APREL Laboratories

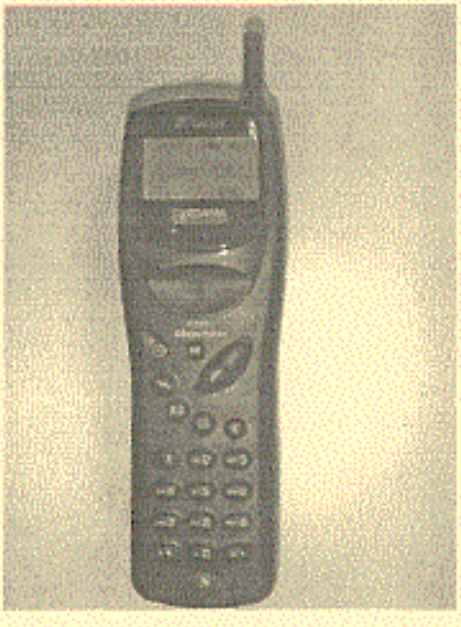
Certification Report on

Specific Absorption Rate (SAR)
Experimental Analysis

TUV PRODUCT SERVICE

TELITAL GSM/Globalstar Handportable Unit SAT550

Date: 04 June, 1999



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CERTIFICATION REPORT

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

Product: TELITAL GSM/Globalstar Handportable Unit (Model SAT550)

Client: TUV Product Service Limited

Address: Segensworth Road Fareham
Hampshire
United Kingdom PO15 5RH

Telecommunications Approval Board - Spectrum Sciences Institute
SAR Certified
APREL Laboratories
A961-SAT550

Project #: TUVB-SAT550-3216

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

Submitted by Paul G Cardinal Date: 14 June 99
Dr. Paul G. Cardinal
Director, Laboratories

Approved by Date: 14/6/99
Dr. Jacek J. Wojcik, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
J. J. Wojcik
PROVINCE OF ONTARIO

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FCC ID:
Applicant: TELITAL S.p.A.
Equipment: GSM/Globalstar handportable unit
Model: SAT550
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 a Telital SAT550 GSM/Globalstar handportable unit. The measurements were carried out in accordance with FCC 96-326. The GSM/Globalstar handportable unit was evaluated for its maximum power level of 26 dBm (398 mW) peak.

The SAT550 was tested at high, middle, and low frequencies, with the maximum SAR coinciding with the peak performance RF output power of channel rf 63 250 (middle, 1618.11 MHz). Test data and graphs are presented in this report.

Based on the test results, it is certified that the product meets the requirements as set forth in the above specifications, for uncontrolled RF exposure environment.

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1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) of a sample of a Telital SAT550 GSM/Globalstar handportable unit. 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

- Telital SAT550 GMPCS Terminal, GSM/Globalstar handportable unit, s/n IMEI: 004400160140941
- TUV Test Jig
- Manufacturer software and Toshiba Laptop Computer (to control the channels)

The dual band product can operate in the European GSM band as well as in the Globalstar band.

The antenna is a 4dB gain helical telescope antenna optimized for the 1584-1664 MHz band. It is located on the left-hand side of the top of the handset, and positioned about 4cm from the surface in contact with the head.

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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
- APREL UH-1, Universal Head-Arm, s/n 001, Asset # 301376
- 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 GSM/Globalstar handportable unit 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 form 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 measurement).
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 GSM/Globalstar handportable unit is positioned in a normal usage position.
7. All tests were performed with the highest power available from the sample GSM/Globalstar handportable unit, 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 manufacture's supplied test software did not permit the GSM/Globalstar handportable unit to transmit with a battery. The SAR scans were performed with a 12 Volt power supply and manufacture test jig constantly attached to the handset via manufacture supplied cables. The setup of the unit, including channel and power level, were controlled from the supplied Toshiba laptop computer and installed test software.

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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 Telital SAT550 GSM/Globalstar handportable unit was put into test mode for the SAR measurements using a laptop computer and software to control the channel.

3) Figure 3 in Appendix A shows a contour plot of the SAR measurements for the Telital SAT550 GSM/Globalstar handportable unit sample operating on the middle channel. The presented values were taken 2.5 mm into the simulated tissue from the Universal Head-Arm's (UH-a) solid inner surface. Figure 1 and 2 in Appendix A show the UH-as used in the measurements, with its arm (empty) in position to hold the GSM/Globalstar handportable unit against the composite ear. The top of the acoustic cavity of the phone is aligned with the top of the composite pinna of the UH-a. A grid is shown inside of the UH-a indicating the orientation of the x-y grid used, with the origin (0,0) at the top of the pinna. The beginning position of the scan was (12,4). The x-axis is positive towards the left and the y-axis is positive towards the bottom.

   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. These measurements are presented as a contour plot in Appendix A Figure 5 and surface plot in Figure 6.

   Figure 7 in Appendix A shows an overlay of the GSM/Globalstar handportable unit's outline, superimposed onto the contour plot. The rest of the testing was centred around the point with the highest SAR as can be seen in Figures 3-6.

   Figures 3 through 6 in Appendix A show that there is a dominant peak, in the contour plots, that diminishes in magnitude with depth into the tissue simulation.

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4) Wide area scans were also performed for the low (rf 3 4) and high (rf 123 496) channels. The peak single point SAR for the scans were:

Channel	Frequency [MHz]	Channel #	Highest SAR [W/kg]			
			Antenna			
			in	out	tilt right	tilt left
Low	1610.73	Rf 3 4	0.411	0.083	0.023	0.021
Middle	1618.11	Rf 63 250	0.560	0.073	0.012	0.085
High	1625.49	Rf 123 496	0.385	0.081	0.029	0.085

5) The middle channel (rf 63 250) (with antenna in) SAR peak was then explored on a refined 0.5 mm grid in three dimensions. Figures 9, 10, and 11 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 0.403 W/kg.

6) 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 8 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 (-0.0769 ± 0.0025 / 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 0.836 W/kg.

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7. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) averaged over 1 g, determined at 1618.11 MHz (channel rf 63 250, middle), of theTelital SAT550 GSM/Globalstar handportable unit, is 0.836 W/kg. The overall margin of uncertainty for this measurement is ± 13.5%. The SAR limit given in the FCC 96-326 safety guideline is 1.6 W/kg. This unit as tested is found to be compliant with this requirement.

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APPENDIX A

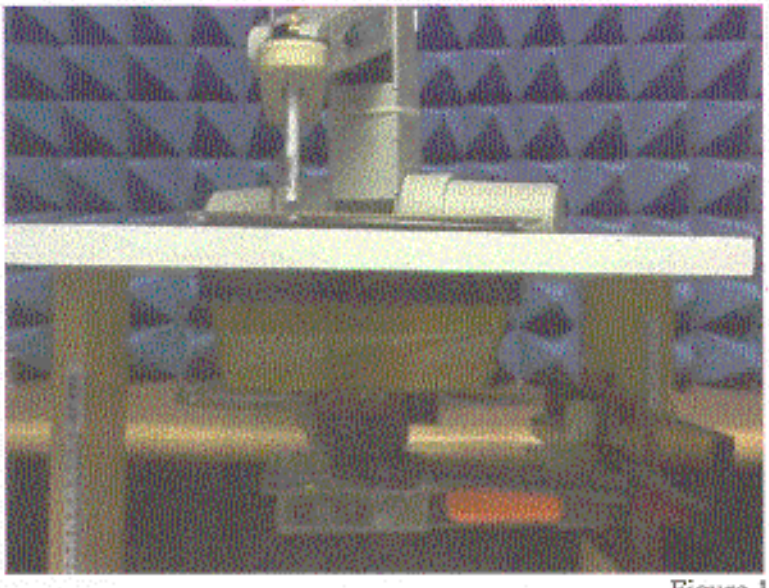

Figure 1

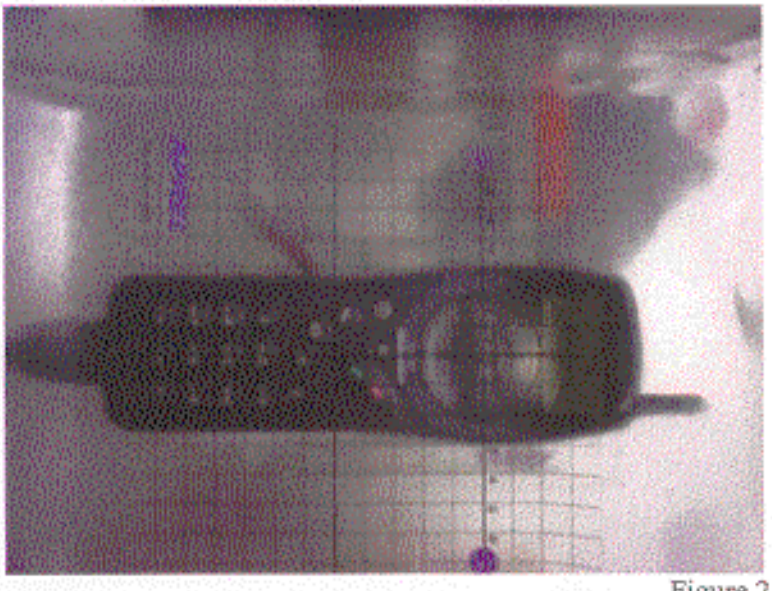

Figure 2

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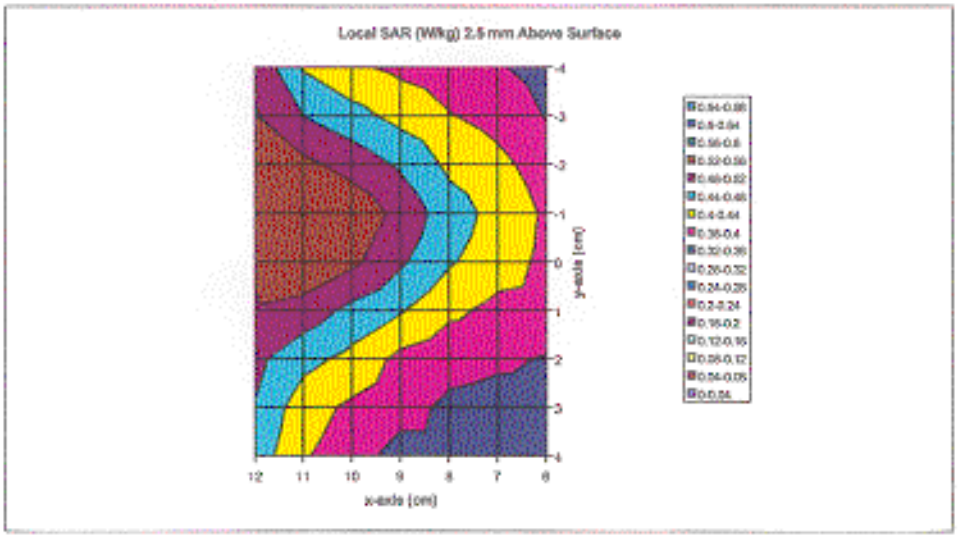

Figure 3

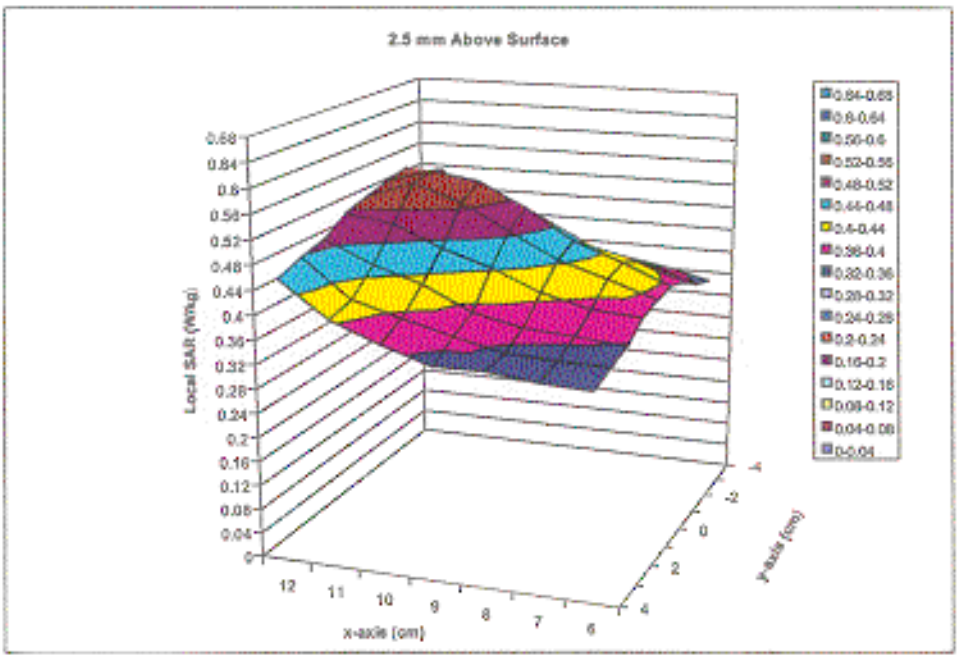

Figure 4

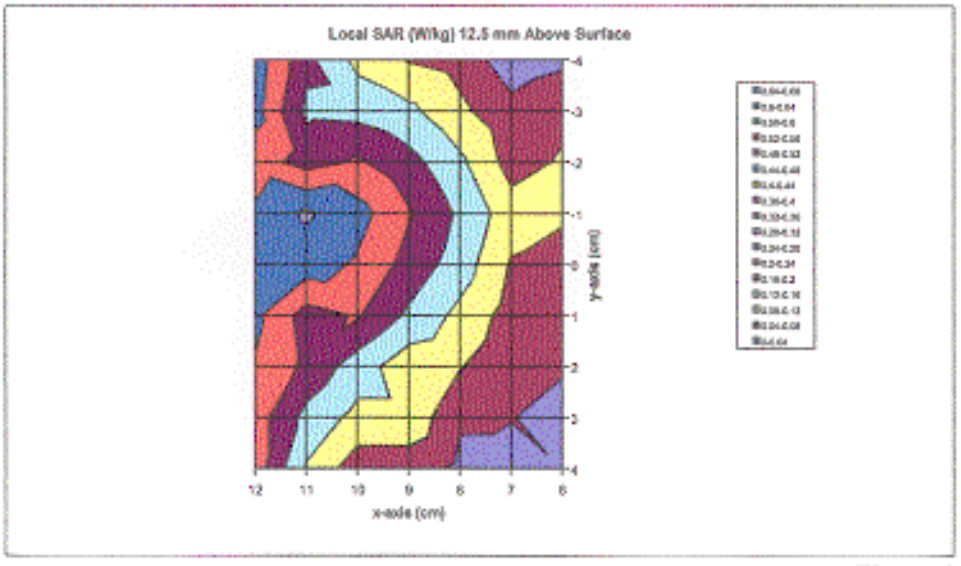

Figure 5

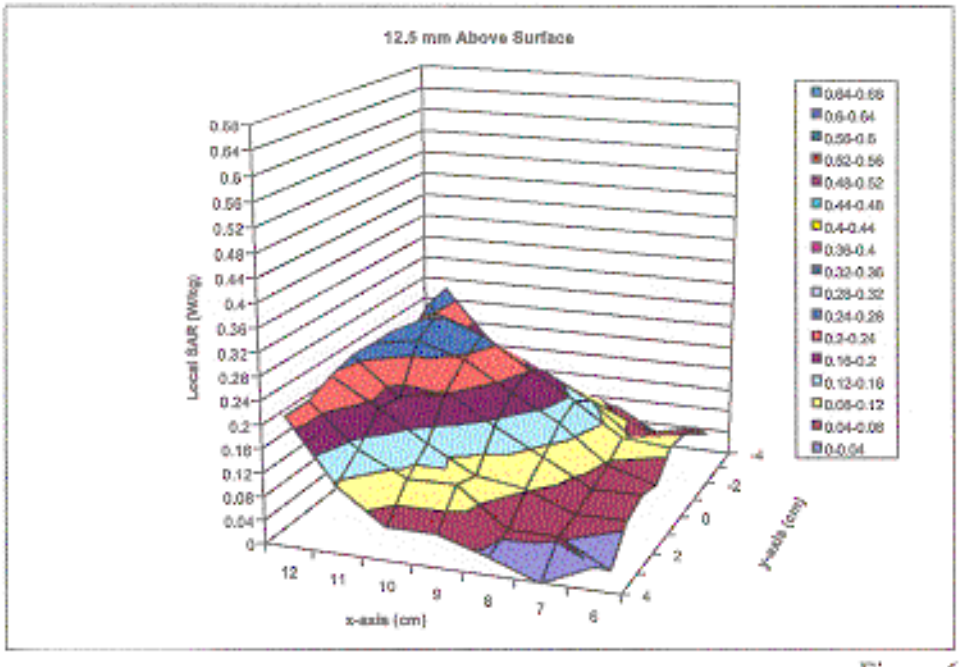

Figure 6

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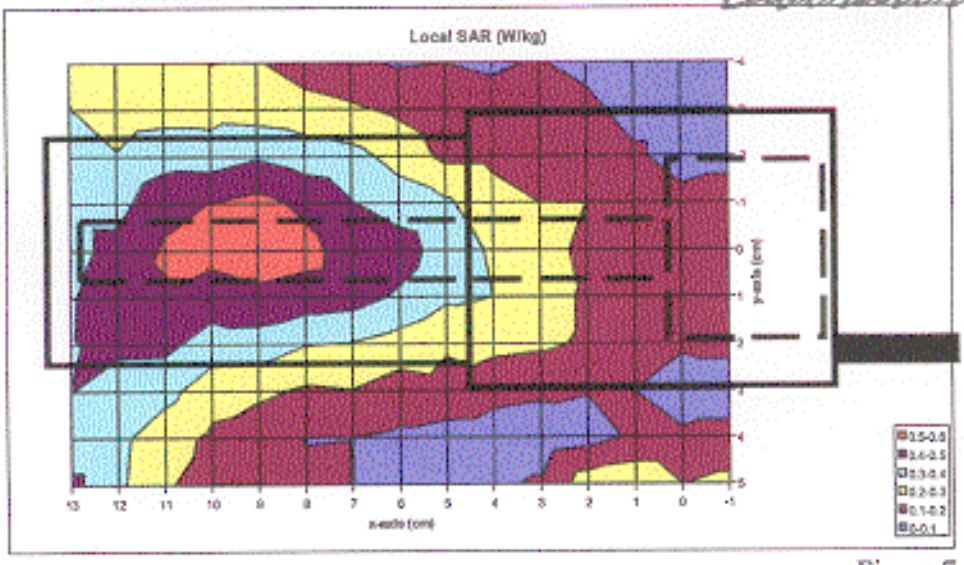

Figure 7

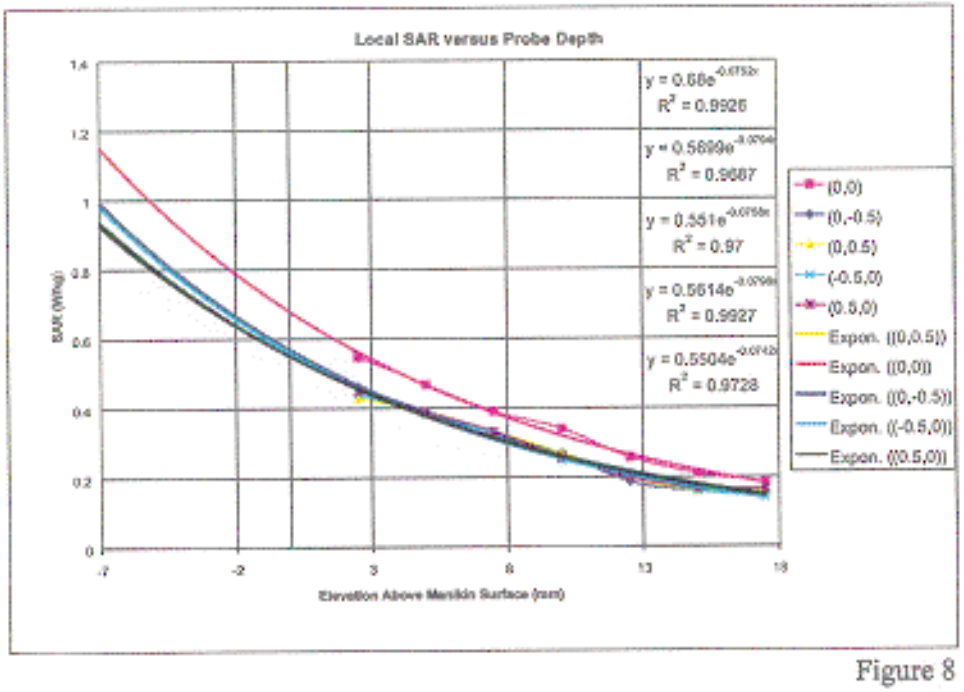

Figure 8

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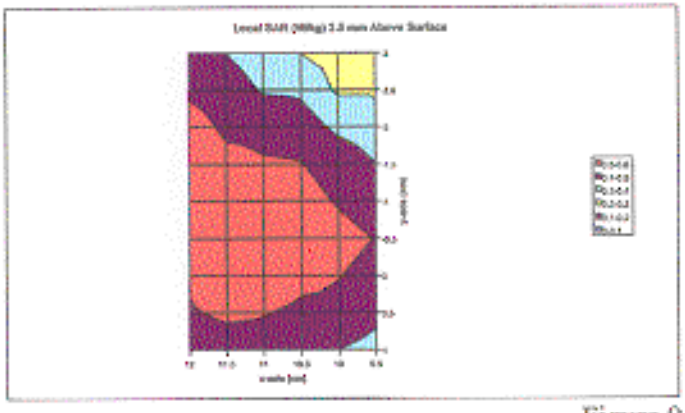

Figure 9

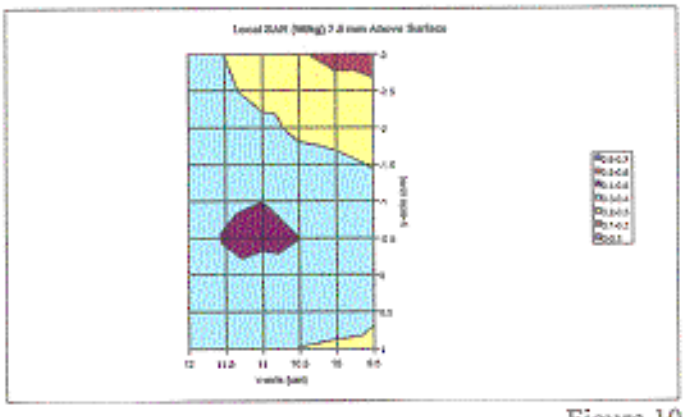

Figure 10

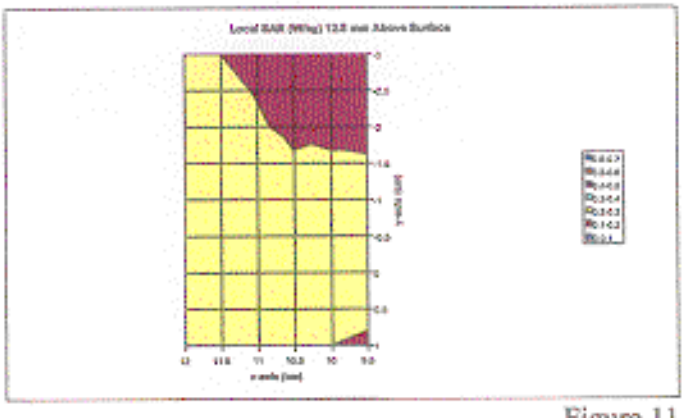

Figure 11

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APPENDIX B

Manufacturer's Antenna Specifications

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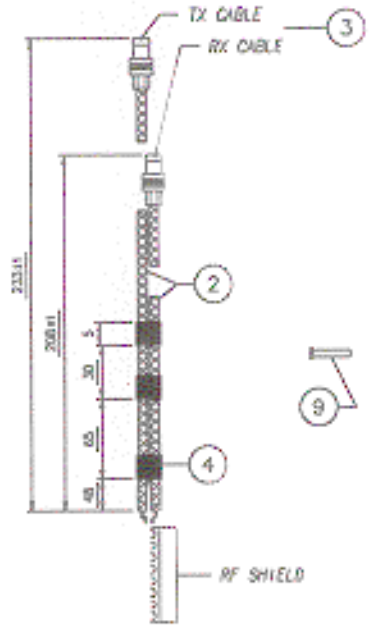

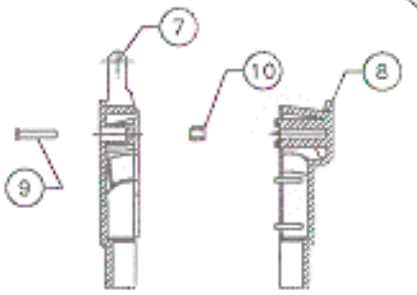

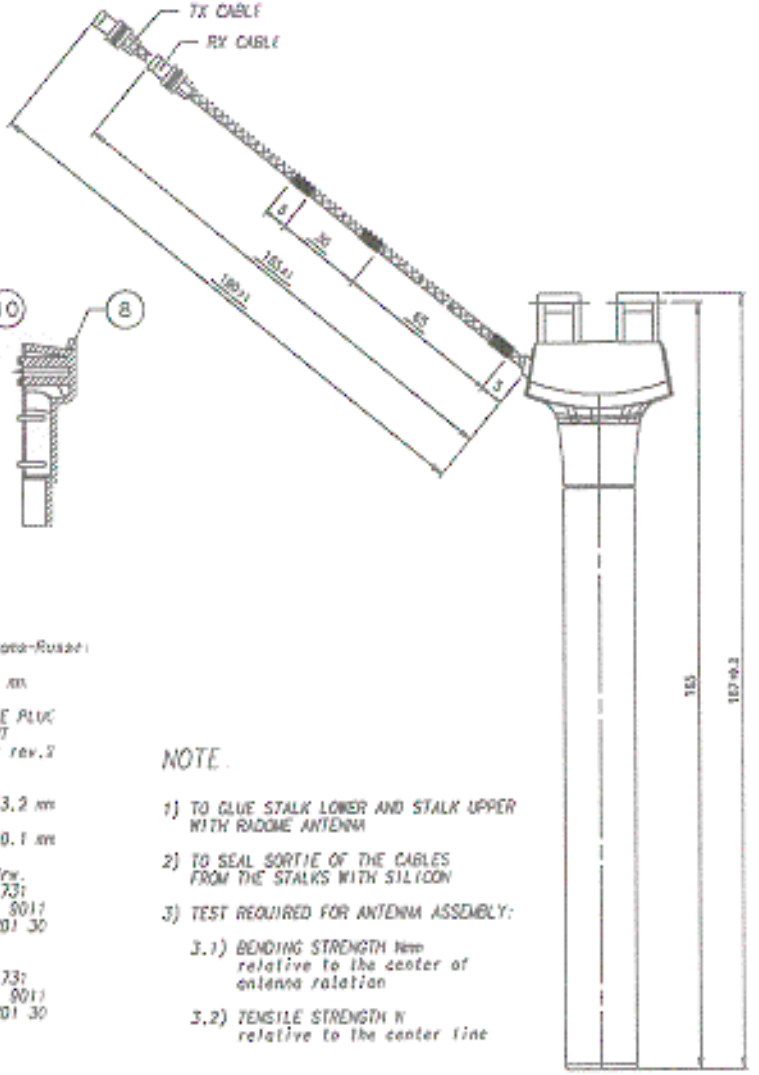

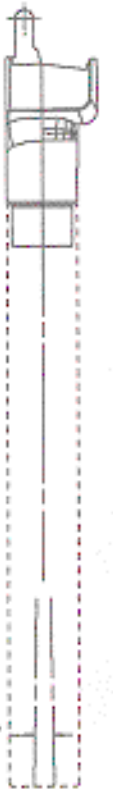

Supplier TELE:

1) ANTENNA

2) COAXIAL CABLE Adams-Russel type FT-086F outer diameter 2 mm

3) OSX STRAIGT CABLE PLUG CRIMP ATTACHEMENT drw.5831-5012-09 rev.2

4) THERMOSHRINK inside diameter 3.2 mm max thickness after shrinking 0.1 mm

5) RADOME ANTENNA drw. material: NORYL 731 color: black RAL 9011 surface finish VDI 30

6) CAP RADOME drw. material: NORYL 731 color: black RAL 9011 surface finish VDI 30

Supplier TELITAL

7) STALK LOWER Telital drw. 1gg0100176

8) STALK UPPER Telital drw 1gg0100177

9) SCREW M1.6x8 Telital drw. 1hh0700026tps

10) THREAD INSERT M1.6 Telital drw. 1hh1100022spo

NOTE

1) TO GLUE STALK LOWER AND STALK UPPER WITH RADOME ANTENNA

2) TO SEAL SORTIE OF THE CABLES FROM THE STALKS WITH SILICON

3) TEST REQUIRED FOR ANTENNA ASSEMBLY:

3.1) BENDING STRENGTH Nmm relative to the center of antenna rotation

3.2) TENSILE STRENGTH N relative to the center line

MODIFICA							Valido da:	
DATA								
telital	Scala: 1:1	Materiale:					Foglio 1	N.fogli 1
	Tol.gen.	Annotazioni:					Sostituisce il N. 1439	
Dis.hauser	Verif.	Denominazione dell'oggetto: antenna assembly					CODICE	
Progetto 0080	Data 19/05/99							

APPENDIX C

Uncertainty Budget

Uncertainties Contributing to the Overall Uncertainty

Type of Uncertainty	Specific to	Uncertainty	
Power variation due to battery condition	phone	0.0%	
Extrapolation due to curve fit of SAR vs d	phone	6.6%	
Extrapolation due to depth measurement	setup	3.8%	
Conductivity	setup	6.0%	
Density	setup	2.6%	
Tissue enhancement factor	setup	7.0%	
Voltage measurement	setup	4.5%	
Probe sensitivity factor	setup	3.5%	
		13.5%	RSS

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APPENDIX D

Simulated Tissue Material and Calibration Technique

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

Deionized water	45.3%
Sugar	54.3%
HEC	0.3%
Bactericide	0.1%
Mass density, ρ	1.30g/ml. (The density used to determine SAR from the measurements was the recommended 1.03kg/m^3 found in Appendix C 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	39.63
Conductivity, σ	1.33 S/m
Tissue Conversion Factor, γ	5.6

	APREL	OET 65 Supplement or dielec.exe	Δ/%
Dielectric constant, ε_r	39.63	43.91	-9.7
Conductivity, σ [S/m]	1.33	1.06	+25.5
Tissue Conversion Factor, γ	5.6	-	-

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SIMULATION FLUID #	981125-MB
CALIBRATION DATE	1-Jun-99
CALIBRATED BY	Tony
Frequency Range	1GHz-2.5GHz
Frequency Calibrated	1600 MHz
Tissue Type	MIXED BRAIN

Position [cm]	Amplitude [dBm]	Phase [deg]
0	-34.82	-144.11
0.5	-36.96	148.91
1	-39.06	90.18
1.5	-40.78	28.39
2	-42.01	-33.84
2.5	-43.67	-96.78
3	-45.63	-155.81
3.5	-47.54	142.63
ΔdB_1	-7.19	Δdeg_1
ΔdB_2	-6.71	Δdeg_2
ΔdB_3	-6.57	Δdeg_3
ΔdB_4	-6.76	Δdeg_4
ΔdB_{AVG} [dB]	-6.81	Δdeg_{AVG} [deg]
dB_{AVG} (α_{AVG}) [dB/cm]	-3.40	deg_{AVG} (β_{AVG}) [deg/cm]
(α_{AVG}) [NP/cm]	-0.3918712	(β_{AVG}) [rad/cm]
f [Hz]	1.60E+09	
μ [H/cm]	1.25664E-08	
ε_0 [F/cm]	8.854E-14	
ε_r	39.63	
$\sigma_{effective}$ [S/m]	1.33	

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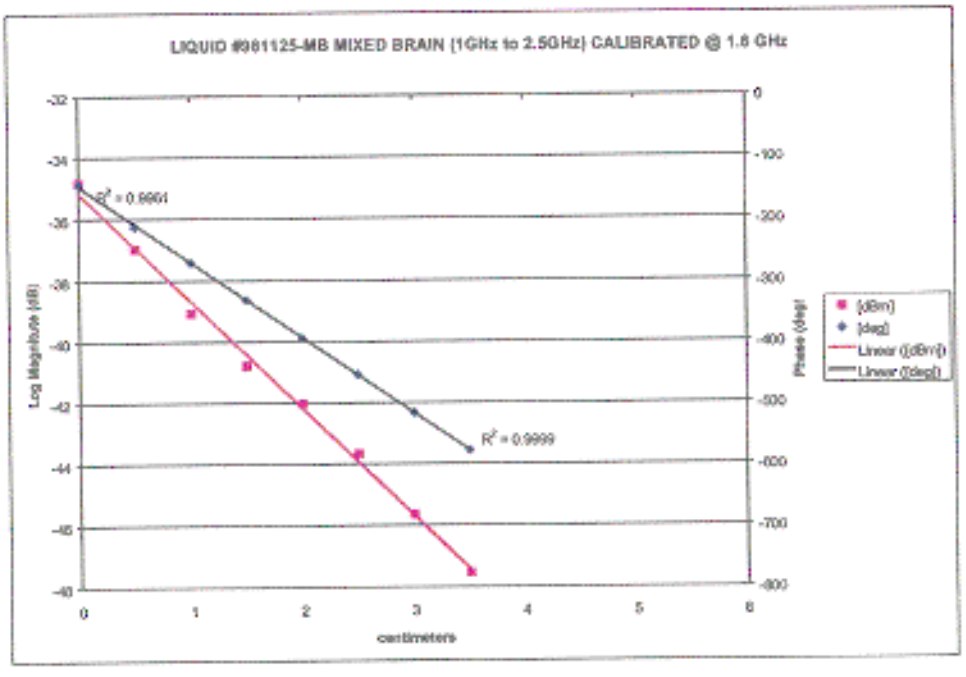

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1624 MHz Data (Heike & Tony)...BRAIN

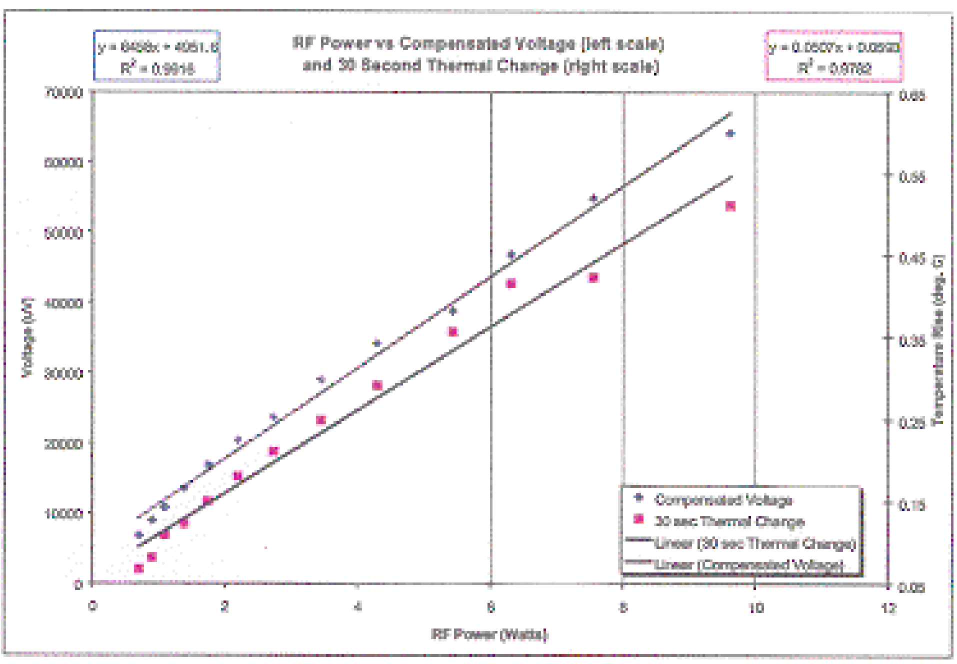
						delta T	Sum		Thermal
RF Power			Ch0	Ch1	Ch2	(30 sec)	V(E)		SAR
W	dBm	R&S	uV	uV	uV	deg. C			W/kg
0.698232	28.44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6895.15		6.23
0.891251	29.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8974.65		7.67
1.081434	30.34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10907.4		10.06
1.380384	31.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13895.7		11.34
1.733804	32.39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17052.5		13.91
2.187762	33.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20541.5		16.70
2.722701	34.35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23751.4		19.55
3.443499	35.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29105.5		23.04
4.295496	36.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	34324.2		28.99
5.432503	37.35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38818.2		33.02
6.309573	38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	49815.5		38.49
7.580922	38.79	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	54959.4		39.25
9.616123	39.83	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64237.8		47.34

Directional Coupler factor 21.26 dB (Asset 100251 cal file data (Janusz, 21 Jul 98))
Additional inline attenuation 20 dB

Sensitivity (e)	0.52	0.54	0.51	- Sensor Sensitivity in mV/ (mW/cm^2)
n = 1.50 e	0.78	0.81	0.765	

Density	1.3	g/cm^3	1300	kg/m^3	- Mardin, summer 97
Conductivity	15.1	mS/cm	1.51	S/m	- Heike 1-Mar-98
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)	6457.96	uV/W	0.00646	V/W	
- standard error or m_v	178.835	uV/W	0.00018	V/W	2.8%
Slope of Measure Temp Change (m_T)	0.05074	C/W	0.05074	C/W	
- standard error or m_T	0.00228	C/W	0.00228	C/W	4.5%

Tissue Conversion Factor (γ) 5.6



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APPENDIX E

Validation Scans

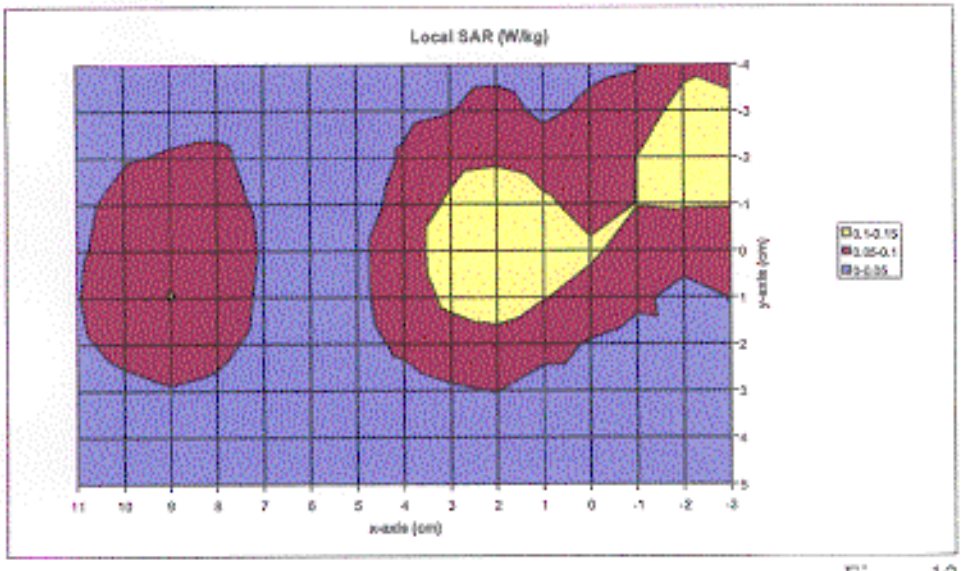

Figure 12

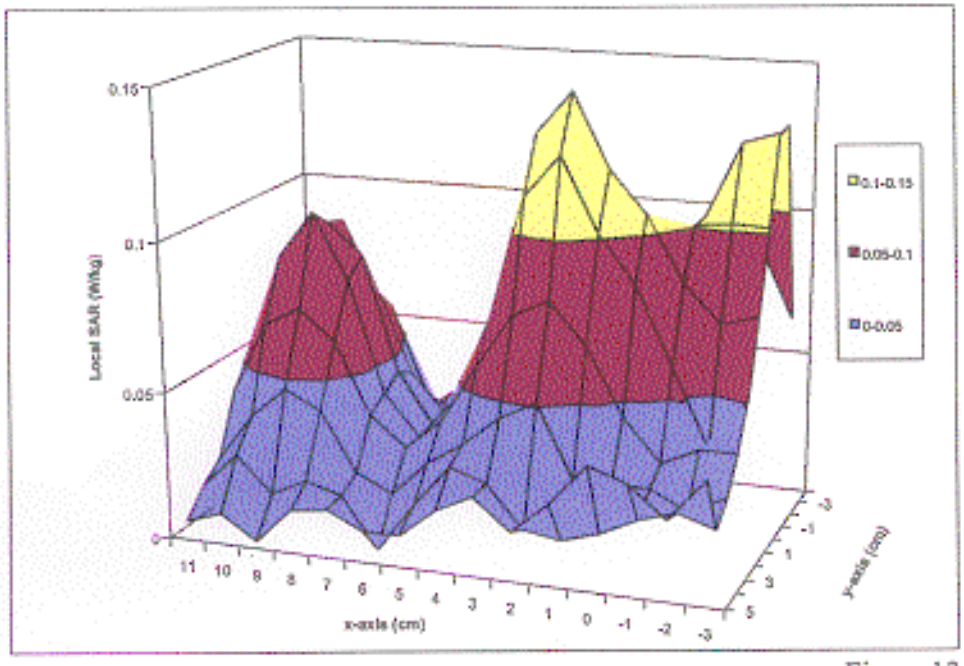

Figure 13

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