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TESTING OF THE MRL 450 SL-AF  
CARDIAC MONITOR

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August 1989

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Final Report for Period November 1987 - January 1988

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USAF SCHOOL OF AEROSPACE MEDICINE  
Human Systems Division (AFSC)  
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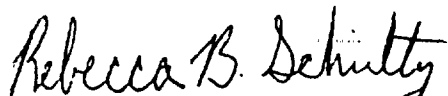
## NOTICES

This interim technical paper was submitted by personnel of the Chemical Defense Branch, Crew Technology Division, USAF School of Aerospace Medicine, Human Systems Division, AFSC, Brooks Air Force Base, Texas, under job order 7930-16-02.

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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.



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FIELD	GROUP	SUB-GROUP										
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09	07											
<b>19. ABSTRACT (Continue on reverse if necessary and identify by block number)</b> The Aeromedical Equipment Evaluation Laboratory tested three MRL 450 AL-AF Cardiac Monitors for electromagnetic interference and susceptibility. All three units tested were within acceptable limits, and the 450 SL-AF was approved for use in USAF aeromedical evacuation aircraft. <i>reynolds</i>												
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# TESTING OF THE MRL 450 SL-AF CARDIAC MONITOR

## BACKGROUND

The USAF School of Aerospace Medicine (USAFSAM/VNC) initially evaluated the Medical Research Laboratories (MRL) Model 450 SL-AF Cardiac Monitor in March 1985 and found it acceptable for use on board U.S. Air Force (USAF) aeromedical evacuation aircraft. The 375th Aeromedical Airlift Wing, Scott AFB, IL, recently purchased twenty-three Model 450 SL-AF units. This report covers the electromagnetic interference test results on a sample lot (three) of the new units. It should be noted that the three units sent for evaluation already had the modifications detailed in our previous paper (1) on the Low-Profile Rigid-Mounted Cable Adapter. These modifications, a Ferranti transistor and shielded alternating current (AC) power supply cord, were made by the manufacturer and are standard items on all Model 450 SL-AF units with serial numbers above 2230.

## METHODS

The Aeromedical Equipment Evaluation Laboratory develops test procedures that cover safety and human factors issues which apply to the equipment to be tested. Specifically, a "performance check" is developed which is a procedure that verifies proper functioning of the equipment under various conditions. An initial inspection is performed by the Lab's BEMT (Biomedical Equipment Maintenance Technician). The BEMT checks battery charging characteristics, leakage current measurements, ground resistance, and any other measurements (i.e., temperature or pressure) necessary to verify that the device conforms to its specifications.

When the device has passed the initial inspection, it is subjected to various "referee tests" that check its performance under various anticipated operational conditions. The referee tests generally involve a repetition of the performance check under the specified conditions. Each referee test also includes any special measurements or procedures necessary due to the peculiarities of the testing conditions.

**Performance Check.** The performance check simply involved operating the MRL unit. A Medi Cal Instruments ECG simulator, Model 410, was connected to the 450 SL-AF via the standard patient ECG cable. A 120 bpm (beats per minute), 1 mV signal was applied to the monitor and all controls were set to maximum, except for the defibrillator and synchronizer which remained off. The units were individually tested on each power supply: 115 VAC/60 Hz; 115 VAC/400 Hz; 28 VDC; and battery.

**Initial Inspection.** Only leakage current and ground resistance were measured. A battery performance check was unnecessary. Heart rate accuracy, defibrillator energy

output and synchronization, and overall condition of the equipment were also checked.

EMI (Electromagnetic Interference). A performance check was accomplished during all phases of the Radiated Emissions and Conducted Susceptibility tests.

Vibration. Vibration tests were not necessary.

Environmental. Environmental testing was not necessary.

Altitude. Altitude testing was not necessary.

Clinical Testing. Clinical tests were unnecessary.

In-Flight Feasibility. In-flight feasibility studies were not necessary.

## RESULTS

No performance degradation was noted during the radiated susceptibility tests. The radiated and conducted emissions were within the acceptable levels specified in MIL-STD-461C, Category A1e (2). Figure 1 compares the EMI results between an unmodified unit and a modified unit.

The Appendix contains copies of the original EMI charts for the tests run on the three MRL units. Each chart shows the spectral frequency range tested for that unit. The dashed lines on the charts indicate the acceptable limit for that frequency.

## CONCLUSIONS

The new group of MRL 450 SL-AF cardiac monitors, with modifications, are approved for use on board USAF aeromedical evacuation aircraft. The three units evaluated had the modifications, a Ferranti transistor and shielded AC power cord, noted in our LPRMCA report (1). The AC power supply cord was clearly labeled as EMI shielded. However, we recommend placing a warning notice on the unit and in the operation/service manual, warning that a shielded cord must be used on the monitor in the interest of flight safety. If the AC power supply cord is not clearly labeled, shielding can be verified by removing the hospital grade plug and examining the ground pin connection for two wires. One is the electrical safety ground; the other is the AC power cord shield connection to ground. Replacement shielded AC power supply cords, Part #2086, can be obtained from the manufacturer.

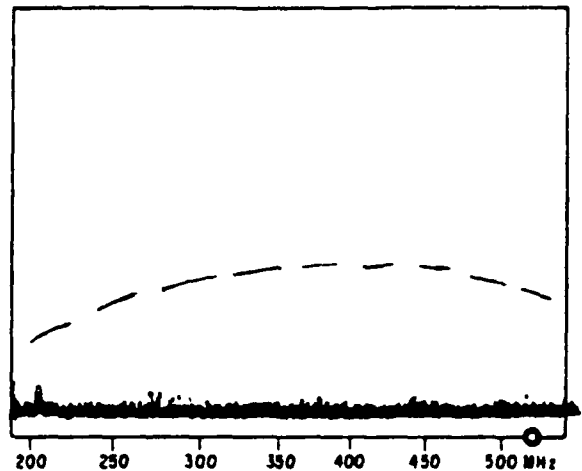
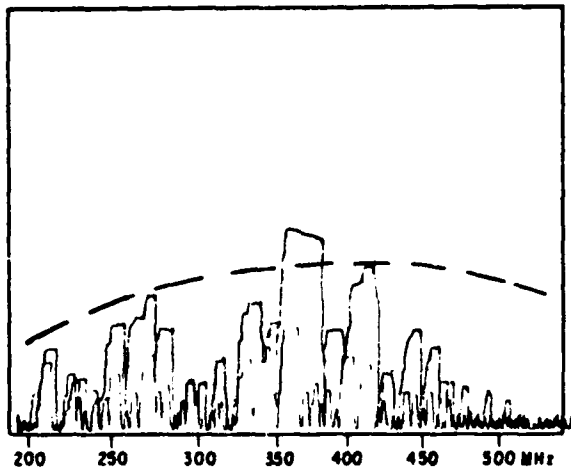


Figure 1. EMI results before (left) and after (right) modifications.

### REFERENCES

1. USAFSAM-TP-89-7, Evaluation of the Low-Profile Rigid-Mounted Cable Adapter for the MRL 450 SL-AF Cardiac Monitor, August 1989.
2. MIL-STD-461C, Electromagnetic emission and susceptibility requirements for the control of electromagnetic interference, Category A1e, 4 August 1986.

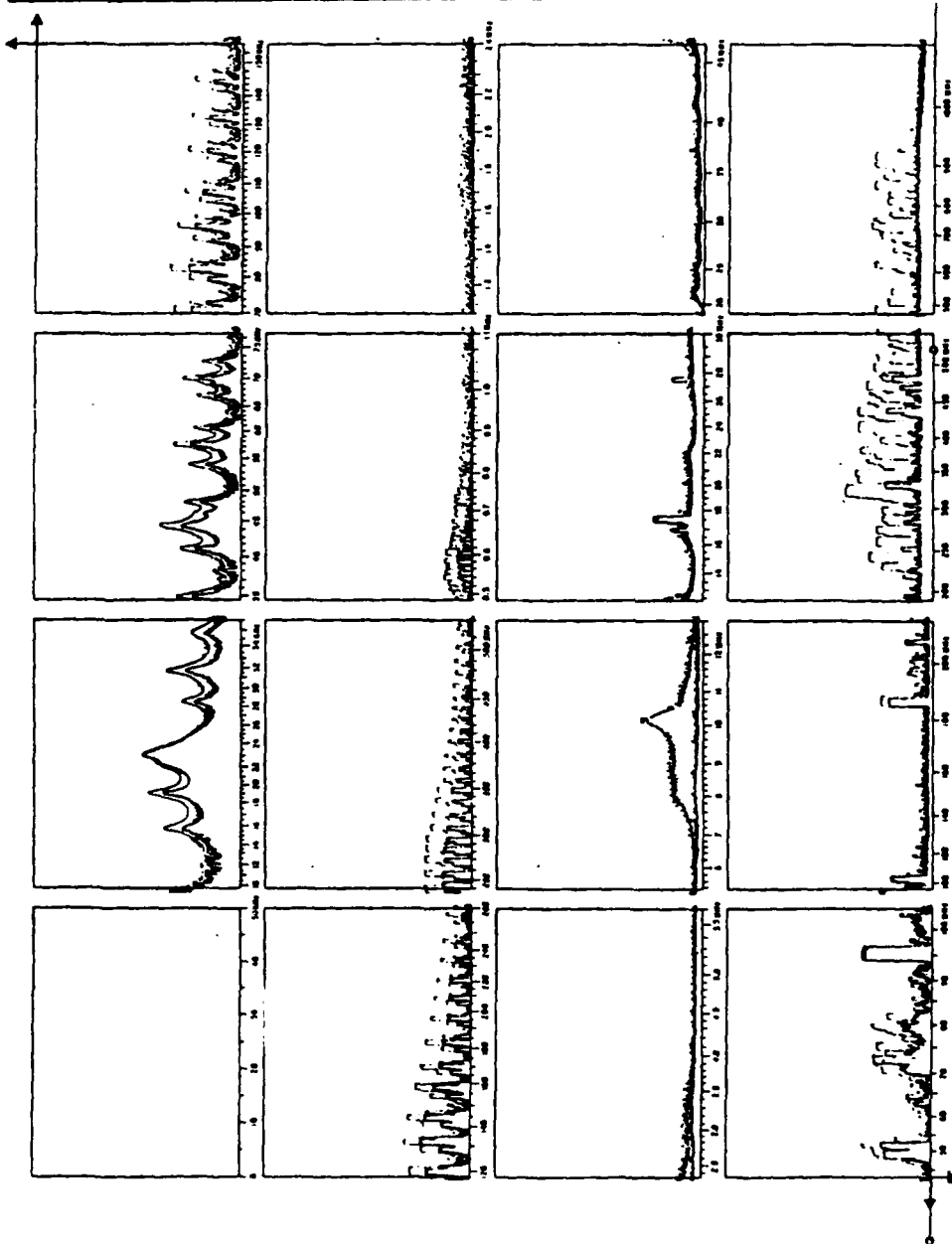


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## APPENDIX

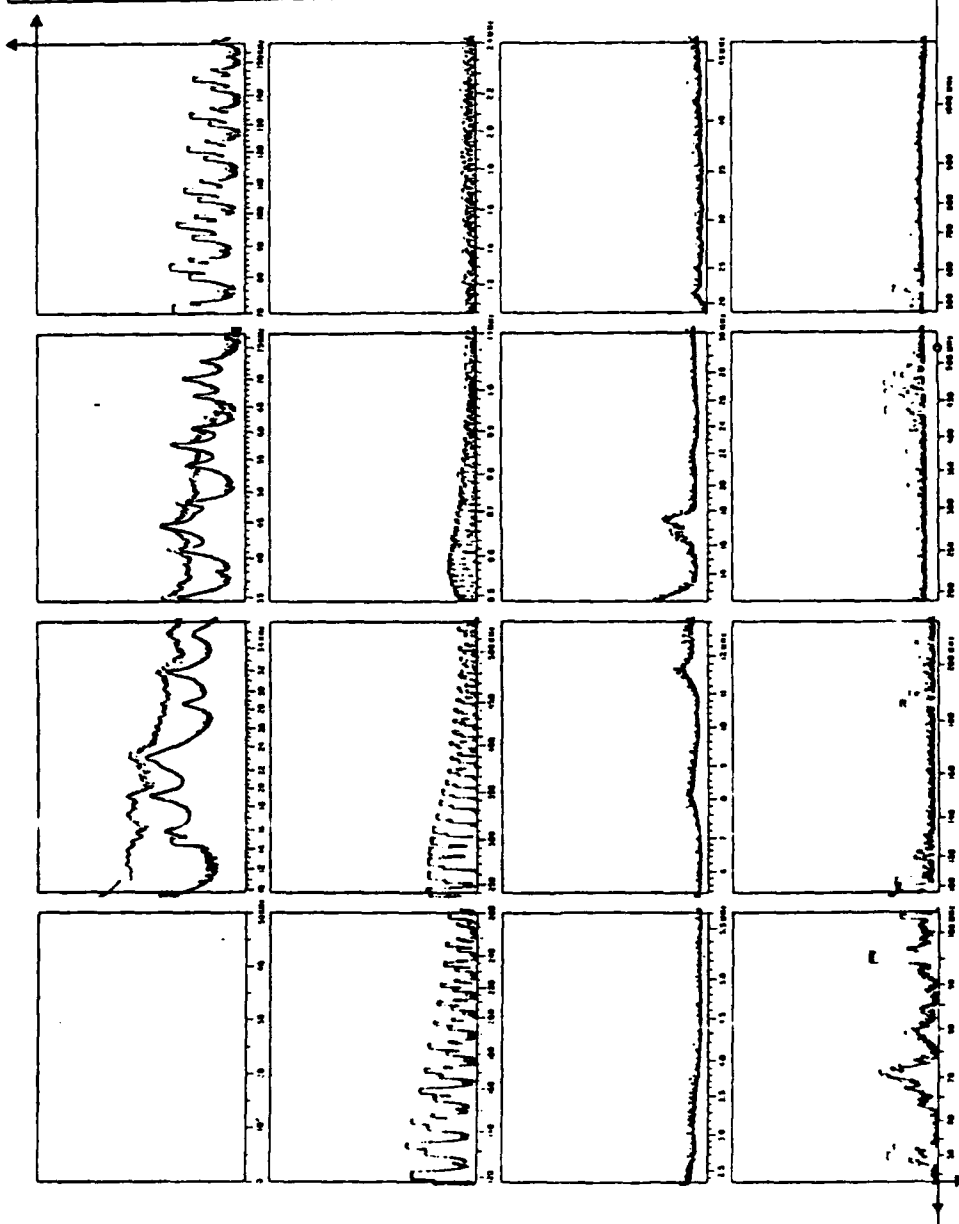
This Appendix contains copies of the original EMI charts for the tests run on the three MRL units. Each chart shows the spectral frequency range tested for that unit. The dashed lines on the charts indicate the acceptable limit for that frequency.

RADIATED EMISSION Narrowband	
TEST SPECIES MPL RESONATOR	
450 SL-1F	
SLV 2278	
TEST METHOD - DE 92	
ICM SPEED	30 sec/para
SPECIMEN OPERATIONAL MODE	fil
SPECIMEN POWER	
IN VDC	RED
IN VAC	GREEN
110 VAC ON	
115 VAC ON	
MEDICAL INTERFER	
VERTICAL	<input checked="" type="checkbox"/>
HORIZONTAL	
SPECIMEN - PORTABLE	<input type="checkbox"/> <input type="checkbox"/>
COMMENTS	
OPERATIONAL MODE	
5.17 VDC ON MPA	
5.17 AMP	
4.00 SECT II	
RENO MIA MODE C/A	
BCB SIMULATOR	
MPLS 410 3/4 689	
MPLS 110 809	
MPLS 101 1.4.11.1007	
DATE TEST COMPLETED	17 DEC 57
TEST COMPLETED BY	F. G. Gable

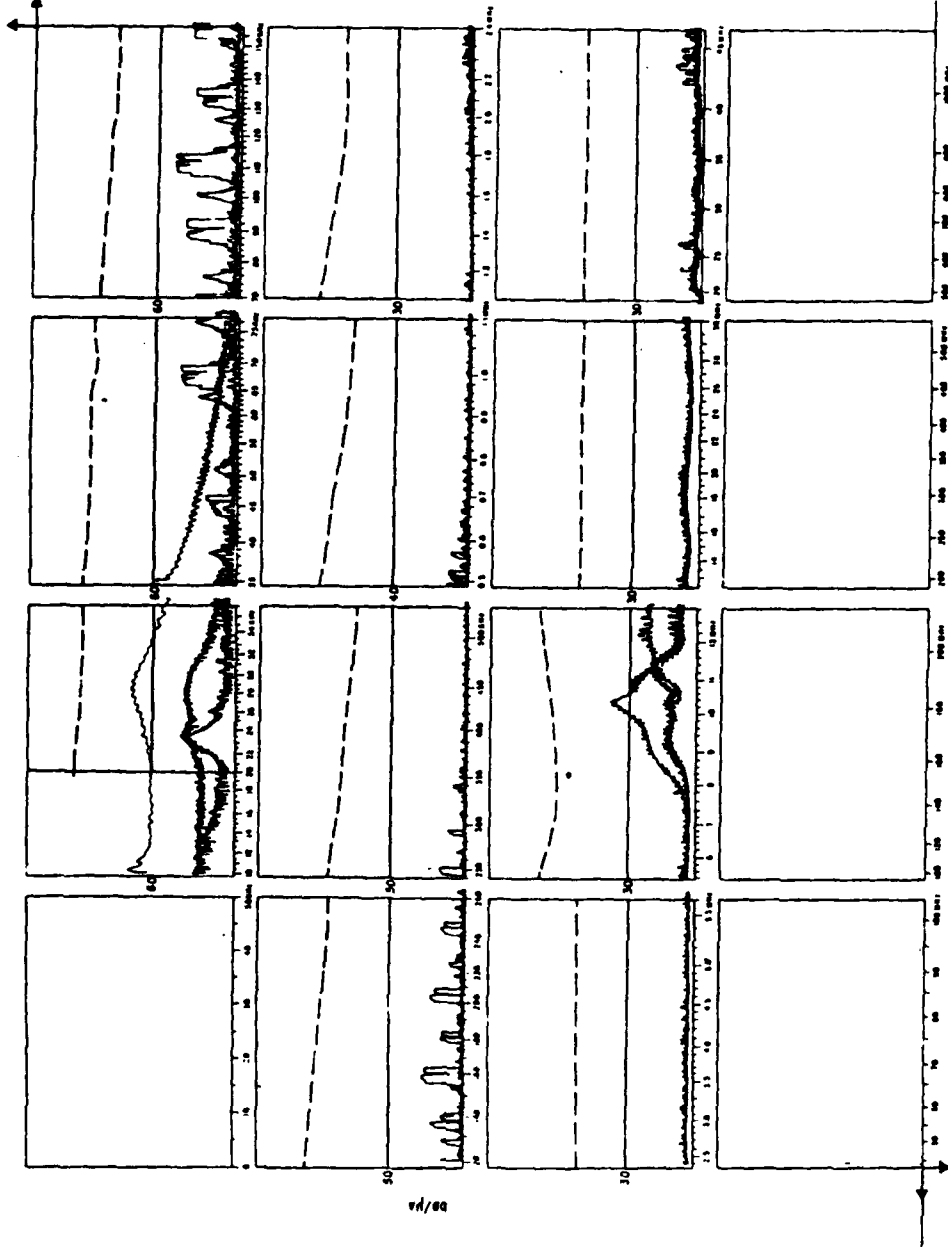




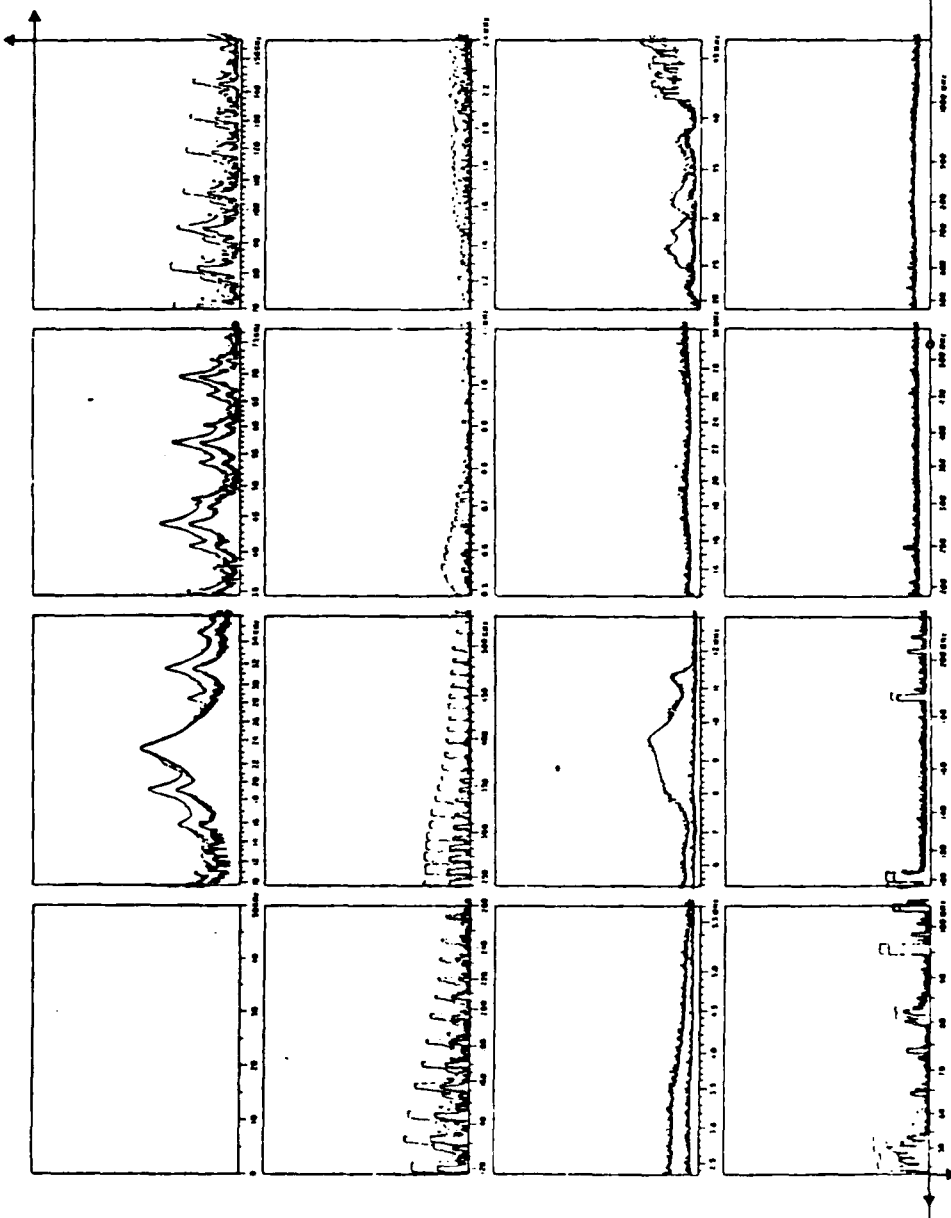
<b>RADIATED EMISSION</b> Measurement	
TEST SPECIMEN	17A DEFORMER
	420 54 05
	3/22/57
TEST METHOD	19 21
MC-WAVE	20.5/20.0
SPECIMEN OPERATIONAL MODE	LC
SPECIMEN POWER	
20 VDC	
115 VAC 60 Hz	BLUE
115 VAC 50 Hz	Red
DIAGNOSTIC INTERFER	
VERTICAL	<input checked="" type="checkbox"/>
HORIZONTAL	
SPECIMEN PORTABLE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
COMMENTS	<p>STANDARDIZED MEASUREMENT WITH 20 MHz BANDWIDTH</p> <p>1000 MHz BANDWIDTH</p> <p>1000 MHz BANDWIDTH</p> <p>1000 MHz BANDWIDTH</p> <p>1000 MHz BANDWIDTH</p> <p>1000 MHz BANDWIDTH</p>
DATE TEST CONDUCTED	12/21/57
TEST CONDUCTED BY	A. J. ...



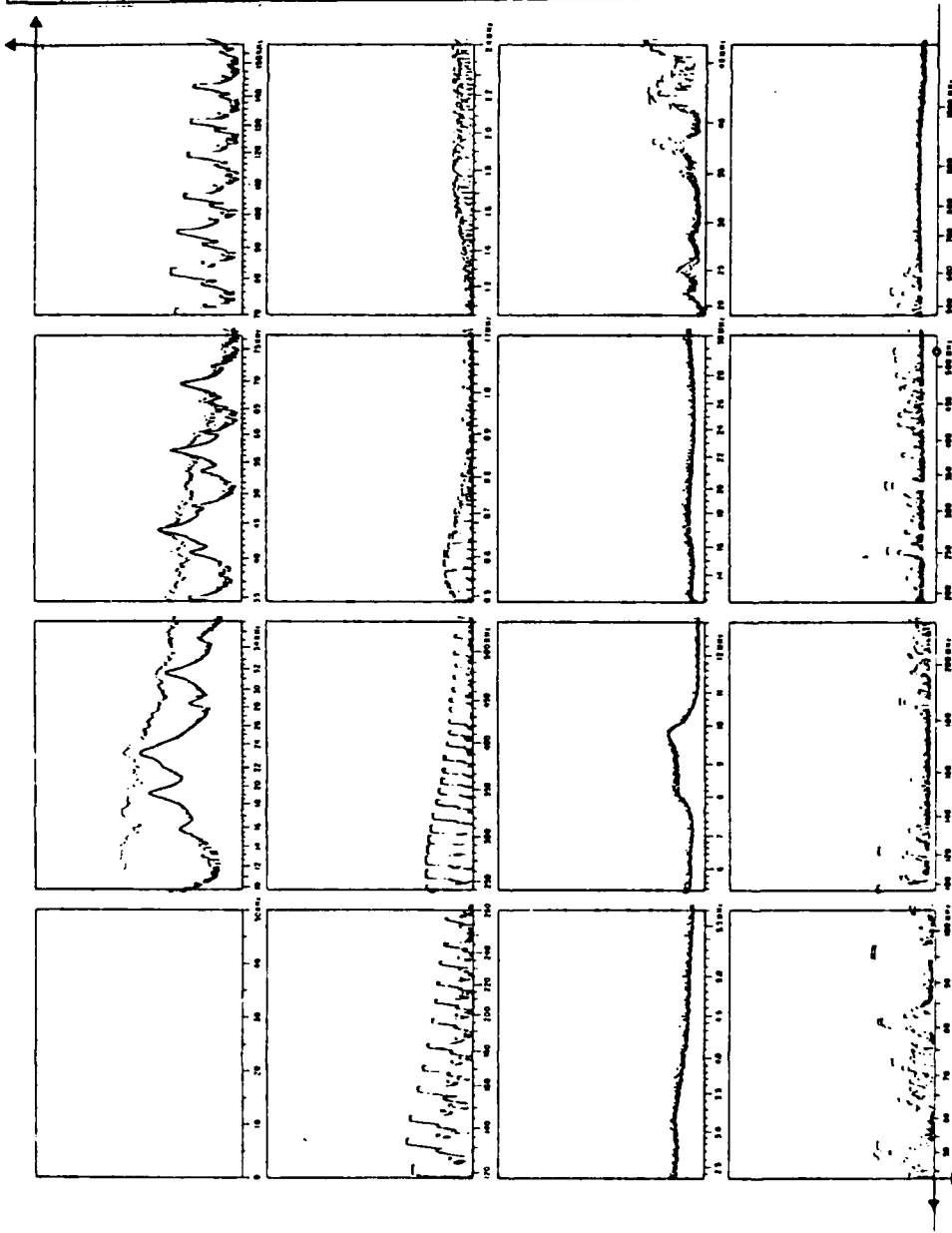
<b>CONDUCTED EMISSION</b> <small>Harmonics</small>	
<b>TEST SPECIMEN</b> MAL OPERATIONAL VSC 5A-7AR 2/22 2.228	<b>TEST METHOD</b> - CE at 100m - 200mV CE at 100mV - 200mV
<b>SCAN SPEED</b> - 50 Hz / 100 Hz	<b>APPLICABLE OPERATIONAL MODE</b> - 2.2
<b>SPECIMEN POWER</b> @ 100 Hz <u>RED</u>	
@ 200 Hz <u>BLUE</u>	
@ 300 Hz <u>GREEN</u>	
<b>SPECIMEN MODE/TYPE</b> : HVA	
<b>COMMENTS</b> OPERATIONAL NIK SYST VSC 5A-7AR 5.26 AMPS 4000 SURGE II USED WITH 400V CAL ECC 3.4MVA/1000 4000 700 7/2 509 4000 120 809 4000 120 809 4000 120 809	
<b>DATE TEST CONDUCTED</b> 17 JUL 87	
<b>TEST CONDUCTED BY</b> J. E. B.	



<b>RADIATED EMISSION</b> Identification	
TEST SPECIMEN	MAL OLF. IMITATOR
TEST METHOD	450 SL. AP
TEST METHOD - SEE	48 22.82
SCAN SPEED	30 SEC/SPAN
SPECIMEN ORIENTATION	VERTICAL
SPECIMEN POWER	IN VAC <u>RED</u>
	OUT VAC <u>GREEN</u>
	110 VAC ON OFF
	115 VAC ON OFF
	NUMERICAL ANTENNA
	VERTICAL <input checked="" type="checkbox"/>
	HORIZONTAL <input type="checkbox"/>
	SPECIMEN PORTABLE <input checked="" type="checkbox"/> <input type="checkbox"/>
COMMENTS	<p>CREATED: BUAL A501E</p> <p>5457 152 CM MAP</p> <p>SIZE AUTO</p> <p>L100 SELECT II</p> <p>11500 400 MHz CAL</p> <p>6 CG SIMULATOR</p> <p>MODEL Y10 511 459</p> <p>DATA 120 0PM</p> <p>AMPLITUDE 1.000 VIT</p>
DATE TEST CONDUCTED	22 DEC 82
TEST CONDUCTED BY	Y/S/ndk



RADIATED EMISSION Narrowband	
TEST SPECIMEN	VPAL DEF/SIMULATOR 400 51-AF 3/12 2282
TEST METHOD - SEE 21	
SCAN SPEED	20 SEC/STEP
SPECIMEN OPERATIONAL MODE	20K
SPECIMEN POWER	
MOD	
115 VOLTAGE	BLUE
115 VOLTAGE	RED
MECHANICAL ANTENNA	<input checked="" type="checkbox"/>
VERTICAL	<input type="checkbox"/>
HORIZONTAL	<input type="checkbox"/>
SPECIMEN MOVABLE	<input type="checkbox"/> 11 <input type="checkbox"/> 00
COMMENTS	OPERATIONAL NOISE SYST VOL ON MAX 5.2E AUTO LEAD SELECT II WLED WITH AUTO CAL ECC SIMULATOR MODEL Y10 94 699 RATED 120 BPM AMPL. TEST 1 MIN VOL?
DATE TEST CONDUCTED	29 APR 87
TEST CONDUCTED BY	<i>[Signature]</i>



**CONDUCTED EMISSION**  
 Measurement

TEST FREQUENCY: 450 50.00 MHz  
500 50.00

TEST METHOD: CE 01 (EN61000-6-10) (30MHz - 300MHz)  
 CE 02 (EN61000-6-10)

SCAN SPEED: 30 SEC/MHz

SPECIFIC OPERATIONAL MODE: CC

SPECIFIC POWER: \_\_\_\_\_

IN VEC: BALCON

FILE NAME: BLUC

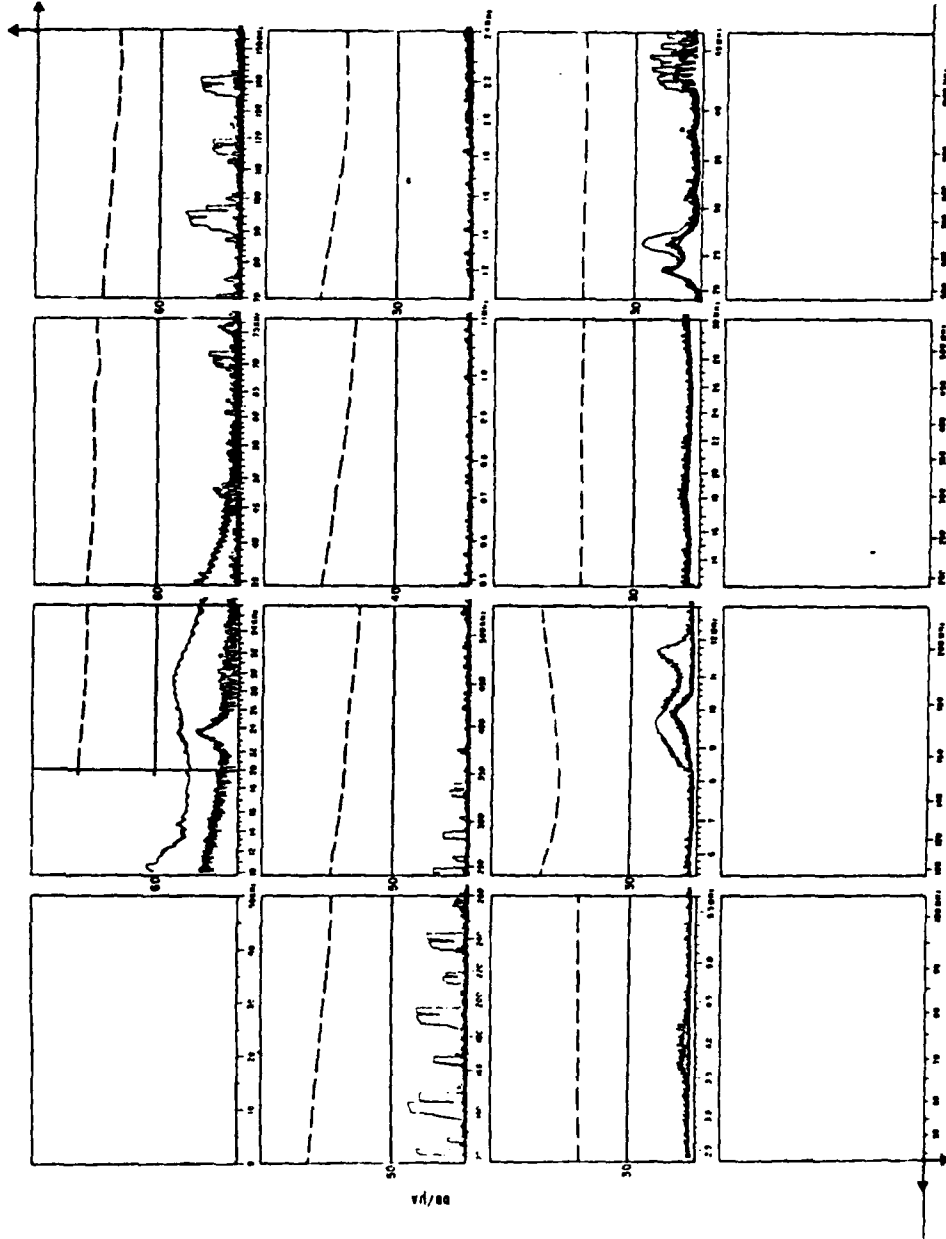
10 VEC MODE: ACD

SPECIFIC MODEL NAME: \_\_\_\_\_

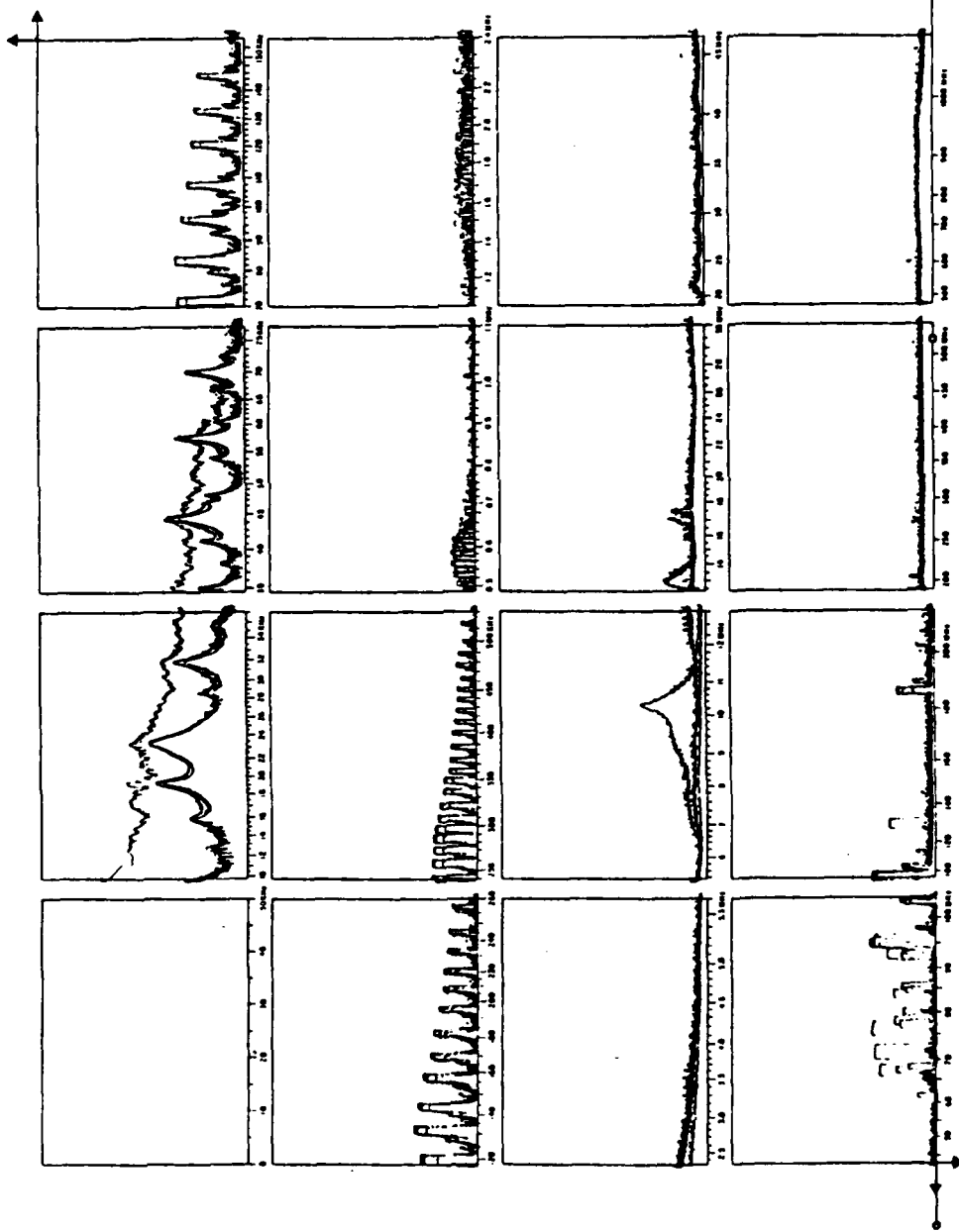
1 \_\_\_\_\_

COMMENTS:  
 OPERATIONAL MODE  
 TEST VOLTAGE: 10V  
 TEST CURRENT: 10A  
 TEST WITH: 10A  
 ECG SIMULATOR  
 MODEL: 400 50.00  
 ANTENNA: 100 50.00  
 AMPLITUDE: 100.00

DATE TEST CONDUCTED: \_\_\_\_\_  
 TEST OPERATOR: \_\_\_\_\_  
 \_\_\_\_\_



<b>RADIATED EMISSION</b> Narrowband	
TEST SPECIMEN MAKE DEF-DRILLATOR NO. S. - AF S/N 2291	TEST METHOD: RE 99
SCALE SPEED 10 SEC/BWD SPECIMEN OPERATIONAL MODE D.C.	SPECIMEN POWER H31701 GREEN M VDC BLACK
115 VAC 60 Hz 1.44C 115 VAC 60 Hz F2D MECHANICAL INTERF.	VERTICAL <input checked="" type="checkbox"/> HORIZONTAL <input type="checkbox"/>
SPECIMEN: INVERTABLE <input checked="" type="checkbox"/> COMMENTS CHAMBER-AL MODE SPT. VIL ON MEAS 3 sec AURC LEAD SELECT II 0520 WITH MEAS 1.4L SCC 5-INITIATED 11.001 4/C 4-834 RATE 120 BPP AMPLITUDE 1 mV/div	DATE TEST CONDUCTED 15 DEC 57 TEST CONDUCTED BY J. E. G.



<b>CONDUCTED EMISSION</b> Manufacturing	
TEST SPECIES MIL SCENARIO 1-A	
MIL 20-45	
X-2281	
TEST METHOD - CE 21 (MIL-STD-461C)	
CE 21 (MIL-STD-461C)	
SCHED SPEED <u>10-25-30-40-50</u>	
SPECIFIC OPERATIONAL MODE <u>L-1</u>	
SPECIFIC POWER	
M VOLT <u>3.000</u>	
VOLTAGE UNIT <u>Ohm</u>	
VOLTAGE RANGE <u>RED</u>	
SPECIFIC POWER UNIT	
<u>MVA</u>	
1	
COMMENTS EXTRINSIC MVA BYST VMA ON HAF SIRE AMB LEAD SELECT MVA 10-25-30-40-50 CE 21 SIMULATION MVA 10 25 30 40 50 MVA 120 RPM MVA 100 RPM	
DATE TEST CONDUCTED 16 OCT 57	
TEST CONDUCTED BY <u>J. J. Smith</u>	

