DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE FOR OPERATIONAL HEALTH (AFMC)
BROOKS CITY-BASE TEXAS

14 Jun 06

MEMORANDUM FOR RSW/BSSG
ATTN: MR. MIKE TAPPAN
2640 LOOP ROAD WEST, BLDG 557
WRIGHT-PATTERSON AFB OH 45433-7106

FROM: AFIOH/SDR
2350 Gillingham Drive
Brooks City-Base TX 78235-5103

SUBJECT: Consult Letter, IOH-SD-BR-CL-2006-0043, Radio Frequency Radiation Hazard Survey for the Compass Call Electronic Counter Measure Systems.

1. Introduction: RSW/BSSG, Wright-Patterson AFB OH tasked the Air Force Institute for Operational Health, Radiation Surveillance Division, Health Physics Consulting Branch (AFIOH/SDRH) to measure the radiofrequency (RF) power densities generated by the different Electronic Counter Measure (ECM) transmitters installed on the EC-130H, Compass Call, aircraft. An RF survey was required due to significant systems modifications to increase the aircraft's capabilities. Capt Néstor A. Ruiz and 1Lt Piper C.M. Williams conducted RF measurements ,from 23 Jan 06 to 1 Feb 06, while the UST-105, low band, mid band, high band, and Special Purpose Emitter Array (SPEAR) systems were transmitting on the EC-130H aircraft.

a. Air Force Occupational Safety and Health Standard (AFOSH STD) 48-9, *Radio Frequency Radiation (RFR) Safety Program*, establishes permissible exposure limits (PELs) for all sources of RF owned or operated by the US Air Force (USAF), or under USAF control.

b. Power densities, boresight to the SPEAR (outside the aircraft), exceeded the controlled and uncontrolled PELs when closer than 97 feet and 177 feet, respectively. No leakage RFR was detected from any equipment rack or transmission line. The average power densities at all manned locations within the aircraft were below the controlled PEL and indistinguishable from background. When transmitting using the low-band (tail) antenna, measurable leakage RFR was detected around the leading edge of the paratrooper (PT) doors, the cargo bay floor-ramp threshold, and at the end of the cargo bay where the transmission lines exit the fuselage.

2. Methodology:

a. Measurements were performed while radiating into dummy loads and antennas as close as possible to full rated power. There are no dummy loads for the UST-105 or the SPEAR. Measurements were performed at all mission crew positions in the cargo compartment, on the flight deck, transmit equipment racks, transmission lines, and in the general vicinity where

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transmission lines exit the fuselage. Measurements were also performed boresight to the SPEAR antennas (outside the aircraft), at the PT and the cargo bay doors (inside the aircraft).

b. The system parameters are classified. A controlled environment is defined as those locations where a RF exposure in excess of the uncontrolled PEL may be incurred by persons that are aware that a RF hazard exists. Some of the emitters are designed to simultaneously transmit more than one specific frequency. When more than one specific frequency is transmitted, compliance with AFOSH STD 28-9 is determined by the following formula:

$$(1)\quad \sum_{i=1}^{n} \frac{E_i^2}{PEL_i^2} \leq 1, \text{and} \sum_{i=1}^{n} \frac{H_i^2}{PEL_i^2} \leq 1$$

Where E (electric field) is in units of volts per meter (V/m) and H (magnetic field) is in units of amps per meter (A/m). If the measurements are in units of power density then the formula is:

$$(2)\quad \sum_{i=1}^{n} \frac{(PD_E)_i}{PEL_i} \leq 1, \text{and} \sum_{i=1}^{n} \frac{(PD_H)_i}{PEL_i} \leq 1$$

Where PD (power density) is in units of milliwatts per centimeter squared (mW/cm^2).

c. For every emitter (Low Band, Mid Band, High Band, and SPEAR), a single frequency was selected and measurements performed at the survey locations while radiating. This Processwas repeated with the same emitter until the worst case scenario of multiple discrete frequencies were employed during actual operational conditions. The data was then analyzed using equations (1) or (2) to determine compliance with AFOSH STD 48-9. This methodology was repeated for each of the emitters except for the UST-105, since it only transmits one discrete frequency. Finally, the single-emitter results were analyzed simultaneously to determine compliance using the worst case scenario of all the emitters transmitting at the same time.

3. Results:

a. No RFR leakage was detected from the equipment racks or transmission lines within the aircraft.

b. Power densities at all aircrew locations within the aircraft meet the exposure criteria for a controlled environment. Attachment 2 contains detailed measurement results.

c. When transmitting with the Low Band antenna only, leakage RFR was identified around the leading edge of the PT doors, the cargo bay floor-ramp threshold, and at the end of the cargo bay where the transmission lines exit the fuselage. Self-induced fields were also measurable around the transmission cables that correspond to the low-band transmitter. In all cases, the power densities were measurable only within four to six inches of the specific location. These locations should not present an occupational risk due to the low probability of personnel standing at close proximity to any of these leaking spots. See Attachment 4 for photos of these locations.

d. Power densities, boresight to the SPEAR (outside the aircraft), exceeded the controlled and uncontrolled PELs when closer than 97 feet and 177 feet, respectively. See Attachment 5 for measurements and power density graphs.

4. Recommendations:

a. Consider installing RFR absorbing material on the leading edge of the PT doors and the cargo bay floor-ramp threshold.

b. Do not allow personnel to touch or grab any transmission line while transmitting.

c. Perform and document annual RFR safety training.

d. Repeat this or a similar survey if new emitters are installed or upgraded.

5. Acknowledgments: We would like to thank all the operators, aircrew, ground crew, and contract personnel for the unconditional availability and assistance during our survey. Their feedback, experience, and skills contributed to acquiring very useful measurements.

6. Please fill and return the critique form included in Attachment 6. If you have any questions please contact Capt Néstor A. Ruiz by calling DSN 240-5364 or sending an email to Nestor.Ruiz@brooks.af.mil.

SCOTT M. NICHELSON, Lt Col, USAF, BSC, CHP, CIH
Chief, Radiation Surveillance Division

Attachments:

1. Personnel contacted & equipment used
2. Data analysis
3. Measurement locations
4. RFR leakage locations
5. SPEAR measurement results and graphs
6. Critique form

Attachment 1
Personnel Contacted & Equipment

Personnel Contacted
Louis Winder, Project Manager,
Det 4 645 MATS, L-3 Communications, Waco, TX

Equipment
Narda Meter, 8718B, SN 1524, Cal due Sep 06

Narda Probes 8741 D, SN 11004, Cal due Sep 06, 8741D, SN 10004, Cal due Aug 06

Attachment 2
Data Analysis

Table 2-1. Average Power Density Measured at Aircrew Locations*

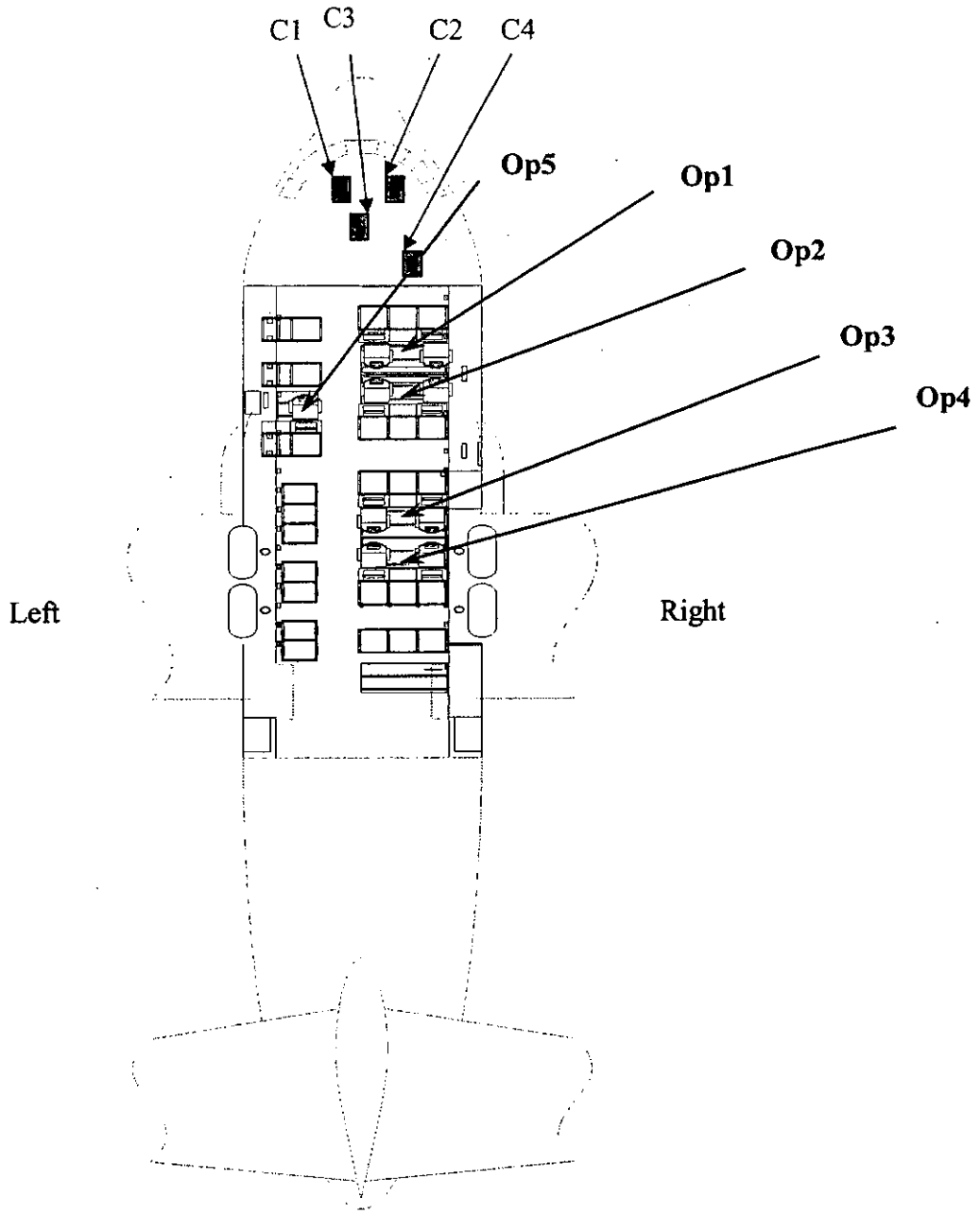
	Radiating Emitter	
Location	Left	Right
C1	0.179	0.207
C2	0.190	0.219
C3	0.201	0.230
C4	0.259	0.242
Op1	0.168	0.196
Op2	0.151	0.125
Op3	0.105	0.074
Op4	0.082	0.083
Op5	0.112	0.104
Loadmaster's bunk	0.380	0.359

Table 2-2. Average Power Density Measured at Leakage Locations*

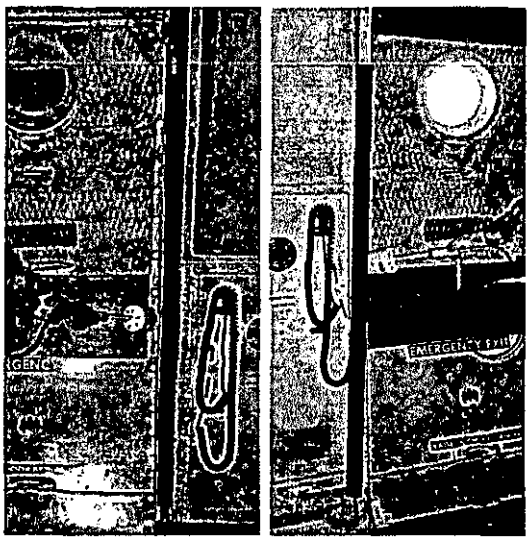
	Radiating Emitter	
Location	Left	Right
PT Door	0.060	0.109
Trans line & Cargo	0.856	0.138
Ramp/Floor threshold	0.468	0.515
Ramp/Floor threshold (max)	**9.349**	**9.405**

*Results represent the sum of the fractions (power density/PEL for all emitters and frequencies) for the E-field. Any number less than 1.0 meets AFOSH STD 48-9.

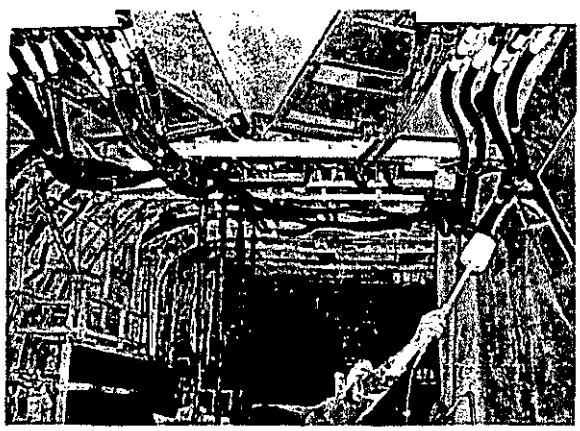
Attachment 3
Measurements locations



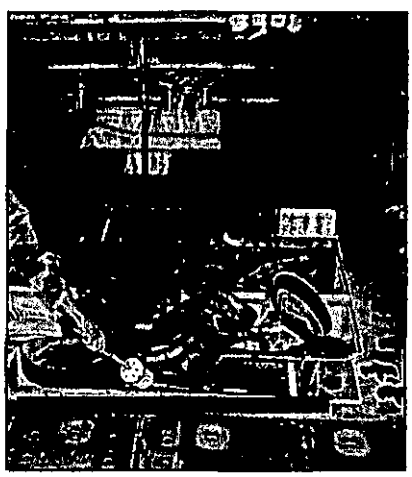
Attachment 4
RFR leakage locations



Left PT Door Right PT Door

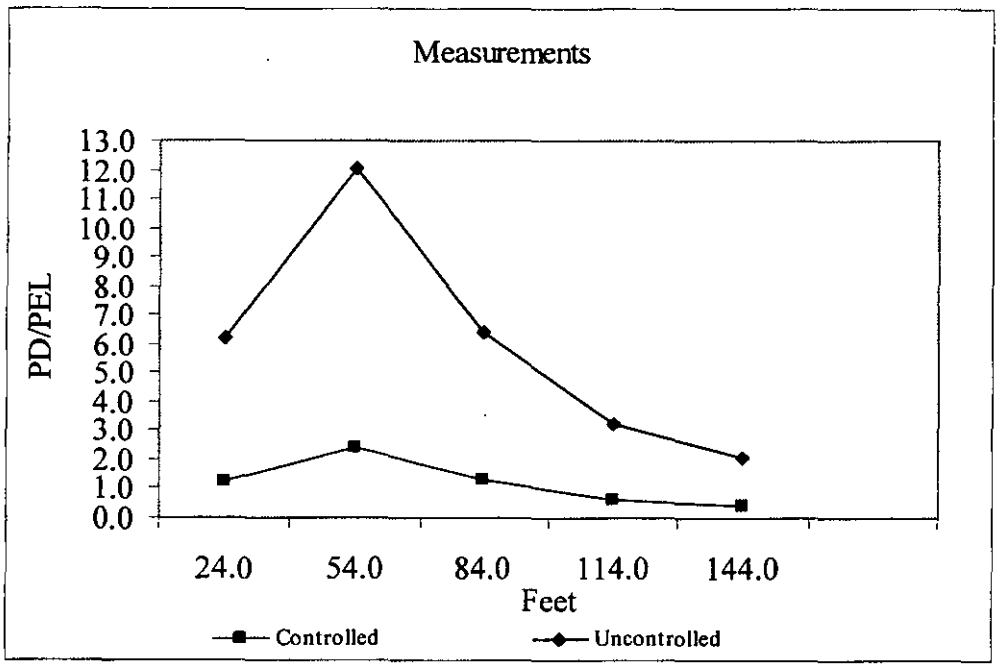


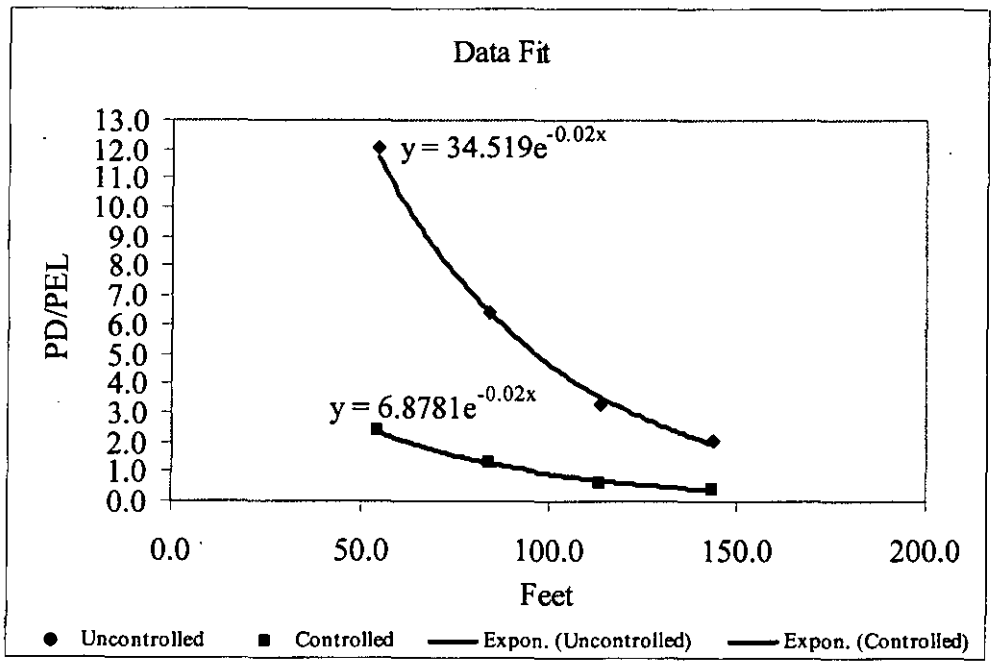
Transmission Lines



Cargo Bay Floor-Ramp Threshold

Attachment 5
SPEAR measurement results





Attachment 6

POINT OF CONTACT:	Capt Néstor A. Ruiz	BASE NAME:	Brooks City-Base
POC PHONE:	DSN 240-5364	DIVISION:	AFIOH/SDRH
STINFO NUMBERS:	IOH-SD-BR-CL-2006- 0043		

This survey is used to help us improve our service to you. Your answer will be held in confidence and will significantly impact on how we allocate resources to meet your needs. Please return this completed form promptly.

Grading Scale:

1	2	3	4	5	6
Extremely Dissatisfied	Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Satisfied	Extremely Satisfied

A	Timeliness: Did you receive your results within the published time limits?	1	2	3	4	5	6
B	Accuracy: Is the report in the proper format? Are your address and other data correct?	1	2	3	4	5	6
C	Content: Does the report answer your questions and provide the necessary data? Are our services per dollar adequate when compared to civilian sector?	1	2	3	4	5	6
D	Customer Support: Have we been courteous and helpful in meeting your special needs (priority service, reporting, format, etc.)?	1	2	3	4	5	6
E	Consult Service: Have we answered your questions and provided necessary materials or reviewed to support your mission requirements?	1	2	3	4	5	6
F	Overall Rating: How would you rate our overall service to you?	1	2	3	4	5	6

Comments / Suggestions: Are there other services that you would like provided in the future? Are there any specifics of your current service you would like to discuss? (Use additional pages if more space is required)

Please return to:

AFIOH/SDR
Attention: Lt Col Scott M. Nichelson
Chief, Radiation Surveillance Division
2350 Gillingham Drive
Brooks City-Base TX 78235-5103