AFRL-DE-PS
TR-1998-1040

SUMMARY OF ELECTROMAGNETIC INTERFERENCE MEASUREMENTS AT MT. HALEAKALA OBSERVATION FACILITIES

Dean I. Lawry
S. L. Langdon
S. J. Gutierrez

April 1998

Final Report

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

AIR FORCE RESEARCH LABORATORY
Directed Energy Directorate
3550 Aberdeen Ave SE
AIR FORCE MATERIEL COMMAND
KIRTLAND AIR FORCE BASE, NM 87117-5776

AFRL-DE-PS-TR-1998-1040

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data, does not license the holder or any other person or corporation; or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report has been reviewed by the Public Affairs Office and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

If you change your address, wish to be removed from this mailing list, or your organization no longer employs the addressee, please notify AFRL/DEOB, 3550 Aberdeen Ave SE, Kirtland AFB, NM 87117-5776.

Do not return copies of this report unless contractual obligations or notice on a specific document requires its return.

This report has been approved for publication.

Dean I. Lawry
Project Manager

FOR THE COMMANDER

Leonard M. Contreras, DR-IV
Chief, Integration & Operations Division

R. Earl Good
Director, Directed Energy Directorate

REPORT DOCUMENTATION PAGE

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	April 98	Final 13 Oct 97-21 Nov 97

4. TITLE AND SUBTITLE
SUMMARY OF ELECTROMAGNETIC INTERFERENCE MEASUREMENTS AT MT. HALEAKALA OBSERVATION FACILITIES

5. FUNDING NUMBERS
PE: 35910F
PR: 4241
TA: ND
WU: 03

6. AUTHOR(S)
Dean I. Lawry
S.L. Langdon
S.J. Gutierrez

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory
Directed Energy Directorate
3550 Aberdeen Ave. SE
Kirtland AFB, NM 87117-5776

8. PERFORMING ORGANIZATION REPORT NUMBER
AFRL-DE-PS-TR-1998-1040

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release: Distribution is Unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 Words)***

This report documents electromagnetic interference (EMI) measurements made at the Air Force's new Advanced Electro-Optical System (AEOS) and the Space Command Optical facilities located at the summit of Mt. Haleakala, Maui, Hawaii. It also documents EMI measurements made at the University of Hawaii's observation facilities also located on Mt. Haleakala. EMI free field measurements were made at various external and internal locations at these facilities to determine the electromagnetic field characteristics created by local television and radio transmitters located nearby. Some limited cable coupling measurements were also made at the AEOS facility. A Tektronix 2716 spectrum analyzer and a EMCO 3104C bicone antenna were used to make the free field measurements. EG&G SCP-1 and SCP-5 clamp on current probes were used to make the cable measurements. External field levels measured within direct line of sight of nearby television transmitting antennas were as high as 5 V/m. Other measurements made inside well shielded areas were in the noise floor of the spectrum analyzer. Measured frequencies ranged from 61 MHz to 450 MHz.

14. SUBJECT TERMS			15. NUMBER OF PAGES
Electromagnetic Measurements	Interference	Spectrum Analyzer	24
Free Fields	Cable Coupling		16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

Dean Lawry/505-853-3392

Table of Contents

List of Figures

List of Tables

1.0 Background

The Directed Energy (DE) Directorate is developing a new Advanced Electro-Optical System (AEOS), a 3.67m telescope located at the summit of Mt Haleakala (10,000 ft). The Advanced Electro-Optical System facility (approx. 40,000 sf) is co-located with the Air Force Space Command Optical facility and the University of Hawaii observatory programs. Prior to construction of the facility, a group from the 1839 Engineering Installation Group, Keesler AFB, performed an Electromagnetic Interference (EMI) survey. Since the construction of the new AEOS facility, a new EMI survey was needed to evaluate impact of the facility on existing systems and to determine levels within the facility itself.

A new fog detection and alert system is being installed to alert the facility operations personnel to the encroachment of fog so as to close the site in time to prevent the systems inside from experiencing extreme humidity. The system consists of a number of weather sensors located on the Southwest slope of Mt. Haleakala. Data gathered by these sensors are transmitted to a central computer at the facility for data reduction and analysis by a radio frequency (RF) link operating at 138.925 MHz. This system is experiencing problems due to nearby transmitters. In addition to the weather sensors, video cameras are being installed to obtain visual coverage of the site. The video system is experiencing EMI interference with the remote control system to aim and focus the camera. The RF link uses a monopole antenna to receive data from the remote weather sensors. A notch filter was added to the system's receiver to reduce signals outside the sensor transmission band, which improved performance, but did not completely eliminate unwanted receiver noise.

The University of Hawaii is also experiencing a EMI problems with some of its charge coupled device (CCD) imaging systems. Ghosting from some of the TV transmitters is interfering with data collection during observations. It was requested that DE provide a limited Electromagnetic (EM) survey to determine the field levels at some of their facilities.

The objectives of the EMI measurements were:

1.) A survey of the AEOS facility to determine the current EM environment.
2.) A detailed look at the specific problems related to the fog detection system
3.) A survey of the Air Force Space Command facility to determine the effect of the AEOS building on the current EM environment
4.) A limited survey of the University of Hawaii facilities to determine the current EM environment.

2.0 Approach

The field measurements made by the 1839 Engineering Installation Group from Keesler AFB were accomplished prior to AEOS construction. Since construction, new measurements were needed to determine the changes in EM Environment due to the new AEOS structure. During the period of 14-16 October, DE made a set of measurements at selected points both internal and external to the AEOS facility. In addition to the facility measurements, field measurements were made on the Space Command Main Observatory building at five rooftop and observatory locations to provide insight into the effect of the AEOS building on the electromagnetic environment. The bulk of the measurements were made while the TV transmitters were radiating, however a limited number of measurements were also made during a short period when most of the TV transmitters were shut off to facilitate background measurements. These measurements provided an opportunity to locate other possible transmissions that were masked by the TV transmissions.

Additional measurements were made for the University of Hawaii Solar Observatory project at various external locations. An additional measurement was taken inside the National Park's summit house, located a short distance North of the AEOS facility, since that is a proposed as a possible location for a video camera as part of the fog alert system.

3.0 Instrumentation

Test Equipment: The equipment used for this effort is delineated in Table 1. All equipment requiring calibration were within there specified calibration cycle. Figure 1 shows the typical equipment configuration.

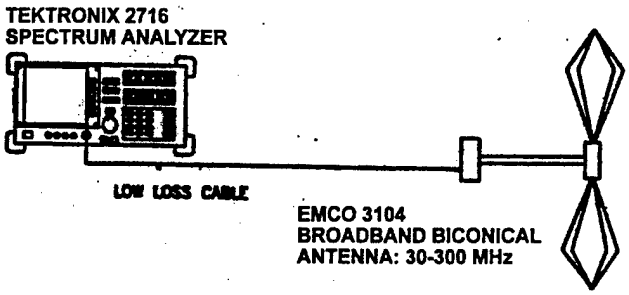

Figure 1: Typical instrumentation setup

Tektronics 2716 Spectrum Analyzer
EMCO 3104C Bicone Antenna
EG&G SCP-1(2) Clamp on Current Probe
EG&G SCP-5(3) Clamp on Current Probe
Various Attenuators, Adapters, Etc

Table 1 : Test Equipment List

4.0 Test Point Locations

Test points were located throughout the various sites atop Mt Haleakala. Several points were acquired inside and outside on the roof of the AEOS building. These locations are illustrated in figures 2, 3 and 4. Figure 5 shows the various measurement locations on the Air Force Space Command facility. Figure 6 shows the measurement locations for the University of Hawaii Observation facilities. Figure 7 is included to show the vertical side view of the AEOS facility for reference. Table 2 defines the AEOS test points taken at these locations. The bicone antenna was rotated until a maximum field strength reading was obtained. Periodically the antenna would be rotated to the vertical position to determine if there were stronger vertical fields. During these checks, vertical responses were always lower than those measured with the antenna in the horizontal position. Variances in the measured levels from the minimum to the maximum were usually not extreme. Positions of the antenna locations were temporary marked with tape on the floor and measurements to nearby reference points were made should measurements need to be repeated in the future. Measurements at all of the specified locations at AEOS were made with the dome closed. Measurements on the fourth floor were also made with the dome in the down position. The results of these measurements are presented in tables shown in the Data Summary Section.

TEST POINT	FLOOR	EXTERNAL	INTERNAL	SIDE
3-E	3rd	Roof		East
3-N	3rd	Roof		North
3-W	3rd	Roof		West
3-S	3rd	Roof		South
3-NI	3rd		Inside-Floor	North
4-EI	4th		Inside-Floor	East
4-NI	4th		Inside-Floor	North
4-WI	4th		Inside-Floor	West
4-SI	4th		Inside-Floor	South
LNEA (On High Lift)	4th		Inside-Floor (Dome Down)	North East
CR (Control Room)	2nd		Inside-Control Room	Near Computer Equipment

Table 2: AEOS Test Point Locations

Five measurements were acquired at the Main Observatory building. These are illustrated in figure 5. Table 3 defines the Main Observatory test points taken.

TEST POINT	LOCATION	INTERNAL	EXTERNAL	DIRECTION
O16	1.6 m dome	On Lift		Facing AEOS
O12	1.2 m dome	On Lift		Facing AEOS
LBD	Roof		Near LBD	Facing AEOS
GD2	Dome Catwalk		GEODSS 2	Facing AEOS
GD3	Dome Catwalk		GEODSS 3	Facing AEOS

Table 3: Main Observatory Building Test

Four external measurements were acquired for the University of Hawaii. These are illustrated in Figure 6. Table 4 defines the test points taken for the University of Hawaii.

TEST POINT	FACILITY	LOCATION	DIRECTION
AGR	Airglow Building	NE Corner	East
ZLR	ZL Building	SW Corner	North East
MEES	MEES Building	SW Corner	East
OGL	West of MEES	Down Hill/Ground Level	North

Table 4: University of Hawaii Test Points

An additional measurement was taken inside the summit house located about a half of a mile North of the AEOS facility at Mt Haleakala State park.

5.0 Data Correction

The data taken on the spectrum analyzer was internally corrected from DBm to V/m using antenna correction factors entered into the instrument. External attenuation used was entered into the device and corrected using the instrument. During the measurements these correction factors were enabled and the field levels were read off the display using the Marker functions. The antenna correction factors are shown below.

Antenna Factors for Bicone Antenna (EMCO 3104C S/N 8904-3945)

MHz	Factor
20	14.7
30	10.2
40	11.5
50	12.7
60	11.9
70	8.4
80	7.7
90	9.7
100	12.2
110	14.7
120	14.6
130	13.4
140	12.6
150	13.1
160	15.5
170	16.9
180	17.1
190	17.6
200	18.2
210	18.2

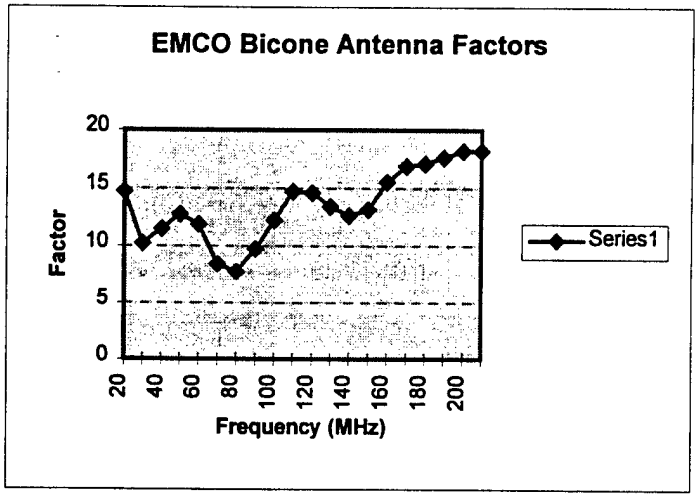

Table 5: Antenna Correction Factors for Bicone Antenna

6.0 Data Summary

The following tables present the EMI measurement data taken at the different observation facilities on Mt. Haleakala. The location of each set of measurements can be referring to the corresponding figure and location code.

MEASUREMENTS ON THE 3RD FLOOR (AEOS)					
		(3-E)	(3-N)	(3-W)	(3-S)
Emitter	Frequency	E-Field	E-Field	E-Field	E-Field
	(MHz)	V/M	V/M	V/M	V/M
Ch 3 KGMB Visual	61	4.43	0.92	0.14	5.01
Ch 3 KGMB Aural	65.5	1.19	0.88	0.19	0.27
Public Radio Hawaii	90.7	1.11	2.09	0.27	1.11
US Navy	131.5			0.004	
Dept of Justice	162.1	1	0.68	0.043	0.41
Dept of Treasury	165.2	0.79		0.007	0.5
Ch 7, KAII, Visual	175.1	1.15	2.87	0.19	4.18
Ch 7, KAII, Aural	179.6	0.82	0.88	0.006	1.85
Ch 10, KHET, Aural	193	1.81	1.57	0.003	3.45
Ch 10, KHET, Visual	197.6	1.23	0.65	0.007	1.08
Ch 12, KMAU, Visual	205	0.82		0.014	1.51
Ch 12, KMAU, Aural	209.3	0.41		0.017	0.34

Table 6: Measurements on the 3rd Floor (AEOS)

MEASUREMENTS ON THE 3RD FLOOR INSIDE (AEOS)		
		(3-NI)
Emitter	Frequency	E-Field
	(MHz)	V/M
Ch 3 KGMB Visual	61	0.28
Ch 3 KGMB Aural	65.5	0.016
Public Radio Hawaii	90.7	0.28
US Navy	131.5	0.062
Dept of Justice	162.1	0.085
Dept of Treasury	165.2	0.025
Ch 7, KAII, Visual	175.1	0.022
Ch 7, KAII, Aural	179.6	0.038
Ch 10, KHET, Aural	193	0.12
Ch 10, KHET, Visual	197.6	0.17
Ch 12, KMAU, Visual	205	0.046
Ch 12, KMAU, Aural	209.3	0.042

Table 7: Measurements on the 3rd Floor Inside (AEOS)

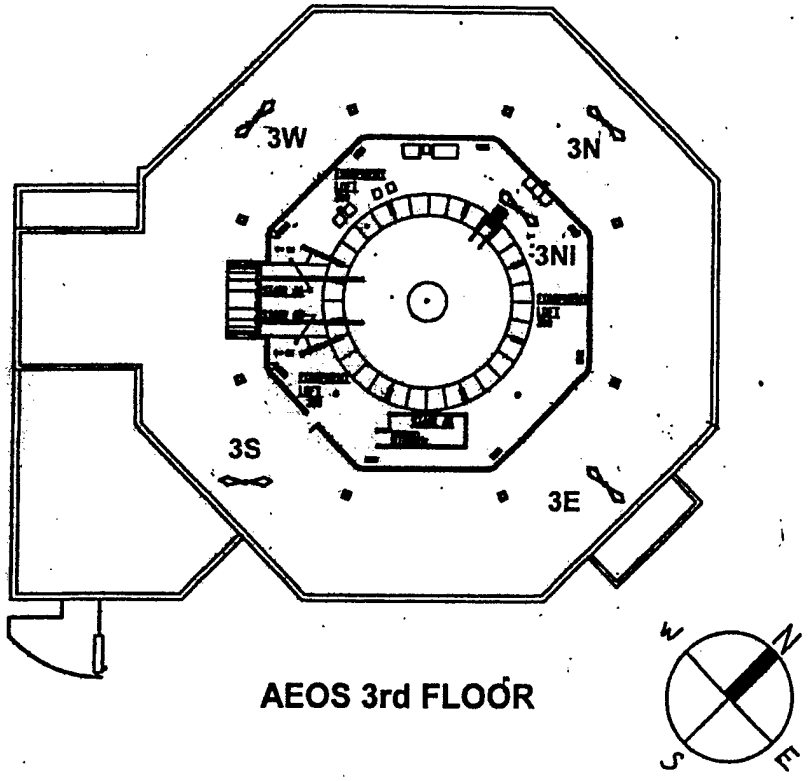

Figure 2 AEOS Third Floor Measurements

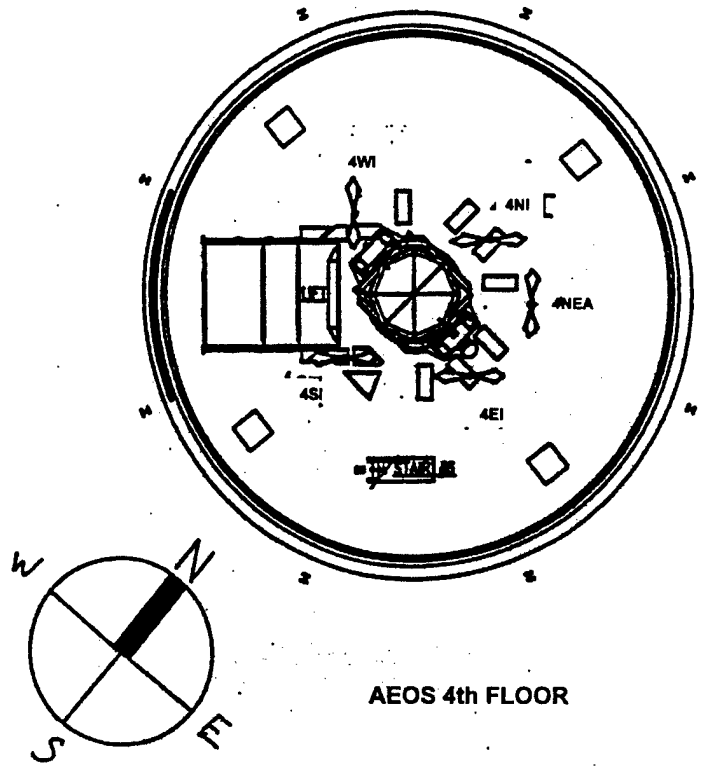

Figure 3 AEOS Fourth Floor Measurements

MEASUREMENTS ON THE 4TH FLOOR INSIDE AEOS (TOP CLOSED)					
		(4-SI)	(4-EI)	(4-WI)	(4-NI)
Emitter	Frequency	E-Field	E-Field	E-Field	E-Field
	(MHz)	V/M	V/M	V/M	V/M
Ch 3 KGMB Visual	61	0.34	0.28	0.39	0.12
Ch 3 KGMB Aural	65.5	0.1	0.056	0.041	0.049
Public Radio Hawaii	90.7	0.024	0.12	0.71	0.085
US Navy	131.5	0.015			
Dept of Justice	162.1	0.073	0.038	0.078	0.016
Dept of Treasury	165.2	0.038	0.031	0.049	0.009
Ch 7, KAII, Visual	175.1	0.05	0.014	0.026	0.072
Ch 7, KAII, Aural	179.6	0.035	0.012	0.042	0.01
Ch 10, KHET, Aural	193	0.13	0.036	0.023	0.022
Ch 10, KHET, Visual	197.6	0.016	0.035	0.023	0.016
Ch 12, KMAU, Visual	205	0.052	0.048	0.024	0.02
Ch 12, KMAU, Aural	209.3	0.075	0.002	0.004	0.007
	124		0.011	0.026	

Table 8: Measurements on the 4th Floor Inside AEOS (Top Closed)

MEASUREMENTS ON THE 4TH FLOOR INSIDE AEOS (TOP OPEN)						
		(4-SI)	(4-EI)	(4-WI)	(4-NI)	(LNEA))
Emitter	Frequency	E-Field	E-Field	E-Field	E-Field	E-Field
	(MHz)	V/M	V/M	V/M	V/M	V/M
Ch 3 KGMB Visual	61	1.27	1.57	1.32	3.41	9.71
Ch 3 KGMB Aural	65.5	0.32	0.68	0.41	0.76	1.6
Public Radio Hawaii	90.7	1.32	0.9	1.09	1	4
US Navy	131.5					
Dept of Justice	162.1	0.21	0.039	0.23	0.61	1.27
Dept of Treasury	165.2	0.41	0.36	0.28	0.15	0.44
Ch 7, KAII, Visual	175.1	0.25	0.56	0.42	1.37	3.84
Ch 7, KAII, Aural	179.6	0.15	0.22	0.15	0.33	2.05
Ch 10, KHET, Aural	193	0.094	0.22	0.2	0.38	1.48
Ch 10, KHET, Visual	197.6	0.032	0.044	0.037	95.5	0.56
Ch 12, KMAU, Visual	205	0.16	0.14	0.068	0.35	1.27
Ch 12, KMAU, Aural	209.3	0.042	0.042	0.003	95.5	0.38
	126			0.1		
	211			0.006		
	458	0.013				
	449.9					0.024

Table 9: Measurements on the 4th Floor Inside AEOS (Top Open)

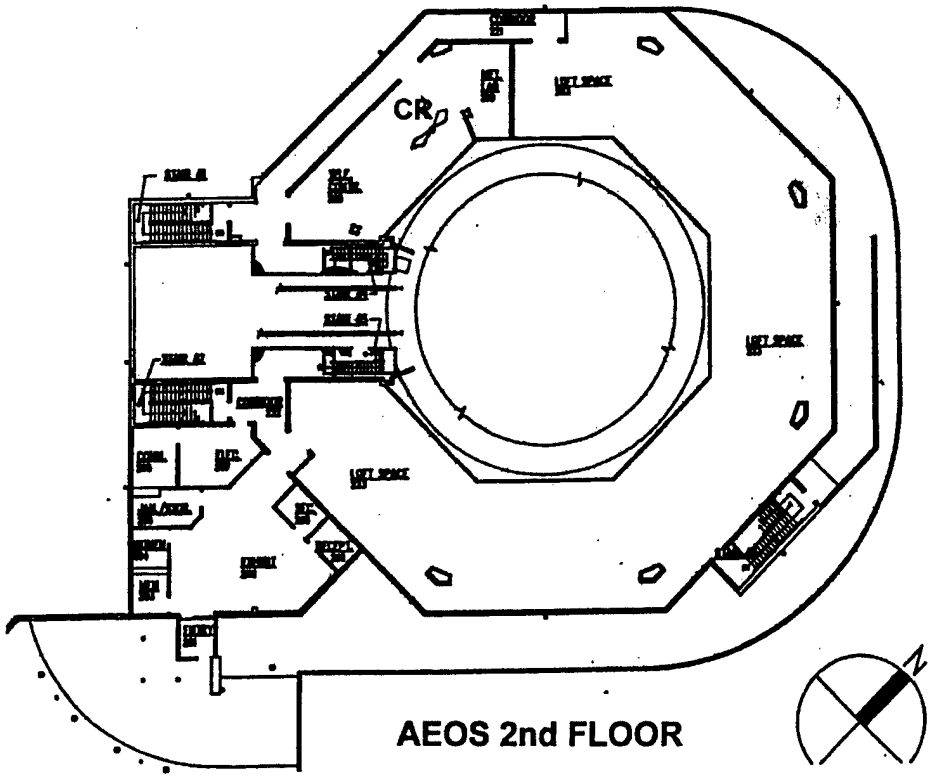

Figure 4 AEOS Second Floor Measurements

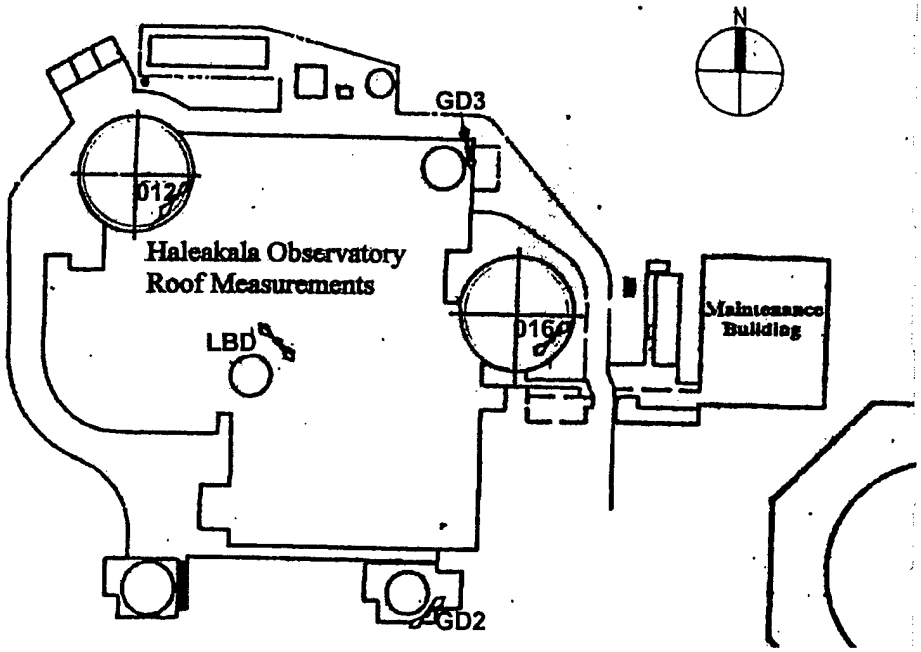

Figure 5 Space Command Haleakala Observatory Roof Measurements

1.6 METER OBSERVATORY			
		Aeos Dome Down	Aeos Dome Up
		O16	O16
Emitter	Frequency	E-Field	E-Field
	(MHz)	V/M	V/M
Ch 3 KGMB Visual	61	4	3.41
Ch 3 KGMB Aural	65.5	0.12	0.27
Public Radio Hawaii	90.7	0.9	0.27
US Navy	131.5		
Dept of Justice	162.1	0.13	0.12
Dept of Treasury	165.2	0.04	0.046
Ch 7, KAII, Visual	175.1	4.69	4.05
Ch 7, KAII, Aural	179.6	1.81	1.32
Ch 10, KHET, Aural	193	1.74	0.86
Ch 10, KHET, Visual	197.6	0.5	0.61
Ch 12, KMAU, Visual	205	1.17	1.27
Ch 12, KMAU, Aural	209.3	0.3	0.42
	450	0.049	

Table 10: Space Command 1.6 Meter Observatory

1.2 METER OBSERVATORY (AEOS DOME UP)		
		O12
Emitter	Frequency	E-Field
	(MHz)	V/M
Ch 3 KGMB Visual	61	0.93
Ch 3 KGMB Aural	65.5	0.52
Public Radio Hawaii	90.7	0.61
US Navy	131.5	
Dept of Justice	162.1	0.089
Dept of Treasury	165.2	0.24
Ch 7, KAII, Visual	175.1	0.8
Ch 7, KAII, Aural	179.6	0.4
Ch 10, KHET, Aural	193	1.51
Ch 10, KHET, Visual	197.6	0.55
Ch 12, KMAU, Visual	205	0.9
Ch 12, KMAU, Aural	209.3	0.26
	291	0.011
	172.9	0.089

Table 11: Space Command 1.2 Meter Observatory

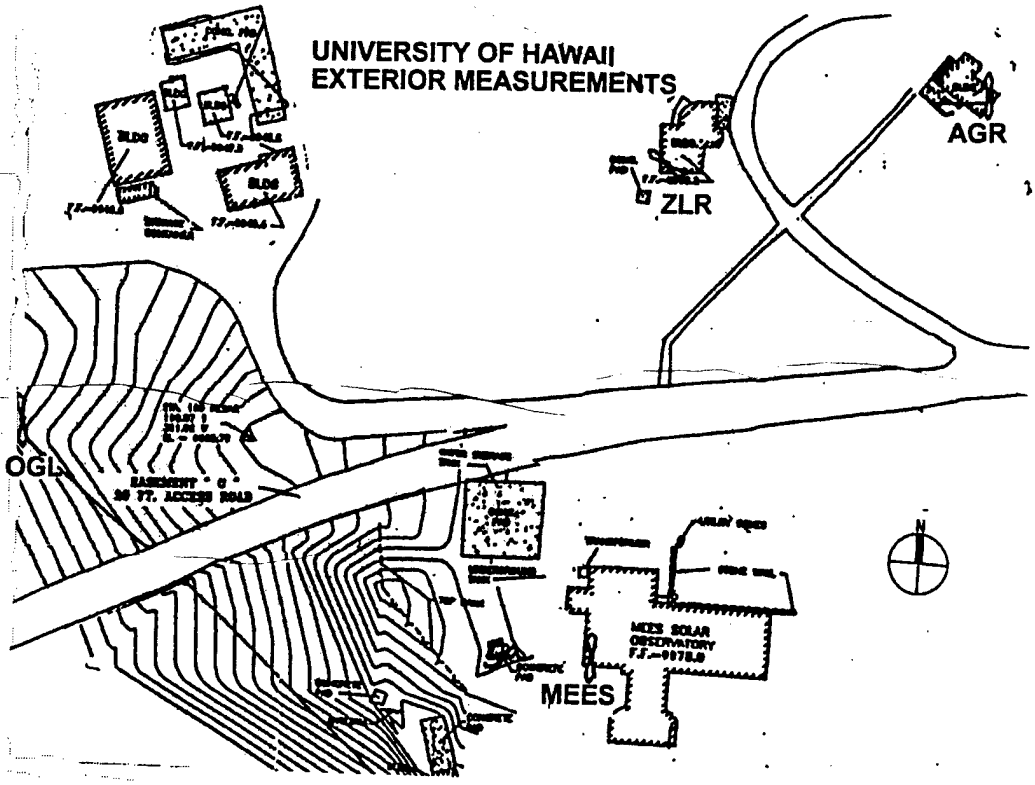

Figure 6 University of Hawaii Measurements

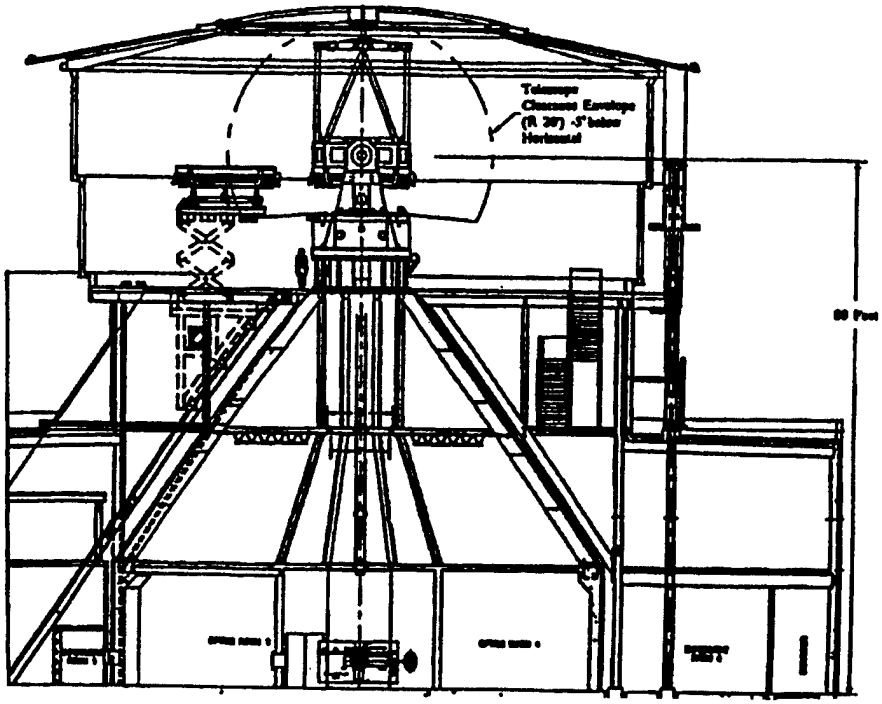

Figure 7 AEOS Facility Side View

LBD BUILDING (OUTSIDE ON THE ROOF)		
		LBD
Emitter	Frequency	E-Field
	(MHz)	V/M
Ch 3 KGMB Visual	61	0.39
Ch 3 KGMB Aural	65.5	0.13
Public Radio Hawaii	90.7	2.18
US Navy	131.5	
Dept of Justice	162.1	0.041
Dept of Treasury	165.2	0.13
Ch 7, KAII, Visual	175.1	0.82
Ch 7, KAII, Aural	179.6	0.28
Ch 10, KHET, Aural	193	0.2
Ch 10, KHET, Visual	197.6	0.047
Ch 12, KMAU, Visual	205	0.084
Ch 12, KMAU, Aural	209.3	0.058
	450	0.011

Table 12: Space Command LBD Building (Outside on the Roof)

GEODSS 2&3 DOMES (OUTSIDE ON THE CATWALK)			
		GD2	GD3
Emitter	Frequency	E-Field	E-Field
	(MHz)	V/M	V/M
Ch 3 KGMB Visual	61	0.62	2.61
Ch 3 KGMB Aural	65.5	0.14	0.8
Public Radio Hawaii	90.7	0.12	1.97
US Navy	131.5		
Dept of Justice	162.1	0.062	0.18
Dept of Treasury	165.2	0.27	0.02
Ch 7, KAII, Visual	175.1	0.27	0.01
Ch 7, KAII, Aural	179.6	0.11	3.28
Ch 10, KHET, Aural	193	0.13	6
Ch 10, KHET, Visual	197.6	0.028	1.97
Ch 12, KMAU, Visual	205	0.021	1.54
Ch 12, KMAU, Aural	209.3	0.012	0.35
	450	0.005	0.021
	125	0.039	

Table 13: Space Command GEODSS 2& 3 Domes (Outside on the Catwalk)

U OF HAWAII AIRGLOW ROOF,ZL ROOF, MEES, & OUTDOOR GROUND LEVEL					
		AGR	ZLR	MEES	OGL
Emitter	Frequency	E-Field	E-Field	E-Field	E-Field
	(MHz)	V/M	V/M	V/M	V/M
Ch 3 KGMB Visual	61	1.43	1.09	0.25	0.1
Ch 3 KGMB Aural	65.5	0.36	0.21	88.4	0.03
Public Radio Hawaii	90.7	0.59	0.21	0.21	0.058
US Navy	131.5	0.42			
Dept of Justice	162.1	0.15	0.049	0.054	0.012
Dept of Treasury	165.2	0.25	0.1	0.035	0.003
Ch 7, KAII, Visual	175.1	3.16	0.22	0.19	0.06
Ch 7, KAII, Aural	179.6	1.27	0.067	0.054	0.004
Ch 10, KHET, Aural	193	2.05	0.2	0.18	0.063
Ch 10, KHET, Visual	197.6	0.61	0.058	0.046	0.02
Ch 12, KMAU, Visual	205	0.83	0.039	0.056	0.011
Ch 12, KMAU, Aural	209.3	0.16	0.013	0.01	0.007
	450	0.005	0.001	0.004	0.0007
	211		0.035		
	455				0.0006

Table 14: University of Hawaii Airglow Roof, ZL Roof, MEES, and Outdoor Ground Level

AEOS DOME CONTROL ROOM, AND SUMMIT HOUSE			
		CR	Summit
Emitter	Frequency	E-Field	E-Field
	(MHz)	V/M	V/M
Ch 3 KGMB Visual	61	0.026	0.21
Ch 3 KGMB Aural	65.5	0.013	0.062
Public Radio Hawaii	90.7	0.014	0.29
US Navy	131.5		
Dept of Justice	162.1	0.002	0.031
Dept of Treasury	165.2	0.003	0.012
Ch 7, KAII, Visual	175.1	off	0.83
Ch 7, KAII, Aural	179.6	off	0.32
Ch 10, KHET, Aural	193	off	off
Ch 10, KHET, Visual	197.6	off	off
Ch 12, KMAU, Visual	205	0.016	0.068
Ch 12, KMAU, Aural	209.3	0.017	0.013

Table 15: AEOS Dome Control Room, and Summit House

BLACKOUT TEST (THIRD FLOOR MEASUREMENTS ON AEOS OUTSIDE)			
		Xmitting	Off
		3S	3S
Emitter	Frequency	E-Field	E-Field
	(MHz)	V/M	V/M
Ch 3 KGMB Visual	61	5.21	Off
Ch 3 KGMB Aural	65.5	0.38	Off
Public Radio Hawaii	90.7	0.5	0.5
US Navy	131.5		
Dept of Justice	162.1	0.15	0.15
Dept of Treasury	165.2	0.29	0.29
Ch 7, KAII, Visual	175.1	3.69	Off
Ch 7, KAII, Aural	179.6	1.54	Off
Ch 10, KHET, Aural	193	Off	Off
Ch 10, KHET, Visual	197.6	Off	Off
Ch 12, KMAU, Visual	205	1.04	1.04
Ch 12, KMAU, Aural	209.3	0.22	0.22

Table 16: Blackout Test (3rd Floor Measurements AEOS Outside)

7.0 Analysis

A general overview of the data shows that measurements taken in direct line of sight of the TV transmitter antennas have the highest field levels. Measurements taken where the TV antennas have been masked by buildings or by terrain show that field levels have been attenuated by 1 to 2 orders of magnitude. Field levels measured inside buildings showed similar reductions in levels.

Cable response measurements made on the fog alert system video camera control cable showed that significant currents were present on the cable. Further examination of the control cable revealed that there was no external shield to provide the necessary electromagnetic protection to prevent unwanted currents from interfering with the control functions. We recommend that the cable be replaced with a shielded cable with connectors that bond the shield to the backshell of the connector around the entire periphery so as to flow currents from the cable shield to the equipment enclosure (assuming it is metal and properly grounded). The shielded cable and connectors need to be properly installed and the equipment enclosures grounded at both ends of the cable. Shields that are "pig tailed" to the enclosure or ground will not provide shielding at frequencies above 1 MHz. A shielded cable should reduce coupling to the control wiring sufficiently to eliminate any functional interference. Cable measurements made from the monopole antenna (used to receive data from the remote sensors) feed indicated that the notch filter that had been installed was performing as intended. While improvement with the filter increased performance additional attenuation of the 61 MHz signal is required. An additional filter centered at 61 MHz, providing at lest 6Db attenuation, in series with the existing filter should be capable of eliminating the 61 MHz interference.

A comparison of the data taken by the 1839th Engineering Group in 1994 before the AEOS facility was constructed with the data taken now reveals some differences. Table 17 shows a summary comparison of these measurements at the AEOS site.

FREQ	40' (1839)	LNEA	3-E	3-MAX
61	4.90	9.71	4.3	5.01
65.5	1.51	1.6	1.19	1.19
90.7	4.95	4.0	1.11	2.09
131.5	1.30	*	*	0.004
162.1	0.98	1.27	1.0	1.0
165.2	0.96	0.44	0.79	.0.79
175.1	7.85	3.84	1.15	2.87
179.6	3.20	1.48	1.81	1.85
193	12.39	1.48	1.81	3.45
197.6	3.89	0.56	1.23	1.23
205.0	9.55	1.27	0.82	1.51
209.3	3.43	0.38	0.41	0.41

- Levels too low to measure

Table 17: Summary Comparison of AEOS Site Data

The column labeled "40' (1839)" is the data taken by the 1839th Engineering Group in 1994 at the forty foot height. This height corresponds closely to the third floor level of the AEOS facility. The 3-E MAX column represents the maximum field levels measured at all four test points made on the third level roof (3-E, 3-N, 3-W, 3-S). There are some significant differences in the data from the 1839th data at the 131.5 MHz, 193 MHz, 205.0 MHz, and 209.3 MHz frequencies. Some of these differences may be the result of reduced transmitter power levels. Other variations may be caused by the AEOS structure. In most cases, except at 61 MHz, the data collected by DE is lower or similar to the results obtained by the 1839th Engineering Group.

FREQ	1839TH DATA	O12
61 MHz	0.93	2.09
65.5 MHz	0.52	0.62
90.7 MHz	0.61	1.23
131.5 MHz	*	0.01
162.1 MHz	0.089	0.09
165.2 MHz	0.24	0.14
175.1 MHz	0.8	2.45
179.6 MHz	0.4	0.97
193 MHz	1.51	2.29
197.6 MHz	0.55	0.88
205 MHz	0.9	4.12
209.3 MHz	0.26	2.16

- Data not included in 1839th Engineering Group report.

Table 18: Space Command AMOS 1.2 Meter Dome Comparisons

Comparison of the 1839th Engineering Group data and the DE data taken at Space Command AMOS facility 1.2 meter dome (Table 18) shows a much higher field level at the 61 MHz frequency. The cause of this higher reading is not clear, but is consistent with the data taken at for the AEOS site/facility during both tests. Similar differences also exist at 175.1 MHz, 205 MHz, and 209.3 MHz. Again these readings are not consistent with readings taken at the AEOS site by the 1839th Engineering Group. The lower readings may be caused by the exact location the readings were taken near the dome. If the location was masked by the dome or building, then they would be consistent. The measurements taken by DE were not masked by the 1.2 meter dome.

It would appear that the AEOS facility has little effect on field levels measured at the Space Command AMOS facility. Most of the field reductions at that facility appear to be caused by terrain. Similar reductions at the University of Hawaii facilities appear to be the result of terrain rather than structures, however, no prior measurements were available for those sites.

DISTRIBUTION LIST

AUL/LSE Bldg 1405 - 600 Chennault Circle Maxwell AFB, AL 36112-6424	1 cy
DTIC/OCP 8725 John J. Kingman Rd, Suite 0944 Ft Belvoir, VA 22060-6218	2 cys
AFSAA/SAI 1580 Air Force Pentagon Washington, DC 20330-1580	1 cy
AFRL/PSOTL Kirtland AFB, NM 87117-5776	2 cys
AFRL/PSOTH Kirtland AFB, NM 87117-5776	1 cy
AFRL/DEHP/William Prather Kirtland AFB, NM 87117-5776	1 cy
AFRL/DEHP/Dr. C. E. Baum Kirtland AFB, NM 87117-5776	1 cy
AFRL/DEBI/Maj Richards Kirtland AFB, NM 87117-5776	2 cys
AFRL/DEBI/Brian Kline Kirtland AFB, NM 87117-5776	2 cys
AFRL/DEBI/SSGT R. Medrano Kirtland AFB, NM 87117-5776	4 cys
AFRL/DEOB/Dr. W. Latham Kirtland AFB, NM 87117-5776	1 cy
AFRL/DEPE/S. Langdon Kirtland AFB, NM 87117-5776	2 cys
AFRL/DEPE/S. Gutierrez Kirtland AFB, NM 87117-5776	2 cys

Official Record Copy
AFRL/DEOB/Dean I. Lawry
Kirtland AFB, NM 87117-5776 5 cys