EXHIBIT ONE

SAR REPORT

ITRONIX CORPORATION

Certification Report on

Specific Absorption Rate (SAR) Experimental Analysis

Itronix Corporation

T5200 Handheld PC with RIM R900M-2-O Radio

Date: 7 May, 1999

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CERTIFICATION REPORT

Subject:	**Specific Absorption Rate (SAR) Experimental Analysis**
Product:	Handheld PC
Model:	T5200 with a Research in Motion R900M-2-O transmitter
Client:	Itronix Corporation
Address:	801 South Stevens Street Spokane, WA 99204
Project #:	ITRB-T5200 R900M2O-3190

Prepared by: APREL Laboratories
51 Spectrum Way
Nepean, Ontario
K2R 1E6

Submitted by ______________ Date: 26 May 99
Dr. Paul G. Cardinal
Director, Laboratories

Approved by ______________ Date: May 26/99
Dr. Jacek J. Wojcik, P. Eng.

J. J. Wojcik

CERTIFICATION REPORT

Subject: **Specific Absorption Rate (SAR) Experimental Analysis**

Product: Handheld PC

Model: T5200 with a Research in Motion R900M-2-O transmitter

Client: Itronix Corporation

Address: 801 South Stevens Street
Spokane, WA 99204

Project #: ITRB-T5200 R900M2O-3190

Prepared by: APREL Laboratories
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Nepean, Ontario
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Submitted by ______________________ Date: ______________
Dr. Paul G. Cardinal
Director, Laboratories

Approved by ______________________ Date: ______________
Dr. Jacek J. Wojcik, P. Eng.

FCC ID:
Applicant: Itronix Corporation
Equipment: Handheld PC
Model: T5200 with a Research in Motion R900M-2-O transmitter
Standard: FCC 96 –326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation

ENGINEERING SUMMARY

This report contains the results of the engineering evaluation performed on an Itronix T5200 handheld PC operating with a built in Research in Motion R900M-2-O Mobitex radio transmitter . The measurements were carried out in accordance with FCC 96-326. The handheld PC was evaluated for its maximum power level of Power Level of 2W(33 dBm).

The Mobitex version of the T5200 was tested at high, middle, and low frequencies, with the maximum SAR coinciding with the peak performance RF output power of channel 720_h (middle, 899 MHz). Test data and graphs are presented in this report.

This unit as tested, and as it will be marketed and used (with a warning in the manual to keep bystanders at least 30mm, or 1.25", from the antenna), is found to be compliant with the FCC 96-326 requirement, for an uncontrolled RF exposure environment

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TABLE OF CONTENTS

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1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) of a sample of an Itronix T5200 handheld PC which incorporates a Research in Motion R900M-2-O Mobitex radio transmitter. These tests were conducted at APREL Laboratories' facility located at 51 Spectrum Way, Nepean, Ontario, Canada. A view of the SAR measurement setup can be seen in Appendix A Figure 1. This report describes the results obtained.

2. APPLICABLE DOCUMENTS

The following documents are applicable to the work performed:

1) FCC 96-326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation

2) ANSI/IEEE C95.1-1992, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

3) ANSI/IEEE 95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

4) OET Bulletin 65 (Edition 97-01) Supplement C (Edition 97-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

3. EQUIPMENT UNDER TEST

- Itronix T5200 with a Research in Motion R900M-2-O Mobitex radio, s/n 905165

The handheld PC's antenna is a ½ wavelength rotateable antenna. The antenna specifications supplied by the manufacturer can be found in Appendix B.

4. TEST EQUIPMENT

- Narda 8021B miniature E-field probe, s/n 04007, Asset # 301339
- CRS Robotics A255 articulated robot arm, s/n RA2750, Asset # 301355
- CRS Robotics C500 robotic system controller, s/n RC584, Asset # 201354
- Tektronix-492 spectrum analyzer, s/n B054562, Asset # 100949
- APREL F-1, flat manikin, s/n 001
- Tissue Recipe and Calibration Requirements, APREL procedure SSI/DRB-TP-D01-033

5. TEST METHODOLOGY

1. The test methodology utilised in the certification of the handheld PC complies with the requirements of FCC 96-326 and ANSI/IEEE C95.3-1992.
2. The E-field is measured with a small isotropic probe (output voltage proportional to E^2).
3. The probe is moved precisely from one point to the next using the robot (10 mm increments for wide area scanning, 5 mm increments for zoom scanning, and 2.5 mm increments for the final depth profile measurements).
4. The probe travels in the homogeneous liquid simulating human tissue. Appendix D contains information about the recipe and properties of the simulated tissue used for these measurements.
5. The liquid is contained in a manikin simulating a portion of the human body.
6. The handheld PC is positioned in such a way that it touches the bottom of the phantom with either the antenna side, the bottom side or the keyboard.
7. All tests were performed with the highest power available from the sample handheld PC, under transmit conditions.

More detailed descriptions of the test method is given in Section 6 when appropriate.

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6. TEST RESULTS

6.1. TRANSMITTER CHARACTERISTICS

The battery-powered transmitter will consume energy from its batteries, which may affect its transmission characteristics. In order to gage this effect the output of the transmitter is sampled before and after each SAR run. In the case of the handheld PC, which does not have an externally accessible feedpoint the radiated power was sampled. In the case of the handheld PC, which does not have an externally accessible feedpoint the radiated power was sampled. A power meter was connected to an antenna adjacent to a fixture to hold the transmitter in a reproducible position. The following table shows the results for the three sets of data used for this report.

Scan		**Relative Power Reading (dB)**		**Battery #**
Type	Height (mm)	Before	After	
Area	2.5	-13.5	-13.5	1
Area	12.5			
Zoom	2.5			1
Zoom	7.5	-13.5	-13.4	
Zoom	12.5			
Depth	2.5 – 17.5	-13.3	-13.2	2

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6.2. SAR MEASUREMENTS

1) RF exposure is expressed as a Specific Absorption Rate (SAR). SAR is calculated from the E-field, measured in a grid of test points as shown in Appendix A Figure 2. SAR is expressed as RF power per kilogram of mass, averaged in 1 cubic centimetre of tissue.

2) The Itronix T5200 handheld PC was put into test mode for the SAR measurements using manufacturer supplied keypad commands to control the channel (initially 720_h, middle, 899MHz) and maximum operating power (nominally 33 dBm), and a duty cycle of 45.45%.

3) Figure 3 in Appendix A shows a contour plot of the SAR measurements for the Itronix T5200 handheld PC sample. The presented values were taken 2.5 mm into the simulated tissue from the Flat Phantom's solid inner surface. The device under test's right edge was 0 mm from the Flat Phantom's solid outer surface (11 mm from antenna's axis). Figure 2 in Appendix A shows the Flat Phantom used in the measurements. A grid is shown inside of the Flat Phantom indicating the orientation of the x-y grid used, with the co-ordinates 5,18 at the bottom left corner of the handheld PC. The x-axis is positive towards the right and the y-axis is positive towards the top. The antenna inside the handheld PC is located at the left end of the device (see pictures in Appendix B).

   A different presentation of the same data is shown in Appendix A Figure 4. This is a surface plot, where the measured SAR values provide the vertical dimension, which is useful as a visualisation aid.

   Similar data was obtained 12.5 mm into the simulated muscle tissue.

   Figure 5 in Appendix A shows the overlay of the Handheld PC's right edge outline, superimposed onto the contour plot previously shown as Figure 3.

   Figures 3 and 4 in Appendix A show that there is a dominant peak.

4) The SAR adjacent to different surfaces of the Handheld PC was investigated on the middle (720_h) channel. The surface being investigated was touching the bottom of the flat phantom.

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Laptop Surface	**Highest Local SAR** (W/kg)
Keyboard	0.30
Bottom	0.09
Right Edge with Antenna	4.06

Subsequent testing was performed with the antenna side of the Handheld PC parallel to the lower surface of the flat phantom.

5) Wide area scans were performed for the low (480_h, 896MHz), middle (720_h,899MHz) and high (960_h, 901MHz) channels. The peak single point SAR for the scans were:

Channel	**Frequency [MHz]**	**Channel # [hexadecimal]**	**Highest SAR [w/kg]**
Low	896	480	3.41
Middle	899	720	4.06
High	901	960	2.63

Wide area scans were also performed for the middle (720_h, 899MHz) channel vs. separation. The peak single point SAR for the scans were:

Channel		**Antenna's Axis to Phantom's Outer Surface Separation**	**Highest Local SAR**
	(MHz)	(mm)	(W/kg)
L	806	11	4.064
		16	2.750
		27	0.9694

Considering the anticipated scaling to the inner surface of the phantom, and for the maximum duty cycle, subsequent testing was performed with an antenna-axis to

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phantom bottom separation of 27 mm.

Figure 10 in Appendix A shows the data plotted as a function of separation and the exponential curves fit to them (Microsoft Excel 97).

6) The middle channel (720_h) SAR peak was then explored on a refined 0.5 mm grid in three dimensions (right edge of DUT 16mm from outer Flat Phantom's surface – 27mm from antenna's axis). Figures 6, 7, and 8 show the measurements made at 2.5, 7.5, and 12.5 mm respectively. The SAR value averaged over 1 cm^3 was determined from these measurements by averaging the 27 points (3x3x3) comprising a 1 cm cube. The maximum SAR value measured averaged over 1cm^3 was determined from these measurements to be 0.496 W/kg.

7) To extrapolate the maximum SAR value averaged over 1 cm^3 to the inner surface of the head phantom a series of measurements were made at a few (x,y) coordinates within the refined grid as a function of depth, with 2.5 mm spacing. Figure 9 in Appendix A shows the data gathered and the exponential curves fit to them (Microsoft Excel 97). The average exponential coefficient was determined to be (-0.0728 ± 0.0016) / mm.

   The distance from the probe tip to the inner surface of the head phantom for the lowest point is 2.5 mm. The distance from the probe tip to the tip of the measuring dipole within the Narda 8021B miniature RF probe is 7 mm. The total extrapolation distance is 9.5 mm, the sum of these two.

   Applying the exponential coefficient over the 9.5 mm to the maximum SAR value average over 1 cm^3 that was determined previously, we obtain **the maximum SAR value at the surface averaged over 1 cm^3** of <u>0.991 W/kg</u> for a 45.45% duty cycle. Through proportional scaling for a duty cycle of 100%, we obtain a maximum SAR at the surface of <u>1.992 W/kg</u>.

7. ANALYSIS

The measurements of highest local SAR versus separation of the antenna housing (for a 100% duty cycle) from the bottom of the phantom (Section 6.2.4) will enable the peak 1g SAR for a separation of 27mm (previous section) to be extrapolated/interpolated for smaller separations.

If the data for Figure 10 is fitted to an exponential equation we get:

$$\text{Peak Local SAR} = 24.79\ e^{-0.0904\text{separation}}$$

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A similar equation will exist for the peak 1g SAR versus separation:

$$\text{Peak 1g SAR} = k\,e^{-0.0904\ \text{separation}}$$

Using this equation with the previous section's data:

Peak 1g SAR for a 100% duty cycle = 1.982W/kg
separation =27 mm

results in a k = 22.75 W/kg, which corresponds to the peak 1g SAR when the separation is zero. A conservative peak 1g SAR of 1.5 W/kg would occur for a separation of 30mm.

8. CONCLUSIONS

The Itronix Corporation T5200 Handheld PC which incorporates a Research in Motion R900M-2-O Mobitex radio transmitter will not expose the user to a maximum Specific Absorption Rate (SAR) exceeding the FCC 96-326 SAR safety guideline limit of 1.6W/kg. However, a bystander in the near proximity of the transmitting antenna may be exposed to such levels.

The maximum SAR averaged over 1g, determined at 899 MHz (middle channel - 720), for a separation between the antenna housing and the phantom of 27 mm, was determined to be 1.991 W/kg. The overall margin of uncertainty for this measurement is ±12.0%. The analysis of the previous section shows that a more conservative 1.5W/kg will not be exceeded for a separation exceeding 30 mm.

This unit as tested, and as it will be marketed and used (with a warning in the manual to keep bystanders at least 30 mm, or 1.25" from the antenna), is found to be compliant with the FCC 96-326 requirement.

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APPENDIX A

Figure 1

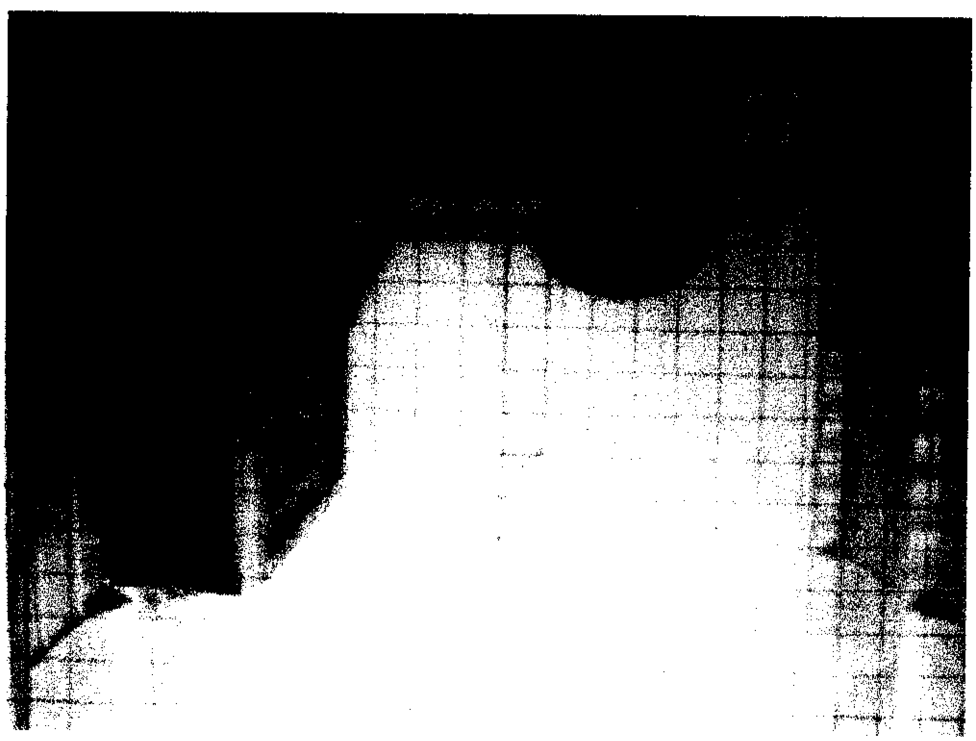

Figure 2

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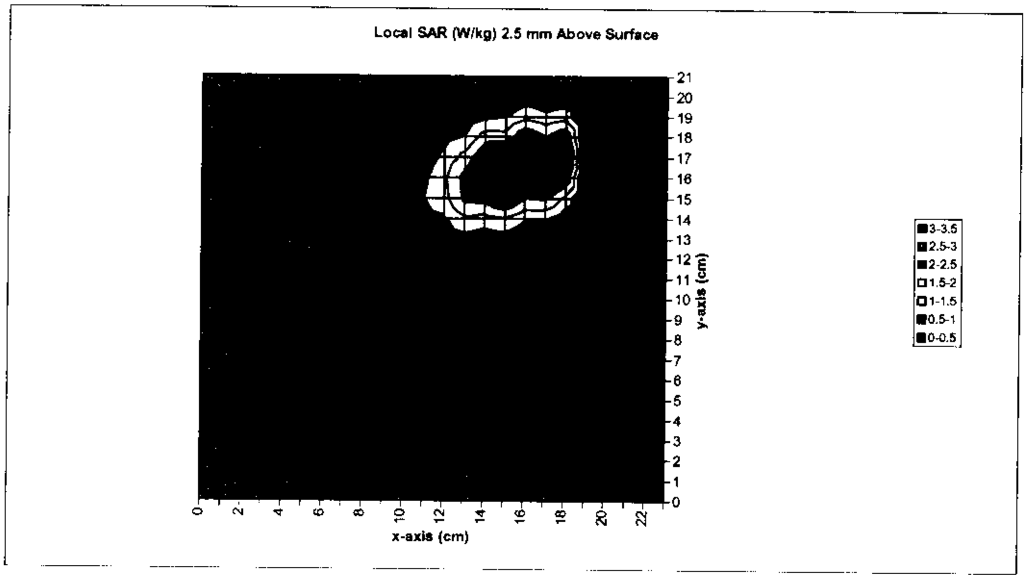

Figure 3

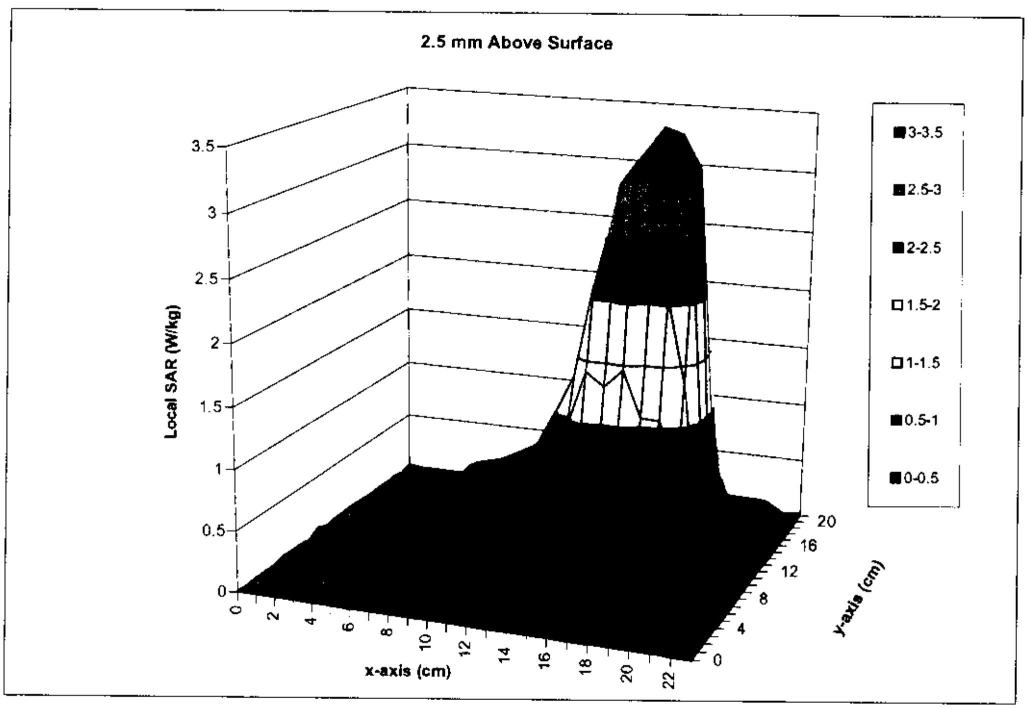

Figure 4

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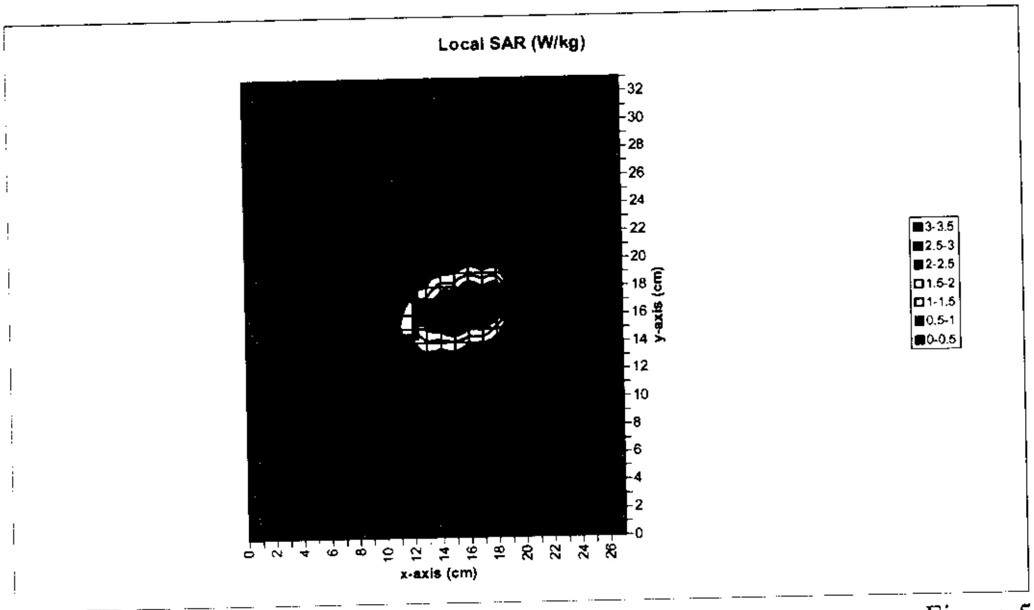

Figure 5

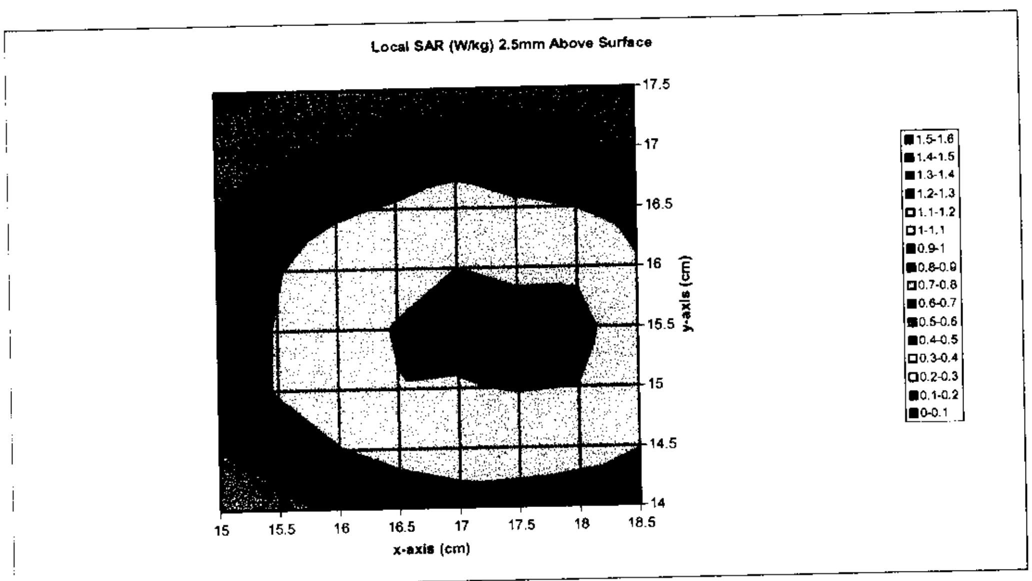

Figure 6

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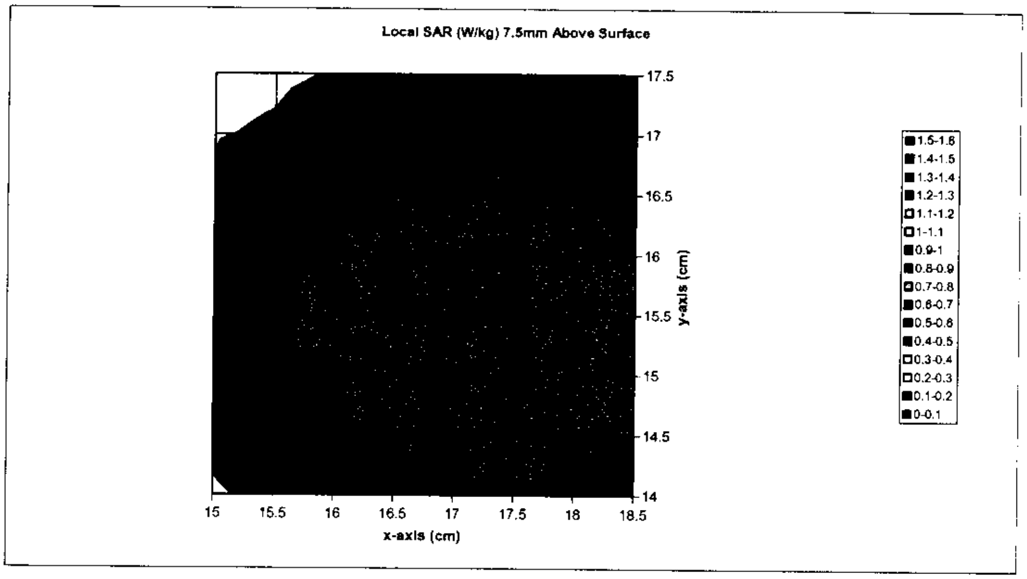

Figure 7

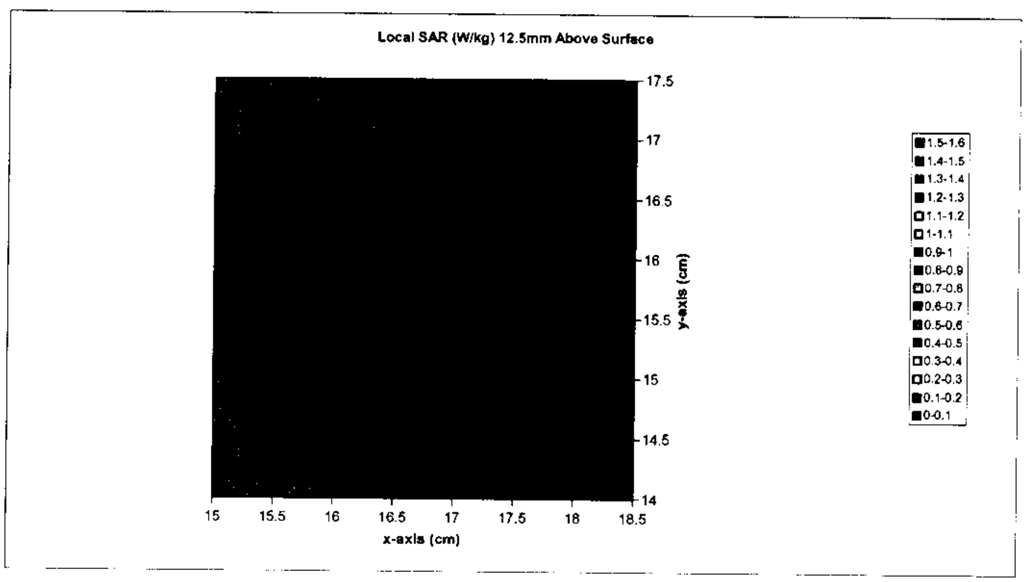

Figure 8

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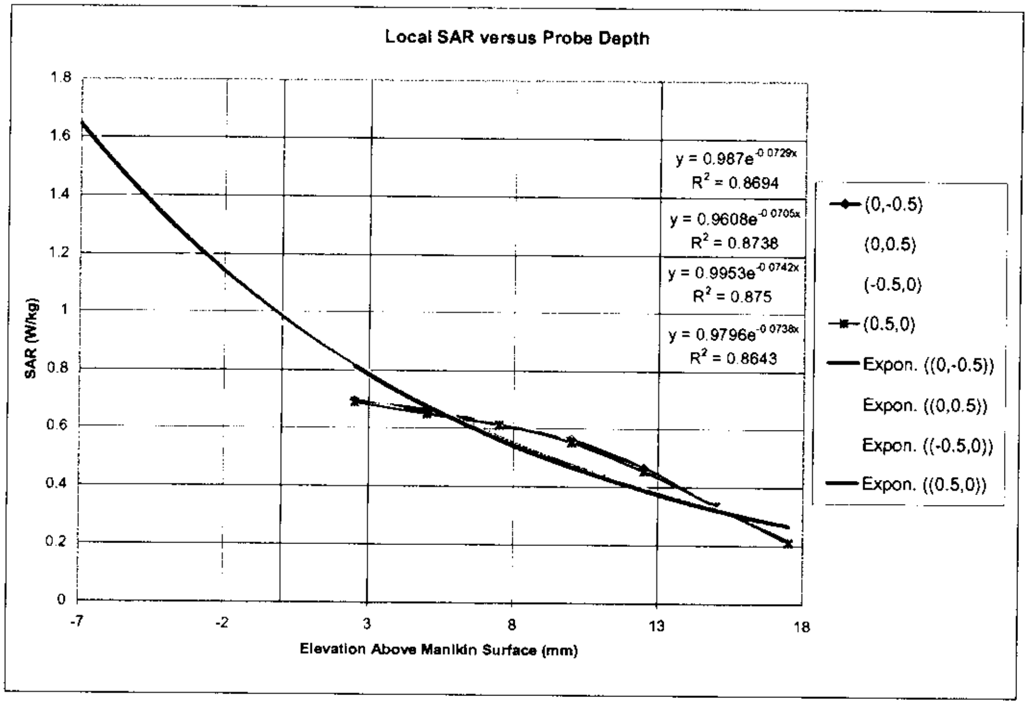

Figure 9

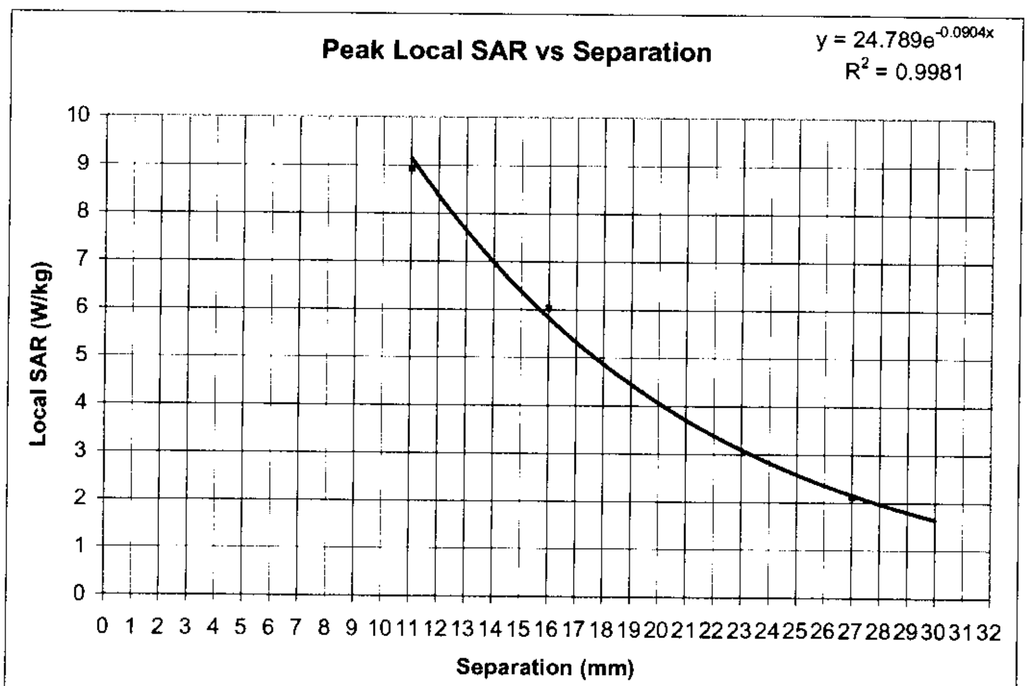

Figure 10

APPENDIX B

Manufacturer's Antenna Specifications

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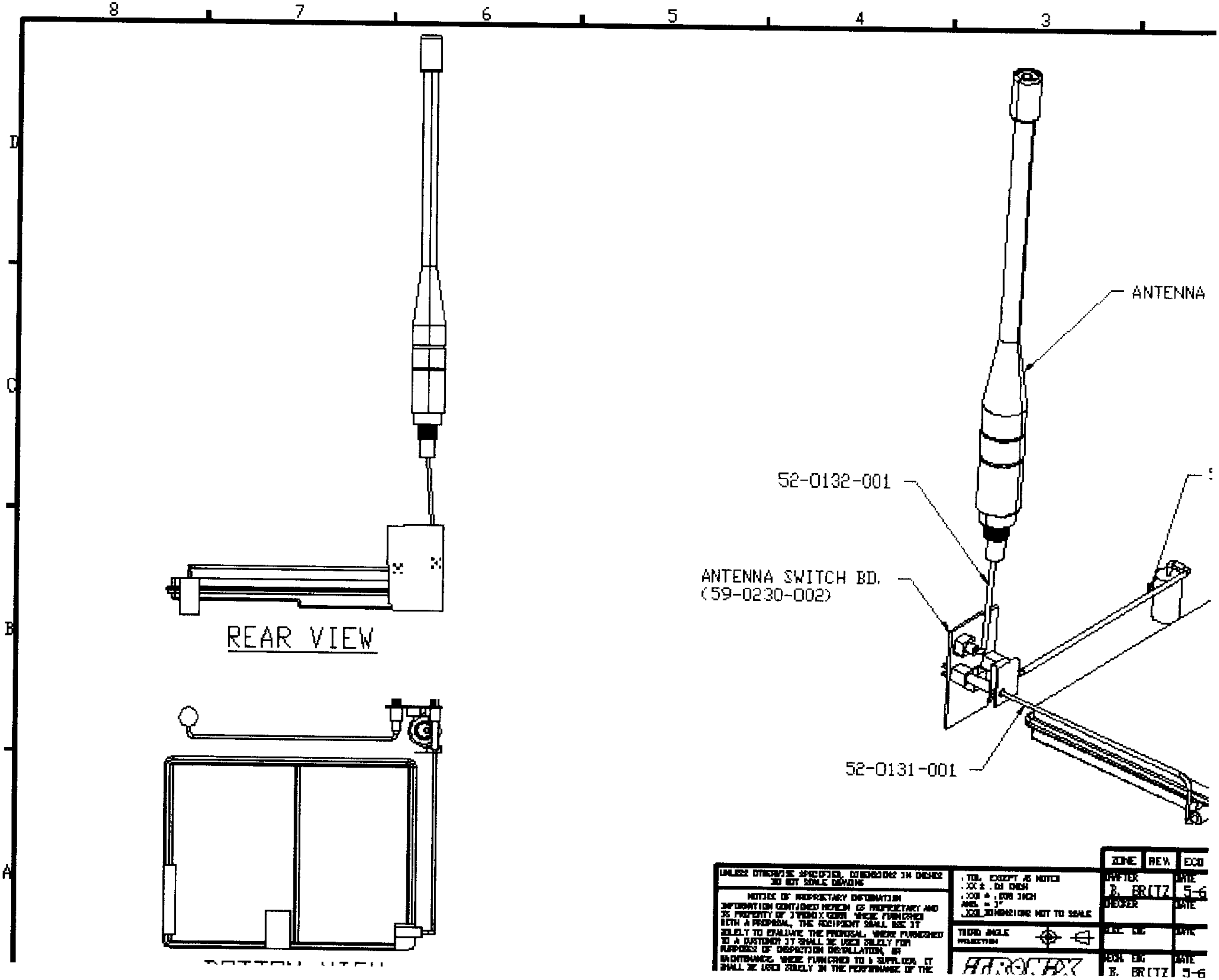

8
7
6
5
4
3
D
C
B
A
ANTENNA
52-0132-001
ANTENNA SWITCH BD.
(59-0230-002)
52-0131-001
REAR VIEW
ZONE
REV
ECO
DRAFTER
B. BRITZ
5-6
CHECKER
DATE
THIRD ANGLE PROJECTION
MECH. ENG
B. BRITZ
5-6

APPENDIX C

Uncertainty Budget

Uncertainties Contributing to the Overall Uncertainty

Type of Uncertainty	Specific to	Uncertainty	
Power variation due to battery condition	phone	1.2%	
Extrapolation due to curve fit of SAR vs	phone	4.5%	
Extrapolation due to depth measuremen	setup	3.6%	
Conductivity	setup	6.0%	
Density	setup	2.6%	
Tissue enhancement factor	setup	7.0%	
Voltage measurement	setup	2.1%	
Probe sensitivity factor	setup	3.5%	
		12.0%	**RSS**

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APPENDIX D

Simulated Tissue Material and Calibration Technique

The muscle mixture used was based on that presented SSI/DRB-TP-D01-033, “Tissue Recipe and Calibration Requirements”.

De-ionised water	52.8 %
Sugar	45.3 %
Salt	1.5 %
HEC	0.3 %
Bactericide	0.1 %

Mass density, ρ	1.30 g/ml (The density used to determine SAR from the measurements was the recommended 1040 kg/m^3 found in Appendix E of Supplement C to OET Bulletin 65, Edition 97-01)

Dielectric parameters of the simulated tissue material were determined using a Hewlett Packard 8510 Network Analyser, a Hewlett Packard 809B Slotted Line Carriage, and an APREL SLP-001 Slotted Line Probe. The dielectric properties are:

Dielectric constant, ε_r	51.3
Conductivity, σ	1.14 S/m
Tissue Conversion Factor, γ	6.3

	APREL	OET 65 Supplement	Δ/%
Dielectric constant, ε_r	51.3	55.96	-8.3
Conductivity, σ [S/m]	1.14	0.97	+17.5
Tissue Conversion Factor, γ	6.3	-	-

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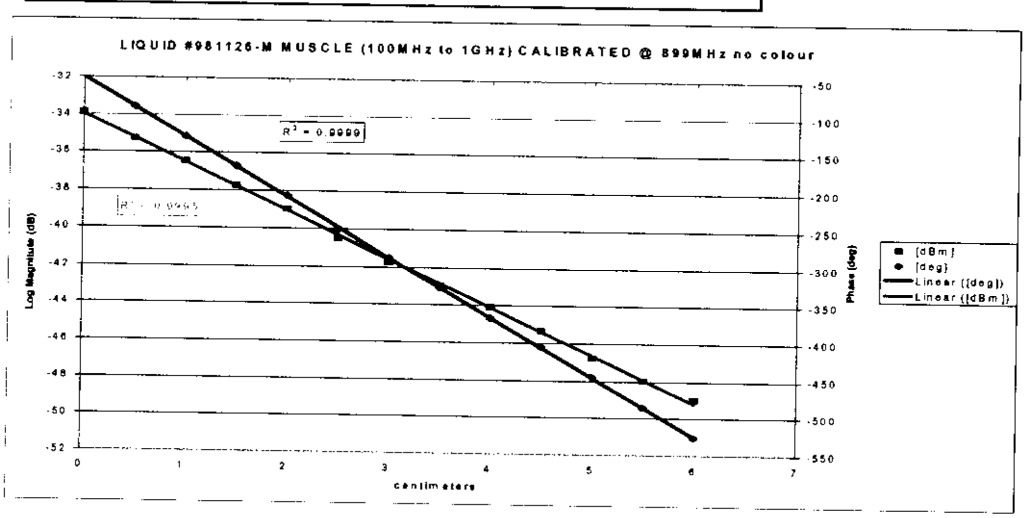
SIMULATION FLUID #	981126-M no colour
CALIBRATION DATE	7-May-99
CALIBRATED BY	Antonio
Frequency Range	100MHz-1GHz
Frequency Calibrated	899 MHz
Tissue Type	Muscle

Position [cm]	Amplitude [dBm]	Phase [deg]	Phase [deg]
0	-33.85	-48.77	-48.77
0.5	-35.27	-88.95	-88.95
1	-36.47	-128.64	-128.64
1.5	-37.72	-167.95	-167.95
2	-38.96	153.44	-206.56
2.5	-40.49	109.23	-250.77
3	-41.71	73.53	-286.47
3.5	-42.94	33.09	-326.91
4	-44.08	-6.8	-366.8
4.5	-45.31	-44.92	-404.92
5	-46.76	-84.28	-444.28
5.5	-47.95	-125.24	-485.24
6	-48.99	-165.46	-525.46

ΔdB_1	-7.86	Δdeg_1	-237.7
ΔdB_2	-7.67	Δdeg_2	-237.96
ΔdB_3	-7.61	Δdeg_3	-238.16
ΔdB_4	-7.59	Δdeg_4	-236.97
ΔdB_5	-7.8	Δdeg_5	-237.72
ΔdB_6	-7.46	Δdeg_6	-234.47
ΔdB_7	-7.28	Δdeg_7	-238.99
ΔdB_{AVG} [dB]	-7.61	$Ddeg_{AVG}$ [deg]	-237.4242857
dB_{AVG} (α_{AVG}) [dB/cm]	-2.54	deg_{AVG} (β_{AVG}) [deg/cm]	-79.14142857
(α_{AVG}) [NP/cm]	-0.292044543	(β_{AVG}) [rad/cm]	-1.381278503

f [Hz]	8.99E+08
μ [H/cm]	1.25664E-08
ε_o [F/cm]	8.854E-14

ε_r	51.3	
$\sigma_{effective}$	1.14	S/m



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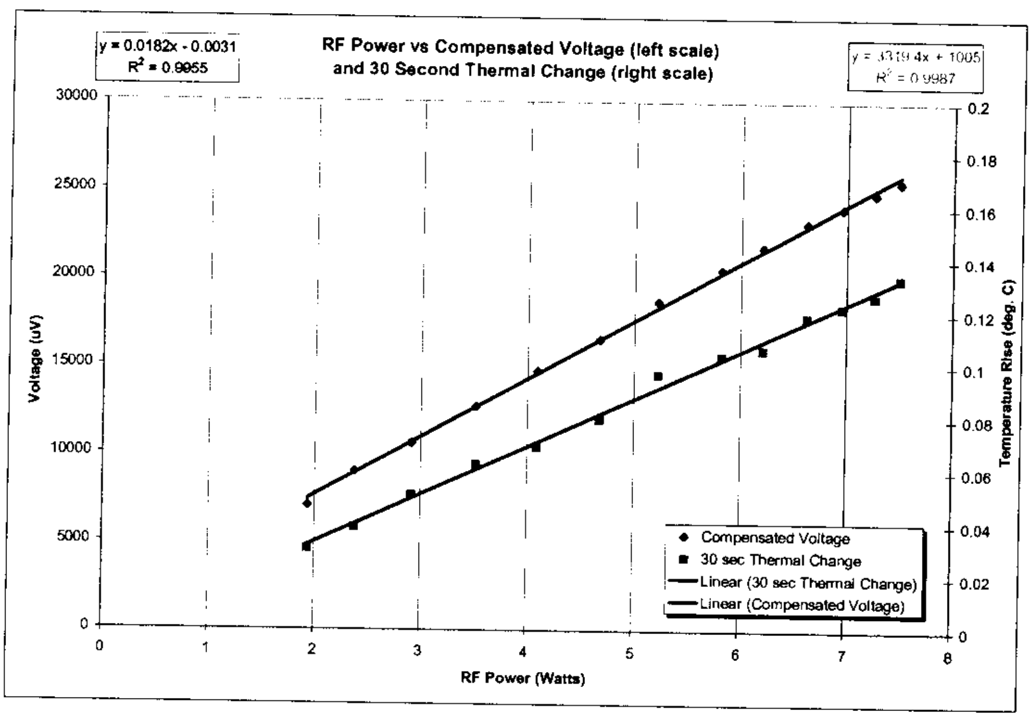
RF Power			Ch0	Ch1	Ch2	(30 sec)	V/Ei		SAR
W	dBm	R&S	uV	uV	uV	deg. C			W/kg
1.936422	32.87	[redacted]					7042.46		2.84
2.37684	33.76	[redacted]					8981.27		3.59
2.910717	34.64	[redacted]					10610.6		4.74
3.515604	35.46	[redacted]					12680.9		5.81
4.092607	36.12	[redacted]					14749.8		6.43
4.677351	36.7	[redacted]					16547.1		7.40
5.223962	37.18	[redacted]					18689.3		8.98
5.821032	37.65	[redacted]					20493.6		9.62
6.20869	37.93	[redacted]					21804.1		9.84
6.622165	38.21	[redacted]					23179.7		11.01
6.950243	38.42	[redacted]					24006.7		11.32
7.26106	38.61	[redacted]					24845.9		11.71
7.498942	38.75	[redacted]					25514.5		12.36

Directional Coupler factor 25.35 dB (Asset 100251 cal file data (Janusz, 21 Jul 96))
Additional inline attenuation 20 dB

Sensitivity (e) 0.693 0.747 0.715 - Sensor Sensitivity in mV/ (mW/cm^2): 899 MHz cal (AU + HW, 1 Sep 98)
η = 1.50 e 1.0395 1.1205 1.0725

Density	1.3	g/cm^3	1300	kg/m^3	- Marcin, summer 97	
Conductivity	11.8	mS/cm	1.18	S/m	- Heike 19-Apr-99	
Heat Capacity (c)	2.775	J/C/g	2775	J/C/kg	- average of Balzano (2.7) and Kuster (2.85) values	
Exposure Time	30	seconds	30	seconds		
Slope of Measure Voltage (m_V)	3319.43	uV/W	0.00332	V/W		
- standard error or m_V	34.6847	uV/W	3.5E-05	V/W		1.0%
Slope of Measure Temp Change (m_T)	0.01831	C/W	0.01831	C/W		
- standard error or m_T	0.00066	C/W	0.00066	C/W		3.6%

Tissue Conversion Factor (γ) 6.3



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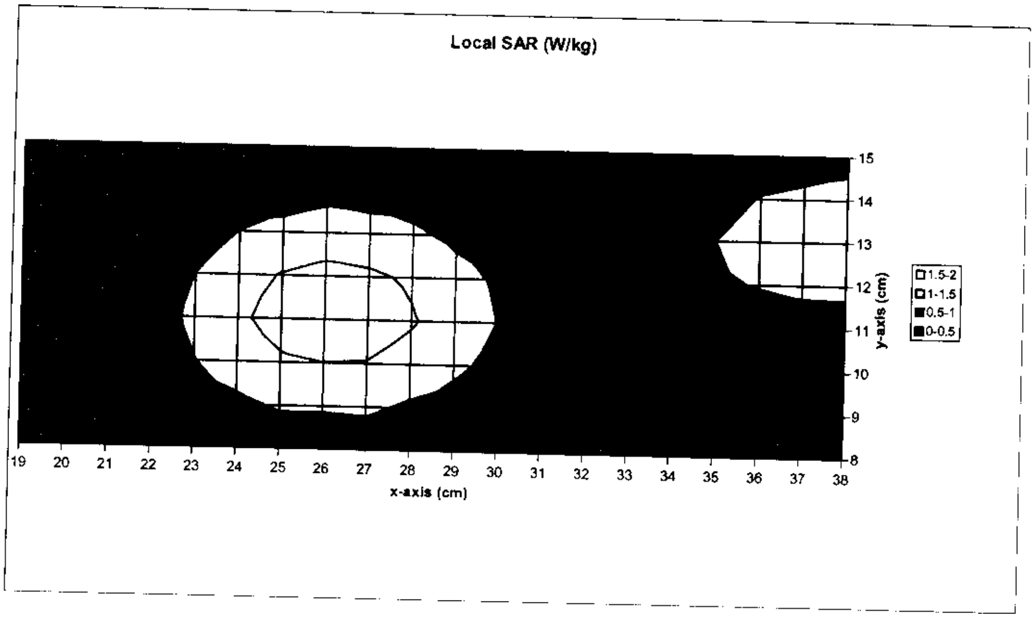
APPENDIX E

Validation Scans



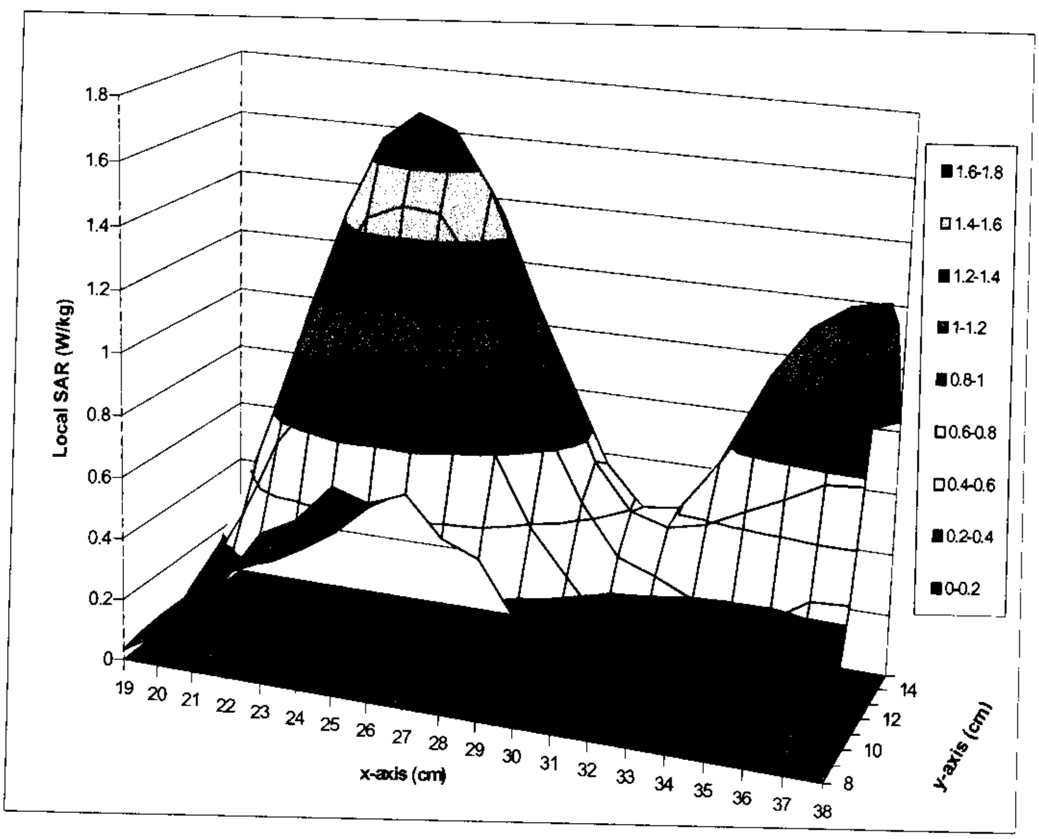


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EXHIBIT TWO

PHANTOM DESIGN REQUIREMENTS

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Spectrum Sciences Institute
RF Dosimetry Research Board

Attention: all comments, suggestions, and inquiries should be addressed to
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Phantom Design Requirements

SSI/DRB-TP-D01-031

PART of SAR Measurements Requirements

SSI/DRB-TP-D01-030

DRAFT

Prepared jointly with:

APREL

Near Field Measurements Laboratory

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- NOTICE -

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TABLE OF CONTENTS

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1.0 INTRODUCTION

1.1 Purpose and Scope of the Standard

The purpose of this document is to standardize the phantom(s) required for Specific Absorption Rate (SAR) testing associated with SAR measuring systems. This document defines the parts and dimensions of the phantom, in accordance with industry standards and practices.

This Standard defines:

- the methodology and procedures used to define a reproducible representation of the human head, hand and arm
- the dimensions on the canonical shapes used, and the materials required
- the hardware required and the proper setup

This Standard is part of a Certification Program Methodology as described in a separate document entitled "SSI/DBR TP-D01-030, Specific Absorption Rate (SAR) Standard For Portable Telecommunications Devices, March 1998". SSI/DBR TP-D01-031 contains specific criteria that must be met for SAR certification.

1.2 Test Facilities

All calibration work as described in this Standard shall be performed at an ISO/IEC Guide 25 accredited laboratory.

1.3 Test Personnel

Personnel performing the calibration will be experienced in relevant measurements (e.g. physical properties or RF characteristics) and supervised by a person proficient in SAR measurements.

1.4 Standard Environmental Conditions

All measurements and calibration should be performed under normal laboratory conditions for physical properties and electrical characteristics as stipulated by ISO/IEC Guide 25. The nominal temperature for physical property measurements and for electrical characterization are 20°C and 23°C, respectively.

2.0 BACKGROUND

Portable communication devices used by consumers typically operate over the range of several watts to a milliwatt, or less, using either analog or digital modulation techniques. Most portable telephones have antennas that radiate within a few centimeters of the user's head. The field strength and field distribution near the antenna are highly dependent on the location, orientation and electromagnetic characteristics of adjacent objects. The head and hand are normally in the reactive near-field region of the antenna where the electromagnetic field is non-propagating. The energy absorbed in the head and hand is mainly due to electric fields induced by the magnetic fields generated by currents flowing through the feedpoint, along the antenna and body of the portable device. The RF energy is scattered and attenuated as it propagates through the tissues of the head, and maximum energy absorption is expected in the more absorptive high water-content tissues near the surface of the head or hand. To account for near-field effects portable devices are evaluated with realistic head models called a phantom.

A phantom is a device that simulates the size, contours, and electrical characteristics of human tissue at normal body temperature. It is composed of a manikin (solid shell) and a tissue-equivalent synthetic material solution (see SSI/DRB-TP-D01-033).

The solid manikin shell is made of a dielectric material, which is transparent to RF energy (i.e. has very low RF absorption), and is as thin as possible while maintaining the strength necessary to hold the mass of simulated tissue.

Current phantoms in use are:

- Universal Head-arm (UniHead) Phantom for ear independent evaluation of the RF exposure in the head of users by telephone-type devices, as well as RF exposure in the head of users of hand held radios positioned in front of the face, and in the hand of users of hand held portable devices

- Flat Phantom for evaluating the RF exposure of other parts of the user body by wireless devices that are not normally used in the vicinity of the head and cannot be accommodated by the UniHead, as well as for experimental investigations. (Such devices would include wireless LAN PCMCIA cards installed in laptop personal computers)

- Insulated Flat Phantom used for the determination of the enhancement factor of synthetic tissue in the calibration of the miniature isotropic electric field (E-field) probes

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3.0 REFERENCES

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4.0 DEFINITIONS

manikin: an RF transparent shell for the phantom
phantom: a device that simulates the size, contours, and electrical characteristics of human tissue

5.0 PHANTOMS

5.1 Universal Head-Arm (UniHead) Phantom

IEC 60959 (TR0 Ed.1.0, 1989, Provisional Head and Torso Simulator for Acoustic Measurements of Air Conduction Hearing Aids) tabulates standard ergonomic data for the human head and torso. A manikin generated from these measurements represents the 95 th percentile of the population.

5.1.1 Head Simulator

The principle dimensions of the head and torso simulator are shown in Figures 5.1 and 5.2 are listed in Table 5.1.

Table 5.1

A	HEAD BREADTH	152 mm
B	HEAD HEIGHT	141 mm
C	BITRAGION DIAMETER	110 mm
D	NECK DIAMETER	103 mm
E	SHOULDER BREADTH	440 mm
F	CHEST BREADTH	279 mm
G	HEAD LENGTH	199 mm
H	TRAGION TO WALL	97 mm
I	CHIN-VERTEX LENGTH	243 mm
J	TRAGION TO SHOULDER	165 mm
K	SHOULDER DEPTH	116 mm
L	CHEST DEPTH	225 mm
M	SHOULDER POSITION	125 mm

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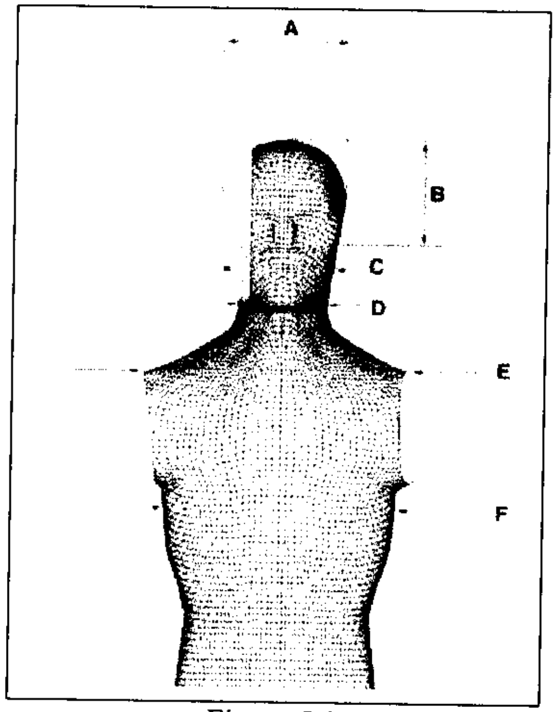

Figure 5.1

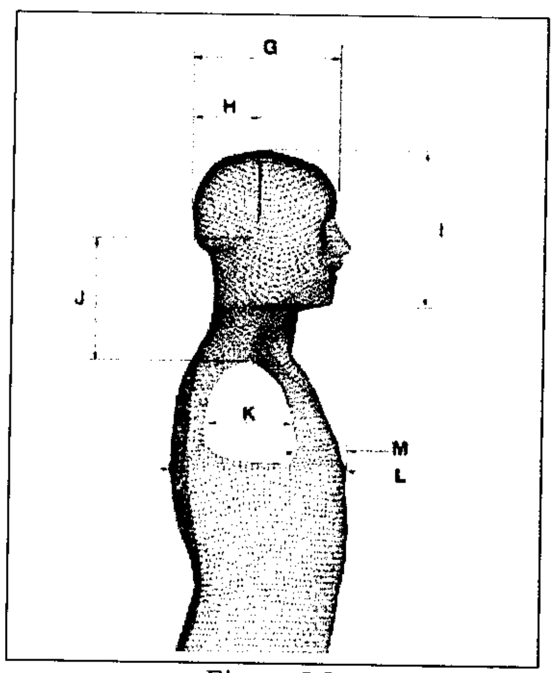

Figure 5.2

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An engineering approximation for a human head simulator can be made from this ergonomic data using basic canonical shapes. If we define one cylinder with the diameter of the head's breadth (A) and a second with the diameter of the chin's diameter (C) and join the two cylinder with a plane tangent to both cylinders and with a contact separation of (I – (A+C)/2) we have the basic shape of the head simulator shown in Figure 5.3. This plane defines the "cheek" of the head simulator. The width of the head simulator can be defined by the length of the head (G).

The head simulator is therefore defined by two quarter cylinders, the plane joining these two sections, for an overall length of 243 mm, and limited to a width of 199 mm.

Figure 5.4 shows an alignment aid for positioning a portable communication device. This applique is defined by the positions of the ears and the eyes within the head. By recognizing that both ears are in the center of their respective sides of the head and that the tip of the pinna of the compressed ear coincides with the beginning of the roll-off of the skull cylinder section, we can define a symmetric, ear independent, reference point at (0,0). This is the tip of the composite pinna. Furthermore, the two shaded spots at (0 ,-7 cm) and (0,+7 cm) correspond to the positions of the humans eyes relative to the ears.

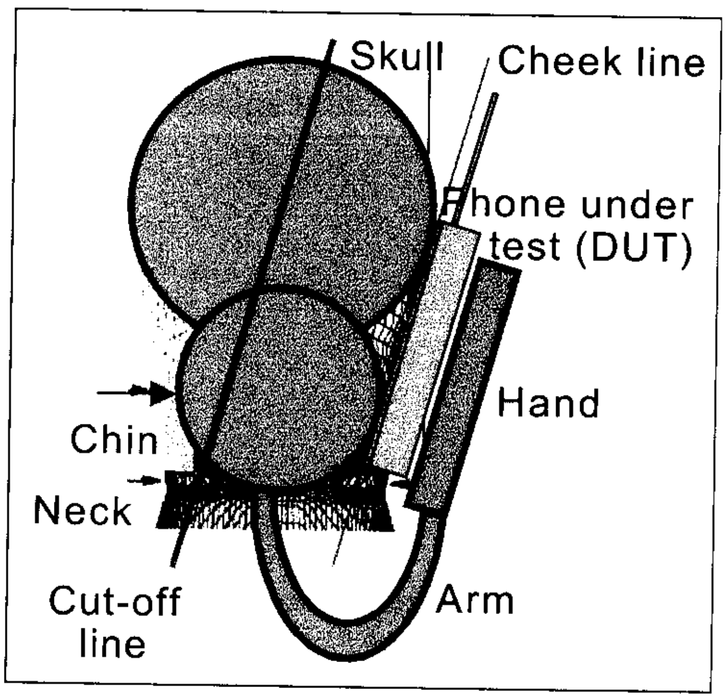

Figure 5.3

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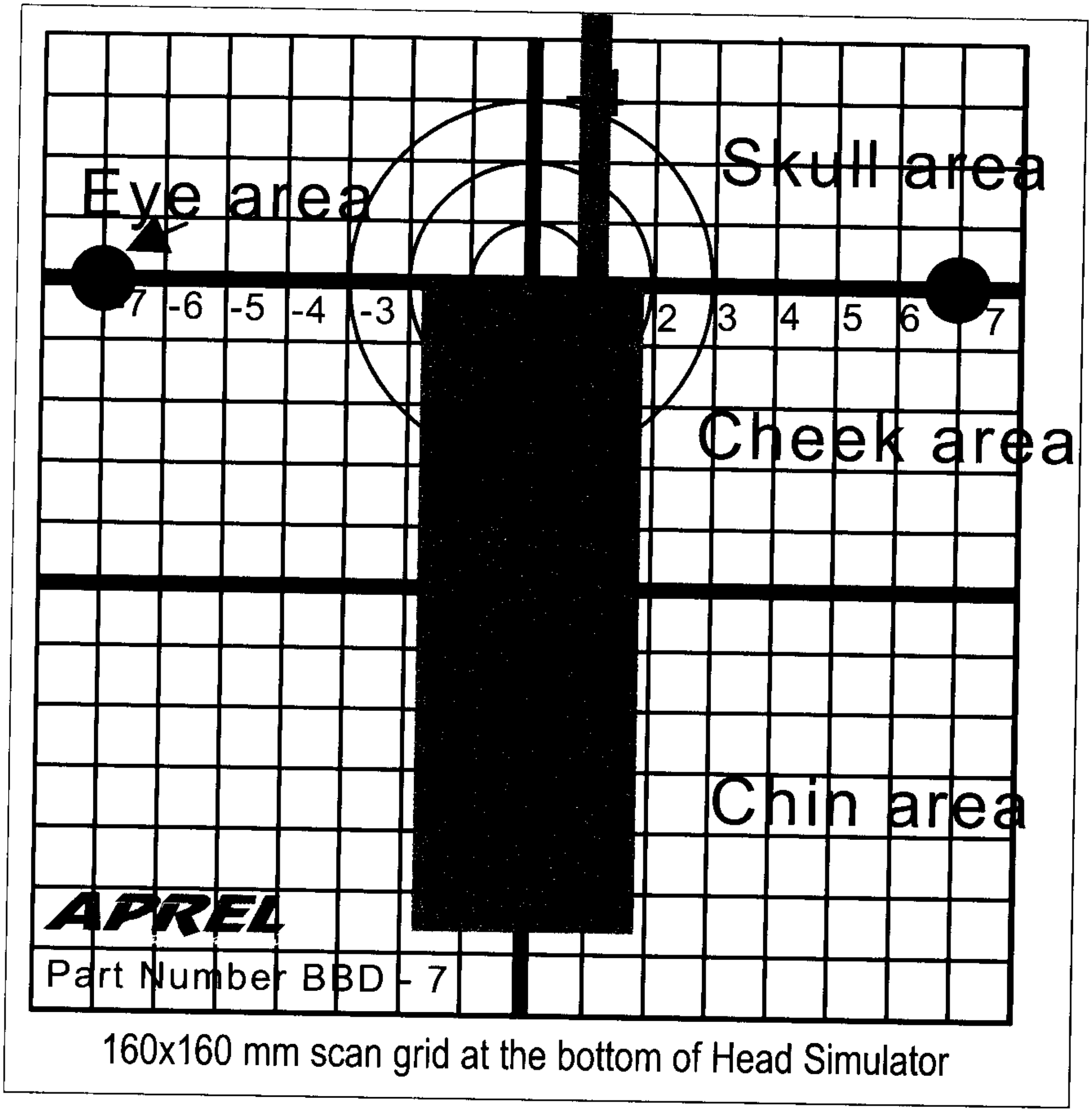

Figure 5.4

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5.1.2 Arm and Hand Simulator

The principal dimensions of the arm and hand are listed in Table 5.2. The hand is represented with a parallelepipedic volume having the dimensions 36x90x110mm. The hand simulator is attached to the head simulator by means of a flexible arm that is attached to a valved nipple. This can provide a continuous conducting link between the liquid in the head where the measurements are taking place and the hand where the handset is being held. Alternatively, with the valve shut, muscle simulating synthetic tissue can be placed in the hand and arm simulator, at the expense of the continuous conducting link.

Table 5.2

	SHOULDER –ELBOW LENGTH	365 mm
	FOREARM-HAND LENGTH	440 mm
	HAND THICKNESS	36 mm
	HAND LENGTH	200 mm
	HAND BREADTH AT THUMB	112 mm
	HAND BREADTH AT METACARPAL	90 mm

Figure 5.5 shows an alignment aid for positioning a portable communication device. This applique is symmetric with respect to the center of the hand simulator. The upper surface of the hand simulator is longer than the defined parallelepipedic volume in order for a dielectric alignment pin to be screwed in to act as a stop for positioning the phone on the hand. In addition, the upper surface is also wider to allow notches to be placed on either side to which an elastic restraint can be attached to hold the portable device in place.

5.1.3 Materials

The materials used for the fabrication of the Universal Head–arm (UH-a) are non-metallic. The support platform and base are constructed of laminated wood for easy cleaning (see Figure 5.6 and Table 5.3). The vertical guides are constructed of hard wood giving precision of vertical movement to the measuring gauge and the hand guide. The head- and hand-simulating volumes are made of Plexiglas. The head simulation has the top edge raised above the platform for easy wrapping and removal for storage when containing tissue-simulating liquid. This allows a substitution of phantoms representing different frequencies. Tissue-simulating liquid contained in the hand volume is connected to tissue simulating liquid contained in the head volume by a flexible arm that can be detached for cleaning and storage. The Plexiglas volume of head is formed and terminally stabilized to its exact characteristics. Plexiglas does not include additives for reinforcement. The manufacturing process for the Universal Head-arm allows precise duplication of

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geometrical and dielectric properties of the setup. Bonding with adhesives and solvents is used. Nylon screws are used to secure some elements. Clear gloss materials and appropriate grids allow verification of proper location and function of the phone under test.

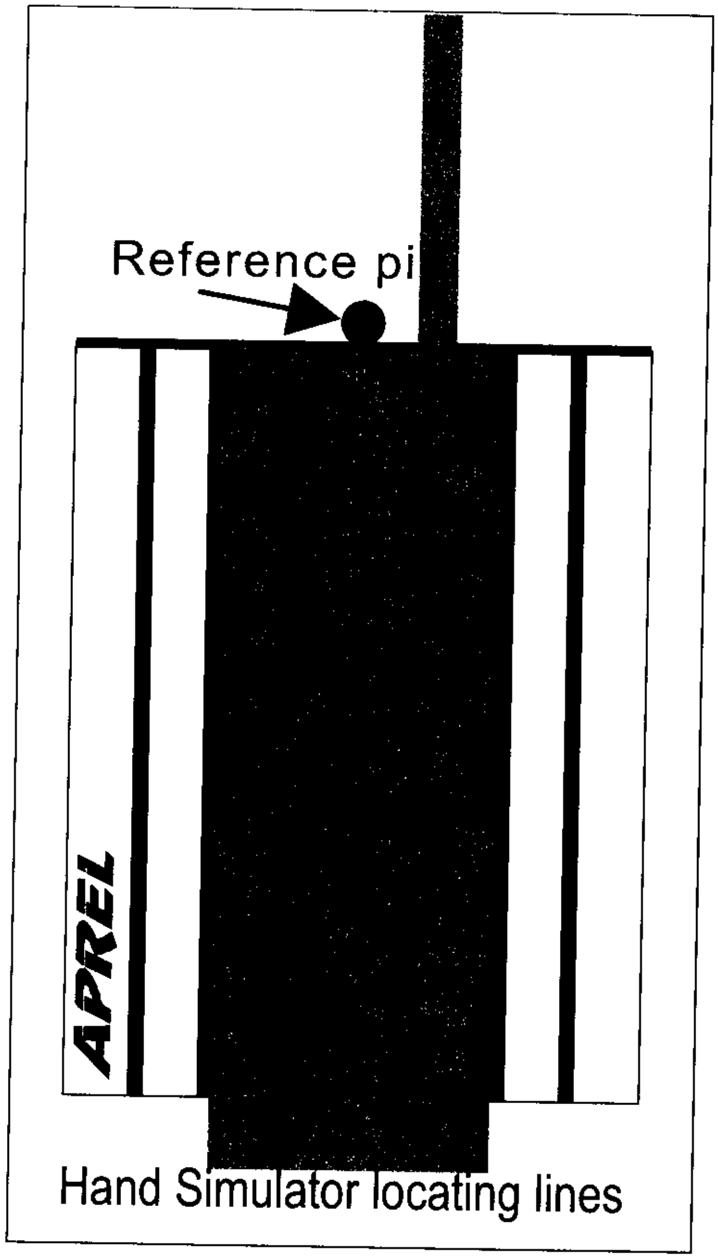

Figure 5.5

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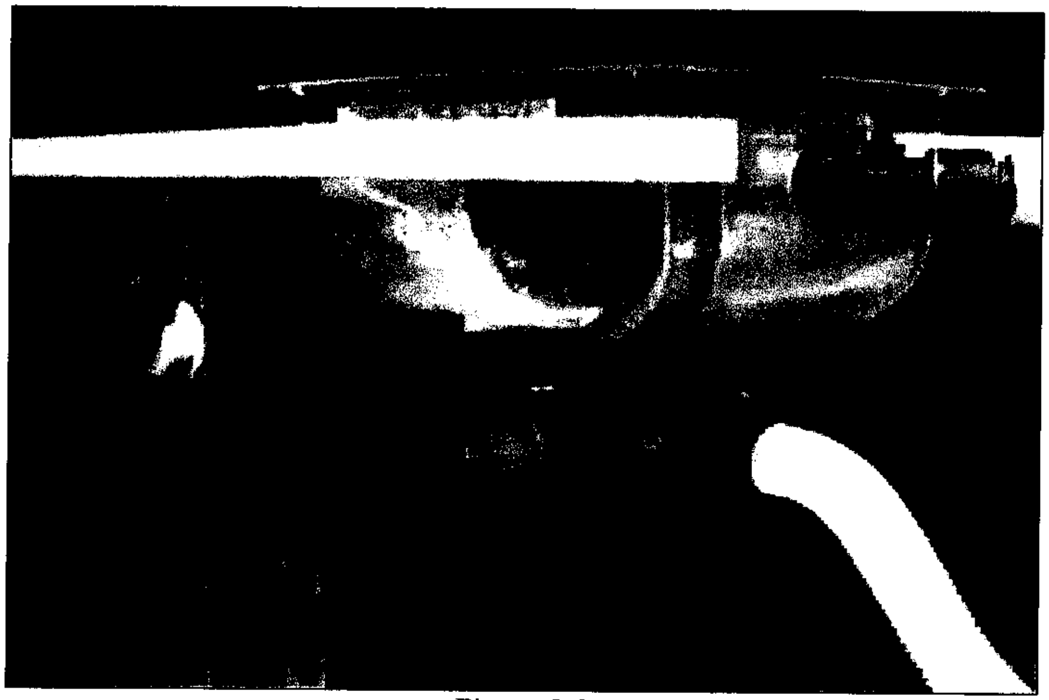

Figure 5.6

Table 5.3

Specifications	
Model	UH-1
Frequency	tissue dependant
Head cut-off section	190 mm x 240 mm
Hand surface	95 mm x 115 mm
Basic scan area	160 mm x 160 mm
Hand position	self-locking
Head-arm-hand connections	fast release type
Dimensions	
-height	410 mm
-length	580 mm
-width	500 mm
Weight	approx. 12 kg

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5.2 Flat Phantom

An acrylic flat phantom with a parallelepipedic volume of 47mm x 14mm x 7mm is used for evaluating the RF exposure of other parts of the user body by wireless devices that are not normally used in the vicinity of the head and cannot be accommodated by the UniHead. (Such devices would include wireless LAN PCMCIA cards installed in laptop personal computers). It can also be suitable for experiment where a larger flat surface is desired that is provided by the UniHead phantom.

Insulated Flat Phantom

A styrofoam flat phantom with a parallelepipedic volume of 32mm x 21mm x 18 mm is used for the determination of the enhancement factor of synthetic tissue in the calibration of the miniature isotropic electric field (E-field) probes.

6.0 SAR LABORATORY SETUP

The phantom is typically setup in relation to the other SAR measurement system equipment as shown in Figure 6.1. The major pieces of equipment for this setup are shown in the Table 6.1.
The articulated robot arm is usually located at one edge or corner of the laboratory space, situated in an RF anaechoically damped area. The miniature isotropic E-field probe is attached to the end of the robot arm by means of a dielectric holder which serves the purpose of displacing the probe from the metal of the robot arm that could perturb the RF fields from the portable communication device under test. The phantom is placed in front of the robot arm, on the phantom support fixture, at a distance as far as possible from the robot, but close enough that the E-field probe can explore the entire interior region of the phantom. Again, this is to minimize the perturbations of the RF fields from the portable communication device under test in the vicinity of the robot arm.

The E-field probe is connected to a data acquisition card inside a computer by means of shielded cables. The computer controls the SAR measurement system by controlling the movement of the robot by communicating with its controller, and recording data from the data acquisition card.

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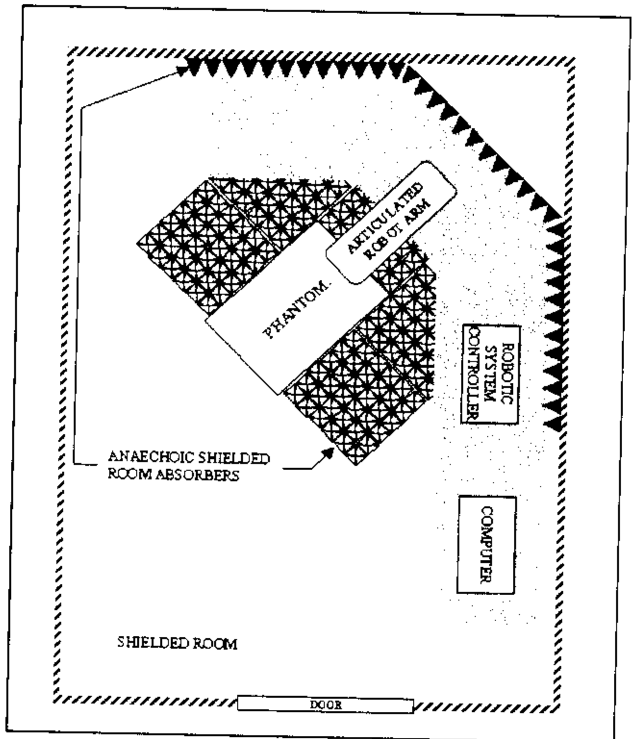

Figure 6.1

Table 6.1

Description	Manufacturer	Model
Articulated Robot Arm	CRS Robotics	A255
Robotic System Controller	CRS Robotics	C500
Phantom	APREL	various
Phantom support fixture	APREL	various
Synthetic Tissue Mixture	APREL	SSI/DRB-TP-D01-033
Miniature E-field probe	Narda	8021B
Probe support fixture	APREL	N/A
Computer	Northern Micro	Pentium 75
Software	Microsoft	Office 97 Pro
Software	APREL	SAR Measurement
Data acquisition card	ComputerBoards	CIO-DAS08-PGH
Miscellaneous Cables	N/A	N/A

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7.0 TEST CONFIGURATIONS USING THE UNI-HEAD

The Universal Head (Uni-Head) had been originally designed by APREL Laboratories for studies of antenna structures and for optimization of radiating characteristics of handsets. In addition of being a design tool, the Uni-Head may be used for most of measurements required in dosimetry. The figure 7.1 below illustrates some typical scenarios using the Uni-head for various devices under test (DUT).

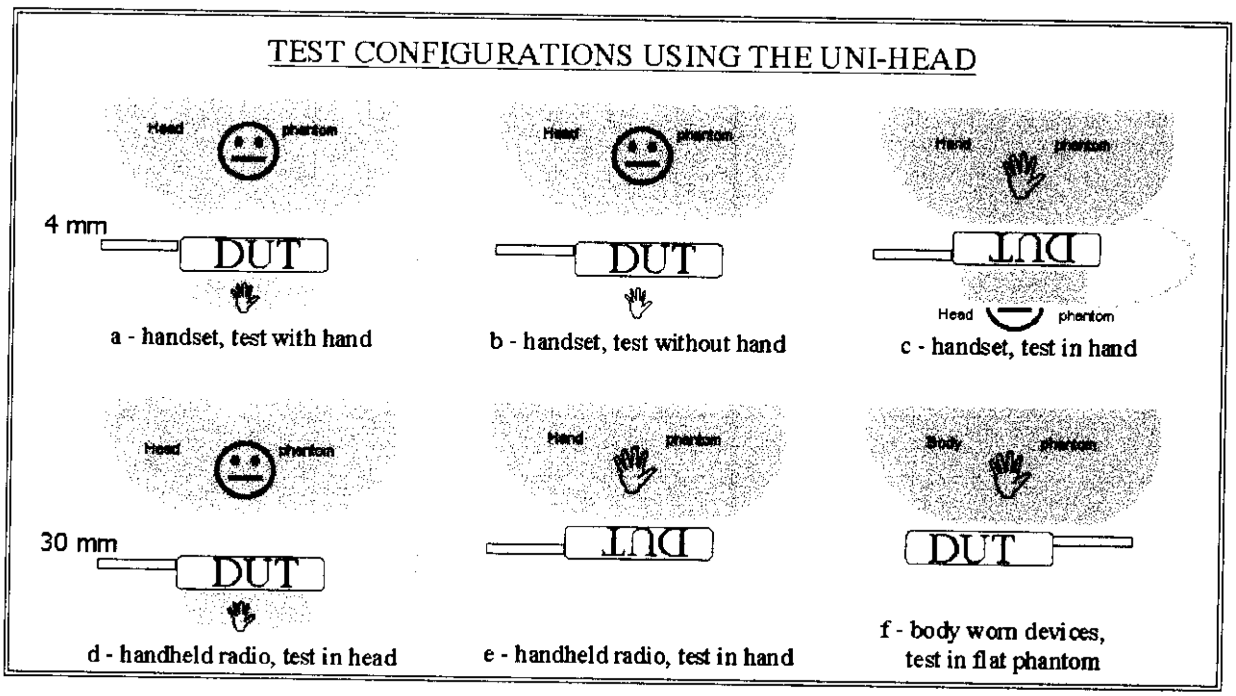

Figure 7.1 (not to scale)

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