBIT 10: Theory of Operation for Nokia Networks Model Presidio

Filename
Theory of Operations.pdf