



## Certification Report on

Specific Absorption Rate (SAR)  
Experimental Analysis on Body

Standard Telecom Co., Ltd.

**NXC-3200**

Test Date: 5 July, 2000



AIRB-Standard Telecom NXC 3200-3490

51 Spectrum Way Nepean ON K2R 1E6  
Tel: (613) 820-2730 Fax: (613) 820-4161  
email: [info@aprel.com](mailto:info@aprel.com)

## CERTIFICATION REPORT

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

Product: Dual Mode Single Band Cellular Handset

Model: NXC-3200

Client: Standard Telecom Co., Ltd.

Address: 926 Kwanyang 2-Dongan-Ku  
Anyang-City, Kyunggi-Do  
Korea 431-062

Project #: AIRB-Standard Telecom NXC 3200-3490

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



Tested by

Delia Zapata  
Delia M. Zapata, BSEE

Date:

July 14, 2000

Submitted by

Paul G. Cardinal  
Dr. Paul G. Cardinal  
Director, Laboratories

Date:

19 July 00

Approved by

J. J. Wojcik  
Dr. Jacek J. Wojcik, P. Eng.

Date:

July 19/2000



Page 1 of 21

51 Spectrum Way  
Nepean, Ontario, K2R 1E6



Project #: AIRB-Standard Telecom NXC 3200-3490

Tel: (613) 820-2730  
Fax: (613) 820 4161  
e-mail: info@aprel.com

© APREL 2000

This report shall not be reproduced, except in full,

without the express written approval of APREL Laboratories.

FCC ID:

Applicant: Standard Telecom Co., Ltd.

Equipment: Dual Mode Single Band Cellular Handset

Model: NXC-3200

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 Standard Telecom model NXC-3200 Dual Mode Single Band Cellular Handset when using a hands-free kit which includes a holster and belt clip (for SAR in the vicinity of the head see report AIRB-Standard Telecom NXC 3200-3489). The measurements were carried out in accordance with FCC 96-326. The cellular handset was evaluated at its maximum nominal power level.

The cellular handset was tested operating at maximum output power in AMPS (27dBm) and CDMA (25dBm) modes on low, middle and high channels, with the antenna extended and retracted, with the two types of battery offered. The cellular handset was configured with the headset attached and with the handset inside its holster. The testing was conducted with the holster belt clip against the phantom and the headset touching the phantom.

The maximum SAR was found to coincide with the peak performance RF output power operating in AMPS mode, on the middle channel (383, 836.49 MHz), with the antenna retracted and using the standard battery. Test data and graphs are presented in this report.

Based on the test results for this device, and as it will be marketed and used with a warning in the manual that the hands-free kit only be used with the phone placed in its holster, it is certified that the product meets the requirements as set forth in the above specifications, for partial body exposure in an uncontrolled RF exposure environment.

The results presented in this report relate only to the sample tested.



## TABLE OF CONTENTS

1. Introduction.....	4
2. Applicable Documents .....	4
3. Equipment Under Test .....	4
4. Test Equipment .....	5
5. Test Methodology .....	5
6. Test Results .....	6
6.1. Transmitter Characteristics .....	6
6.2. SAR Measurements .....	7
7. Conclusions .....	10
APPENDIX A. Measurement Setup and SAR Graphs .....	11
APPENDIX B. Manufacturer's Specifications .....	16
APPENDIX C. Uncertainty Budget.....	17
APPENDIX D. Simulated Muscle Tissue Material and Calibration Technique.....	18
APPENDIX E. Validation Scans on a Flat Phantom.....	21

## TABLE OF FIGURES

Figure 1. Setup and Close up of Setup .....	11
Figure 2. Grid inside the Phantom.....	11
Figure 3. Contour Plot of the Area Scan 2.5mm Above Phantom Surface.....	12
Figure 4. Surface Plot of the Area Scan 2.5mm Above Phantom Surface.....	12
Figure 5. Contour Plot of the Area Scan 12.5mm Above Phantom Surface.....	13
Figure 6. Surface Plot of the Area Scan 12.5mm Above Phantom Surface.....	13
Figure 7. Zoom Scan 2.5mm Above Phantom Surface.....	14
Figure 8. Zoom Scan 7.5mm Above Phantom Surface.....	14
Figure 9. Zoom Scan 12.5mm Above Phantom Surface.....	14
Figure 10. Overlay of the DUT's Outlines Superimposed onto the Area Scan Contour .....	15
Figure 11. Local SAR versus Sensor Separation.....	15
Figure 12. Contour Plot of the Reference Area Scan 2.5mm Above Phantom Surface .....	21



## 1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) of a sample of a Standard Telecom model NXC-3200 Dual Mode Single Band Cellular Handset. 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 C95.3-1992, 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

- Standard Telecom model NXC-3200 Dual Mode Single Band Cellular Handset, S/N 22, received on 4 July 2000.

The cellular handset will be called DUT (Device Under Test) in the following.

The DUT is a cellular headset that can operate at two different modes: AMPS and CDMA. Table 1 presents the corresponding output power for each mode, and the transmission frequency associated with each channel.



MODE	Output Power	Channel		
		L/M/H	#	Frequency
AMPS	27 dBm / 501 mW	L	991	824.04
		M	383	836.49
		H	799	849.97
CDMA	25 dBm / 316 mW	L	1011	824.64
		M	383	836.49
		H	779	848.37

Table 1. DUT transmission characteristics

The DUT antenna is located at the top ride side of the device when viewed from the keyboard side. The antenna is an Avantego  $\frac{1}{4} \lambda$  retractable whip over a  $\frac{1}{4} \lambda$  fixed helix stub. Its typical gain is  $-2.2$  dBd when the whip is retracted and  $-1$  dBd when extended.

A photograph of the DUT, antenna and battery types can be found in Appendix B. See the manufacturer's submission documentation for drawings and more design details.

#### 4. TEST EQUIPMENT

- APREL Triangular Dosimetric Probe Model E-009, s/n 115, Asset # 301420
- CRS Robotics A255 articulated robot arm, s/n RA2750, Asset # 301335
- CRS Robotics C500 robotic system controller, s/n RC584, Asset # 301334
- APREL F-1, flat manikin, s/n 001
- Tissue Recipe and Calibration Requirements, APREL procedure SSI/DRB-TP-D01-033
- Anritsu MS2661C Spectrum Analyzer (9KHz - 3GHz)

#### 5. TEST METHODOLOGY

1. The test methodology utilised in the certification of the DUT 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 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 DUT, inside its holster, is positioned with the holster's belt clip parallel to and touching the bottom of the phantom.
7. All tests were performed with the highest power available from the sample DUT in the AMPS and CDMA modes, with high, middle and low channels under transmit conditions.

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

## 6. TEST RESULTS

### 6.1. TRANSMITTER CHARACTERISTICS

The battery-powered DUT will consume energy from its batteries, which may affect the DUT's 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 this DUT, the conducted power was sampled. A power meter was connected to the antenna feed point. The following table shows the conducted RF power sampled before and after each of the six sets of data used for the worst case SAR in this report.



Scan		Conducted Power Readings (dBm)		D (dB)	Battery #
Type	Height (mm)	Before	After		
Area	2.5	27.0	27.2	0.2	Standard 6
Area	12.5	27.0	27.0	0.0	Standard 4
Zoom	2.5	27.0	-	-	Standard 5
Zoom	7.5	-	-	-	Standard 5
Zoom	12.5	-	26.9	-0.1	Standard 5
Depth	2.5 – 22.5	27.0	26.85	-0.15	Standard

## 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 10 grams of tissue for the extremities and 1 gram of tissue elsewhere.
- 2) The DUT was put into test mode for the SAR measurements by using manufacturer supplied keyboard commands to control the mode, channel of operation and the maximum operating power (nominally 27dBm in AMPS mode and 25dBm in CDMA mode).
- 3) Figure 3 in Appendix A shows a contour plot of the SAR measurements for the DUT (AMPS mode, middle channel, 383, 836.49 MHz) with the holster and clip, standard battery and with the antenna retracted). The presented values were taken 2.5 mm into the simulated tissue from the flat phantom's solid inner surface. Figures 1 and 2 in Appendix A show the phantom used in the measurements. A grid is shown inside of the phantom indicating the orientation of the x-y grid used, with the co-ordinates (0,0) on the top left (orange dot). The y-axis is positive towards the right and the x-axis is positive towards the bottom. In this position the antenna is aligned with y=11, and the bottom of the device, with x=40.

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

Figure 10 in Appendix A shows an overlay of the DUT's outlines, superimposed onto a contour plot similar to that shown as Figure 3, and which includes the head set and cable draped across the bottom of the phantom.

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.

- 4) Wide area scans were performed operating at maximum output power (27 dBm / 501 mW), in AMPS mode with standard and large type batteries, the antenna extended and retracted for the low (991, 824.04 MHz), middle (383, 836.49 MHz) and high (799, 849.97 MHz) channels.

Wide areas scans were then performed in CDMA mode (25 dBm / 316 mW), for the worst case: DUT with the antenna retracted and using a standard battery while operating on the high, middle and low channels. The peak single point SAR for the scans were:

MODE	Battery type	Antenna position	Channel			Highest SAR [W/kg]
			L/M/H	#	Frequency (MHz)	
AMPS	Standard	retracted	L	991	824.04	0.48
<b>AMPS</b>	<b>Standard</b>	<b>retracted</b>	<b>M</b>	<b>383</b>	<b>836.49</b>	<b>0.51</b>
AMPS	Standard	retracted	H	799	849.97	0.33
AMPS	Standard	extracted	L	991	824.04	0.36
AMPS	Standard	extracted	M	383	836.49	0.45
AMPS	Standard	extracted	H	799	849.97	0.31
AMPS	Large	retracted	L	991	824.04	0.43
AMPS	Large	retracted	M	383	836.49	0.50
AMPS	Large	retracted	H	799	849.97	0.30
AMPS	Large	extracted	M	383	836.49	0.36
CDMA	Standard	retracted	L	1011	824.64	0.38
CDMA	Standard	retracted	M	383	836.49	0.40
CDMA	Standard	retracted	H	779	848.37	0.25
<b><i>DUT w/o holster and belt clip, placed with battery side of worst case configuration against bottom of phantom</i></b>						
<b>AMPS</b>	<b>Standard</b>	<b>retracted</b>	<b>M</b>	<b>383</b>	<b>836.49</b>	<b>1.65</b>



All subsequent testing was performed with the DUT operating in AMPS mode (nominally 27 dBm output power), using a standard battery, with the antenna retracted and transmitting on the middle channel (383, 836.49 MHz).

- 5) The DUT was then explored on a refined 5 mm grid in three dimensions. Figures 7, 8 and 9 show the measurements made at 2.5, 7.5 and 12.5 mm respectively. The SAR value averaged over 1 gram was determined from these measurements by averaging the 27 points (3x3x3) comprising a 1 cm cube. The maximum SAR value measured averaged over 1 gram was determined from these measurements to be 0.336 W/kg.
- 6) To extrapolate the maximum SAR value averaged over 1 gram to the inner surface of the phantom a series of measurements were made at a few (x,y) co-ordinates within the refined grid as a function of depth, with 2.5 mm spacing. Figure 11 in Appendix A shows the data gathered and the exponential curves fit to them. The average exponential coefficient was determined to be  $(-0.0549 \pm 0.0013) / \text{mm}$ .
- 7) The distance from the probe tip to the inner surface of the phantom for the lowest point is 2.5 mm. The distance from the probe tip to the tip of the measuring dipole within the APREL Triangular Dosimetric Probe Model E-009 is 2.3 mm. The total extrapolation distance is 4.8 mm, the sum of these two.

Applying the exponential coefficient over the 4.8 mm to the maximum SAR value averaged over 1 gram that was determined previously, we obtain the maximum SAR value at the surface averaged over 1 gram, **0.437 W/kg**.



## 7. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) averaged over 1 g, determined at 836.49 MHz (383, 27 dBm, 501 mW) of a Standard Telecom model NXC-3200 Dual Mode Single Band Cellular Handset when used with the Standard Telecom hands-free kit, including the holster, is 0.437 W/kg. The overall margin of uncertainty for this measurement is  $\pm 11.9\%$  (Appendix C).

Only one SAR peak was observed and it was situated over the handset. No SAR of any significance with respect to health and safety guidelines was measured on the headset or its cord.

The SAR limit given in the FCC 96-326 safety guideline is 1.6 W/kg for partial body exposure in an uncontrolled RF exposure environment. Considering the above, this unit as tested, and as it will be marketed and used with a warning in the manual that the hands-free kit only be used with the phone placed in its holster, is found to be compliant with this requirement.



## APPENDIX A. Measurement Setup and SAR Graphs

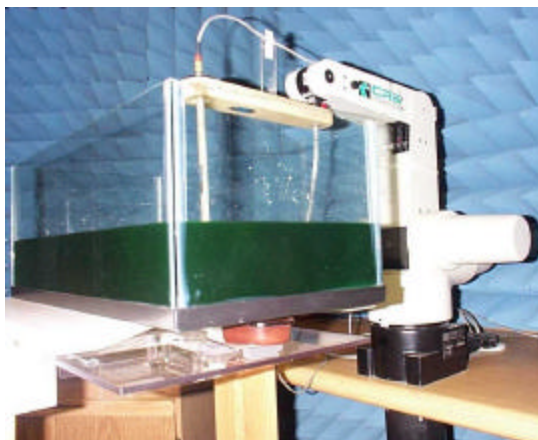


Figure 1. Setup and Close up of Setup

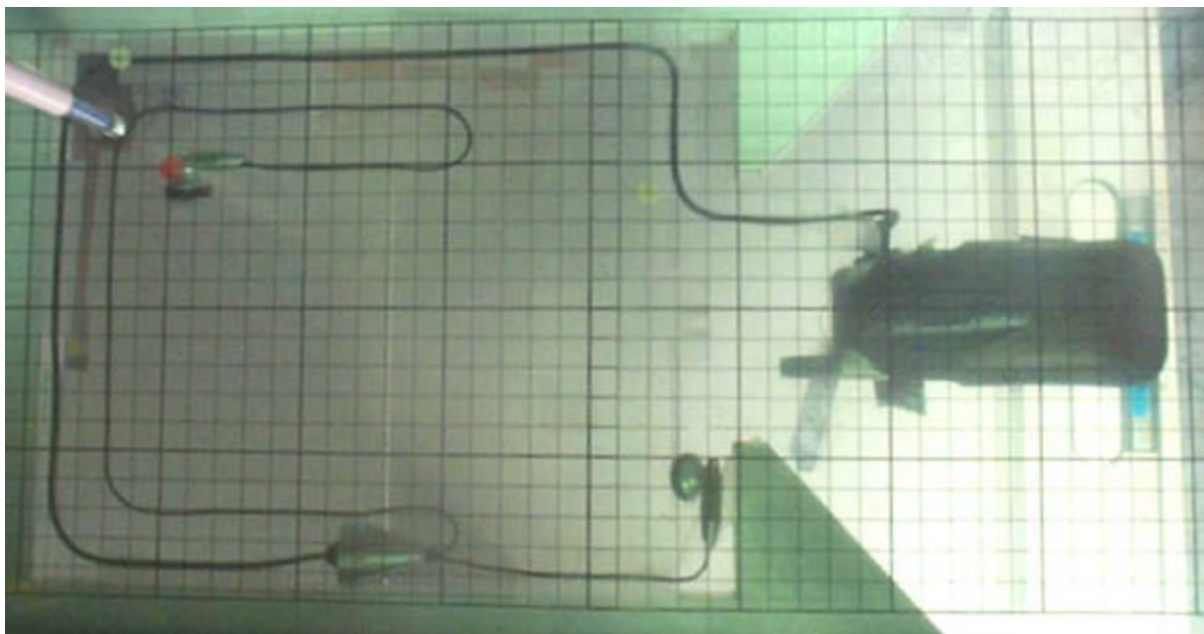


Figure 2. Grid inside the Phantom



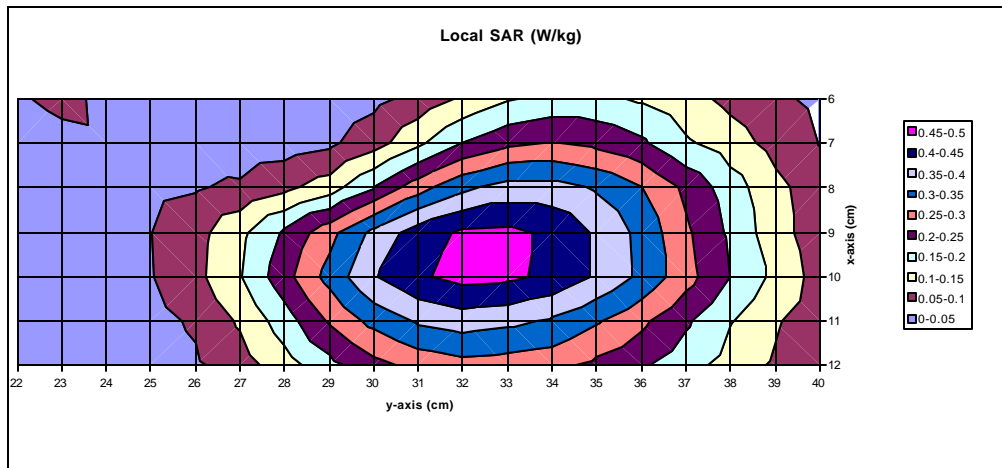


Figure 3. Contour Plot of the Area Scan 2.5mm Above Phantom Surface

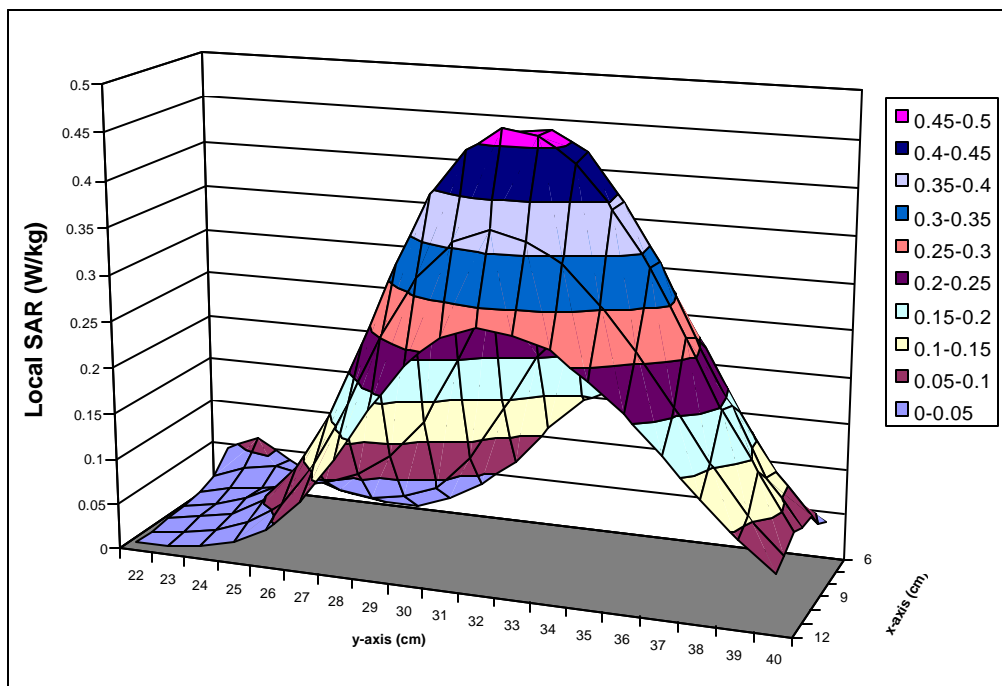


Figure 4. Surface Plot of the Area Scan 2.5mm Above Phantom Surface

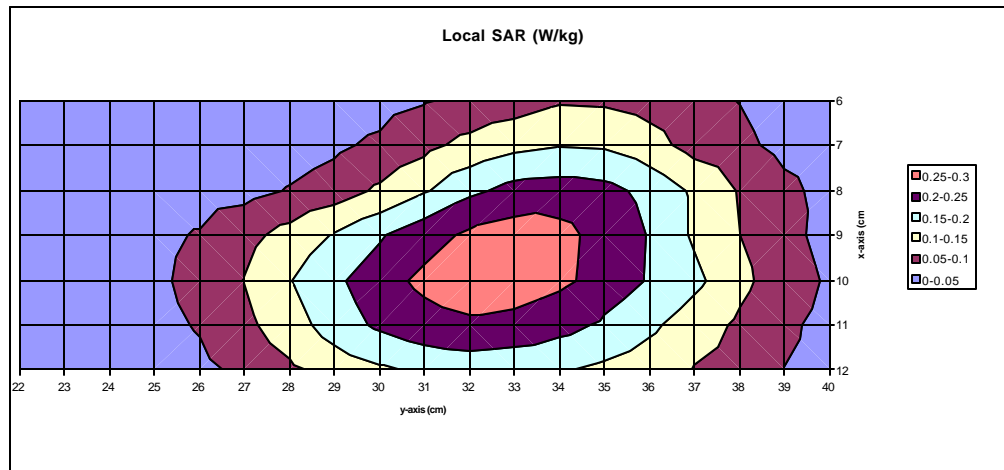


Figure 5. Contour Plot of the Area Scan 12.5mm Above Phantom Surface

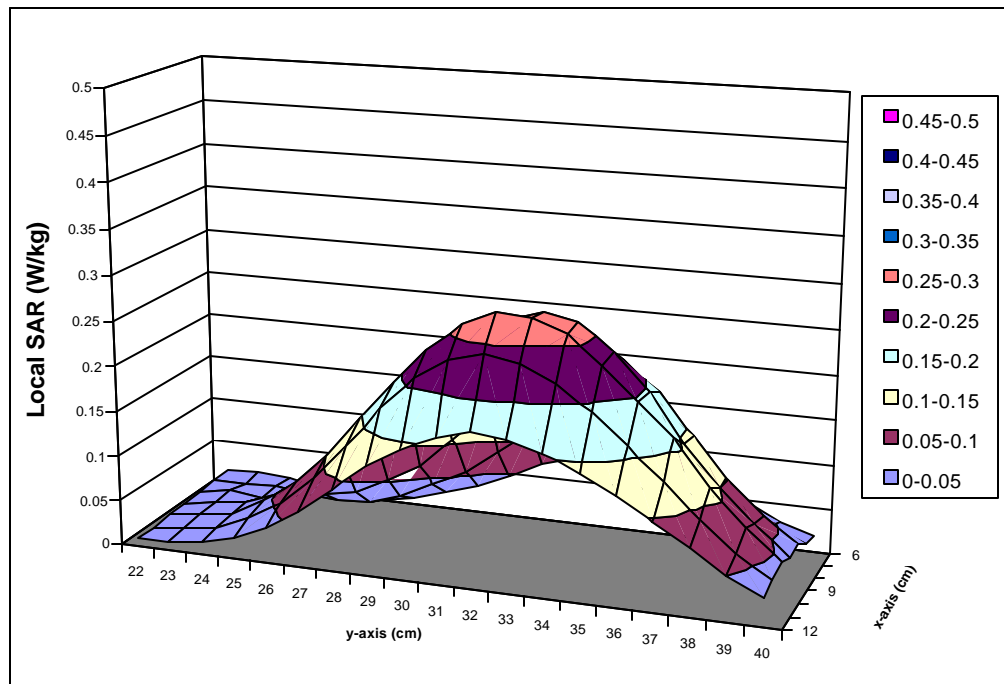


Figure 6. Surface Plot of the Area Scan 12.5mm Above Phantom Surface

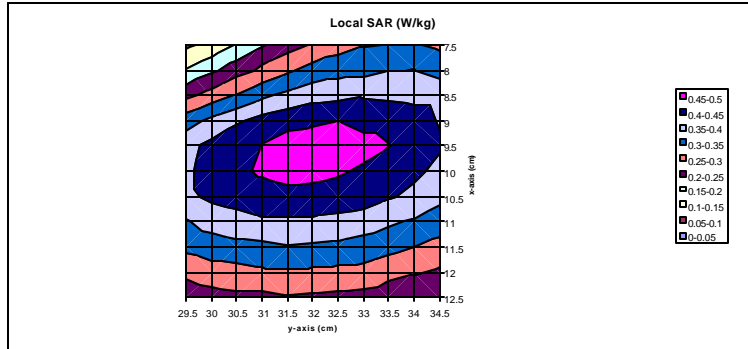


Figure 7. Zoom Scan 2.5mm Above Phantom Surface

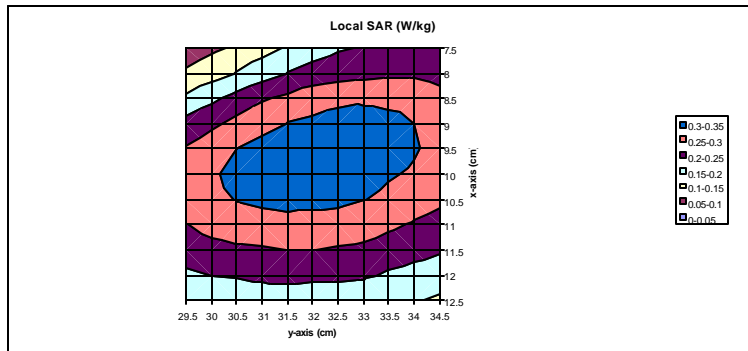


Figure 8. Zoom Scan 7.5mm Above Phantom Surface

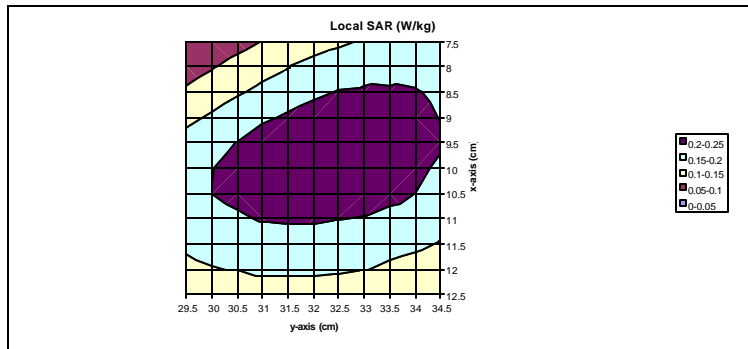
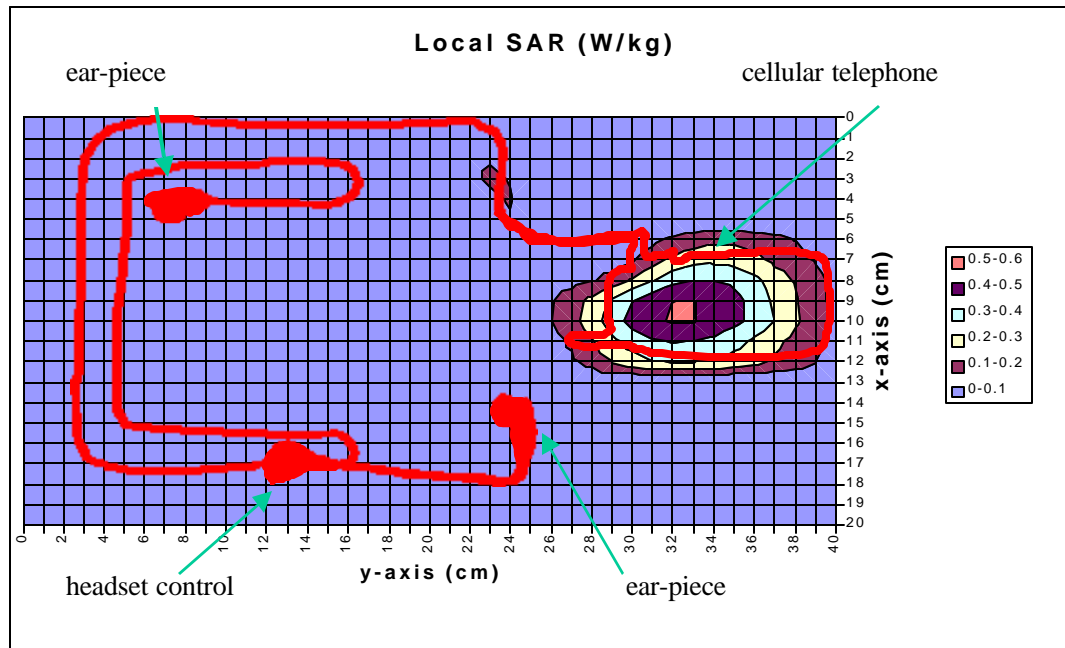


Figure 9. Zoom Scan 12.5mm Above Phantom Surface

Figure 10. Overlay of the DUT's Outlines Superimposed onto the Area Scan



Contour

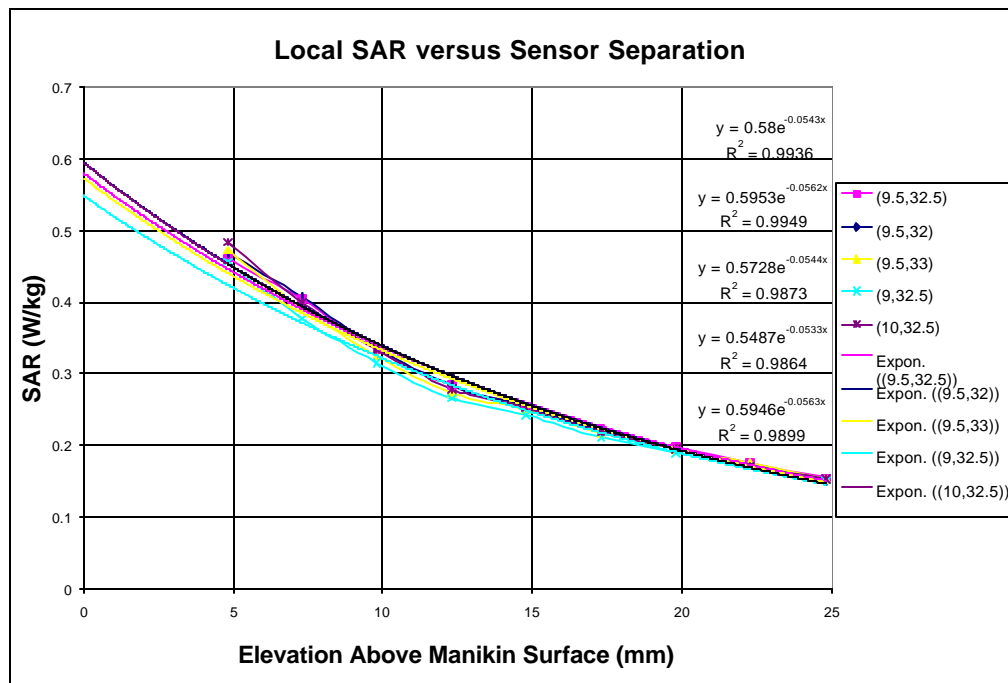


Figure 11. Local SAR versus Sensor Separation

## APPENDIX B. Manufacturer's Specifications



### ANTENNA

Fixed helix antenna with retractable whip and not defined gain.



### BATTERY TYPES

Standard battery, NB-320S (left)

Large battery, NB-320L (right)

(See manufacturer's submission documentation for drawings and more design details)

## APPENDIX C. Uncertainty Budget

### Uncertainties Contributing to the Overall Uncertainty

Type of Uncertainty	Specific to	Uncertainty
Power variation due to battery condition	phone	2.3%
Extrapolation due to curve fit of SAR vs depth	phone	4.8%
Extrapolation due to depth measurement	setup	2.7%
Conductivity	setup	6.0%
Density	setup	2.6%
Tissue enhancement factor	setup	7.0%
Voltage measurement	setup	1.0%
Probe sensitivity factor	setup	3.5%
		<b>11.9% RSS</b>



## APPENDIX D. Simulated Muscle Tissue Material and Calibration Technique

The 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,  $\rho$  1.30 g/ml  
(The density used to determine SAR from the measurements was the recommended 1040 kg/m<sup>3</sup> 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.

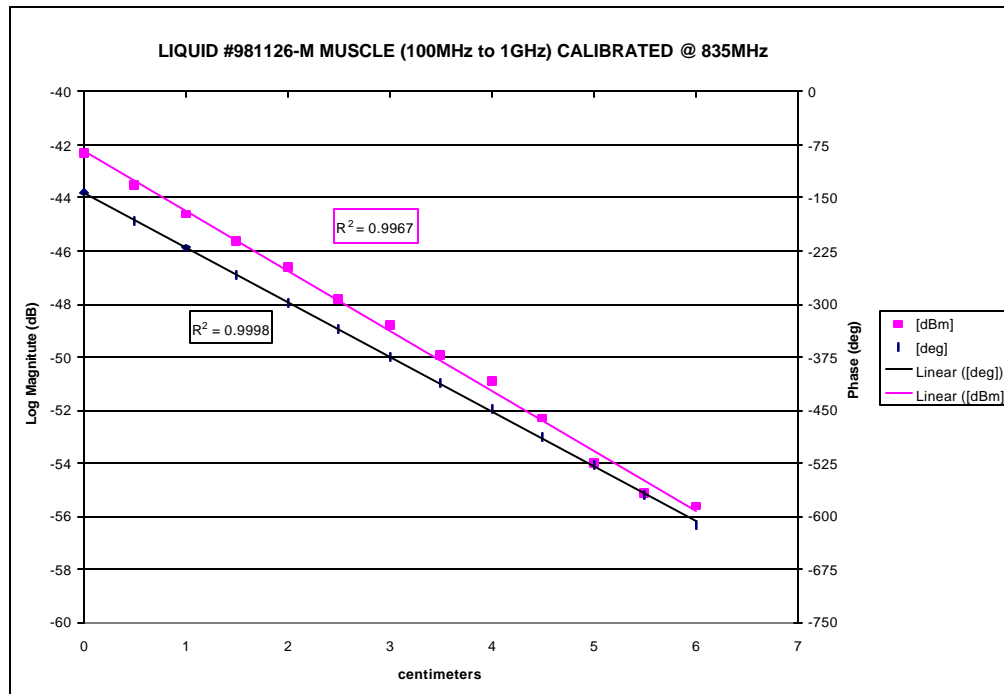
The dielectric properties at 835 MHz are:

	APREL	OET 65 Supplement	$\Delta$ / % (OET)
Dielectric constant, $\epsilon_r$	57.0	56.11	1.6%
Conductivity, $\sigma$ / [S/m]	1.06	0.946	12.2%
Tissue Conversion Factor, $\gamma$	8.52	-	-



SIMULATION FLUID # 981126-M  
 CALIBRATION DATE 4-Jul-00  
 CALIBRATED BY Ken O'Donnell  
 Frequency Range 100MHz-1GHz  
 Frequency Calibrated 835 MHz  
 Tissue Type Muscle

Position	Amplitude	Phase	
(cm)	(dBm)	(deg)	(deg)
0	-42.3	-141.6	-141.6
0.5	-43.5	178.6	-181.4
1	-44.6	139.6	-220.4
1.5	-45.6	101.2	-258.8
2	-46.6	61.8	-298.2
2.5	-47.8	24.4	-335.6
3	-48.8	-13.7	-373.7
3.5	-49.9	-52.6	-412.6
4	-50.9	-89.1	-449.1
4.5	-52.3	-127	-487
5	-54	-167.3	-527.3
5.5	-55.1	150.9	-569.1
6	-55.6	108.8	-611.2
$\Delta dB_1$	-6.5	$\Delta \text{deg}$	-232.1
$\Delta dB_2$	-6.4	$\Delta \text{deg}$	-231.2
$\Delta dB_3$	-6.3	$\Delta \text{deg}$	-228.7
$\Delta dB_4$	-6.7	$\Delta \text{deg}$	-228.2
$\Delta dB_5$	-7.4	$\Delta \text{deg}$	-229.1
$\Delta dB_6$	-7.3	$\Delta \text{deg}$	-233.5
$\Delta dB_7$	-6.8	$\Delta \text{deg}$	-237.5
$\Delta dB_{\text{avg}}$ (dB)	-6.77	$\Delta \text{deg}_{\text{avg}}$ (deg)	-231.47
$\text{dB}_{\text{avg}}$ (x AVG) (dB/cm)	-2.26	$\text{deg}_{\text{avg}}$ ( $\beta_{\text{avg}}$ ) (deg/cm)	-77.157
$(\alpha_{\text{avg}})$ (NP/cm)	-0.260	$(\beta_{\text{avg}})$ (rad/cm)	-1.3466
$f$ [Hz]	8.35E+08		
$\mu$ [H/cm]	1.25664E-08		
$\epsilon_0$ [F/cm]	8.854E-14		
$\epsilon_r$	57.0	1.6%	
$\sigma_{\text{effective}}$	1.06	S/m	12.2%



## 835 MHz Data (Heike & Tony) Muscle with E-115

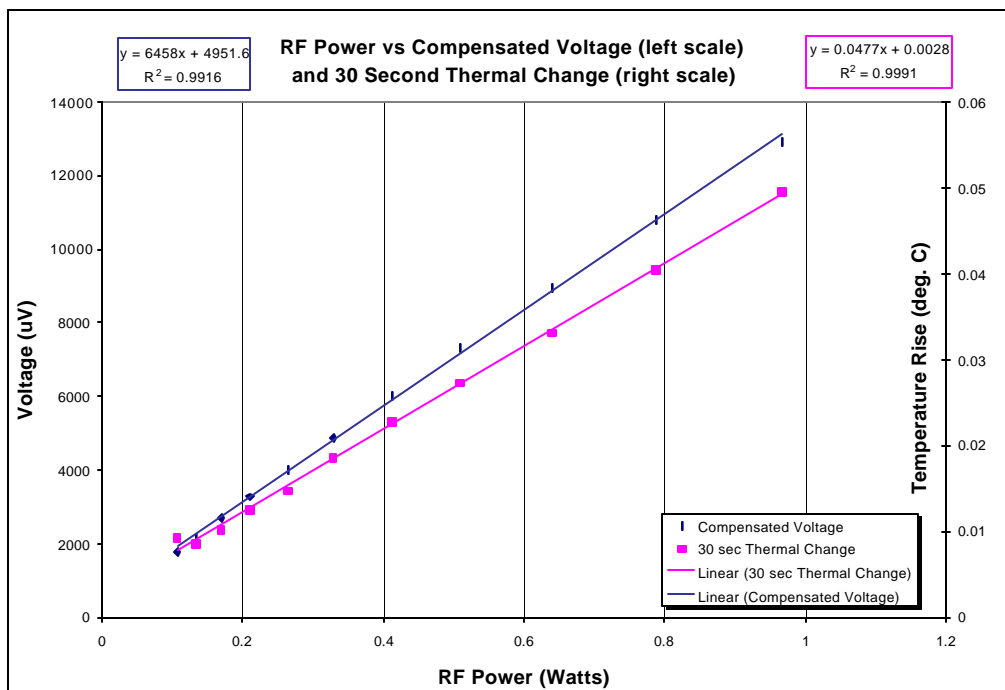
RF Power		Ch0	Ch1	Ch2	delta T (30 sec)	Sum	Thermal
W	dBm	R&S	uV	uV	deg. C	V/Ei	SAR
0.10666	20.28	-25.61	391	1196	2954	0.0093	1793
0.133352	21.25	-24.64	439	1440	3638	0.0086	2178
0.168044	22.28	-23.61	513	1782	4517	0.0102	2688
0.210863	23.24	-22.65	586	2173	5542	0.0125	3277
0.263027	24.2	-21.69	684	2661	6787	0.0147	3999
0.328095	25.16	-20.73	830	3247	8276	0.0185	4876
0.412098	26.15	-19.74	1001	4028	10205	0.0227	6012
0.509331	27.07	-18.82	1196	4932	12402	0.0273	7313
0.639735	28.06	-17.83	1440	6079	15137	0.0331	8941
0.787046	28.96	-16.93	1733	7397	18188	0.0405	11111
0.966051	29.85	-16.04	2100	8960	21680	0.0495	13888

Directional Coupler factor 25.9 dB (Asset 100251 cal file data)  
Additional inline attenuation 20 dB

Sensitivity (e) 1.66 1.72 1.68 - Sensor Sensitivity in mV/ (mW/cm<sup>2</sup>): 835 MHz cal  
n = 1.50 e 2.49 2.58 2.52

Density 1.3 g/cm<sup>3</sup> 1300 kg/m<sup>3</sup>  
Conductivity 10.8 mS/cm 1.08 S/m  
Heat Capacity (c) 2.78 J/C/g 2775 J/C/kg  
Exposure Time 30 seconds 30 seconds  
Slope of Measure Voltage (m<sub>v</sub>) ### uV/W 0.013 V/W  
- standard error or m<sub>v</sub> 124 uV/W 0.0001 V/W 1.0%  
Slope of Measure Temp Change (m<sub>t</sub>) 0.05 C/W 0.0482 C/W  
- standard error or m<sub>t</sub> 0 C/W 0.0007 C/W 1.5%

Tissue Conversion Factor (g) 8.52



## APPENDIX E. Validation Scans on a Flat Phantom

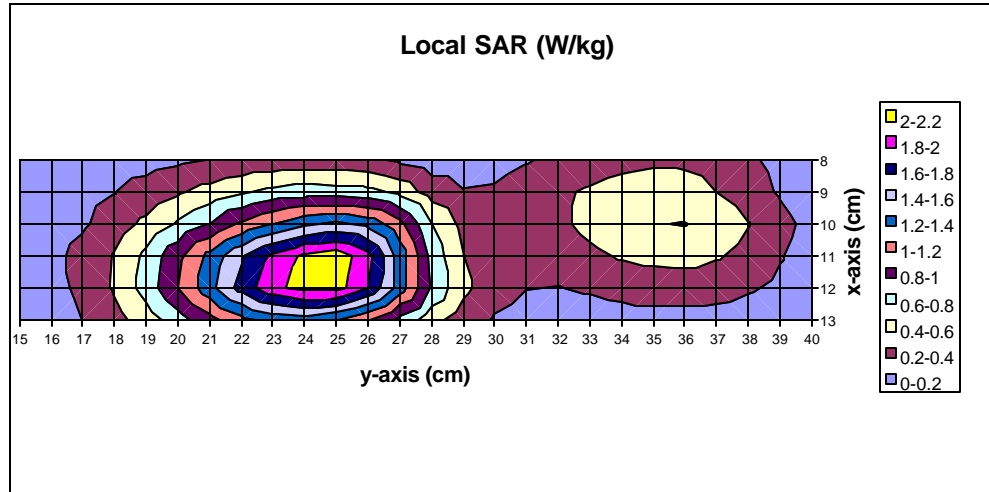


Figure 12. Contour Plot of the Reference Area Scan 2.5mm Above Phantom Surface

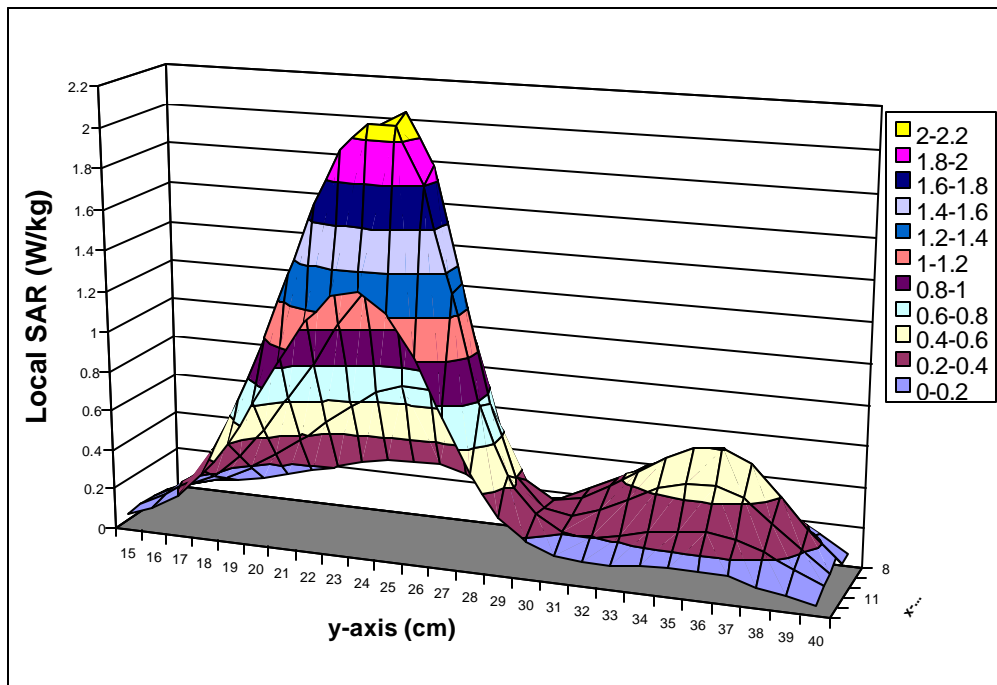


Figure 13. Surface Plot of the Reference Area Scan 2.5mm Above Phantom Surface