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a report

to the california coastal commission

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and the united states navy

on the coastal effects of radar emissions
from the navy's surface warfare engineering facility
at port hueneme, california

coastal programs division
office of ocean and coastal resource management
national ocean service
national oceanic and atmospheric administration

march 2000

A Report to the California Coastal Commission and the United States Navy

On

The Coastal Effects of Radar Emissions from the Navy's Surface Warfare Engineering Facility at Port Hueneme, California

Submitted by the

Coastal Programs Division
Office of Ocean and Coastal Resource Management
National Ocean Service
National Oceanic and Atmospheric Administration

Contents

Introduction

This document contains a report by the Coastal Programs Division of the Office of Ocean and Coastal Resource Management (OCRM) to the California Coastal Commission (Commission) and the United States Navy on the coastal effects of radar emissions from the Navy's Surface Warfare Engineering Facility (SWEF) at Port Hueneme (pronounced WHY-KNEE-ME), California. OCRM is the federal agency responsible for the administration of the federal Coastal Zone Management Act (CZMA) (16 USC §§ 1451 to 1465) and is part of the National Ocean Service, within the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. OCRM appreciates the opportunity to assist the Commission and the Navy in this matter.

Charge to the Panel

The five technical panel members were charged with providing, to the Navy and the Commission, through OCRM, their independent and objective scientific evaluation on whether, and to what extent, the operation of the SWEF poses impacts to any land or water use or natural resource of the coastal zone or impacts safe public access to the coastal zone. To assist the panel members in making their evaluations, OCRM provided materials that were agreed upon by the Commission and the Navy. The panel participated in discussions with the Navy, the Commission, the Citizen Observer, and OCRM on December 14, 1999, in Ventura California. In their participation, the panel members were not representing or working for OCRM, the Navy or the Commission. The panel members are not and were not an advisory or consensus group, but provided their own independent views.

Coastal Effects - Summary of Panel Members' Evaluations

This section summarizes the evaluations by the technical panel, which are included in Appendix 2. A brief general summary is provided, followed by a summary for each of the five panel members. Some of the summaries contain recommendations for consideration by the Navy and the Commission. The summaries and the panel members' evaluations are ordered alphabetically. The length of a particular panel member's summary, relative to the other summaries, is not an indication of importance or weight. All five evaluations, and summaries, should be accorded equal weight.

General Summary - The panel members found that the operation of the SWEF, including its radiofrequency emissions, *in accordance with the Navy's described operational and safety guidelines*, do not, *generally*, pose impacts to any land or water use or natural resource of the coastal zone and do not represent a public health risk. Some of the panel members stated that there may be health or exposure risks to people on vessels transiting or anchoring in the harbor. Most of the panel members recommended steps the Navy can, or should, take to further ensure that the operation of the SWEF is safe, that the Navy's operational and safety guidelines are carefully adhered to and monitored and that radiofrequency measurements in the uncontrolled (off-base) environment are adequate to continue to assess the impact of the radiofrequency emissions. These recommendations are provided after the applicable panel member's summary.

Summary of Each Panel Member's Evaluations

Dr. Ross Adey - Overall, from the data provided to the Panel by the Navy, the SWEF operation is in general compliance with Department of Defense (DoD) Directive 6055.11, with the notable exception that ships entering and leaving Port Hueneme Harbor may be transiently exposed to field levels above the Permissible Exposure Limit (PEL) while under way. They may be more severely exposed if remaining anchored for extended periods at certain sections of the harbor entrance. At least three major considerations affect a determination of potential health risks for Navy personnel in controlled environments and for civilian residents in adjoining housing developments.

1. Available epidemiological studies offer supporting evidence for dose-dependent effects of cumulative microwave exposure over many years.
2. Adverse health effects have been reported with microwave fields at mean incident power

levels below tissue heating thresholds.

3. In the absence of tissue heating as the vehicle for observed adverse microwave bioeffects, further medical microwave research will be necessary to determine the role of peak pulse power and pulse repetition frequencies.

The U.S. Radiofrequency Interagency Working Group (RFIAWG) identified needed changes and updates in microwave safety guidelines. These include: (1) selection of an adverse effect level for chronic exposures not based on tissue heating and considering modulation characteristics, and peak intensities not associated with tissue temperature elevation; (2) recognition of different safety criteria for acute and chronic exposures at athermal levels; (3) recognition of defects of time-averaged dosimetry that does not differentiate between intensity-modulated Radio Frequency (RF) radiation exposure and Carrier-Wave (CW) exposure, and therefore not adequately protecting the public.

Recommendations:

- Complete 360° rotation of any SWEF radar system should no longer be permitted.

- Antenna mobility should be limited to seaward sectoring, with sector margins determined by coordinates of coastline intercepts. Under no circumstances should antenna traverses across adjoining coastal zones be permitted.

- The Navy should issue a general warning to mariners not to remain in a zone extending seaward 2 miles from the SWEF base, with eastern and western margins defined as in recommendation 2, above.

- The Navy should provide, annually, to NOAA, or to a Federal agency designated by NOAA, complete logs of activity in all SWEF radar systems. These reports should include all epochs of operation, the duration of each epoch, and the limits of antenna sectoring.

- DoD should review and implement, in a timely manner, any new safety guidelines developed by RFIAWG in conjunction with the American National Standards Institute (ANSI) for protection of the public.

- Until new Federal safety guidelines now under consideration by RFIAWG are implemented, no blanket approval of the SWEF operation should be affirmed.

Dr. Robert C. Beason - The "bottom line" is that the Navy is operating within the safety guidelines and the SWEF does not present any hazard to civilians in the public areas. The only potential problem would be if an extremely tall ship came into the harbor, but the harbor is probably not capable of handling such a vessel. There is a potential hazard for wildlife, i.e., birds, that might occupy the roof of the buildings while the antennas are emitting a signal. It is possible that the movement of the antennas would flush the birds away.

Recommendation: The Navy might want to mount a camera on the roof of the SWEF or otherwise monitor the roof to verify that birds are not roosting in front of operating transmitters.

Dr. John D'Andrea - Under applicable DoD and National Institute of Electrical and Electronic Engineers (IEEE)/ANSI guidelines, the emissions from the SWEF pose no hazard to people or wildlife that are in the public access area of the coastal zone surrounding the SWEF. The main SWEF beams are restricted to heights well above the public and shipping areas and do not pose a hazard. The small fraction of energy from beam "sidelobes" that may reach the public beaches or waterways are below applicable guidelines and are not a hazard in these areas. The controls proposed by the Navy seem very reasonable.

Recommendations: None.

Dr. Joe A. Elder - The Navy surveys show that public exposures at ground or water levels outside the base perimeter are below 1 mW/cm^2 and I conclude that these surveys show no significant public health risk at these publically accessible locations from exposure to radiofrequency radiation from the SWEF radars. The Navy reports show that a special case of potential public exposure in excess of the general population limit of 1 mW/cm^2 exists on the superstructure of cargo ships in the Port Hueneme ship channel. Safety procedures can ensure safe exposure levels on ships and permit the Navy to fulfill the SWEF mission. Also, the Navy's public exposure data is the minimum necessary to reach these conclusions on the public health impact with my confidence rating of "adequate." Public health evaluations with a higher confidence rating, such as "very good" to "excellent," would enhance the public's reception of the evaluations and be more helpful to public health officials.

Recommendations:

- When cargo ships are stationary in the shipping channel in front of the SWEF, or in front of the SWEF during transit through the channel, safeguards should prevent energization of SWEF radars that produce power densities of 1 mW/cm^2 or greater on cargo ships.

- The Navy should submit to the public [through the Commission] a well-designed, comprehensive public exposure assessment study within a reasonable time, e.g., six months, after submission of OCRM's report to the Commission.

Mr. Edwin Mantiply - If the SWEF follows the engineering and procedural controls as specified in Navy documents, the SWEF should not represent a health risk or affect the offsite environment. It is possible for the SWEF radars to exceed safety limits if used contrary to the Navy's operating guidelines. Thus, the Navy needs to ensure that active radars are not pointed in any direction that causes exposures to exceed safety limits. Procedural controls may be necessary to prevent illumination of transiting ships resulting in exposure to vessel personnel and possibly unacceptable reflections. Engineering controls that would prevent these exposures are apparently impractical.

Recommendations:

- The Navy should designate a microwave safety officer to ensure compliance with safety measures.

- The Navy should provide for simple harbor and channel observation and appropriate operator clearance to transmit.

Background

The Navy operates the SWEF, which is a radar testing and training facility. The SWEF tests the Navy's various radars and simulates combat scenarios to test a ship's combat systems. In conducting these tests, the radars use high frequency radar emissions. The SWEF is used to support the continued improvement of combat and weapon systems in terms of safety, reliability (and consequently, availability), maintenance requirements, operational capabilities, and performance. The equipment installed at the SWEF allows ships' combat systems to be tested, evaluated, and changed without requiring installation onboard ships or equipping a laboratory at sea. Obtaining fleet support from ships is very difficult and expensive, and it requires extensive lead-time to schedule. Using the SWEF provides a cost-effective means of providing realistic, verifiable surface combat and defense systems data to the Navy surface fleet, U.S. Coast Guard, and some foreign navies. It is estimated that performing these engineering and development tasks at the SWEF instead of using fleet resources saves the Navy over $13 million each year.

The Commission is concerned that the radar emissions may pose public health risks and may affect coastal uses and resources (public access near the SWEF, coastal shipping, commercial and recreational fishing, and wildlife). The Navy does not believe that the SWEF poses public health risks or causes coastal effects.

The Commission implements California's federally-approved CZMA Coastal Management Program. The Commission requested that the Navy provide, pursuant to the CZMA federal consistency requirement (16 USC § 1456(c)(1) and 15 CFR part 930, subpart C), a consistency determination and other information for the SWEF. The Navy declined and, instead, provided the Commission with negative determinations, pursuant to 15 CFR § 930.35(d). The Navy determined that negative determinations met the requirements of the CZMA in this instance; accordingly, the Navy provided negative determinations for the installations of TARTAR Mk 74 Mod 6/8, the Aegis SPY-A, the AEGIS Mk 99 Director, SBQ-99 Radar, and the TISS System. <u>See</u> Appendix 1 for brief descriptions of the CZMA and the CZMA federal consistency requirement.

In August 1998, the Commission requested that OCRM informally mediate the matter. The Navy agreed to participate in informal negotiations. The purpose of the informal negotiations is to assist the Commission and the Navy in determining, relying on input from an independent and objective technical panel, whether radar emissions from the SWEF will adversely affect the public's use of coastal resources and the resources themselves.

Participants

The mediation parties are the Commission and the Navy. OCRM is the mediator. By agreement of the parties, OCRM obtained the participation of five experts in radar emissions to assess the coastal effects of the SWEF. These five experts comprised the technical panel. OCRM, the Commission and the Navy were fortunate to have the input from five experts who are highly respected nationally and internationally. The panel members volunteered their time, in the midst of their very busy schedules. The panel members were diligent, engaged and well-prepared for our discussions. Their expertise was clearly evident. On behalf of OCRM, the Commission, the Navy, and the Citizen Observer, we greatly appreciate and thank the panel members for their time and assistance, and their institutions: U.S. Environmental Protection Agency, the Naval Health Research Center at Brooks Air Force Base, University of California Riverside, and State University of New York at Geneseo.

In addition, the Commission chose a Citizen Observer to participate in the panel's review process. The Citizen Observer, Lee Quaintance, is from a community nearby the SWEF. On behalf of OCRM, the Commission and the Navy, we greatly appreciate and thank Mr. Quaintance for providing his time and thoughtful and useful information and input during the panel process.

The participants in the mediation and panel discussions were:

OCRM/CPD	Mr. Jeffrey R. Benoit Director, OCRM	Mr. David W. Kaiser Federal Consistency Coordinator, CPD
Commission	Mr. Mark Delaplaine Federal Consistency Supervisor	Mr. Dan Olivas California Attorney Generals Office
Navy	Ms. Suzanne Duffy Deputy Director, Technical Operations Naval Surface Warfare Center HQ	Mr. Chuck Hogle System Engineer
	Ms. Jeanne Prussman, Assistant Counsel, Naval Sea Systems Command Office of Counsel	Ms. Vickie Writt, Environmental Program Manager, Naval Sea Systems Command
Panel Members	Dr. Ross Adey University of California Riverside	Dr. Robert C. Beason State University of New York, Geneseo
	Dr. John D'Andrea Chief Scientist Naval Health Research Center Brooks Air Force Base	Dr. Joe A. Elder Special Assistant National Health and Environmental Effects Research Laboratory, U.S. EPA
	Mr. Edwin Mantiply National Air and Radiation Environmental Laboratory, U.S. EPA	
Citizen Observer	Mr. Lee Quaintance Oxnard, California	

The Process

OCRM obtained the participation of the panel members during the Spring and Summer of 1999. OCRM provided to the panel members a package of materials for their review. The panel members received the information between August and September 1999. The review package was agreed to by OCRM, the Commission, and the Navy, with substantial input by the Citizen Observer. The documents included:

- **Questions to Guide the Panel Members' Assessments.** These questions are from OCRM's memorandum to the Commission and the Navy (Nov. 6, 1998) and are the questions that the Navy answers in a letter to OCRM (Dec. 14, 1998).

- **Navy's Response to SWEF Questions.** This document, a letter from J.W. Phillips, Navy, to David Kaiser, OCRM (Dec. 14, 1998), provides the Navy's response to the above questions.

- **The Beacon Foundation's Response to the Navy's Response to SWEF Questions.** This document responds to the Navy's December 14, 1998, response to the above SWEF questions. The Beacon document is dated January 5, 1998, but it is actually a January 5, ***1999***, document.

- **Background Material from the Commission.** This document, a memorandum from Mark Delaplaine, Commission, to Interested Parties (Sep. 15, 1998), contains a more detailed description of the issues between the Commission and the Navy and includes several background attachments. Attachment 3 of Delaplaine's September 15 memorandum contains the Radiation Hazard Reports of 1989, 1994, 1996, and 1997. Classified versions of these reports were provided to the panel members who hold proper clearances (Ed Mantiply and John D'Andrea).

- **RadHaz Survey of December 1998.** This document is a survey conducted by the Navy for the AN/SPQ-98 and MK-99 radars.

- **Three Beacon Memoranda, Dated April 3, 1999, August 20, 1997, and October 27, 1997.** These memoranda provide additional information on the Navy's documentation of effects from the SWEF.

- **Two One-Pagers on the CZMA and the CZMA Federal Consistency Requirement.** These two documents provide the Panel members with a brief description of the CZMA program and the CZMA federal consistency requirement, under which the Commission is able to review the SWEF facility.

The panel members began their reviews of the material in September-October 1999. In October, all participants agreed that the panel would review the materials during the rest of the Fall and meet in December to discuss the materials and the panel members' preliminary findings. The group listed in the above participant's chart met on December 14, 1999. The meeting started with a tour of the SWEF at Port Hueneme and a welcome by the SWEF Commanding Officer, Captain James W. "Stretch" Phillips. The group then observed the facility from the nearby community and beach and La Jenelle Park. The group then met for the rest of the day at the Commission's offices in Ventura.

At the December 14 meeting, the group discussed preliminary findings for each of the questions provided to the panel. These questions are repeated below. At that time, the panel members requested additional information. The Navy provided this information to the panel in January and February 2000, which included: (1) a to-scale map of the SWEF and surrounding area, (2) classified versions of appendices D and E of the 1997 Radiation Hazard Survey to the two panel members with appropriate clearances (Ed Mantiply and John D'Andrea), and (3) information regarding the diameter of the antennas and peak power levels. Subsequently, one panel member asked for further information on antenna azimuth and patterns, which the Navy provided in February. In addition, Ed Mantiply provided his calculations regarding some dish dynamics to his fellow panel members for their consideration. The panel members submitted their findings to OCRM in February and March 2000, and are included, unedited for content, in Appendix 2.

Following receipt of the panel members' evaluations, OCRM submitted a draft of this report to the panel members, the Commission, the Navy and the Citizen Observer for comment. No changes were made to the panel members' evaluations or summary of their evaluations unless specifically agreed to by the applicable panel member. Following receipt of comments, OCRM revised and finalized the report for submission to the Commission and the Navy.

OCRM, the Navy and the Commission agreed that the questions listed below should be answered. These questions were provided to the Panel. Some Panel members used this format, while others provided their own narrative.

1. **Do the radar frequency (RF) emissions from the SWEF pose a risk to people who use coastal resources?**

In answering this question, the following questions should also be considered:

1.a. Do the SWEF RF emissions affect public access and recreation at public beaches and La Jenelle Park, coastal shipping, or commercial or recreational fishing?

1.b. What is the maximum level (and duration) of foreseeable exposure that could be received by a shipboard person?

1.c. Does the evidence support the Navy's conclusion that no harmful exposure could occur on a nearby ship (including transiting ships, moored ships, dredging ships, fishing vessels, etc.)?

1.d. How does the lowered height of the radar on Building 5186 affect exposure calculations to ships and public areas?

1.e. Can reflection of SWEF radar emissions off metal ship structures focus and intensify exposure?

2. **Is there potential for adverse effects on wildlife from SWEF radar emissions?**

3. **What is the baseline worst case scenario for SWEF radar emissions in the uncontrolled environment?**

In answering this question, the following questions should also be considered:

3.a. What are the maximum RF levels that could be emitted at the same time and what would be the effect of such levels on the uncontrolled environment?

3.b. What are the maximum RF levels that could be directed at a particular point, i.e., a shipboard person, and what would be the effect of such levels on a point in the uncontrolled environment?

3.c. What are the expected operational maximum RF levels and what effect would such emissions have on the uncontrolled environment?

3.d. Are multiple source RF emissions a factor in any worst case scenario (i.e., a ship moving through several radar beams)?

3.e. What is the distinction between RF emission capabilities "as installed" versus "as operated?"

3.f. What controls are in place to ensure that an RF standard is not exceeded?

3.g. What are the consequences to people in the uncontrolled environment if an RF standard was exceeded by various percentages? Are there thresholds above an RF standard that the Commission could use to determine whether the Commission should be concerned?

4. How will the Navy interact with the Commission in the future?
In answering this question, the following questions should also be considered:

4.a. What technical information should the Navy provide and the Commission seek, and what will be available, in reviewing modifications to the SWEF?

5. With what RF standards does the Navy comply? What do those standards mean? What is the status of evolving international RF emission standards and would the international standards be useful in determining whether SWEF RF emissions pose a risk to coastal users? How will the Navy respond if/when the international standards change?

6. How do SWEF RF emissions compare to other radar emissions?

7. To what extent is the Navy, in response to these questions, relying on information that is not available to the public?

Appendix 1 - Description of CZMA and Federal Consistency

The CZMA. The CZMA, enacted in 1972, created a national coastal management program to comprehensively manage competing uses of and impacts to coastal uses and resources. The CZMA's objectives describe the importance of the coastal zone for its variety of natural, commercial, recreational, ecological, industrial and esthetic resources; the variety of these resources to the nation; and the need to preserve, protect, develop and restore or enhance these resources for this and succeeding generations. The CZMA defines and authorizes the Coastal Zone Management Program and the National Estuarine Research Reserve System. It is the only national authority that works with all sectors of government to comprehensively manage and address the many and increasing pressures on the use of our coastal areas and our coastal and ocean environments.

This program is implemented by state Coastal Management Programs (CMPs) and National Estuarine Research Reserves (NERRs) in partnership with the federal government. Eligible states may develop CMPs and NERRs pursuant to federal requirements. Thirty-three states have approved CMPs. Of the two remaining eligible states, Indiana is developing a program and Illinois is not currently participating. There are twenty-four federally designated NERRs in eighteen states. Five additional reserves are in development. The CZMA program is administered by the Office of Ocean and Coastal Resource Management, which is part of the National Ocean Service, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce.

As part of federal approval of the state CMPs and NERRs, state CMPs and NERRs receive annual operating funds through cooperative agreements with NOAA. These funds are used by state agencies and local governments for a variety of management, research, permitting, enforcement, education and project specific activities.

Federal Consistency. The federal consistency requirement (CZMA § 307) is a primary incentive for states to join the national coastal management program. It is a powerful tool that states use to address effects on coastal uses or resources that are the result of federal actions. Federal consistency also helps to avoid conflicts between states and Federal agencies by fostering cooperation, consultation and coordination.

Federal consistency requires that federal actions, in or outside the coastal zone, that affect any coastal use or resource must be consistent with the enforceable policies of state CMPs. This "effects test" is the basis of consistency and includes reasonably foreseeable effects. There are no geographical boundaries and no categorical exemptions to the effects test. While it is a powerful tool, it is important to note that state CMPs concur with 95-97% of all federal actions. Enforceable policies are state CMP policies that are legally binding under state law and approved by NOAA.

Federal actions include federal agency activities, federal approval activities and federal financial assistance activities. Federal agency activities are activities or development projects proposed by a federal agency (CZMA § 307(c)(1)). Federal agency activities must be consistent to the maximum extent practicable with the enforceable policies of a state's CMP. Consistency can help build support for federal actions. Early coordination between state CMPs and federal agencies more often leads to CMP and public support and a smooth federal consistency review. Early coordination through consistency also helps a federal agency to avoid costly last minute changes to projects in order to comply with CMP enforceable policies.

Federal approval and assistance activities are proposed or undertaken by a non-federal entity, but require federal approval (CZMA § 307(c)(3)) or are applications for federal funding by a state or local government agency (CZMA § 307(d)). Federal approval and assistance activities must be fully consistent with the enforceable policies of state CMPs.

Appendix 2 - Panel Members' Evaluations

Appendix 2A - Technical Panel Member's Evaluation

Mediation Between the Navy and the California Coastal Commission
The Navy's Surface Warfare Engineering Facility, Port Hueneme

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This document provides the independent evaluation of Dr. Ross Adey regarding the effects of radar emissions from the Navy's Surface Warfare Engineering Facility (SWEF) at Port Hueneme, California, on the public's use of, and the wildlife on or about, the land and water areas around the SWEF. This evaluation is provided to the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (OCRM) as part of the mediation process developed between OCRM, the Navy and the California Coastal Commission (Commission). OCRM, as the mediator, will summarize this evaluation in a report to the Commission and the Navy, and will attach the evaluation to its report.

The five technical panel members are charged with providing, to the Navy and the Commission, through OCRM, their independent and objective scientific evaluation on whether, and to what extent, the operation of the SWEF poses impacts to any land or water use or natural resource of the coastal zone or impacts safe public access to the coastal zone. Panel members, in making their evaluations, shall use the materials provided by OCRM and the discussions held between the panel members, the Navy, Commission, OCRM and the Citizen Observer, on December 14, 1999, in Ventura, California. The panel members in their participation on the panel do not represent or work for OCRM, the Navy or the Commission. The panel members are not an advisory or consensus group, but will provide their own independent views.

Dr. Ross Adey provided his evaluation in the following manner:

Introduction

OCRM, the Navy and the Coastal Commission have agreed on a set of seven questions to be addressed by Panel members individually, presumably in the expectation that they would establish uniformity under a common rubric and simplify development of the Final Report. I shall answer these questions at an appropriate place in this Response.

However, the frame of reference for these questions studiously avoids the main charge to the Panel, namely, to consider potential health risks for those who may be chronically exposed to the separate and collective microwave emanations from the SWEF Facility.

Under this rubric, primary consideration of compliance by the Navy with a relaxed and outmoded DoD Directive becomes parenthetic and even irrelevant in the light of current biomedical scientific knowledge.

Since the Navy plans to continue operation of the SWEF at its present level, or in an expanded form, for the indefinite future, evaluation of potential health hazards should also take account of possible effects of cumulative dose over many years' exposure.

Sharp concerns have recently been expressed by other Federal bodies charged with surveillance and safety standard setting in this area of public health. They recognize the need to consider the role of potentially hazardous tissue interactions with athermal (non-heating) microwave fields ignored in the current DoD Directive.

The DoD Directive 6055.11

This directive establishes *Permissible Exposure Limits* (PELs) for controlled (Navy personnel) and uncontrolled (Civilian) environments, and may be summarized in the following way. The essential measurement involves energy of the microwave field absorbed by tissue as heat, expressed as the *Specific Absorption Rate (SAR)* in W/kg. As a national standards setting body, the American National Standards Institute (1992) recognized a tissue dose of 4.0 W/kg as a *thermal* (heating) tissue threshold likely to be associated with adverse effects and proposed an exposure limit in Controlled Environments at 0.4 W/kg, thus creating a supposed "safety margin" of 10. For Uncontrolled Environments, a larger safety margin was set with a PEL 50 times lower at 0.08 W/kg.

Since actual measurement of tissue SARs under environmental conditions is not a practical technique, DoD 6055.11 also establishes a PEL as a function of *incident field power density*, expressed as the amount of energy falling on a surface/unit area, and expressed in mW/cm^2. This PEL is also a function of radar frequency. For an X-band radar operating at 10 GHz, the PEL for Controlled Environments is fixed at 10 mW/cm^2 and for Uncontrolled Environments at 6.67 mW/cm^2; and since most practical field density measurements measure the *electric component* of the electromagnetic field, a simple yardstick relating incident field energy to its electric component relates an incident field of 1.0 mW/cm^2 to an electric field of 61 V/m.

These models will be discussed further in relation to *peak-pulse-power* vs. *time-weighted average (TWA)*.

Deficiencies in DoD Directive 6055.11 as a basis for evaluation of potential health hazards

Radar signals are generated as a continuous stream of very brief radiated pulses. Each pulse typically lasts between a millionth and a billionth of a second. They repeat regularly at typical rates of several hundred per second. Because the pulses are so brief, the proportion of time that the transmitter is ON in any one second is only a small fraction of a second. This small fraction or percentage is known as the *duty cycle*.

This duty cycle determines the *average* radiated power of the radar signal, also termed the *time weighted average (TWA)* of the radar transmitter. It is thousands of times less than the *peak pulse* *power* of the individual pulses in the radar signal. It is a measure of the *heating power* of the radar signal.

For decades, the TWA and the heating power of radar signals have been a convenient basis for safety guidelines promulgated by regulatory agencies world wide, including WHO, the U.S. ANSI and the U.S. DoD, specifically in the advisory role played by the U.S. Air Force in Standards SubCommittee 28 of the IEEE, acting in turn as advisory to ANSI. They have ignored the option for possible health effects in exposures to fields below tissue heating thresholds (*athermal exposures)*.

Evidence will be cited that laboratory and epidemiological studies over more than a decade, including key studies conducted in DoD laboratories, have confirmed the concept of microwave tissue interactions carrying potential health implications with fields at athermal levels.

Long neglected because of an absence of tissue heating, it is now increasingly recognized by cognizant Federal agencies that future health safety standards should take account of the peak pulse power and the rate of its pulse train. Since future operations at SWEF are planned for many years, prudence suggests that this Panel should draw attention to possible changes in Federal microwave safety guidelines that will address athermal bioeffects.

Issues identified by U.S. Radiofrequency Interagency Work Group (RFIAWG) in planned revisions of ANSI/IEEE RF/microwave exposure standards

In a communication (6/17/99) addressed to the Institute of Electrical and Electronics Engineers (IEEE) Subcommittee 28 Risk Assessment Working Group, the RFIAWG identified 14 issues that the RFIAWG believes needs "to be addressed to provide a strong and credible rationale to support RF exposure guidelines." These 14 issues include the following:

4.a. Selection of an adverse effect level

"Should the thermal basis for exposure limits be reconsidered, or can the basis for an unacceptable/adverse effect still be defined in the same manner used for the 1991 IEEE guidelines? Since the adverse effect level for the1991 guidelines was based on acute exposures, *does the same approach apply for effects caused by chronic exposure to RF radiation, including exposures having a range of carrier frequencies, modulation characteristics, peak intensities, exposure duration, etc., that does not elevate tissue temperature on a macroscopic scale?"* (Emphasis added)

4.b. Acute and chronic exposures

"There is a need to discuss and differentiate the criteria for guidelines for acute and chronic exposure conditions. The past approach of basing the exposure limits on acute effects data with an extrapolation to unlimited chronic exposure durations is problematic . . . . *For lower level ("nonthermal"), chronic exposures, the effects of concern may be very different from those for acute exposure (e.g., epigenetic effects, tumor development, neurologic symptoms) . . . . If the chronic exposure data are not helpful in determining a recommended exposure level, then a separate rationale for extrapolating the results of acute exposure data may be needed . . . . A clear rationale needs to be developed to support the exposure guideline for chronic as well as acute exposure.* (Emphasis added)

4.c. Pulsed (intensity) or frequency-modulated RF radiation

"Studies continue to be published describing biological responses to non-thermal ELF-modulated RF radiation exposures that are not produced by CW (unmodulated) RF radiation. These studies have resulted in concern that exposure guidelines based on thermal effects, and using information and *concepts (time-averaged dosimetry, uncertainty factors) that mask any differences between intensity-modulated RF radiation exposure and CW exposure, do not directly address public exposures, and therefore may not adequately protect the public.* The parameter used to describe dose/dose rate and used as the basis for exposure limits is time-averaged SAR (Specific Energy Absorption Rate); *time-averaging erases the unique characteristics of an intensity-modulated RF radiation that may be responsible for producing an effect. Are the results of research reporting biological effects caused by intensity-modulated, but not CW exposure to RF radiation sufficient to influence the development of RF exposure guidelines? If so, then how could this information be used in developing these guidelines?* (Emphasis added)

None of these issues have been addressed in DoD Directive 6055.11. From its initial thermalizing origins, it may be considered an increasingly inadequate and inappropriate guideline on issues of health risks likely to face the SWEF operation in the near future, and certainly within the projected lifetime of its planned operation.

Epidemiological and experimental evidence of health-related effects of pulsed RF/microwave exposures at athermal levels

5.a. Military medicine: a recent focus on potential health risks of pulsed microwave fields

Military medical authorities in the USA, in the former Soviet bloc and in the People's Republic of China have recently reviewed personnel exposures to pulsed microwave sources, with the conclusion that they may face health risks not appropriately defined by the heating capacity of the fields.

A review by the U.S. Army Medical Research Establishment, McKesson BioServices, and the Directed Energy Bioeffects, Human Effectiveness Directorate, Brooks AFB, San Antonio TX, concluded that "Russian/Former Soviet Union research into pulsed RF bioeffects is scarcely known to Western scientists and has never been comprehensively reviewed in Western literature (Pakhomov and Murphy, 1999). Even some key findings, which may affect the conceptual approach to RF safety, seem to be not known in the West, and their replication in Western laboratories has never been attempted . . . . Particular emphasis in these studies was given to RF-induced changes in nervous system function . . . . *Modulation often was the factor that determined the biological response to radiation and reactions to pulsed and CW emissions at equal time-averaged intensities in many cases were substantially different. These results showed that bioeffects of pulsed RF may involve some specific mechanisms . . . . Some studies (of low-intensity pulsed microwaves) reported potentially pathogenic effects that may affect the current conceptual approach to pulsed RF safety."* (Emphasis added)

Studies from the People's Republic of China have compared effects of pulsed (935/sec, pulse width 1.2μsec) and CW microwave fields on brain enzyme activity in mice (Chiang, 1999). There was a significant reduction with pulsed fields at athermal levels, but no effects from CW exposures at comparable average incident power levels. Using ultra-wideband pulses (rise time 24 nanosec, half duration 340 nanosec, E-field 40 kV/m), T-maze learning was slowed for 3 days after exposure, and was accompanied by changes in brain content of neurotransmitter molecules.

References:

Pakhomov, A.G., Murphy, M.R. A review of Russian/Former Soviet Union research on pulsed R.F. bioeffects. Symposium on Biological Effects, Health Consequences and Standards for Pulsed Radiofrequency Fields. International Commission on Nonionizing Radiation Protection and WHO. Ettoll Majorare, Erice, Sicily. November 21-25, 1999.

Chiang, H. Research on bioeffects of pulsed RF in China. Symposium on Biological Effects, Health Consequences, and Standards for Pulsed Radiofrequency Fields. International Commission on Nonionizing radiation Protection and WHO. Ettol Majorare, Erice, Sicily. November 21-25, 1999.

5.b. Epidemiological studies of health risks associated with long-term exposure to pulsed RF/microwave fields at athermal levels

Long term exposures to athermal pulsed microwave fields emphasize the possible role of *cumulative dose,* although sensitivity and specificity of epidemiological studies may be limited in the long term by numerous low-level confounding factors. A spectrum of studies offer evidence of health risks associated with these exposures, including neuropsychological developmental defects, enhanced brain tumor risks, and pathophysiological changes in blood lymphocytes possibly presaging the onset of leukemia.

5.b.1. Motor and psychological functions of school children living near an early warning military radar transmitter

A Russian early warning military radar system operated for more than 25 years at Skrunda, Latvia. The system operated at frequencies of 154-162 MHZ. The pulse duration was 0.8 millisec and pulse repetition frequency 24.4 Hz. Mean transmitter output power (Time Weighted Average, TWA, as used in the tissue heating model of DoD Directive 6055.11) was 50 kW, antenna numerical gain 1800, and peak antenna radiated power 1.25 Megawatts. At all homes located in front of the radar antennas, electric field intensities were less than levels permitted by Soviet safety guidelines at 2 m height (10 $\mu W/cm^2$, 6.13 V/m) and by IEEE maximum permissible exposures in controlled or uncontrolled environments. Fields 3.5-6.4 km in front of the antenna at 2 m height were 0.2-0.4 V/m RMS (Kalnins et al., 1996).

Studies were performed on 966 children (425 M, 541 F) aged 9-18 years. Findings in children born and living constantly in the path of the antenna main lobe were compared with children living to one side of the main lobe or behind the antenna (Kolodynsky and

Kolodynska, 1996). Motor functions, memory and attention differed significantly between exposed and control groups. Children living in front of the radar antenna had less developed memory and attention functions. They had slower reaction times and their sustained neuromuscular endurance was impaired.

5.b.2. Brain tumor mortality risk among male microwave workers; evidence for effects of cumulative dose

A cooperative study by the U.S. National Cancer Institute (Thomas et al., 1987) examined brain tumor risks associated with occupational exposure to microwaves based on death certificates in a case-control study in northern New Jersey and southern Louisiana. The relative risk (RR) for all brain tumors was elevated among men exposed to RF/microwave radiation (RR = 1.6; 95% confidence interval = 1.0,2.4) and was significantly elevated among men exposed for 20 years or more. All the excess risk was derived from jobs involving design, manufacture, installation and repair of electrical or electronic equipment, while risks among RF/microwave-*exposed* workers not engaged in electrical or electronics jobs were not elevated. *However, risks of astrocytic tumors among these electronics manufacture and repair workers increased with duration of exposure to tenfold among those employed for 20 years or more. These workers may also be exposed to soldering fumes, solvents and various other chemicals.* Typical risks from these chemical factors alone are around two.

5.b.3. Chromosome aberrations in human blood lymphocytes after occupational exposure to microwave radiation

Formation of micronuclei in cells results from separation of portions of the main nuclear mass of DNA. The separated portions lie free in the cellular cytoplasm and are a measure of DNA damage. They may be associated with ultimate development of cancerous changes. Their occurrence was assessed in blood lymphocytes of workers with long microwave exposure, as a measure of possible trends towards leukemia (Garaj-Vrhovac et al., 1990). Exposures averaged 15 years (range 8-25 years). *Exposures were athermal in a power density range 10-50 $\mu W/cm^2$, at levels more than one hundred times lower than acceptable PEL levels for X-band radars in uncontrolled environments, under DoD Directive 6055.11.*

The study compared the incidence of aberrations in microwave workers and a parallel series of workers exposed to the industrial carcinogen vinyl chloride. The highest individual micronucleus values after vinyl chloride exposure was 18.3% and for the chromosome aberrations 12%. In microwave workers, comparable values were 27.9% for micronuclei and 31.5% for chromosome aberrations. Microwave workers showed a much higher frequency of acentric and dicentric fragments, and ring chromosomes compared to those exposed to vinyl chloride.

References

Kolodynski, A.A., and Kolodynska, V.V. Motor and psychological functions of school children living in the area of the Skrunda Radiation Location Station in

Latvia. *Science of the Total Environment* 180:87-93, 1996.
Kalnins, T., Krizbergs, R., Romancuks, A. Measurement of the intensity of electromagnetic radiation from the Skrunda radio location station, Latvia. *Science of the Total Environment* 180:51-56, 1996.
Thomas, T.L., Stolley, P.D., Stemhagen, A., Fontham, A., Bleecker, M.L., Stewart, P.A., and Hoover, R.N. Brain tumor mortality risk among men with electrical and electronics jobs: a case-control study. *J. Nat. Cancer Inst.* 79:233-237, 1987.
Garaj-Vhrovac, V., Fucic, A., and Horvat, D. Comparison of chromosome aberration and micronucleus induction in human lymphocytes after occupational exposure to vinyl chloride monomer and microwave radiation. *Periodicum Biologorum* 92:411-416, 1990.

5.c. Athermal microwave exposures in an animal model modify behavior and brain drug action

A DoD study performed by the U.S. Army Medical Research Detachment, Brooks AFB, Texas has examined the effects of athermal ultra-wideband microwave pulses on brain drug action and Behavior (Seaman et al., 1999).

A significant aspect of this study is the athermal character of tissue energy absorption from ultra-wideband pulses with a *peak* duration of less than one-billionth of a second. The following summarizes exposure conditions:

Field electric gradient: 102 kV/m = incident field: 2800 W/cm^2
Pulse duration: 0.9 *nanosec*; Rise time: 160 picosec
Tissue energy absorption (SAR): 37 *milliwatts*/kg
(**Energy absorption is ~100 times below DoD PEL of 0.4W/kg)
Duty cycle: 600 pulses/sec, = 5.4 X 10^{-5}%
(** For 100% duty cycle, CW SAR would be 10.8 *Megawatts*/kg**)

Mice were given a drug that prevented normal synthesis of the brain regulatory chemical nitric oxide (NO). In mice, this caused excessive and bizarre movements. NO is extremely sensitive to electromagnetic fields. A 30 min exposure to this pulsed field showed a significant effect ($P = 0.02$) in reducing hyperactivity induced by the NO-synthase inhibitor drug.

Reference:
Seaman, R.L., Belt, M.L., Doyle, J.M., and Mathur, S.P. Hyperactivity caused by a nitric oxide synthase inhibitor is countered by ultra-wideband pulses. *Bioelectromagnetics* 20:431-439, 1999.

6. Assessment of engineering and biophysical aspects of SWEF environmental microwave exposures

Navy data supplied to the Panel identifying major radar systems now operating at SWEF, or capable of operational status, have undergone a series of significant updates in the course of the Panel's deliberations. The following models and calculations are based on data sheets provided on Feb. 7, 2000.

The largest system listed is the FCS MK 92, operating as the FCS MK 92 CAS in Search Mode, or as FCS MK 92 STIR-Track in Tracking Mode. Approximate transmitter *peak power is listed as 1 MW (million watts)* in both modes. *However, following DoD Directive 6055.11, the Navy used a Time-Weighted-Average (TWA) or heating measure for further calculations of PELs and personnel safe Separation Distances*. This average is the product of pulse duration and pulse repetition frequency (the Duty Cycle as defined above) and leads to *a much lower average output power of 1000 W.*

RFIAWG has identified concerns of Federal regulatory authorities that further developments in health safety guidelines should recognize the significance of peak power in pulsed RF/microwave sources. I have cited epidemiological and experimental evidence in support of that view, including DoD studies in an animal model.

Evaluation of peak power in system operation of the FCS MK 92 STIR-Track involves the following parameters:

a. Peak Transmitter Output Power 1.0 MW

b. Antenna Gain (dBi) 41.5 dBi: Gain measures the focusing power of the antenna, expressed as the ratio of power in the focused beam to power coming from an omnidirectional antenna radiating spherically and uniformly in all directions (isotropic radiator). In the real world, gain is measured against a dipole radiator (dBd) and is 2.2 dB less than when measured as dBi. Thus, the MK 92 Antenna Gain = 41.5 - 2.2 = 39.3 dBd

c. System Loss (Coupling losses, etc) 7 dB: (This figure seems very high) Thus, the system efficiency (measured from transmitter through coupling system to radiated signal from the antenna) = 39.3 - 7 = 32.3 dbd. OR, expressed numerically ~ 1500.

d. On-Axis Peak Radiated Power: This is expressed as the product of the Peak Transmitter Output Power multiplied by the Numerical System Gain = 10^6W X 1500 = 1500 Megawatts.

e. Power levels radiated in the first side lobe

   The signal radiated in the on-axis main lobe of this antenna is large. In view of the high power in the main lobe, power levels in the first side lobe of the antenna must be evaluated, and specifically, the angle of this side lobe with respect to the main lobe. With a stated minimum operational elevation for this antenna of 5 degrees, high side lobe powers may expose persons in controlled and uncontrolled environments at ground level to significant peak pulse fields, within and beyond the Navy's calculated safe separation distances.

   If the minuscule characters in the Navy's Tables of Technical Parameters can be interpreted correctly, the first side lobe of the FCS MK 92 STIR-Track has a power level -18 dB below the on-axis power of the main lobe (or about 1.5%), and is at an angle of less than 10° to the main lobe. Thus, its peak power would be on the order of 20 MW. When operated at the minimum authorized elevation of 5°, much of this side lobe signal would have a "touch down" point closer to the antenna than for the main lobe, and to illuminate surface structures at peak power levels as much as 1000 times higher than calculated or measured with the accepted convention of a PEL calculated from a Time-Weighted-Average (heating model).

7. Mode of antenna operation: sectoring vs. rotation

Antennae capable of 360° rotation obviously illuminate a specific sector for only a brief epoch during each rotation. Typically, this is in the range of 0.4-0.8%, and substantially reduces the cumulative exposure dose. However, this situation may change sharply in sectoring for target tracking over narrow angles, with much longer "dwell times" in a single direction.

8. Summary and conclusions

Overall, from the data provided to the Panel by the Navy, the SWEF operation is in general compliance with DoD Directive 6055.11, with the notable exception that ships entering and leaving Pt. Hueneme Harbor may be transiently exposed to field levels above the PEL while under way. They may be more severely exposed if remaining anchored for extended periods at certain sections of the harbor entrance.

At least three major considerations affect a determination of potential health risks for Navy personnel in controlled environments and for civilian residents in adjoining housing developments.

1. As discussed in detail in the body of this submission, available epidemiological studies offer supporting evidence for dose-dependent effects of cumulative microwave exposure over many years.
2. Adverse health effects have been reported with microwave fields at mean incident power levels below tissue heating thresholds.
3. In the absence of tissue heating as the vehicle for observed adverse microwave bioeffects, further medical microwave research will be necessary to determine the role of peak pulse power and pulse repetition frequencies.

The U.S. Radiofrequency Interagency Working Group (RFIAWG) has identified needed changes and updates in current microwave safety guidelines. They include: (1) selection of an adverse effect level for chronic exposures not based on tissue heating and considering modulation characteristics, and peak intensities not associated with tissue temperature elevation; (2) recognition of different safety criteria for acute and chronic exposures at athermal levels; (3) recognition of defects of time-averaged dosimetry that does not differentiate between intensity-modulated RF radiation exposure and CW exposure, and therefore not adequately protecting the public.

Recommendations

- Complete 360° rotation of any SWEF radar system should no longer be permitted.

- Antenna mobility should be limited to seaward sectoring, with sector margins determined by coordinates of coastline intercepts. Under no circumstances should antenna traverses across adjoining coastal zones be permitted.

- Until new Federal safety guidelines now under consideration by RFIAWG are implemented, no blanket approval of the SWEF operation should be affirmed.

- The Navy should issue a general warning to mariners not to remain in a zone extending seaward 2 miles from the SWEF base, with eastern and western margins defined as in Recommendation 2, above.

- Complete logs of activity in all SWEF radar systems should be provided to NOAA, or to another cognizant Federal agency designated by NOAA, on an annual basis. These reports should include all epochs of operation, the duration of each epoch, and the limits of antenna sectoring.

- Any new safety guidelines developed by RFIAWG in conjunction with ANSI for protection of the public should receive prompt DoD review and implementation in a timely manner.

Appendix 2B - Technical Panel Member's Evaluation

Mediation Between the Navy and the California Coastal Commission
The Navy's Surface Warfare Engineering Facility, Port Hueneme

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This document provides the independent evaluation of Dr. Robert C. Beason regarding the effects of radar emissions from the Navy's Surface Warfare Engineering Facility (SWEF) at Port Hueneme, California, on the public's use of, and the wildlife on or about, the land and water areas around the SWEF. This evaluation is provided to the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (OCRM) as part of the mediation process developed between OCRM, the Navy and the California Coastal Commission (Commission). OCRM, as the mediator, will summarize this evaluation in a report to the Commission and the Navy, and will attach the evaluation to its report.

The five technical panel members are charged with providing, to the Navy and the Commission, through OCRM, their independent and objective scientific evaluation on whether, and to what extent, the operation of the SWEF poses impacts to any land or water use or natural resource of the coastal zone or impacts safe public access to the coastal zone. Panel members, in making their evaluations, shall use the materials provided by OCRM and the discussions held between the panel members, the Navy, Commission, OCRM and the Citizen Observer, on December 14, 1999, in Ventura, California. The panel members in their participation on the panel do not represent or work for OCRM, the Navy or the Commission. The panel members are not an advisory or consensus group, but will provide their own independent views.

Dr. Robert Beason responded to the following questions in making his evaluation:

1. **Do the radar frequency (RF) emissions from the SWEF pose a risk to people who use coastal resources?**

   In answering this question, the following questions should also be considered:

   1.a. Do the SWEF RF emissions affect public access and recreation at public beaches and La Jenelle Park, coastal shipping, or commercial or recreational fishing? No. The radar beams are above the people on the ground.

1.b. What is the maximum level (and duration) of foreseeable exposure that could be received by a shipboard person? A ship parked in the ship channel would receive the maximum dosage. Most or all of the RF energy would be above such a ship.

1.c. Does the evidence support the Navy's conclusion that no harmful exposure could occur on a nearby ship (including transiting ships, moored ships, dredging ships, fishing vessels, etc.)? Yes, unless a ship has a superstructure that extends 95–110 ft above the surface of the water.

1.d. How does the lowered height of the radar on Building 5186 affect exposure calculations to ships and public areas? It would lower the elevation at which an object would receive RF radiation in a linear fashion.

1.e. Can reflection of SWEF radar emissions off metal ship structures focus and intensify exposure? Yes, but this would be significant only for structures within or immediately adjacent to the main beam.

2. **Is there potential for adverse effects on wildlife from SWEF radar emissions?** Yes; primarily for birds that roost or nest on the roofs of SWEF buildings 1384 and 5186 and those immediately adjacent.

3. **What is the baseline worst case scenario for SWEF radar emissions in the uncontrolled environment?**

In answering this question, the following questions should also be considered:

3.a. What are the maximum RF levels that could be emitted at the same time and what would be the effect of such levels on the uncontrolled environment? It depends on the elevation above the ground the measurement is made. At ground or water level it will be negligible.

3.b. What are the maximum RF levels that could be directed at a particular point, i.e., a shipboard person, and what would be the effect of such levels on a point in the uncontrolled environment? It would depend on the elevation above the ground. The worst case would be 95–110 ft. above the ground with the Mk99, MK57-B, and MK92 transmitting simultaneously. At ground level the combined signals would not be detectable.

3.c. What are the expected operational maximum RF levels and what effect would such emissions have on the uncontrolled environment? Negligible at ground or water level.

3.d. Are multiple source RF emissions a factor in any worst case scenario (i.e., a ship moving through several radar beams)? Only for a ship that extends 100 ft. above the waterline.

3.e. What is the distinction between RF emission capabilities "as installed" versus "as operated?" Operational modifications limit the output power or the elevation and/or azimuth that the antenna can emit.

3.f. What controls are in place to ensure that an RF standard is not exceeded? The design and technical (electromechanical and computer software) limits would prevent it.

3.g. What are the consequences to people in the uncontrolled environment if an RF standard was exceeded by various percentages? Are there thresholds above an RF standard that the Commission could use to determine whether the Commission should be concerned? Not at the ground or water level.

4. **How will the Navy interact with the Commission in the future?**

In answering this question, the following question should also be considered:

4.a. What technical information should the Navy provide and the Commission seek, and what will be available, in reviewing modifications to the SWEF? Measured and calculated RF levels at the ground and center of the radiated pattern at distances of interest to the public and the commission.

5. **With what RF standards does the Navy comply? What do those standards mean? What is the status of evolving international RF emission standards and would the international standards be useful in determining whether SWEF RF emissions pose a risk to coastal users? How will the Navy respond if/when the international standards change?** IEEE and DoD standards.

6. **How do SWEF RF emissions compare to other radar emissions?** Less than Federal Aviation Administration and U.S. Air Force ground based aircraft surveillance radars that I've used in the past and more than private marine and avian radars.

7. **To what extent is the Navy, in response to these questions, relying on information that is not available to the public?** Very little. The Navy has used the "worst situation" data in their calculations, i.e., the longest wavelengths within the specific frequency bands.

<u>References</u>

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Bruderer, B. and A. Boldt. 1994. Homing pigeons under radio influence. Naturwissenschaften 81:316-317.

Bruderer, B., D. Peter, and T. Steuri. 1999. Behavior of migrating birds exposed to x-band radar and a bright light beam. J. Exp. Biol. 202:1015-1022.

Appendix 2C - Technical Panel Member's Evaluation
Mediation Between the Navy and the California Coastal Commission
The Navy's Surface Warfare Engineering Facility, Port Hueneme

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This document provides the independent evaluation of Dr. John D'Andrea regarding the effects of radar emissions from the Navy's Surface Warfare Engineering Facility (SWEF) at Port Hueneme, California, on the public's use of, and the wildlife on or about, the land and water areas around the SWEF. This evaluation is provided to the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (OCRM) as part of the mediation process developed between OCRM, the Navy and the California Coastal Commission (Commission). OCRM, as the mediator, will summarize this evaluation in a report to the Commission and the Navy, and will attach the evaluation to its report.

The five technical panel members are charged with providing, to the Navy and the Commission, through OCRM, their independent and objective scientific evaluation on whether, and to what extent, the operation of the SWEF poses impacts to any land or water use or natural resource of the coastal zone or impacts safe public access to the coastal zone. Panel members, in making their evaluations, shall use the materials provided by OCRM and the discussions held between the panel members, the Navy, Commission, OCRM and the Citizen Observer, on December 14, 1999, in Ventura, California. The panel members in their participation on the panel do not represent or work for OCRM, the Navy or the Commission. The panel members are not an advisory or consensus group, but will provide their own independent views.

Dr. John D'Andrea responded to the following questions in making his evaluation, and included in his response the Navy's responses to these questions which the Navy provided earlier to the Commission and which were part of the materials provided to the technical panel:

1. Do the radar frequency (RF) emissions from the SWEF pose a risk to people who use coastal resources?

Based on the facts stated below, it is my opinion that the radar emissions from SWEF are within the guidelines of the Department of Defense Instruction 6055.11 and IEEE/ANSI C95.1-1999 for uncontrolled exposures. Uncontrolled environments are locations where exposures to radiofrequency (RF) emissions do not exceed the permissible exposure limits of the DODI 6055.11. This includes locations such as public access areas where personnel would not expect to encounter higher levels of RF energy. Under these guidelines the emissions pose no hazard to people or wildlife that are in the public access area of the coastal zone surrounding SWEF. I agree with the Navy's answer to this question.

I base the statements above on the radiation survey measurements taken in 1997 at the SWEF by Space and Naval Warfare Center, Charleston (SPAWAR) which did not find emissions that exceeded the uncontrolled area PELs (DODI 6055.11). There was agreement by the five panelists at the December 14, 1999, meeting at Ventura, CA that the Navy did not exceed the PELs of the DODI 6055.11 for the uncontrolled areas surrounding the SWEF.

NAVY RESPONSE TO QUESTION 1. *SWEF radio frequency (RF) emissions do not pose a risk to people who use coastal resources. There is no unsafe public exposure to RF emissions from SWEF radars. Radars do not pose a risk to the public because the various radars at SWEF have been modified to restrict their transmitter power levels as well as the direction and elevations in which they can radiate. The SWEF radars that have a hazard zone that extend beyond the SWEF fence, can only radiate out toward sea and or at high elevations (as shown in table 1). The radars do not emit toward the ground or at coastal water locations. Therefore no significant RF emissions are capable of reaching the public either at nearby beaches, parks or locations where commercial or recreational ships and their crew are present. A ship can not get close enough to the SWEF to enter the RF hazard zones. The RF hazard zones (or safe separation distances) from the radar is the area in front of the SWEF extending towards the shipping channel that is used to enter Port Hueneme. (Figure 19). These hazard zones are elevated above the water level (40-95ft) as shown in figures (1-16) and point upwards as shown in figures (17 and 18). The radar beams are straight beams and do not arc. A ship is prevented from getting close enough to SWEF to enter the hazard zone because of the draft and length of the ship and the shallow depth of the channel (encl. (1) a copy of a portion of the Deep Draft Vessel log at Port Hueneme), (figure 17). RF emission surveys conducted in October 1996 (report dated Jan 1997, hereinafter "1997 survey") confirms that there is no risk to the public. The RF hazard surveys of 1989, 1994,1997 and 1998 also verify that the emission sectors and power level restrictions were properly implemented. The 1997 survey was the most comprehensive because it included all active radars at SWEF at that time and surveyed ground and water areas to verify RF levels. During this survey, measurements were collected near the beaches, jetties and at various locations on the water in front of the SWEF complex (the uncontrolled areas where the general public may be located) with all radars radiating simultaneously and with their modifications in place. (Modifications in place prevent the radars from radiating in an improper direction by effectively turning off the radars.) For the 1997 survey, the radars were pointed just inside their emission sectors (directions in which RF emissions are permitted) and measurements were conducted at locations where the radars could not point. This was to demonstrate that no RF emissions were encountered from reflected energy. The 1997 survey measurements were completed to confirm that cumulative RF emissions from all sources were within Navy specifications for areas where the general public may be located and are insignificant. Navy specifications are based on Institute of Electrical and Electronics Engineers / American National Standards Institute (IEEE/ANSI) levels for exposure. The Navy uses the IEEE/ANSI standards for RF exposure and incorporates them into the Navy instruction on RF exposure. The 1997 survey (page E4) shows that the emissions, near the ground and at water level are either not detectable with the test equipment or in one case 0.1mw/sq.cm, well below a power density level that would indicate a RF hazard zone. This means that the RF exposure is insignificant and poses no risk to the public. Thus, the 1997 survey confirmed that there are no RF hazards from radars at the SWEF. Accordingly, the SWEF radar frequency emissions do not pose a risk to people who use coastal resources.*

In answering this question, the following questions should also be considered:

1.a. Do the SWEF RF emissions affect public access and recreation at public beaches and La Jenelle Park, coastal shipping, or commercial or recreational fishing?

As stated in my answer to question 1 above, the level of microwave emissions from SWEF that might reach people in these areas are very low. The sidelobes of radar beams from all of the test radars have decayed to low levels at the public beaches or the shipping areas. In addition, all of the main beams are restricted to heights well above the public and shipping areas and do not pose a hazard. The small fraction of energy from beam sidelobes that may reach the public beaches or waterways are below the PELs of DODI 6055.11 and are not a hazard in these areas. I agree with the Navy's response to this question.

NAVY RESPONSE TO QUESTION 1.a. *Public access and recreation at public beaches and La Jannelle Park, coastal shipping or commercial or recreational fishing are not affected by RF emissions from SWEF radars. The radars do not affect the public because the radars have been modified as necessary to restrict their transmitter power levels and to restrict the direction and elevations in which they can radiate. The SWEF radars that have a hazard zone that extend beyond the SWEF fence can only radiate out toward the open sea at high elevations. The radars cannot emit toward the ground or at coastal water locations. Therefore no significant RF emissions are capable of reaching the beaches, La Janelle Park or places where commercial or recreational ships and their crew are present. RF emission surveys of 1989, 1994, 1997 confirm that SWEF RF emissions do not affect public access and recreation at beaches and La Janelle Park, and coastal shipping or commercial or recreational fishing. The 1997 survey, which involved all radars at the SWEF operating simultaneously, confirms that the beaches and park are free from unsafe RF emissions. The surveys of 1989, 1994, 1997 also confirm that existing RF hazard zones are outside of the shipping channel and outside any area that a ship could enter (figures 1-16). Because of the high elevations of the radar beams, a ship would need to have operator areas 65 feet or higher above water level to be in the RF hazard zone. This hypothetical ship would also need to be close enough to the SWEF to enter the RF hazard zone. However, this is physically impossible given that ships of that height (65 feet or higher) would have a draft of greater than 21 feet and the water under the RF hazard zone is only 16 feet deep. The hazard zones are elevated above the water level (40-65ft) as shown in figures (1-16) and point upwards when tracking. The only radar that has a RF hazard zone less than 65 feet is the MK 74 MOD 6/8 TRACK. That radar's RF hazard zone stops approximately 300 feet short of the shipping channel over shallow water and therefore is not a concern to commercial shipping. Recreational vessels are not tall enough to enter into the hazard zones regardless of how close they get to the SWEF and therefore cannot be affected. Thus, RF emissions from SWEF could not effect any existing ship (Figure 19).*

1.b. What is the maximum level (and duration) of foreseeable exposure that could be received by a shipboard person?

The main beams of all of the radars are elevated above the ground from 40 ft to 117 ft. The FCS MK 99 radar, for example, is further restricted from ground exposure by +5 deg thereby restricting direct exposure of personnel on the ground or on a ship in the ship channel. The lowest is the TARTAR MK74MOD 6/8/A/N/SPG-51C Track which still does not produce an unsafe exposure in the shipping channel. I agree with the Navy's conclusions, for example, that MK 74 Mod 14 CWI radar exposures on "*a cargo ship with a 21 foot draft, passing the radar at the closest point at high tide moving at 5 knots, the exposure to a person onboard the ship would be would be 1.0 seconds at 6.2 mw/sq.cm (milliWatt per square centimeter).*"

NAVY RESPONSE TO QUESTION 1.b. *The equipment that causes the maximum exposure is the MK 74 Mod 14 CWI radar when it is stationary and radiating towards the shipping lane. This radar has a RF hazard zone that extends the furthest of any radars at SWEF. Using a ship that can get the closest to the SWEF (however, still not in the RF hazard zone), a cargo ship with a 21 foot draft, passing the radar at the closest point at high tide moving at 5 knots, the exposure to a person onboard the ship would be would be 1.0 seconds at 6.2 mw/sq.cm (milliWatt per square centimeter). This exposure level is safe regardless of the length of time, according to the Navy standards (based on IEEE/ANSI standards). Even if the ship were to ground and remain stationary, the exposure to shipboard personnel would be 6.2mw/sq.cm, which according to the Navy standard is safe regardless of the time of exposure. When exposed to RF levels below the standard, personnel are safe regardless of the length of exposure time. Thus, there are no exposure limits applied to shipboard personnel.*

1.c. Does the evidence support the Navy's conclusion that no harmful exposure could occur on a nearby ship (including transiting ships, moored ships, dredging ships, fishing vessels, etc.)?

A ship, at the closest point to SWEF, is still not in violation of the uncontrolled PEL for the FCS MK-99 radar. The main beam uncontrolled PEL extends to 1320. However, this radar is restricted to a +5 deg lowest antenna elevation. Since it is already 65 ft (or more) above the ship channel any ship passing under the beam would have to much taller than 65 ft to be in the main beam. The sidelobe at this distance would be an order of magnitude or more below that of the main beam. This exposure level is safe regardless of the length of exposure time. Even if the ship were to ground and remain stationary, the exposure to shipboard personnel would be below the uncontrolled PEL. I agree with the Navy answer to this question.

NAVY RESPONSE TO QUESTION 1.c. *The evidence supports the Navy's conclusion that no harmful exposures could occur on nearby ships. As indicated in the 1997 survey on page E4, measurements taken at numerous water locations show that no significant RF is located on the water in front of the SWEF complex. The 1997 survey confirms that no harmful exposure could occur on a nearby ship (including transiting ships, moored ships, dredging ships, fishing vessels, etc.), (reference 3, page E4). The radars at SWEF emit RF at high elevations above ships. Only insignificant levels of RF were measured at any point on the water surface in the 1997 survey (actual measurements were approximately 6 feet above the water). During the 1997 survey (reference (3) page E4), a boat was used to collect RF emission data at distinct points on the water inside and outside the jetties in front of the building where RF radars point. Measurements at the water locations were collected with all radars aimed to the measurement points and emitting RF simultaneously. This was done in order to measure the cumulative effects of all radars at ground and water locations. The maximum RF level was 0.1 mw/sq. cm. at one measurement point closest to the west jetty. That maximum RF level (0.1mw/sq.cm) is a power density level, which is well below the Navy standard and is considered insignificant. RF levels at all other locations were so small that they were undetectable. The RF hazard limit for directional radars used during the test vary from slightly greater than 3 to slightly less than 7 mw/sq.cm, and is 3000% to 7000% greater than the power density measured. At the power level of 0.1mw/sq, the allowed duration is indefinite—a person can safely remain for any length of time. The 1997 survey supports the Navy's conclusion that no harmful exposure could occur on a nearby ship or people (including transiting ships, moored ships, dredging ships, fishing vessels, or their crews).*

1.d. How does the lowered height of the radar on Building 5186 affect exposure calculations to ships and public areas?

I agree with the Navy that the radar elevation above ground does not affect the exposure calculations. Based on the measurements in the 1997 survey there are not public access areas with measurable exposure from this radar.

NAVY RESPONSE TO QUESTION 1.d. *The lowered height of building 5186 does not affect exposure calculations for either ships or the public areas. The MK 74 MOD 6/8, the system installed on building 5186, is approximately 40 feet above the water, which is lower than any other installation at the SWEF complex. The system does not point toward the coastal water or ground, and therefore emits RF above locations where boats or people may be present. The height of the radar installation on building 5186 does not change how exposure calculations are performed. (Formulas not reproduced here) Furthermore, RF hazard surveys confirm that the building height does not impact public exposure. Measurements were collected at six water locations and nine ground locations when the MK 74 MOD 6/8 system was surveyed during December 1996 (reference (3) page E2). Measurements were collected at ground locations along the beach in front of the building, east and west jetties, and along the fence line adjacent to the radar. Measurements were also collected at water locations including areas in front of the radar inside and outside of the mouth of the harbor and locations adjacent to the La Jannelle Park. All of these locations were chosen because they are areas where recreational boaters, swimmers, dredging ships or fisherman could be located. At all fifteen locations, no RF was detected. These measurements in the 1997 survey support the Navy's conclusion that the lowered height does not affect the public.*

1.e. Can reflection of SWEF radar emissions off metal ship structures focus and intensify exposure?

I agree partly with the Navy that reflections of metal surfaces generally do not intensify fields. Scattering would most likely occur. However, if the incident wave is normal to a flat surface some intensification could happen due to return reflections and depending on the separation distance of the target from the reflecting surface. However, the reflecting surface would have to be at the same elevation as the radar source and perfectly normal. Corner reflectors have been used in the laboratory to enhance exposures. Generally, two surfaces at 45 degrees to each other in a V shape can setup multiple reflections to increase energy deposition. This also requires the incident wave to be perfectly normal into the apex of the reflectors. I suggest that a moving very tall ship several hundred feet from the source a perfect alignment would be extremely rare and any reflections would normally scatter and would not result in enhanced absorption in people. Under the circumstances of SWEF (such as location, height of radars above ground, restriction of point toward water or ground), and distance to the shipping channel, I believe any intensification of a side beam would be minimal and would not result in a hazard.

NAVY RESPONSE TO QUESTION 1.e. *Reflections do not focus or intensify exposure to RF from SWEF. When RF reflects off a metal structure the primary effect is scattering (wave "breaks apart"). The effect of scattering is to break up the electromagnetic wave and reflect it in all directions. When the wave is "broken up" the power associated with the reflection is greatly weakened. If the electromagnetic wave hits a flat structure, the wave energy is both absorbed by the metal structure and reflected at the same angle as the initial electromagnetic wave. The wave is not refocused. Therefore, it is impossible for the reflected electromagnetic wave to have the same intensity or greater intensity than the original emission.*

2. Is there potential for adverse effects on wildlife from SWEF radar emissions?

I agree with the Navy that the only wildlife likely to encounter fields strong enough to cause any effect would be birds and possibly insects. Encounters with SWEF radar beams are likely to be short. These biota would have to fly directly in the main beam and remain there for several minutes and the likelihood of injury would depend on other factors such as ambient temperature. Birds flying in a microwave beam at different ambient temperature was investigated in the laboratory by Byman et al. (1985). They studied the effects of 2450 MHZ on bird flight. They flew budgerigars (Melopsittacus undulatue) in a wind tunnel with airflow set at 37 km/hr for 10 min. periods. The flying budgerigars were exposed to microwaves in the range of 18-109 mW/cm^2 in ambient air temperatures that varied from 25 to 32 degrees C. Leg-dropping during flight was observed and was the first indication of thermoregulatory behavior during flight. This behavior increased as ambient air temperature increased and occurred more frequently during flights with microwave irradiation. Premature landings would occur at the highest air temperatures and microwave levels. I do not expect that birds exposed to SWEF emissions, however, could fly for sufficient periods of time in the main radar beam to absorb enough energy to produce hyperthermia. The beams are narrow and in some cases rotating which means that exposures would not be longer than a few seconds which is not sufficient to harm the animal. The potential for adverse effects on wildlife seems to be a low probability. I asked during a tour of the SWEF facility if injured or dead birds were ever found around the antennas where high intensity beams are to be found. The answer was no injured or dead birds have ever been found.

Byman, D.; Wasserman, F. E.; Schlinger, B. A.; Battista, S. P.; Kunz, T. H. Thermoregulation Of Budgerigars Exposed To Microwaves (2.45 GHz, CW) During Flight. *Physiol Zool* 58(1):91-104, 1985.

NAVY RESPONSE TO QUESTION 2. *The wildlife on the ground and in the water near the SWEF are not affected by radar emissions. The 1997 RF survey, (reference (3)) confirms that RF levels on the ground and on the water are insignificant, even with multiple radars active simultaneously. Since the concentrations of RF are localized to areas well above the ground, the only wildlife that may be affected are birds. However, any risk is greatly reduced by the bird's movement in flight. Furthermore, birds will not remain on moving radars or other equipment and therefore will not be exposed to intense radar emissions.*

3. What is the baseline worst case scenario for SWEF radar emissions in the uncontrolled environment?

NAVY RESPONSE TO QUESTION 3. *Since the RF hazard zones do not extend into the shipping channel, the Navy developed a worst case scenario to analyze the effect of SWEF radar emissions in the uncontrolled environment. This scenario included the MK 86 SPG 60, the MK 92 STIR TRACK and the MK 92 STIR CWI radars. Other radars were eliminated from this worst case study because their power is too low to have any effect on the shipping channel or their beams do not overlap within the shipping channel. The worst case scenario would occur when several radar beams overlap in the shipping channel. To do this the radars would have to be tracking a target and the target would have to be low enough to keep the radars pointed near the horizon. The radars do not present any RF hazards even when their beams are combined. Details of the analysis are contained in the answer to 3.b.*

In answering this question, the following questions should also be considered:

3.a. What are the maximum RF levels that could be emitted at the same time and what would be the effect of such levels on the uncontrolled environment?

The Navy survey with several radars operating simultaneously did not produce field measurements in areas where people would be that exceeded the uncontrolled PELs. This outcome is reasonable and expected since all of the emissions from SWEF are high frequency compact beams. The probability of these intersecting and providing a multiple beam exposure with enhanced energy deposition, which could exceed the uncontrolled PEL in locations that could be occupied by the public, seems unlikely to this reviewer. The likelihood of such an effect is no greater than exposure from the individual beams. That is because the beam sources (antennas) are elevated and some of the radars are further restricted +5 deg above level. The radar beams will be overhead and exposure of people on the ground would be unlikely.

NAVY RESPONSE TO QUESTION 3a. *The Navy addressed the maximum RF levels that could be emitted at the same time in the 1997 RF survey. The 1997 RF survey (reference (3)) was conducted with all radars operating simultaneously and reported measured RF levels of zero or 0.1mw/sq.cm at one location. These measured RF levels were either well below the power density level that would indicate a RF hazard zone or were undetectable at all ground and coastal water locations. While SWEF radars are used individually and not simultaneously, the 1997 RF survey reported that operating SWEF radars simultaneously at the maximum power levels have no significant impact on the uncontrolled environment. Furthermore, the radars do not point toward the coastal water or ground, and therefore emit RF above locations where boats or people may be present (see figure 1-16).*

3.b. What are the maximum RF levels that could be directed at a particular point, i.e., a shipboard person, and what would be the effect of such levels on a point in the uncontrolled environment?

I agree completely with the Navy's response to this question.

NAVY RESPONSE TO QUESTION 3b. *The maximum RF levels achievable at a particular point, i.e. a shipboard person, was considered by analyzing what could occur when multiple radars track a target such that their radar beams overlap over the harbor shipping lane. This maximum level is a power density ratio of 0.41. The Navy's analysis included the beams from MK 92 STIR, MK 92 CWI, and MK 86 AN/SPG-60. Because these radars are installed in the same general location they can track a single target with beams pointing over the shipping channel. The excluded radar beams overlap or intersect at great distances from the SWEF where their power levels are significantly reduced. The following analysis demonstrates that there is no RF hazard from those radar beams overlapping in the shipping channel.*

In the following example, a point was chosen at the edge of the shipping lane closest to the radars where several radars can point, and it is a location where a person could be standing on a ship (between 55 and 60 ft above the water). An overlap of 6 feet was required such that a person would be in the beam of the radar (whole body exposure to the emissions). The basic question when referring to multiple radars and multiple beams is cumulative impacts. Cumulative impact is calculated by first calculating the absolute power level at one specific location (i.e., distance from the radar). Next, a ratio is calculated for each single radar (absolute power level at a single location divided by the permissible exposure level). The final step in determining if the hazard specification is reached is to add all the ratios from each radar. If *the answer is greater than one (1), the specification for permissible exposure is exceeded. If one (1) or less, the specification for permissible exposure has not been exceeded. The beams will have a 6-foot overlap starting at 80 feet above the water at 1000 feet from the radars where they are aligned in bearing. The point of overlap is outside the shipping lane away from the SWEF complex. The multiple radar calculation for the three radars whose beams intersect over the shipping lane yields the following power at the selected point and the power to permissible exposure limit ratios: MK 86 SPG-60 (power density is 0.53 mw/sq.cm, permissible exposure limit is estimated at 5.0 mw/sq.cm, ratio of power to exposure limit is 0.53/5.0 = 0.11) MK 92 STIR TRACK (power density is 0.24 mw/sq.cm, permissible exposure limit is estimated at 5.0 mw/sq.cm, ratio of power to exposure limit is 0.24/5.0 = 0.05) MK 92 STIR CWI (power density is 1.51 mw/sq.cm, permissible exposure limit is estimated at 6.0 mw/sq.cm, ratio of power to exposure limit is 1.51/6.0 = 0.25) Adding these three ratios together yields 0.11+0.05+0.25=0.41, which is well below the specification of a ratio of 1.0. Therefore, there are no hazards from multiple radars. There is no mission requirement to operate these radars together. Therefore, the likelihood of simultaneous transmissions at the location discussed above is small. In addition, the beams overlap 80 feet above ground level and therefore do not effect ships. There are no effects on shipboard personnel or public areas.*

3.c. What are the expected operational maximum RF levels and what effect would such emissions have on the uncontrolled environment?

I agree with this answer. The Navy has used the approved method for evaluating multiple sources of RF. From the C95.1 1999 standard, "When a number of sources at different frequencies, and/or broadband sources, contribute to the total exposure, it becomes necessary to weigh each contribution relative to the maximum permissible exposure (MPE) . . . . To comply with the MPE, the fraction of the MPE in terms of E^2, H^2 (or power density) incurred within each frequency interval should be determined and the sum of all such fractions should not exceed unity." The Navy has provided a good analysis of a possible multiple exposure scenario.

NAVY RESPONSE TO QUESTION 3c. *The maximum operational RF level that could be reasonably expected is the same as the maximum RF level that could be directed to a point in space. That is a power density ratio of 0.41. The maximum RF level achievable could occur when multiple radars track a target such that their radar beams overlap over the harbor shipping lane. The Navy's analysis included the beams from MK 92 STIR, MK 92 CWI, and MK 86 AN/SPG-60. Because these radars are installed in the same general location they can track a single target with beams pointing over the shipping channel. The excluded radar beams overlap or intersect at great distances from the SWEF where their power levels are significantly reduced. The following analysis demonstrates that there is not a RF hazard as a result of these radars pointing so that their beams overlap in the shipping lane. In the following example, the point will be chosen at the edge of the shipping lane, closest to the radars, where several radars can point to a location on a ship where a person may be standing (between 55 and 60 ft above the water). An overlap of 6 feet was required such that a person would be in the beam of the radar (whole body exposure to the emissions). The basic question when referring to multiple radars and multiple beams is cumulative impacts. Cumulative impact is calculated by first calculating the absolute power level at one specific location (i.e., distance from the radar). Next, a ratio is calculated for each single radar (absolute power level at a single location divided by the permissible exposure level). The final step in determining if the hazard specification is reached is to add all the ratios from each radar. If the answer is greater than one (1), the specification for permissible exposure is exceeded. If one (1) or less, the specification for permissible exposure has not been exceeded. The beams will have a 6-foot overlap starting at 80 feet above the water at 1000 feet from the radars where they are aligned in bearing. The point of overlap is outside the shipping lane away from the SWEF complex. The multiple radar calculation for the three* *radars whose beams intersect over the shipping lane, yields the following power at the selected point and the power to permissible exposure limit ratios: MK 86 SPG-60 (power density is 0.53 mw/sq.cm, permissible exposure limit is estimated at 5.0 mw/sq.cm, ratio of power to exposure limit is 0.53/5.0 = 0.11) MK 92 STIR TRACK (power density is 0.24 mw/sq.cm, permissible exposure limit is estimated at 5.0 mw/sq.cm, ratio of power to exposure limit is 0.24/5.0 = 0.05) MK 92 STIR CWI (power density is 1.51 mw/sq.cm, permissible exposure limit is estimated at 6.0 mw/sq.cm, ratio of power to exposure limit is 1.51/6.0 = 0.25) Adding these three ratios together yields 0.11+0.05+0.24=0.41, which is well below the specification of a ratio of 1.0. Therefore, there are no hazards from multiple radars. There is no mission requirement to operate these radars together. Therefore, the likelihood of simultaneous transmissions in the location discussed above is small. In addition, the beams overlap 80 feet above ground level and therefore do not affect ships. There are no effects on shipboard personnel or public areas.*

3.d. Are multiple source RF emissions a factor in any worst case scenario (i.e., a ship moving through several radar beams)?

The Navy has, in my opinion provided a good answer to this question. From the 1997 survey they conclude that any multiple RF emissions do not pose a combined hazard. I agree with this analysis.

NAVY RESPONSE TO QUESTION 3d. *In the Navy's constructed worst case scenario discussed above, we consider the RF emissions from multiple radars. However, the 1997 survey, which analyzed all radars operating simultaneously, confirmed that there were no cumulative RF hazards caused by multiple beams. Multiple sources were considered in the 1997 survey including all active radars at SWEF at that time. During this survey, measurements were collected near the beaches, jetties and at various locations on the water in front of the SWEF complex (the uncontrolled areas where the general public may be located) with all radars radiating simultaneously and with their modifications in place. The 1997 survey reports with their water surface measurements support the Navy's conclusion that no harmful exposure could occur on a nearby ship or people (including transiting ships, moored ships, dredging ships, fishing vessels, or their crews). It should be noted that multiple exposures to RF do not have an accumulative effect. Unless a vessel is in a hazard zone, there should be no effect from the radar beam. If a vessel where in a hazard zone, there would be a time exposure limit applied to personnel aboard.*

3.e. What is the distinction between RF emission capabilities "as installed" versus "as operated?"

NAVY RESPONSE TO QUESTION 3e. *"As installed" refers to the actual way the equipment is installed. In the case of the radars at SWEF, it means that rather than the equipment being installed with the RF power capabilities and radiation sections of a shipboard system. The radars are restricted to lesser power levels and specific radiation sectors (see table (1) for the restrictions on a specific radar). "As operated" refers to the set of operational restrictions and the procedures that ensures that the various safety constraints remain in effect. For example, procedures are in place at the SWEF complex to ensure emission sectors are operating properly each and every time a radar actively radiates out the antenna. The procedures consist of items such as a check of the RF emission sectors into dummy load (an internal device used to simulate radiation out of the antenna), prior to radiating out of the antenna. The radars at SWEF are installed with their maximum power levels set to a level that will meet minimum mission requirements and protect personnel. This means that in many cases the RF power output of the radars has been reduced during installation, when compared to standard Navy shipboard installations. In addition, the allowable emission sectors (directions in which RF emission is permitted), have also been reduced to minimum mission requirements, yielding emission sectors that are frequently less than that used in the fleet. Table (1) shows the power levels and emission sectors as installed at SWEF.*

3.f. What controls are in place to ensure that an RF standard is not exceeded?

The controls proposed by the Navy seem very reasonable.

NAVY RESPONSE TO QUESTION 3f. *There are several different controls to ensure that our RF emission limits are not exceeded. These controls are related to installation design, the modifications to the equipment and restricted access to the facility. At the SWEF complex, whenever a system is being considered for installation, the Navy completes an installation design. The installation drawing includes the projected power level as well as the elevation and bearing restrictions. After the Navy installs the equipment, the Navy conducts an electromagnetic radiation hazard survey to verify that the power level restrictions have been properly implemented. The Navy uses the results of a pre-installation assessment to determine where the systems will be installed, and any limitations on the direction in which the systems will emit radio frequencies. Following radar system installation, the Navy conducts a site survey called a Hazards of Electromagnetic Radiation to Personnel (HERP) to test the radio frequency emission strength and further define acceptable and unacceptable directions to emit radio frequencies. Surveys concentrate on radio frequency emissions that are transmitted into the sky through the antenna located on the roof, as well as emissions inside the equipment spaces in the building. In addition, safety controls are applied across the board to all radars installed at the SWEF complex to preclude radars from pointing at houses, beaches, parks or commercial buildings within the area. The radars at SWEF have safety controls (sensors, switches, and/or procedures) which restrict radio frequency emissions to well defined areas. Safety switches send an electrical signal to the radar and stop the transmitter from operating when the radars' antenna is pointed in direction where it should not radiate. In some cases, the computer program functioning with the equipment senses the antenna position in elevation and/or bearing and automatically shuts down the radar if it is pointed into a non-radiate sector (performing the same function as the safety switches). Emissions from these radar systems are limited to well defined sectors and not toward water or land adjacent to SWEF. Procedures are in place at the SWEF complex to ensure emission sectors are operating properly each and every time a radar actively radiates out the dummy load (an internal device used to simulate radiation out of the antenna), prior to radiating out of the antenna. American National Standards Institute (ANSI) and DoD exposure limits in the uncontrolled environment (public) are maintained in all adjacent public areas. If RF studies and/or RF field measurements indicate potential hazards to personnel within the complex or to the general public, radar characteristics would be changed to ensure that RF safety limits are met. This involves changing the physical placement of an antenna, lowering transmitter output power, and adjusting RF transmission sectors (establishing non-radiate sectors) in both bearing and elevation, and establishing administrative procedures for RF transmissions. Radar equipment is protected from unauthorized access. The entire complex is located on Navy-owned property with a personnel exclusion fence around the perimeter. Routine public access to the SWEF complex is not permissible. All radars are installed on buildings that are accessible through the building entrance only and are installed between approximately 30 to over 100 feet above the ground.*

3.g. What are the consequences to people in the uncontrolled environment if an RF standard was exceeded by various percentages? Are there thresholds above an RF standard that the Commission could use to determine whether the Commission should be concerned?

In the development of the IEEE/ANSI C95.1 guidelines a number of sources of information were studied. One such source was a survey of the scientific literature. Several studies had determined that the threshold for reliable behavioral change during RF exposure was a specific absorption rate of approximately 4.0 W/kg. This rate of absorption would raise body temperature of the animals approximately 1 deg C within 1 hour of exposure. After exposure ceased the animals quickly recovered and were not harmed. This rate of absorption, 4.0 W/kg, has been used by a number of safety standards organizations during the last 20 years as the level to avoid. To put this level of absorption in perspective, consider that the energy used by a sleeping human is approximately 1.1 W/kg. Standing produces 1.8 W/kg while walking produces approximately 4.3 W/kg and running is about 18 W/kg. The IEEE C95.1 1991 recommended exposure guidelines are based on a number of considerations that resulted in a two tier standard. The PEL was then set ten times below 4.0 W/kg. Thus, for workers who utilize RF radiation in the workplace, the PEL was set at 0.4 W/kg specific absorption rate (SAR). For the general public the PEL was set fifty times below 4.0 W/kg at 0.08 W/kg. A brief exposure to RF levels above the uncontrolled PEL but below the controlled PEL (averaging times adhered to) does not, in this reviewer's opinion pose a cause for great concern. The standards are rather conservative and offer a very reasonable range of protection. As stated in the Navy's response below, the DoD action level for investigation of an overexposure is five times the exposure limit. In this case, for uncontrolled PELs, that is up to the controlled area exposure PEL.

NAVY RESPONSE TO QUESTION 3g. *The consequences of exposing a body to RF levels greater than the permissible exposure limit is body heating. The primary effect is surface skin heating with very little penetration into the body. The Navy uses the DoD standard to define an overexposure that warrants an investigation. The value for overexposure is five times the permissible exposure limit. This means that if the permissible exposure limit is 6 mw/sq. cm, a RF hazard would be investigated if the exposure is 30 mw/sq.cm or greater. The public cannot get close enough to the radar for an overexposure to occur. It would be reasonable for the Commission to be concerned if the public would be exposed to RF levels that exceed the Navy standard.*

4. How will the Navy interact with the Commission in the future?

NAVY RESPONSE TO QUESTION 4. *The Navy is hopeful that this process will improve our interaction with the Commission. The Navy will comply with the Coastal Zone Management Act by submitting negative determinations or consistency determinations as appropriate prior to the installation or modification of a radar system at the SWEF. The determinations will include a description of the equipment being installed or modified including any safety controls or modifications in place and any potential impact on the coastal zone. After the system is installed and the RF hazard report is completed, the Navy will provide the Commission with a copy of the RF hazard report verifying the actual conditions of operation. RF hazard reports can only be conducted after a new system is installed or a modification is installed. The Navy will assign a point of contact to be available to the Commission to address follow-up questions or provide other information.*

In answering this question, the following questions should also be considered:

4.a. What technical information should the Navy provide and the Commission seek, and what will be available, in reviewing modifications to the SWEF?

The Navy's response is a good answer to the question.

NAVY RESPONSE TO QUESTION 4a. *To assist the Commission in reviewing additions to SWEF, the Navy will provide a description of the equipment and provide information explaining where the RF hazard zones exist in relation to the uncontrolled areas including the shipping channel. The Navy will also explain any safety controls or other modifications in place. In addition, the Navy will provide copies of all final RF hazard reports. The Navy will also perform an analysis of any new radar to determine if the new* *radar may have a beam that could intersect with other radars within the shipping channel. If the radar has a beam that overlaps with other radars, the Navy will calculate the permissible exposure ratio and make adjustments as necessary. This analysis will become part of the installation design. The Navy will provide the results of this analysis to the Commission.*

5. With what RF standards does the Navy comply? What do those standards mean? What is the status of evolving international RF emission standards and would the international standards be useful in determining whether SWEF RF emissions pose a risk to coastal users? How will the Navy respond if/when the international standards change?

The response provided by the Navy below is, in this reviewer's opinion, also well done.

NAVY RESPONSE TO QUESTION 5a. *The Navy follows the Department of Defense (DOD) standard which is based on the National Institute of Electrical and Electronics Engineers (IEEE) and American National Standards Institute (ANSI) standard for RF exposure. DOD standard 6055.11of February 1995 "Protection of DOD Personnel from Exposure to Radio Frequency Radiation" sets exposure limits for all radars located at SWEF.*

5(b) What do those standards mean? *Safety exposure guidelines have been established to prevent harmful effects in human beings from exposure to RF fields. All DoD radar systems and operations, including those at SWEF, are required to follow the same guidelines. The guidelines are based upon a consensus derived voluntary standard, developed by the IEEE, which is a Non-Governmental Standards Organization. The standard was approved and adopted by the ANSI. The ANSI standard was developed after more than nine years of open, public review by over 120 internationally recognized experts from over 14 different disciplines, including scientists, public health officials, medical doctors, engineers, and technical experts from industry, academia, and government. The ANSI guidelines cover the frequencies from 3 kHz to 300 GHz and include guidelines for two distinctly different environments, controlled and uncontrolled. Generally, controlled environments represent areas that may be occupied by personnel who accept potential exposure as a concomitant of employment or duties, by individuals who knowingly enter areas where such levels are to be expected, and by personnel passing through such areas. Existing physical arrangements or areas, such as fences, perimeters, or weather deck(s) of a ship may be used in establishing controlled environments. Uncontrolled environments generally represent living quarters, workplaces, or public access areas where personnel would not expect to encounter high levels of RF energy. The maximum Permissible Exposure Limits (PELs) for the controlled environment is established based on a 10 times safety factor (0.4 W/Kg) averaged over the whole body. In the uncontrolled environment, the exposure limit is based on a 50 times safety factor (0.08 W/Kg), averaged over the whole body. The PELs for controlled environments for radars installed at SWEF are based on scientifically derived values to limit the absorption of electromagnetic energy in the broader human resonance frequency range of 100 kHz to 6 GHz and to restrict induced currents in the body. For uncontrolled environments, further reduction occurs to control RF levels in areas such as living quarters and workplaces that are not associated with RF radars. That reduction is based on a consensus designed to maintain lower exposure levels in the uncontrolled environment. The basis and the rationale for the PELs in controlled and uncontrolled environments are addressed in IEEE C95.1- 1991. The following web site provides a detailed discussion concerning the basis, background and application of IEEE C95.1-1991. (http://homepage.seas.upenn.edu/~kfoster/rf_mw.h tm)*

5(c) What is the status of evolving international RF emission standards and would international standards be useful in determining whether SWEF RF emissions pose a risk to coastal users? *The World*

Health Organization, (WHO) in May of 1996, launched an international project to assess health and environmental effects of exposure to electric and magnetic fields, which became known as the International EMF project. The project will last for five years and will bring together current knowledge and available resources of key international and national agencies and scientific institutions in order to arrive at scientifically-sound recommendations for health risk assessments of exposure to static and time varying electric and magnetic fields in the frequency range of 0-300 GHz. This project is still on-going and recommended standards are not expected until the completion of the project (sometime in 2001). A review of the WHO reports to date indicates that the RF exposure standards for the RF region that the radars at SWEF operate may have little or no change. However studies are still in progress and until the results are available, the Navy cannot assess the applicability to radars at SWEF.

5(d) How will the Navy respond if/when the international standards change?" *As changes to the international standards are made; they are reviewed and adopted by the IEEE and ANSI. DOD will change its' standards to comply with the IEEE/ANSI standards and the Navy will comply with those revised DOD standards. Further information on the WHO efforts on EMF can be obtained from web page http://www.who.int/peh-emf//contents encl. (2) ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH THE international EMF Project (http://www.who.int/inf-fs/en/fact181.html and encl. (3) ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH Health Effects of Radio frequency Fields Based on: Environmental Health Criteria 137 "Electromagnetic Fields (300Hz to 300GHz), World Health Organization, Geneva, 1993, and the report of the Scientific Review under the auspices of the International EMF Project of the World Health Organization, Munich,Germany, November 1996. http://www.sho.int.inf-fs/en/fact183.html and encl. (4) ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH, PUBLIC PERCEPTION OF EMF RISKS http://www.who.int.inf-fs.en.fact184.html are provided for additional information.*

6. How do SWEF RF emissions compare to other radar emissions?

The Navy's response to this question is reasonable and accurate.

NAVY RESPONSE TO QUESTION 6. *RF emissions from SWEF radars are generally much less than from those deployed for commercial application. SWEF emissions from radars occur occasionally (a few hours a week), while emissions from other commercial radar are continuous. One example is the NEXRAD doppler weather radar used by the National Weather Bureau to assess storms and predicts weather patterns. These systems are located throughout the United States and operate continuously (see encl. (5)). RF emissions produced by the NEXRAD radar are lower in frequency than all SWEF radars (with one exception-MK 23 TAS). Since the radar operates over a continuous 360- degree extent, there are no radiation hazards with this radar (similar to the search radar at SWEF). The fact that this radar rotates through 360 degrees of coverage mitigates any RF hazards that may be present from fixed beam operation (non-rotating). The output power is 1560 watts, which is more than some radars at SWEF and less than others. The primary difference is that the NEXRAD radars operate continuously, while SWEF radars only operate only a few hours a week. Another example is the AN/SPS-73 navigation radar installed onboard boats or ships. The radar is used for navigation and can operate at frequencies similar to the majority of those at SWEF. The installation of these radars on boats is such that the surrounding areas are irradiated with RF. However, as with the SWEF search radar, no hazards are present because the antenna rotates see encl. (6). This type of radar also operates continuously while the boat is underway. The output power is 25,000 watts (X-band) or 30,000 watts (S-band), which is more power than any radar at SWEF. This differs from the radar at SWEF in that the radars at SWEF only operate occasionally. An airport surveillance radar (ARSR-4) is also included for comparison (encl. (7)). This is a type of airport radar that is used by the Federal Aviation Administration (FAA) for tracking aircraft out to 250 miles. It is also a search radar and operates continuously, unlike the radars at SWEF. The fact that this radar rotates through 360 degrees of coverage mitigates any RF hazards that may be present from fixed beam operation (non-*

rotating). Again, the primary difference between this radar and the SWEF radars (in terms of RF emissions) are that this operates continuously, while the radars at SWEF operate occasionally. Los Angeles International Airport uses two ASR-9 air surveillance radars for tracking aircraft. These radars are also located adjacent to communities but are not hazardous because they rotate over 360 degrees. The fact that this radar rotates through 360 degrees of coverage mitigates any RF hazards that may be present from fixed beam operation (non-rotating). The frequencies of these radars are lower than those at SWEF, which will yield lower permissible exposure limits than radars at SWEF. Average power is 1500 watts, which is greater than some radars at SWEF and less than others. Other RF emission sources include microwave relay stations and radio stations. These produce RF emissions on a continuous basis, unlike SWEF radars that emit only a few times each week. In contrast to radio station emissions that are intended to cover the communities, SWEF radar emissions are directed at the open seas and at high elevations. Encl. (8) is a profile of emission data collected in a residential community by Evans Associates. The plot shows various levels of RF (below the permissible exposure limit) throughout the community.

7. To what extent is the Navy, in response to these questions, relying on information that is not available to the public?

I find the Navy's answer to this question quite acceptable also. I have used the formulas contained in enclosure 9 to make calculations for the SWEF radars to predict uncontrolled safe separation distances. A few of these are shown in the table below illustrating that the safe separation distance given by the Navy is within the minimum and maximum distances calculated for the frequency range containing the Navy's exact, but classified, radar frequency. The only radar that did not fall in the range I calculated was the FCS MK99 which differed by less than 1% (2 ft.).

<u>SWEF Radar Evaluation of Safe Separation Distance for Uncontrolled Area</u>

RADAR	System Loss dB	Antenna Gain dB	Power Avg. W	SWEF UCSSD*	Check UCSSD	Rotating Duty Cycle
FCS MK 92 CAS-CWI	8.73	35.5	5000	<173ft @10 GHz to 20 GHz	<175ft @10 GHz to <143 @ 20 GHz	N/A
FCS MK 92 STIR-CWI	6.52	42	5000	<462ft @10 GHz to 20 GHz	<476ft @10 GHz to <389ft @ 20 GHz	N/A
MK 23 TAS	0	21	5600	<2.5ft @1 GHz to 2 GHz	<2.76ft @ 1 GHz to <1.96ft @2 GHz	0.0092
TARTAR MK 74 MOD 6/8/A/N/SPG-51C-Track	(1.87)	39.5	550	<486ft @ 4 GHz to 6 GHz	<492ft @ 4 GHz to <402ft @ 6 GHz	N/A
FCS MK99	2.48	43	12000	<1320ft @10 to 20 GHz	<1318ft @ 10 GHz to <1076ft @ 20 GHz	N/A

*UCSSD- Uncontrolled Safe Separation Distance

NAVY RESPONSE TO QUESTION 7. *The Navy, for national security reasons, has had to rely on certain information that is not available to the public. This information regards exact operating frequencies at SWEF, certain safe separation distance and power density calculations. The Navy will continue to offer access to this classified information to the Commission or its representative with the appropriate security clearance. The exact operating frequencies at SWEF must be classified to protect the national defense. The Navy has used frequency ranges that contain the actual frequency numbers when providing information to the public. As a result, the RF hazard zones discussed in this document are* *larger than would be required if the Navy used the exact frequencies. Finally, proprietary software owned by Space and Naval Warfare Systems Center (SPAWAR) was initially used to make safe separation distance calculations, and power density calculations. The software used for making the calculations is not available to the public. However, this was only used for convenience and was not needed to actually perform these calculations. Encl. (9) shows methods used to make these same calculations by hand, which will give results differing little from those using the proprietary software.*

Appendix 2D - Technical Panel Member's Evaluation

Mediation Between the Navy and the California Coastal Commission
The Navy's Surface Warfare Engineering Facility, Port Hueneme

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This document provides the independent evaluation of Dr. Joe A. Elder regarding the effects of radar emissions from the Navy's Surface Warfare Engineering Facility (SWEF) at Port Hueneme, California, on the public's use of, and the wildlife on or about, the land and water areas around the SWEF. This evaluation is provided to the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (OCRM) as part of the mediation process developed between OCRM, the Navy and the California Coastal Commission (Commission). OCRM, as the mediator, will summarize this evaluation in a report to the Commission and the Navy, and will attach the evaluation to its report.

The five technical panel members are charged with providing, to the Navy and the Commission, through OCRM, their independent and objective scientific evaluation on whether, and to what extent, the operation of the SWEF poses impacts to any land or water use or natural resource of the coastal zone or impacts safe public access to the coastal zone. Panel members, in making their evaluations, shall use the materials provided by OCRM and the discussions held between the panel members, the Navy, Commission, OCRM and the Citizen Observer, on December 14, 1999, in Ventura, California. The panel members in their participation on the panel do not represent or work for OCRM, the Navy or the Commission. The panel members are not an advisory or consensus group, but will provide their own independent views.

Dr. Joe A. Elder's evaluation is contained in the following letter, with attachments:

February 17, 2000

Mr. David W. Kaiser
Federal Consistency Coordinator
Office of Ocean and Coastal Resource Management
Room 11208 (N/ORM3)
1305 East-West Highway
Silver Spring, MD 20910

Dear Mr. Kaiser:

This letter is my response to the charge given to the Technical Review Panel to provide to the Navy and the California Coastal Commission through the Office of Ocean and Coastal Resource Management, U.S. Department of Commerce, an independent and objective scientific evaluation on whether, and to what extent, the operation of the U.S. Navy Surface Warfare Engineering Facility (SWEF), poses impacts to any land or water use or natural resource of the coastal zone or impacts safe public access to the coastal zone. The issue being addressed is the safety of the SWEF high frequency radar emissions. My review consists of the following sections: 1) summary and conclusions, 2) general comments, 3) references and 4) attachments.

SUMMARY AND CONCLUSIONS

The mission of the U.S. Navy Surface Warfare Engineering Facility (SWEF) is to trouble-shoot and install state-of-the-art naval weapon systems. Because of this mission, the SWEF is a unique land-based facility with 16 radars. The radars are mounted on the roof of a multistory building and are oriented so that the radar beams are directed outward or upward, not downward. The height of the radars and the orientation of the radar beams are important reasons why there are low radiofrequency radiation (RFR) exposures in areas accessible to the public at ground or water levels. The Navy surveys show that public exposures at ground or water levels outside the base perimeter are below 1 mW/cm^2 and I conclude that the Navy surveys show no significant public health risk at these publically accessible locations from exposure to radiofrequency radiation from the SWEF radars.

The Navy reports show that a special case of potential public exposure in excess of the general population limit of 1 mW/cm^2 exists on the superstructure of cargo ships in the Port Hueneme shipping channel. I believe that safety procedures can ensure safe exposure levels on cargo ships and permit the Navy to fulfill the SWEF mission. My recommendation follows. When cargo ships are stationary in the shipping channel in front of the SWEF or when cargo ships are in front of the SWEF during transit through the channel, safeguards should prevent energization of SWEF radars that produce power densities of 1 mW/cm^2 or greater on cargo ships.

My strongest criticism of the Navy reports is that the public exposure data is the minimum necessary to reach these conclusions on the public health impact with my confidence rating of "adequate." Public health evaluations with a higher confidence rating, such as "very good" to "excellent," would enhance the public's reception of the evaluations and be more helpful to public health officials. For these reasons, I recommend that the U.S. Navy submit to the public a well-designed, comprehensive public exposure assessment study within a reasonable time, e.g., six months, after the Technical

Review Panel results are made public (more details under GENERAL COMMENTS).

Also discussed below is the conclusion that SWEF radar emissions do not significantly affect free-flying birds.

GENERAL COMMENTS

Approach: My approach to the evaluation of the SWEF in regards to public health is to compare the measured RFR exposure levels or calculated levels in publically accessible areas to the maximum permissible exposure limits promulgated in 1996 by the Federal Communication Commission (FCC, 1996). The FCC guidelines, based primarily on the recommendations of the National Council on Radiation Protection and Measurements (NCRP 1986), apply to the general population (uncontrolled exposure areas) as well as occupational (controlled) areas. The FCC quidelines are used instead of the Department of Defense (DOD)/Navy guidelines (DOD 1995) for the following reasons.

1) The federal health and safety regulatory agencies concerned with RFR issues assisted in the development of the FCC guidelines. These agencies are the Environmental Protection Agency (EPA), Food and Drug Administration, National Institute for Occupational Safety and Health, and Occupational Safety and Health Administration. In a letter dated July 25, 1996, the EPA Administrator wrote the FCC Chairman that the FCC guidelines address EPA concerns about adequate protection of public health from exposure to RF radiation (copy of letter attached; see EPA 1996).

2) The FCC permissible general population exposure limit is more protective than the DOD/Navy limit for SWEF radar frequencies >1.5 GHz to 20 GHz. The FCC guideline is 1 mW/cm^2 for these frequencies and this limit is up to 10 times less than the permissible limit for uncontrolled (public) areas in the DOD/Navy guideline. [From 1.5 GHz - 15 GHz, the DOD/Navy limit increases as a function of frequency [frequency(in MHZ)/1500] from 1 mW/cm^2 at 1.5 GHz to 10 mW/cm^2 at 15 GHz and is 10 mW/cm^2 for frequencies up to 20 GHz.]

While it may be appropriate for the Navy to apply the DOD guidelines within the confines of the Navy base for both controlled areas and uncontrolled areas, it is my personal opinion that the more protective FCC guideline for uncontrolled (public) areas should be used to evaluate radar exposure levels in areas accessible to the public beyond the perimeter of the Navy base. This position is taken with the knowledge that the FCC guidelines do not apply to military facilities; the FCC guidelines regulate commercial radiofrequency facilities such as AM and FM radio antennas, television broadcast stations, microwave relay facilities, cellular phones/base stations, etc. Which guideline applies to the public outside the Navy base perimeter is not an important issue for this evaluation because the RFR exposures at ground/water levels in publically accessible areas are below the limits for both the FCC and DOD/Navy guidelines (except for the special case discussed below of RFR exposure of the superstructure of cargo ships in the shipping channel).

Special case of radar exposure of cargo ship superstructure: The Navy documents include a statement made by Commander P. K. Benfield on August 11, 1998 that "...SWEF does not radiate ships in the harbor or the channel" (Attachment 6 in Attachment 4). I interpret this statement to mean that the Navy does not permit RFR exposures on ships to exceed the DOD/Navy guidelines sufficiently high for a prolonged period, absorbed RF energy can cause severe heat stress and death. For example, an exposure of 150 - 160 mW/cm^2 for about seven minutes is lethal for the Dark-eyed Junco exposed at 2.45 GHz at an ambient temperature of 7 - 13 °C (45 - 55 °F) (EPA 1984). Under different conditions, e.g., higher ambient temperature, the lethal exposure level due to heat stress would be less but the exposure time could be expected to be of the order of a few minutes, far longer than the time needed for a free-flying bird to transit a radar beam. These reasons appear to explain why I have never read or heard that free-flying birds have been killed by radar beams. This statement was made at the December 14, 1999 meeting of the Technical Review Panel and none of the other panel members, who have 20 or more years of RFR experience, rebutted my concluding statement about free-flying birds.

The lethality study mentioned above is summarized in the attachment (EPA, 1984) entitled "Responses of Airborne Biota to Microwave Transmission from Satellite Power System (SPS)." Other effects on birds exposed to RFR were studied and changes in foraging behavior, migratory orientation and social interaction were reported; however, "these changes were judged to be small and probably not critical to survival."

Disclaimer: The opinions and conclusions in this letter are my own and do not necessarily represent those of my employer, the U.S. Environmental Protection Agency.

I trust that you and your agency will find my review helpful and constructive in the mediation of the SWEF radar emissions issue between the Navy and the California Coastal Commission.

Sincerely yours,

/s/

Joe A. Elder, Ph.D.
Member, Technical Review Panel

cc w/o attachments:
Dr. Harold Zenick, Associate Director for Health, NHEERL, EPA
Edwin Mantiply, OAR/NAREL, EPA
Norbert Hankin, OAR/ORIA, EPA

References

DOD (1995). Protection of DOD Personnel from Exposure to Radio Frequency Radiation. DOD Standard 6055.11, February 1995. (See Table 2A, Permissible Exposure Limits (PELs) for Uncontrolled Environments.)

EPA (1984). Responses of Airborne Biota to Microwave Transmission from Satellite Power System (SPS). Project Summary. EPA-600/S1-84-001, September 1984.

EPA (1996). Letter from Carol M. Browner, Administrator, U.S. Environmental Protection Agency, to Reed E. Hundt, Chairman, Federal Communications Commission, July 25, 1996.

FCC (1996). Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation. Federal Communications Commission (FCC) Report and Order, FCC 96-326, August 1, 1996. (See Table 1B, Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure, page 92.)

NCRP (1986). Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields. National Council on Radiation Protection and Measurements (NCRP), Report No. 86, April 2, 1986. (See Figure 17.2, Criteria for exposure to RFEM fields, page 280.)

ATTACHMENTS

EPA (1984). Responses of Airborne Biota to Microwave Transmission from Satellite Power System (SPS). Project Summary. EPA-600/S1-84-001, September 1984.

EPA (1996). Letter from Carol M. Browner, Administrator, U.S. Environmental Protection Agency, to Reed E. Hundt, Chairman, Federal Communications Commission, July 25, 1996.

United States
Environmental Protection
Agency

Health Effects
Research Laboratory
Research Triangle Park NC 27711

Research and Development

EPA-600/S1-84-001 Sept. 1984

EPA

Project Summary

Responses of Airborne Biota to Microwave Transmission from Satellite Power System (SPS)

Studies were conducted to determine whether 2.45 GHz microwave radiation (as would be produced by the proposed Satellite Power System) constitutes a hazard to exposed avian species or influences their survival. Several species of birds were used to study a number of endpoints: aversion/attraction to the microwave field, change in migratory orientation, social interactions, lethality, thermoregulatory responses, molt, foraging behavior, nesting and reproduction, and effect on bird flight. In several cases the birds responded simply to an additional thermal insult. Some of the effects found could alter the survivability of the birds if sufficiently high microwave fields are encountered. For a few endpoints, including foraging behavior, migratory orientation and social interaction, it was not clear if the modified response was thermally based. However, these changes were judged to be small and probably not critical to survival.

This Project Summary was developed by EPA's Health Effects Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In an effort to find a reliable pollution-free energy source as an alternative to fossil fuels, the Department of Energy has actively examined a number of possible energy sources. One such source involves collecting the energy of the sun by a network of satellites and transmitting it in the form of microwave energy (2.45 GHz) to rectennas on the earth's surface. In assessing the environmental impact of this proposed Satellite Power System (SPS), the effects of microwaves on airborne biota is an important consideration. The focus of this report is on the avian species since birds are commonly found in areas likely to be selected as rectenna sites. Further, their complete freedom of movement precludes preventing their exposure during flights across the area or when landing on the rectenna.

The goal of this program is to determine whether microwave irradiation adversely alters a wide range of complex avian behaviors that are essential to their survival. Effects of 2.45 GHz microwaves have been studied extensively in mammalian species, e.g., rats, mice, rabbits and monkeys, but very little information is available for birds. Avian species, generally, have higher rates of metabolism (especially during flight), stand on two feet and have an elongated neck that increases the amount of isolation between the head and thorax. All of these anatomical features can be expected to increase the susceptibility of birds to hyperthermia, vestibular and neuromuscular dysfunction as well as more subtle altered behaviors, e.g., inappropriate migratory behavior due to interference with normal astronomical or geomagnetic clues.

In this study the experiments were designed to provide, where possible, dose-response data for a variety of different migratory and non-migratory behavioral and physiologic endpoints. Non-migratory behaviors include breeding, flocking, feeding and social interaction among birds. Effects of microwaves on migratory behavior were evaluated by comparing the orientation of irradiated and non-irradiated birds (that normally migrate) during the time of seasonal migrations. Finally, experiments were carried out to determine if birds are able to perceive and respond to microwave irradiation, the relationship between dose and changes in body temperature under a variety of ambient conditions, and the relationship between dose and lethality.

Summary Text

Exposure Facilities

Microwave exposures were conducted in both indoor (laboratory) and open field areas. The microwave irradiation facilities were designed to provide plane-wave illumination with a power density variation of ± 0.5 dB maximum over the cages, and/or flight area, during all acute and short-term chronic studies. The radiating source for all experiments was a standard-gain horn which provided linearly polarized radiation.

The acute-exposure field studies (at Manomet Bird Observatory) required only the illumination of a 15 x 15 x 15 cm microwave-transparent cage. Thus, horn-to-cage spacing of 1.37 meters provided the required power density uniformity using a simple overhead mounted horn. By varying the horn-to-platform spacing, and by adjusting the microwave power generator control, the power density at the surface of the platform could be varied from about 1 mW/cm^2 to over 100 mW/cm^2. For orientation studies, the horn was placed on the ground and the subjects were raised on a microwave-transparent platform 2.74 meters above the horn.

The Arthur D. Little (laboratory) facility required the uniform, simultaneous illumination of multiple cages of approximately 1.0 x 1.0 x 0.6 m each. Four such cages were uniformly illuminated with a horn-to-cage spacing of at least 7.3 meters. At this spacing, a power density of 25 mW/cm^2 was acheived with a total radiated power of about 4.6 kW. The Cober S6F generators, which are 6 kW microwave power sources, provided adequate power margin. Measurements indicated the presence of 180 Hz amplitude modulation which may reach 60 percent at low generator output, <1 kW, but declines to about 40% above 3 kW output.

The horns were positioned for overhead illumination. This configuration, shown in Figure 1, yielded a power density variation of ± 1 dB over a floor space of 4' x 6'. A total of five irradiation chambers were used, together with two replicas for housing and heating the control birds. Three of the chambers were operated at 0.1, 1.0 and 10 mW/cm^2, for chronic studies. Another chamber was operated at 25 mW/cm^2 for subchronic exposure studies while the fifth was used in conjunction with the wind tunnel and for those studies involving acute exposures.

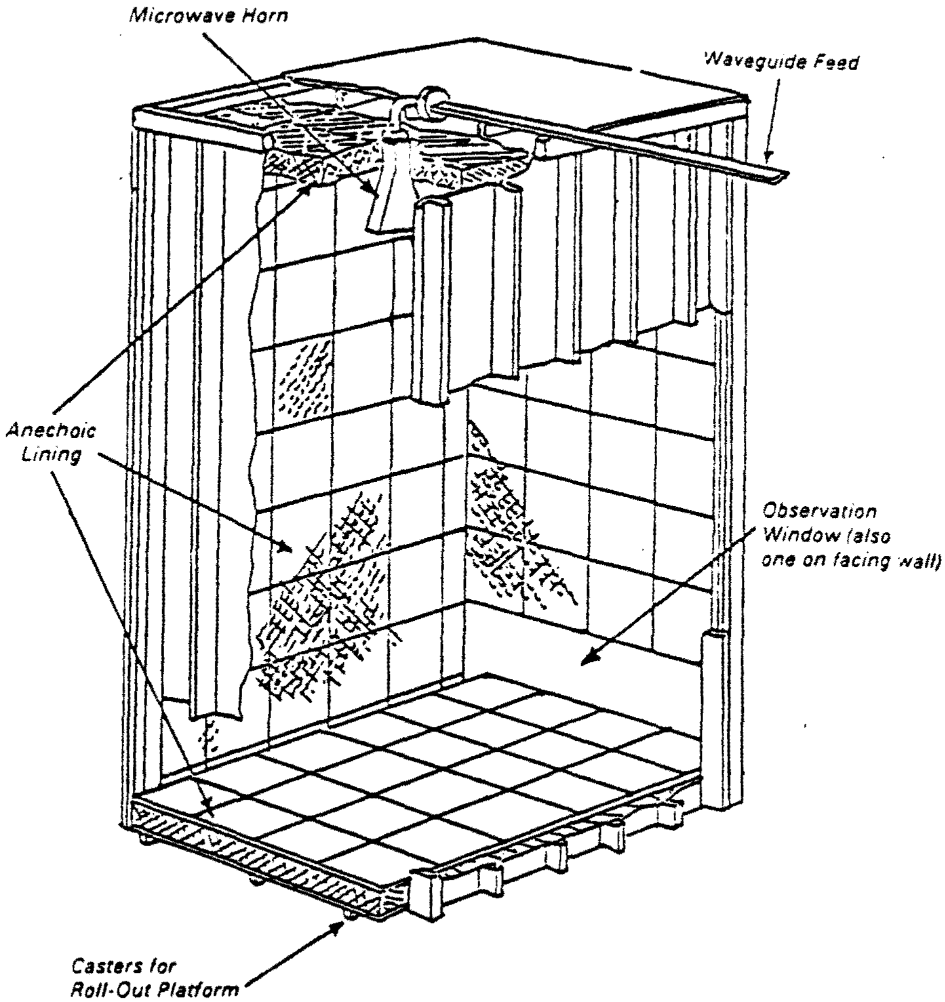


Figure 1. Microwave irradiation chamber—final design.

An open-jet wind tunnel for study of birds in flight was designed and built. The wind tunnel and flight chamber configuration (Figure 2) consisted of two fans, placed side by side, followed by a honeycomb flow straightener, a contraction nozzle, a second flow straightener, the working chamber, and finally an outlet diffuser. Upstream fans were used so that the air velocity in the flight chamber could be controlled by restricting the air flow to the fans through the use of blocking lattice-works of different open area placed in front of the air inlet. This technique allowed the use of constant speed fan motors rather than the variable speed motors used in tunnels with downstream fans.

For flight training and exposure of Budgerigars, a 1.0 x 0.6 x 0.6 m cage with four solid transparent sides and two screened ends was placed in the airstream of the wind tunnel approximately 0.54 m from the outlet honeycomb flow-straightener. The flow was adjusted to provide a velocity of 37 km/h at the level of the training perch, and a variation of < 2.4 km/h was measured over the remainder of the cage.

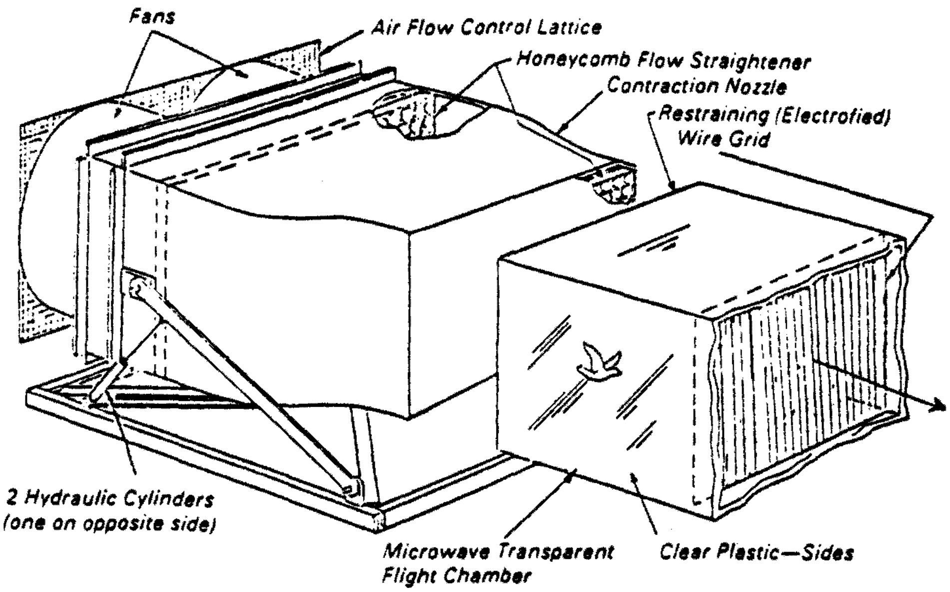


Figure 2. *Wind tunnel and flight chamber.*

Aversion/Attraction

These experiments determine if birds can perceive the presence of microwave irradiation by observing whether House Finches (*Carpodacus mexicanus*) and Blue Jays (*Cyanocitta cristata*) exhibit an attraction or an aversion to the field when exposed to power densities of 10, 25, and 50 mW/cm^2.

At all three power densities, House Finches showed non-random movement within the test cage based on the number of times that birds were observed in the microwave-irradiated or in the non-irradiated areas. At 10 mW/cm^2, House Finches exhibited behavior consistent with attraction to the field by perching more often in the exposed areas of the cage during microwave irradation than in the shielded areas. House Finches, at a power density of 25 or 50 mW/cm^2, were observed to perch more frequently in the non-irradiated areas of the cage, suggesting an aversion to the microwave field (Table 1). Blue Jays also showed non-random movement within the test cage at all exposure levels. Birds were observed in the exposed areas of the cage significantly fewer times than in the microwave shielded areas (Table 2). These results indicate that Blue Jays exhibit an aversion to microwave irradiation at all three power densities. Based on these results, birds exposed to microwave irradiation at a rectenna site would appear to be capable of responding to the field by either avoidance or attraction depending upon the power density of the field and the ambient conditions of temperature, humidity, wind speed and solar radiation.

Thermoregulatory Behavior

To investigate the relationship between microwave exposure and the onset and duration of patterns of thermoregulatory behaviors, a series of experiments were carried out with House Finches (small bird - 17 to 24 g) and Blue Jays (medium-sized bird - 75 to 100 g) at each of five power densities: 0.1, 1, 10, 25 and 50 mW/cm^2. Cages were arranged so that the birds sitting on the perch were oriented perpendicular to the E vector of the microwave field. To quantify thermoregulatory behavior, birds were observed for one or more of four distinctive postures which represent behavioral responses to increasing thermoregulatory stress.

Cloacal temperature was used as a measure of body temperature. Each bird's temperature was monitored continuously before, during and after 10 minutes of exposure to microwave radiation. Ambient temperatures generally remained within $\pm$ 2° (20°C) and there was essentially no air movement (wind) over the restrained birds.

House Finches and Blue Jays show behavioral responses to microwave-induced heat stress which are good indicators of increased cloacal temperatures during microwave irradiation. For both species, studies of behavior and cloacal temperature indicate that there is no observable thermoregulatory stress induced by microwave irradiation of 10 mW/cm^2 or less. At 25 mW/cm^2 the larger Blue Jays show more signs of stress than House Finches. At 50 mW/cm^2, both House Finches and Blue Jays exhibit signs of thermal stress and show significant elevation in cloacal temperature during 10 minutes of irradiation. Blue Jays showed the larger behavioral response (Figure 3) suggesting that they must expend more energy for heat dissipation than House Finches for similar rises in cloacal temperature. Both species experienced significantly greater elevation in cloacal temperature when the longitudinal axis of the body was oriented parallel to the E vector compared

Table 1. *Aversion/Attraction of Birds to Microwave Fields - House Finches*

Power Density	*Cage Area*	*Pre-exposure*	*Exposure*	*Post-exposure*
		**Number of times House Finches were observed in Area A or B*		
a) 10 mW/cm^2	*A Shielded*	*1104*	*906*	*861*
	B Exposed	*792*	*992*	*912*
	$\bar{X}$ ambient temperature = 23.4°C; $\bar{X}$ relative humidity = 72%			
	X^2 = 51.3, df = 2, $p < 0.01$			
b) 25 mW/cm^2	*A Shielded*	*876*	*1133*	*959*
	B Exposed	*889*	*691*	*735*
	$\bar{X}$ ambient temperature = 22.4°C; $\bar{X}$ relative humidity = 68%			
	X^2 = 56.98, df = 2, $p < 0.05$			
c) 50 mW/cm^2	*A Shielded*	*860*	*993*	*925*
	B Exposed	*1012*	*721*	*806*
	$\bar{X}$ ambient temperature = 21.1°C; $\bar{X}$ relative humidity = 47%			
	X^2 = 53.05, df = 2, $p < 0.01$			

**The total number of observations of House Finches in a symmetrical cage with two quadrants shielded from, and two quadrants exposed to, microwave irradiation at 10, 25, and 50 mW/cm^2. The null hypothesis being tested with a X^2 analysis (3x2 X^2 contingency tables, df = 2) is that the frequency of observations in the shielded and exposed areas of the cage is independent of the pre-exposure, exposure, and post-exposure periods. Observations were made every six seconds during the last ten minutes of each 30-minute period (pre-exposure, exposure, and post-exposure periods). Birds were observed continuously through a pre-exposure, exposure and post-exposure period. Each of 10 birds was tested twice.*

Table 2. Aversion/Attraction of Birds to Microwave Fields - Blue Jays

Power Density	Cage Area	*Number of times Blue Jays were observed in Area A or B		
		Pre-exposure	Exposure	Post-exposure
a) 10 mW/cm^2	A Shielded	875	961	996
	B Exposed	926	805	678
	$\bar{X}$ ambient temperature = 19.1°C; $\bar{X}$ relative humidity = 44%			
	X^2 = 41.76, df = 2, $p < 0.01$			
b) 25 mW/cm^2	A Shielded	716	1070	708
	B Exposed	887	661	766
	$\bar{X}$ ambient temperature = 19.5°C; $\bar{X}$ relative humidity = 50%			
	X^2 = 110.58, df = 2, $p < 0.001$			
c) 50 mW/cm^2	A Shielded	791	1113	1009
	B Exposed	947	663	762
	$\bar{X}$ ambient temperature = 19.6°C; $\bar{X}$ relative humidity = 53%			
	X^2 = 108.22, df = 2, $p < 0.01$			

**The total number of observations of Blue Jays in a symmetrical cage with two quadrants shielded from, and two quadrants exposed to, microwave irradiation at 10, 25, and 50 mW/cm^2. The null hypothesis being tested with a X^2 analysis (3x2 X^2 contingency tables, df = 2) is that the frequency of observations in the shielded and exposed areas of the cage is independent of the pre-exposure, exposure, and post-exposure periods. Observations were made every six seconds during the last ten minutes of each 30-minute period (pre-exposure, exposure, and post-exposure periods). Birds were observed continuously through a pre-exposure, exposure, and post-exposure period. Each of the 10 birds was tested twice.*

to perpendicular orientation. At 50 mW/cm^2, parallel orientation proved lethal for some House Finches after 9 minutes of irradiation even though the ambient temperature did not rise above 24°C.

Foraging

Behavior involving the ability of birds to search for and manipulate food was studied in the White-throated Sparrow (*Zonotrichia albicollis*). This experiment was designed to quantify the impact of the SPS system on the foraging behavior of a small avian species by using a standard optimal foraging laboratory study technique. Three basic experiments were performed: acute multiple (brief) exposures conducted at power densities of 0.0, 0.1, 10.0 and 25.0 mW/cm^2 for 2, 20 or 200 minutes; 7-day exposures conducted at power densities of 0.0, 0.1, 1.0, 10.0, and 25.0 mW/cm^2; and 4-week exposures conducted at power densities of 0.0 and 25.0 mW/cm^2.

For the acute multiple exposures, foraging efficiency was found to be influenced by changes in ambient temperature and relative humidity, but no acute effects were found that correlated with dose levels of microwave exposure. Seven-day continuous exposures resulted in no significant differences in foraging behavior between sham- and microwave-treated birds. Significant differences in foraging efficiency were found among birds receiving different power densities but, again, the differences were not found to be dose-related. Birds exposed in the 4-week studies showed no significant differences in foraging efficiency between pre-exposure, exposure, and post-exposure periods despite significant differences in ambient room and exposure chamber temperatures. When compared to (parallel) sham control birds, microwave-treated birds showed a significantly lower search efficiency during the post-exposure period; however, this one difference should not indicate differential survival between control and microwave-treated birds.

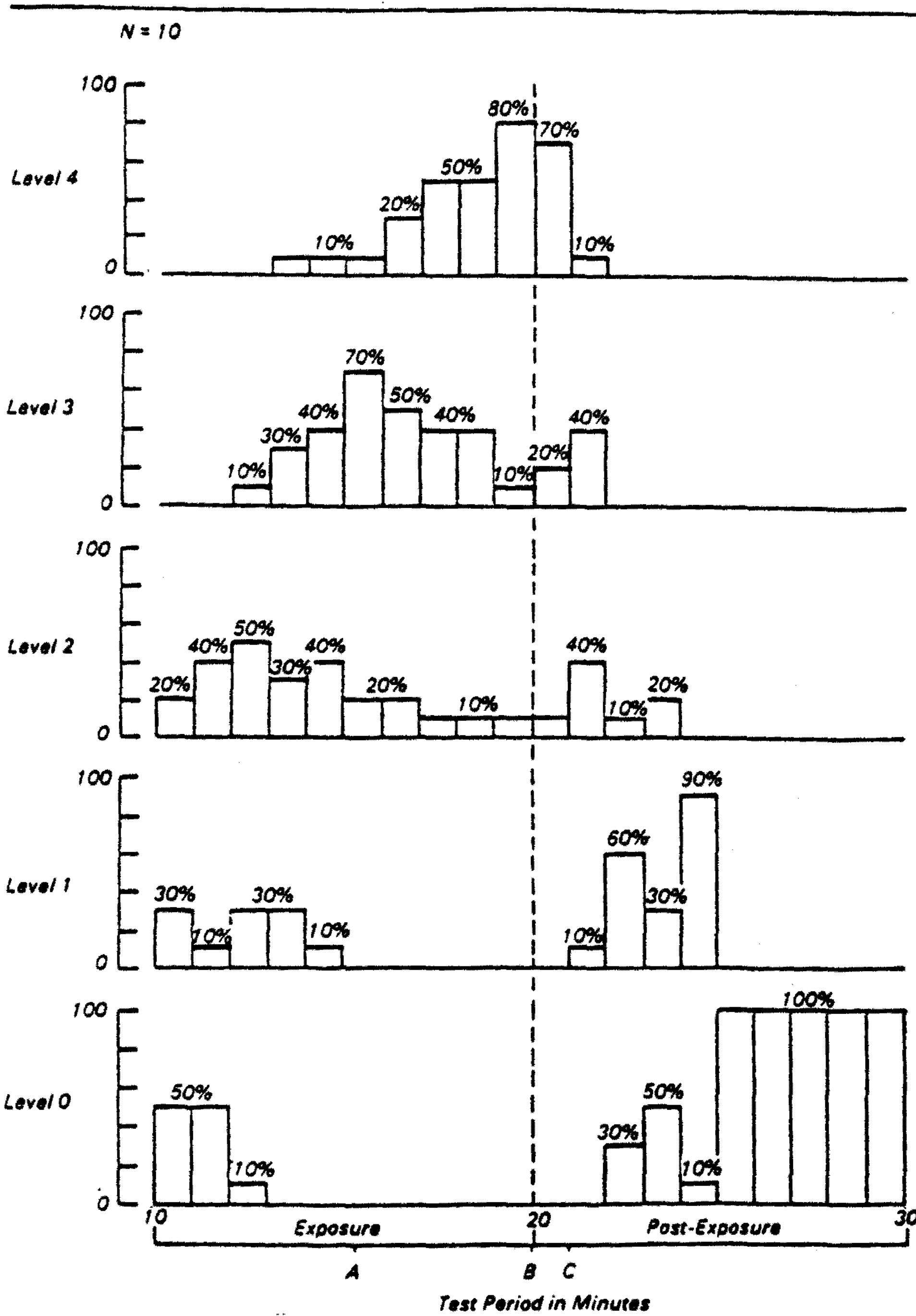
Orientation

These experiments were carried out to determine whether microwave irradiation disrupts the ability of birds to mitigate properly. Associated with premigratory preparation is an increased nocturnal activity. This nocturnal restlessness, known as "Zugenruhe" may, in captivity, have a directional component which reflects the true direction of the intended migration. This research was designed to answer the questions of whether exposure to microwaves impairs premigratory restlessness, influences the ability of a bird to maintain directional movements during migration, or alters the chosen direction of orientation. The procedures developed by Emlen and Emlen (1966) were used to study avian orientation. The "Emlen cage" consists of an inverted cone made of polystyrene (for microwave transparency) lined with blotting paper. The narrow base to the cage is centered around an ink pad while the top of the cage is covered by a transparent material, usually plastic hardware cloth. The caged bird therefore has a clear view of the night sky and will leave an ink footprint on the blotting paper each time it makes an attempt to escape. This record of the bird's activity provides data on the directional preference of that bird.

Microwave exposure did not change the quantity of nocturnal activity, or "Zugenruhe," exhibited by White-throated Sparrows. Approximately one-third of all birds tested maintained directional behavior, regardless of cloudcover or other environmental variables. Microwaves did not affect the ability of birds to maintain oriented movements. Also, microwaves (Figure 4) did not affect the specific directional preferences of non-randomly orienting birds grouped under various cloudcover conditions. The non-treated birds, however, showed their movements to be non-randomly distributed on nights with clear skies and on all nights combined. The same distributions of microwave-treated birds were found to be random. Therefore, while the mean angles, or preferred directions were statistically the same, the microwave-treated birds showed a greater dispersion of chosen directions around the mean. This is a significant finding which can be attributed to microwave exposure. Hence, we conclude that although there was no significant change in directional preference by birds under exposure to microwaves at the power densities projected for use by the SPS, the increased dispersion of those treated birds represents an influence which must be considered as potentially hazardous to migratory birds in the absence of more definitive experimental data.

Bird Flight

The average size of many common avian species (5 cm in length) is such that many birds should have a maximum microwave absorption efficiency at 2.45 GHz. During prolonged flight birds are often near the limit of their ability to dissipate metabolic heat. Therefore the effect of the additional heat load imposed by a microwave field was studied. Budgerigars were trained to fly in a wind tunnel and exposed to microwave radiation at 50 mW/cm^2. Each experimental subject was flown for two 10-minute periods a day, a control flight and a microwave flight with a minimum of 30 minutes of rest between the flights. In normal flight, the bird's legs were observed to be aligned close to the body and parallel to its axis. Under conditions of thermal stress or hyperthermia, the bird dropped its legs to expose its toes and



(A = five minutes after onset of irradiation; B = ten minutes after onset of irradiation; C = one minute after termination of irradiation.)

Figure 3. Percentage of Blue Jays showing stress at each of the five thermoregulatory response levels during and after irradiation with 50 mW/cm².

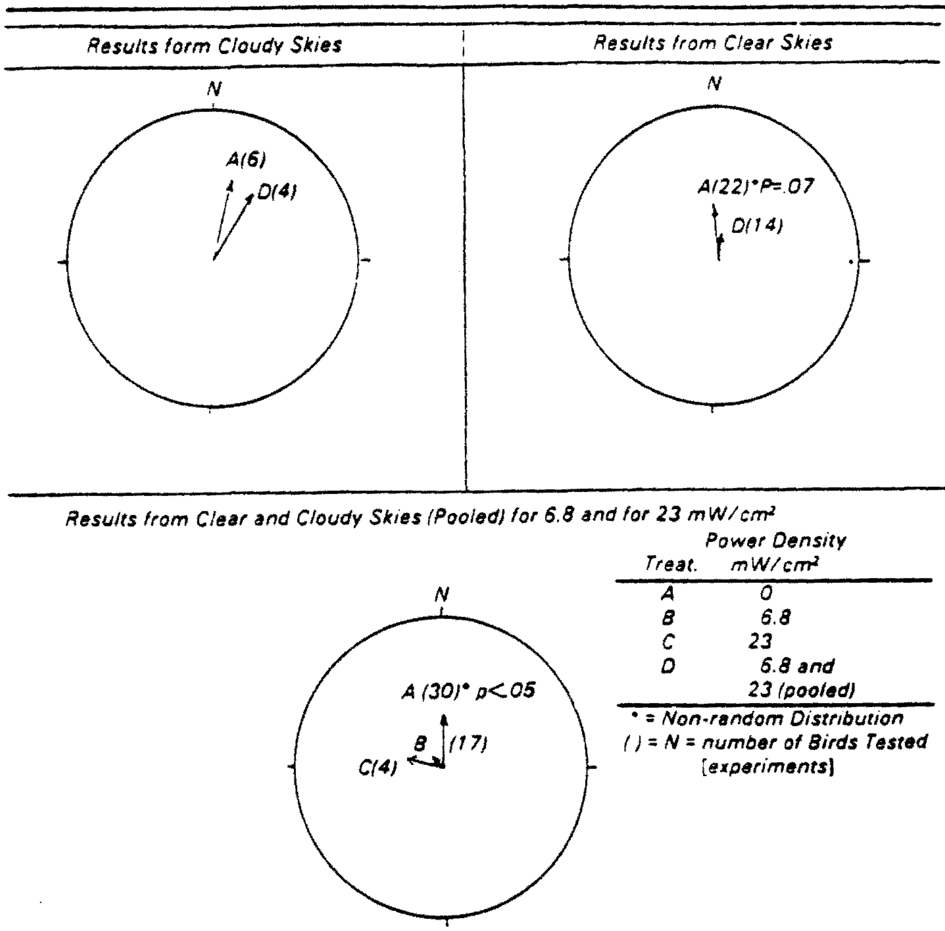
tarsa-metatarsus to the airstream. In addition, during thermal stress, birds flew with their mouths open (gaping). If a Budgerigar showed evidence that it was clearly unable to maintain flight for the full 10 minutes, the experiment was terminated. Thermoregulatory behavior after flight was ranked according to severity.

When irradiated at 50 mW/cm², birds began to show high levels of stress at ambient temperatures above 26°C and demonstrated an inability to fly for 20 mintues at air temperatures above 32°C. After exposure at air temperatures above 33°C, Budgerigars required at least 10 minutes to recover fully after flight. At air temperatures above 28°C the birds irradiated during flight generally showed higher body temperatures than without exposure. Based on these data, a microwave field of 50 mW/cm² could impair bird flight in the field, forcing the bird to engage in thermoregulatory behaviors and land prematurely. The long post-flight cooling period might adversely affect a bird's ability to forage or escape predators. A 50 mW/cm² power density is approximately equivalent to an 8°C rise in ambient temperature to a flying Budgerigar.

Reproductive Behavior

In view of the likelihood of birds entering and nesting within the SPS rectenna site, it was essential to determine the effects of microwave irradiation on reproductive success. Bird behavior for six breeding pairs of Zebra Finches were characterized as random, maintenance, feeding, reproductive, aggressive or thermoregulatory. Birds exposed to continuous microwave radiation (25 mW/cm²) were able to breed successfully. Although the irradiated pairs of Zebra Finches produced fewer eggs and fewer fertile eggs, there was no significant difference in the number of fledglings produced by the irradiated and control pairs of birds. This may simply show that the Zebra Finch already has the ability to compensate for environmental factors which may affect its reproductive success.

The effect of 25 or 50 mW/cm² microwave irradiation on embryonic development in bird eggs exposed when incubating parents are absent from the nest was studied by irradiating fertile Coturnix Quail eggs twice a day for 30 minutes throughout the 17-day normal incubation period (for this species). The hatchability of eggs irradiated by 25 mW/cm² did not differ from that of control eggs. No significant differences were observed in the rates of growth of chicks hatched from control and 25 mW/cm² exposed eggs during the first 26-28 days post-hatch nor from control and 50 mW/cm² exposed eggs during the first 15 days post-hatch. No evidence of teratogenesis was observed as indicated by the absence of deformed chicks hatched from eggs that had been irradiated at 25 or 50 mW/cm². Based on these data, microwave irradiation by 25 mW/cm² should not notably reduce egg hatchability in the field.



Treat.	Power Density mW/cm²
A	0
B	6.8
C	23
D	6.8 and 23 (pooled)

* = Non-random Distribution
( ) = N = number of Birds Tested [experiments]

Figure 4. *Mean directions exhibited by groups of birds under various conditions of cloudcover and microwave exposure (6.8; 23 mW/cm²).*

Social Interaction

The White-throated Sparrow (*Zonotrichia albiocollis*) and the Dark-eyed Junco (*Junco hyemalis*) were studied to assess the effects of acute microwave radiation on the behavior and position of birds within a flock dominance hierarchy. Initial observations provided basic flock structure data and the dominance order within the flock. Encounters between birds were classified as either active agression or avoidance.

Initially one and later two birds from five-bird hierarchies were exposed. Ultimately, 17 birds from 12 flocks were exposed to 4 combinations of microwave power and duration, in addition to 3 sham control birds from 2 additional flocks. Although the irradiated birds maintained their positions in the hierarchies (with one exception), some appeared to have changed their level of aggression after exposure at 25 mW/cm². These changes, however, are not considered inconsistent with survival of birds at an SPS rectenna site.

Lethal Levels of Microwave Irradiation

The lethal level of microwave irradiation for the Dark-eyed Junco exposed at an ambient temperature of 7 to 13°C appears to be on the order of 150-160 mW/cm² over 7 $\pm$ 0.5 minutes based on exposures at 130, 150 and 160 mW/cm². Power densities of 100 to 130 mW/cm² for up to 20 minutes result in no observable signs of heat stress other than gaping. Exposure to near lethal levels of microwave irradiation results in stress-related behaviors that are characterized by gaping, panting, crouching and loss of muscular coordination or equilibrium. The rapid onset of gaping has been observed at all power levels from 25 mW/cm² to 160 mW/cm² beginning as soon as 30 seconds after the start of exposure.

Molt of Birds Exposed to Microwave Radiation

Molt was chosen as a sensitive indicator of the possible deleterious effects of microwave irradiation on the endocrine and autonomic nervous systems of birds. House Finches were studied to determine if continuous microwave exposure alters molting.

All control and exposed birds completed the molting process. The time required for the last half of molting was essentially the same for the controls and the birds exposed to 1 and 10 mW/cm². The rate of molting was slower in the two birds that were exposed to 25 mW/cm². Whether the slower rate of molting resulted from microwave exposure or some other variable (e.g., the birds used in these experiments had already started molting when trapped and the change in environment from the wild to the laboratory may have affected the molting process) will require additional study.

An examination of control birds and those exposed at 25 mW/cm² revealed no observable gross or histopathologic changes in any of the major organs that could be attributed to microwave treatment. Similarly, each bird was observed for changes in muscle tone, righting reflex, vestibular function, pupillary response to light, corneal opacity and response to pain (cornea). No differences were observed between control and irradiated birds.

☆U. S. GOVERNMENT PRINTING OFFICE: 1984/759-102/10711

This Project Summary was authored by staff of Arthur D. Little, Inc., Cambridge, MA 02140; Boston University, Boston, MA 02214; and Manomet Bird Observatory, Manomet, MA 02345.

***Daniel F. Cahill and John W. Allis** are the EPA Project Officers (see below).*

The complete report, entitled "Responses of Airborne Biota to Microwave Transmission from Satellite Power System (SPS)," (Order No. PB 84-141 191; Cost: $32.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officers can be contacted at:

Health Effects Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

United States
Environmental Protection
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JUL 25 1996

THE ADMINISTRATOR

Honorable Reed E. Hundt
Chairman
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

Dear Mr. Hundt:

Thank you for your letter of July 1, 1996, advising me that the Federal Communications Commission (FCC) is completing the process of updating its radio frequency (RF) exposure guidelines, and asking that the Environmental Protection Agency (EPA) review the FCC's approach to developing new guidelines.

As you point out in your letter, EPA commented on a 1993 proposed rule on RF exposure guidelines and recommended that the FCC consider adopting certain features of the National Council on Radiation Protection and Measurements (NCRP) guidelines along with others recommended by the American National Standards Insititute (ANSI) and the Institute of Electrical and Electronics Engineers, Inc. (IEEE). The National Institute for Occupational Safety and Health (NIOSH), the Food and Drug Administration (FDA), and the Occupational Safety and Health Administration (OSHA) also commented on this proposal and proposed additional changes.

As a result of these comments, you indicated that you are considering an approach that responds to the recommendations made by the EPA and by the other federal health and safety agencies, incorporates elements from both ANSI/IEEE and NCRP, and includes: 1) adoption of limits for field strength and power density limits based on NCRP recommendations (the ANSI/IEEE and NCRP limits are similar up to 1500 MHz, above which NCRP has different MPE limits); 2) adoption of ANSI/IEEE limits for localized specific absorption rate (SAR) (again, similar to NCRP); 3) deferring adoption of the ANSI/IEEE radiated power exclusion clause pending possible future consideration of a modified version; 4) a categorical exclusion policy for certain transmitters; and 5) endorsement of measurement procedures described in ANSI/IEEE C95.3 and NCRP Report No. 119.

We have reviewed this proposal and the document provided to us through the Interdepartment Radio Advisory Committee, "FCC Draft of July 2, 1996, in the Matter of Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation". This new approach is consistent with our comments made in 1993 and addresses our concerns about adequate protection of public health. I commend you for taking this action. If there are any questions please refer them to Mary T. Smith, Director, Indoor Environments Division, Office of Radiation and Indoor Air, 202-233-9370.

I appreciate the opportunity to express EPA's support for the FCC proposed plans, and look forward to continuing cooperation between our agencies.

Sincerely,

Carol M. Browner

Appendix 2E - Technical Panel Member's Evaluation

Mediation Between the Navy and the California Coastal Commission
The Navy's Surface Warfare Engineering Facility, Port Hueneme

Name: **Mr. Edwin Mantiply**

Position: **Environmental Scientist**
Affiliation: **National Air and Radiation Environmental Laboratory**
U.S. Environmental Protection Agency
Address: **540 South Morris Avenue**
Montgomery, Alabama 36115-2601

Phone: **334-270-3400**
Email: **mantiply.edwin@epa.gov**

This document provides the independent evaluation of Mr. Edwin Mantiply regarding the effects of radar emissions from the Navy's Surface Warfare Engineering Facility (SWEF) at Port Hueneme, California, on the public's use of, and the wildlife on or about, the land and water areas around the SWEF. This evaluation is provided to the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (OCRM) as part of the mediation process developed between OCRM, the Navy and the California Coastal Commission (Commission). OCRM, as the mediator, will summarize this evaluation in a report to the Commission and the Navy, and will attach the evaluation to its report.

The five technical panel members are charged with providing, to the Navy and the Commission, through OCRM, their independent and objective scientific evaluation on whether, and to what extent, the operation of the SWEF poses impacts to any land or water use or natural resource of the coastal zone or impacts safe public access to the coastal zone. Panel members, in making their evaluations, shall use the materials provided by OCRM and the discussions held between the panel members, the Navy, Commission, OCRM and the Citizen Observer, on December 14, 1999, in Ventura, California. The panel members in their participation on the panel do not represent or work for OCRM, the Navy or the Commission. The panel members are not an advisory or consensus group, but will provide their own independent views.

Mr. Edwin Mantiply's evaluation is contained in the following letter and attached figures:

January 31, 2000

David W. Kaiser
Federal Consistency Coordinator
Office of Ocean and Coastal Resource Management
1305 East-West Highway
(Room 11208 (N/ORM3))
Silver Spring, MD 20910

Dear Mr. Kaiser:

This document is my response to the request by the National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management to evaluate whether the radar emissions from the Navy's Surface Warfare Engineering Facility (SWEF) at Port Hueneme, California pose environmental or safety impacts.

At the frequencies of operation at SWEF, the Environmental Protection Agency has supported the National Council on Radiation Protection and Measurements (NCRP) criterion of 1 milliwatt per square centimeter (mW/cm^2) average power density from 1.5 to 100 gigahertz (GHz) for continuous exposure in the public environment. If the SWEF facility is implementing the engineering and procedural controls on the azimuth and elevation of transmitting antennas as specified in Navy documents, the offsite exposure levels should be less than this criterion and not represent a health risk or affect the offsite environment.

The SWEF facility is not intrinsically safe. This means that it is possible, if improperly directed, for the radars at SWEF to expose offsite personnel to power densities exceeding the above criterion. In use onboard ship, the radars acquire, track, and illuminate targets at any in-range location above sea level. For this mission, the radars can be depressed in elevation as much as 30 degrees below the deck plane. Since mainbeam power densities can exceed exposure criteria out to more than a thousand feet from these dish antennas, and the dish mounts allow pointing below the horizon, it is incumbent on the SWEF facility to prevent pointing active radars in any direction that causes exposures to exceed safety criteria.

Engineering and procedural controls are mandatory and should be the responsibility of a designated microwave safety officer who is a full time employee of the SWEF facility. This officer should personally inspect the engineering and procedural control systems on a regular basis and sign the inspection reports. Engineering controls include transmitter cutoff switches on the antenna mounts and redundant software controls that should not allow the mechanical cutoff switches to be activated. Since the SWEF mission requires pointing a dish in any direction while the transmitter is off, hardware blocks are not an appropriate engineering control.

Procedural controls may be necessary to prevent illumination of transiting ships resulting in exposure to shipboard personnel and possibly unacceptable reflections. Time averaging is usually not considered practical for offsite exposure so that a limit of 1 mW/cm^2 should apply to transiting ships. By normal procedures the level at the nearest edge of the shipping channel 500 feet from the Mk 74 Mod 14 illuminator radar would be about 6 mW/cm^2,65 feet above the water. Documents provided include a statement by Commander Paul Benfield on August 11, 1998 that "... SWEF does not radiate ships in the harbor or the channel." Engineering controls that would prevent these exposures are apparently impractical. Therefore, simple harbor and channel observation and appropriate operator clearance to transmit seem to be necessary.

The results of several calculations for the 15 radars at SWEF are given in the attached two tables. Note that the Mk 74 Mod 6/8 CWI has been deleted since "radiation is not permitted out of the antenna." These tables are based on the most recently supplied data from the Navy. The first table hides columns that contain less interesting data while the second table shows all relevant data. We have calculated the mainbeam distance for 1 mW/cm^2. This distance is determined from the gain, loss, and average power of the radar by the far field formula $r = \sqrt{\frac{PDG}{4\pi S}}$, where S is the power density of 1 mW/cm^2, P is the average power radiated in milliwatts, D is the rotational duty cycle which is the horizontal width of the mainbeam divided by 360 degrees, and G is the mainbeam power gain which is unitless, and r is the desired distance in centimeters (cm) - converted to feet (ft) by dividing by 30.48 cm/ft. This formula is a rearrangement of $S = \frac{PDG}{4\pi r^2}$, which means that the power density is the radiated power (corrected for rotation) multiplied by an antenna gain or directivity factor and divided by the area of a sphere of radius r. P in milliwatts (mW) is obtained from the tabulated average "power used in calculation" in watts (W) and system loss in decibels (dB) from

$$P(\mathrm{mW}) = (\text{average power}(\mathrm{W}))\left(1000\ \frac{\mathrm{mW}}{\mathrm{W}}\right)\left(10^{\left(\frac{\text{-loss(dB)}}{10}\right)}\right)$$

. This average radiated power is given in watts in the tables. The power gain factor G (unitless) is obtained from the tabulated antenna gain in decibels referenced to an isotropic radiator (dBi) using $G = 10^{\left(\frac{\text{gain(dBi)}}{10}\right)}$.

Numerical modeling of dish antennas similar to those at SWEF, using the Ohio State University reflector antenna code (NECREF Version 3.0), indicates that the maximum field at sea level is found at about 75% of the "touchdown distance." This is the case for the models studied because side-lobe near fields are weak enough that the smaller distance to the dish where these fields dominate is inadequate for the side-lobe fields to be greater than the mainbeam fields at the much larger touchdown distance. This suggests that touchdown distance calculations are adequate to determine the maximum sea level field and to demonstrate compliance at sea level when the touchdown distance is greater than the safe mainbeam distance. This is important for offsite field measurements because the maximum offsite fields may be relatively far away from the SWEF and measurements near the fence will not find these fields. The tables show the touchdown distance calculated from height above sea level divided by the tangent of the angle below the horizon of the lower edge of the mainbeam with the radar oriented to minimum elevation. This angle is usually half the 3 dB beam width given by the Navy.

The maximum fields directly below the dish are due to feed spillover. Modeling shows them to be about the same as the maximum field at approximately the touchdown distance. Figures 1 and 2 show average power density as a function of horizontal distance at sea level for a rough (using available information) model of the SPG-51C-Track radar on Building 5186 pointed level with the horizon. Figure 1 shows the maximum average power density at sea level of 0.056 mW/cm^2 at about 2200 feet. After touchdown the power density smoothly decreases with the range squared. Figure 2 shows the result of spillover causing maximum fields where one can just see the feed horn at a location to the side and somewhat behind the dish. Figure 3 gives the average power density at the center of the mainbeam for the same model. Here, the near-field region of gain reduction is seen at less than 200 feet where the on-axis power density is not a straight line on the log-log plot and no longer varies as $1/r^2$.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) published guidelines for limiting field exposure in Health Physics in April 1998. These guidelines include a reference level for general public exposure to peak power density of 1 watt per square centimeter (W/cm^2) over the frequency range of 2 to 300 GHz. The tables include the mainbeam distance at which the peak power density is calculated to be 1 W/cm^2 (1000 mW/cm^2). This calculation is similar to the one above for average power density except that rotational duty cycle is not used. These distances are generally smaller than the average power density distances so that in general control based on the NCRP average power density criteria will also limit peak power density to less than the ICNIRP guidelines.

The rotating search radars at SWEF produce pulsed time-varying microwave fields similar to those generated by common air traffic and weather radars. Rarely can these sources exceed average power density limits unless the rotation is stopped. Peak power density limits near the reference levels given by ICNIRP have not been adopted in the United States but would probably impact common existing radars. The tracking and illuminating radars at SWEF are equivalent to a stopped weather radar and require greater analysis and care to meet safety criteria. The new Weather Service pulsed Doppler radar do occasionally stop to characterize tornadic activity. Similar systems are being installed at TV broadcast stations for local detailed coverage of violent weather. Thus, radars similar to those at SWEF are not rare. The carrier-wave (CW) illuminating radars emissions are most similar to occupational exposures close to police radar units and commercial security systems that use CW Doppler shifts to measure speed and detect movement.

The worst case scenario for offsite exposure at the SWEF facility assuming pointing (against procedures and defeating interlocks) a fully powered active radar outside of the software and hardware limits would probably only involve one of the two high power CW illuminators. The contribution of other radars intentionally directed at the same point would probably be insignificant. If the FCS Mk 99 could be pointed down 17 degrees below the horizon at occupants of a small boat near shore directly south of Building 1384, the range would be 220 ft in the mainbeam. A simple calculation gives an average power density of 240 mW/cm^2. However, because of near field gain reduction a better numerical model calculates a power density of 200 mW/cm^2. This is 200 times the NCRP criterion. At 10 GHz the skin reflection coefficient is 74 % and the depth of penetration is 0.3 cm, so about 51 mW of power would be absorbed in each square centimeter of skin to a depth of 0.3 cm. If blood flow did not cool the skin, there would be a temperature rise of about $4.4° F$

every minute. I have experience a similar exposure to my hand for about 30 seconds. The sensation was one of gentle but persistent heating. Whole body exposure to this level would be equivalent to sun bathing, but continuing exposure would probably damage the eyes if the exposed individual faced the radar for a long time. Cataracts are formed in the eyes of rabbits exposed to this level for about 1 hour. Damage to the testes would also be expected in about an hour. Observed direct cellular effects of some concern for chronic low-level exposure appear to exist above a threshold and do not become proportionately more intense at higher exposure. So, in my opinion, acute heating exposures are not likely to have any effect other than those associated with short term heating, such as cataracts, testicular damage, skin burns, brain or other organ damage. There would be greater concern for the same exposure level at much lower frequencies than generated by SWEF because of deeper penetration into the body, formation of internal hot spots, and lack of internal temperature sensation. In such a case, organ damage could occur before the exposure was recognized. However, even at the bottom of the lowest frequency band used at SWEF (1 GHz) the depth of penetration into skin and muscle is about an inch.

It is desirable that offsite measurements quantify the highest fields, even if these fields are much less than 1 mW/cm^2. The Narda survey instruments previously used, although accurate at high fields are not very useful at 0.1 mW/cm^2. I suggest using a small gain-calibrated horn with a battery-powered microwave power meter and making two orthogonal measurements with the horn pointed at the radar. In choosing locations for measurement the relatively large distances of mainbeam touchdown and the presence of elevated structures should be considered.

Lack of detailed geometry for the dish antennas limits confidence in the models. However, the work done so far is adequate to be sure that when properly operated the radars do not cause offsite exposures greater than safety guidelines used in the United States. With complete details, measurement confirmation, funding, and time the fields could be calculated and displayed as map overlays for the region surrounding the site. This level of effort is usually confined to epidemiological studies. Given the occasional nature of radar operations, the SWEF facility is not a good candidate for such a study. I feel that a national, numerical model and disease-registry based study of long operating air traffic control radars would be more productive.

Note, I confirm that the exact frequencies of the radars on the classified survey data sheets are within the frequency bands given on the Navy supplied tables. The exact frequencies are the only information I have been given that has not been supplied to the panel at large.

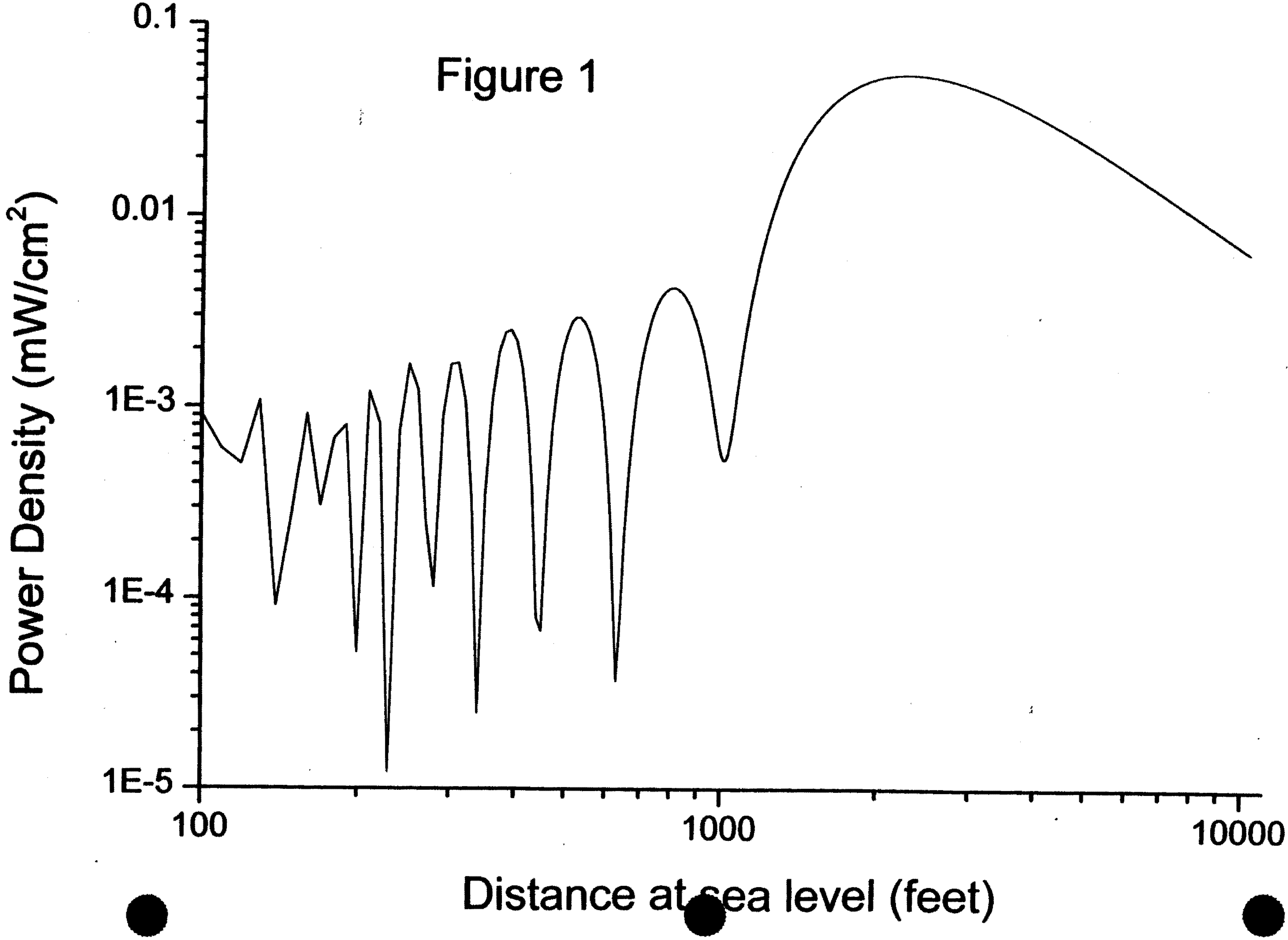
Sincerely,

/s/

Edwin D. Mantiply
Environmental Scientist

Enclosures

Figure 1



Power Density (mW/cm²)
0.1
0.01
1E-3
1E-4
1E-5
100
1000
10000
Distance at sea level (feet)

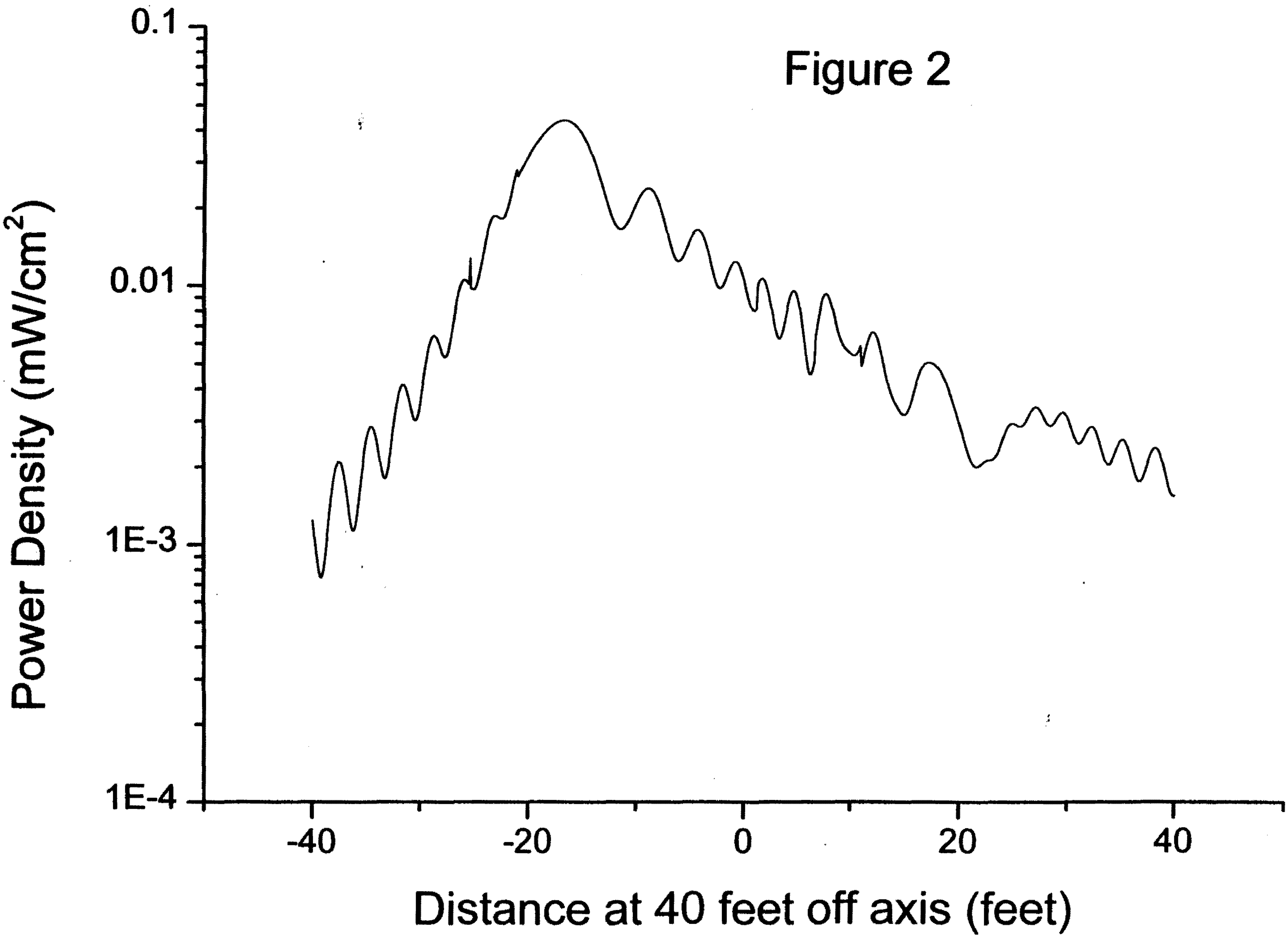
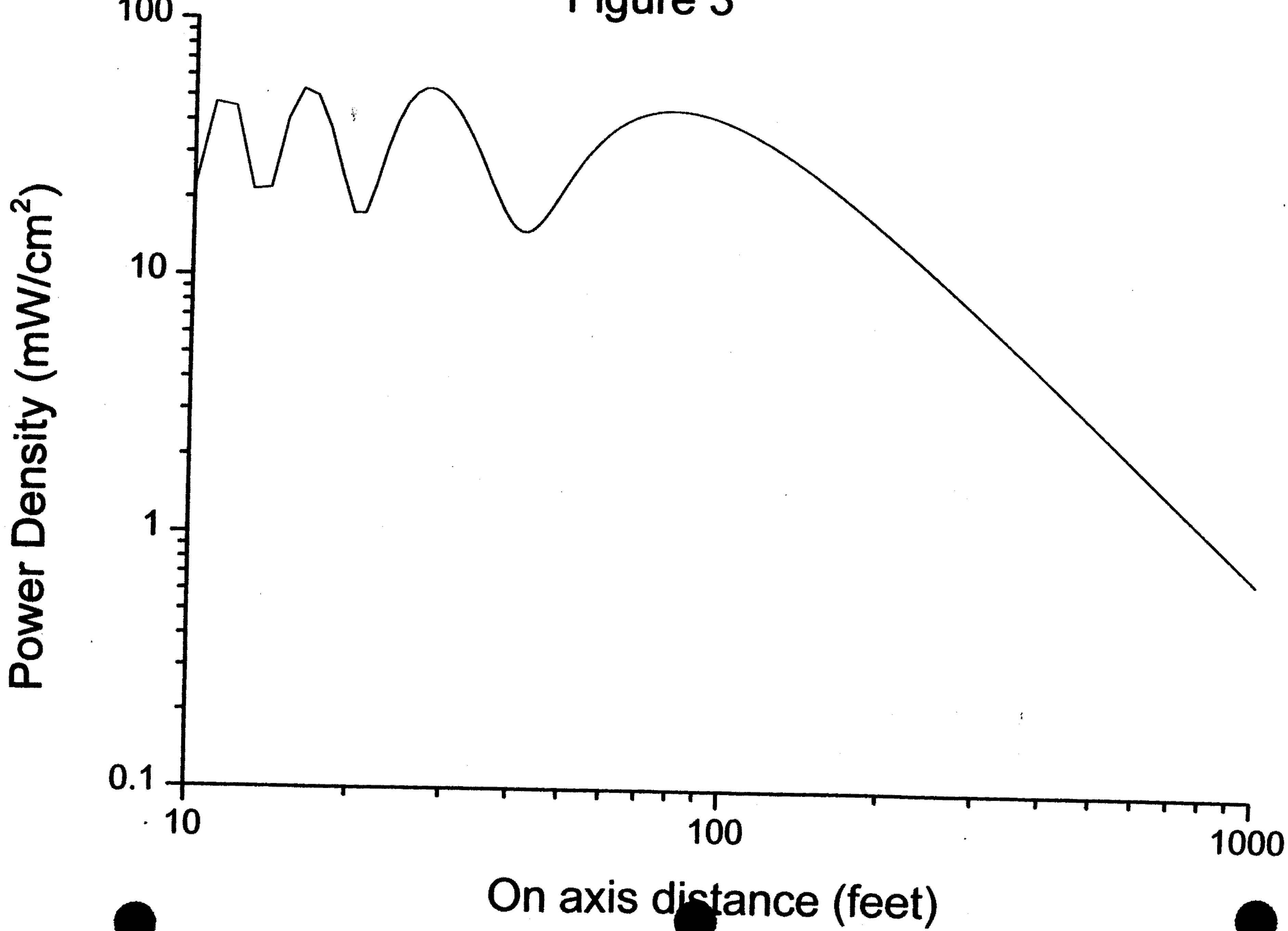


Figure 2
Power Density (mW/cm²)
0.1
0.01
1E-3
1E-4
-40
-20
0
20
40
Distance at 40 feet off axis (feet)

Figure 3



100
10
1
0.1
Power Density (mW/cm²)
10
100
1000
On axis distance (feet)

Radar Name	Frequency Band (GHz)	Maximum Antenna Gain (dBi)	Loss (dB)	Approximate Transmitter Peak Power (watts)	Peak Power Radiated (watts)	Mainbeam Distance for 1 W/cm^2 Peak Power Density (feet)	Rotational Duty Cycle (1 for non-rotating radars)	Power used in Calculation (average watts)	Average Power Radiated (watts)	Mainbeam Distance for 1 mW/cm^2 Average Power Density (feet)	Bearing (degrees)	Beam Width (degrees)	Minimum Beam Elevation (degrees)	Antenna Dimensions (feet)	Edge of Mainbeam below Horizon (degrees)	Height above Sea Level (feet)	Touchdown Distance (feet)
FCS MK 92 CAS-CWI	10-20	35.5	8.73	5,000	670	14	1	5,000	670	451	142 - 92	2.4	0	4 ft-diameter	1.200	95	4,535
FCS MK 92 CAS-Track	8-10	35	4	400,000	159,243	208	1	400	159	208	142 - 92	2.4	0	4 ft-diameter	1.200	95	4,535
FCS MK 92 CAS Search	8-10	35	3	1,000,000	501,187	368	0.0039	1,000	501	23	0 - 360	1.4-horiz 4.7-vert	1.4	5 ft-horiz 3 ft-vert	0.950	85	5,126
FCS MK 92 STIR-CWI	10-20	42	6.52	5,000	1,114	39	1	5,000	1,114	1,230	151 - 257	1.0-horiz/vert	0	7 ft-diameter	0.500	80	9,167
FCS MK 92 STIR-Track	8-10	41.5	7	1,000,000	199,526	491	1	1,000	200	491	151 - 257	1.2-horiz/vert	0	7 ft-diameter	0.600	80	7,639
MK 86 SPG-60	8-10	41	2.2	5,500	3,314	60	1	825	497	732	152 - 261	1.2-horiz/vert	0	7 ft-diameter	0.600	65	6,207
MK 86 SPQ-9A	8-10	37.5	0	1,200	1,200	24	0.0042	57.6	58	11	0 - 360	1.5-horiz 0.75-vert	0	6.8 ft-horiz 2.7 ft-vert	0.375	65	9,931
MK 74 MOD 14 (TARTAR SM2/NTU)-CWI	10-20	42.5	1.82	1,500	986	39	1	1,500	986	1,226	138 - 263	1-horiz/vert	0	9 ft-diameter	0.500	65	7,448
MK 74 MOD 14 (TARTAR SM2/NTU)-Track	5-6	39.6	2.27	50,000	29,646	152	1	1,600	949	861	138 - 263	1.6-horiz/vert	0	9 ft-diameter	0.800	65	4,655
MK 23 TAS	1-2	21	0	200,000	200,000	46	0.0092	5,600	5,600	24	117 - 269	3.3-horiz -6 to + 75-vert	0	14 ft-horiz 2 ft-vert	6.000	117	1,113
MK 57 NSSMS Radar A	10-20	36.5	0	1,800	1,800	26	1	1,800	1,800	830	137 - 255	2-horiz/vert	0	3 ft-diameter	1.000	65	3,724
MK 57 NSSMS Radar B	10-20	36.5	0	1,800	1,800	26	1	1,800	1,800	830	117 - 260	2-horiz/vert	0	3 ft-diameter	1.000	95	5,443
TARTAR MK 74 MOD 6/8/A/N/SPG-51C-Track	4-6	39.5	-1.87	25,000	38,454	171	1	550	846	804	133 - 184	1.6-horiz/vert	0	9 ft-diameter	0.800	40	2,865
AN/SPQ-9B	8-10	43	0	10,000	10,000	131	0.0042	300	300	46	0 - 360	1.5-horiz 1.0-vert	0	9 ft-horiz 6.75 ft-vert	0.500	70	8,021
FCS MK 99	10-20	43	2.48	12,000	6,779	108	1	12,000	6,779	3,404	0 - 360	1-horiz/vert	5	7.9 ft-diameter	-4.500	65	no touchdown

Radar Name	Frequency Band (GHz)	Maximum Antenna Gain (dBi)	Peak Power Radiated (watts)	Mainbeam Distance for 1 W/cm^2 Peak Power Density (feet)	Rotational Duty Cycle (1 for non-rotating radars)	Average Power Radiated (watts)	Mainbeam Distance for 1 mW/cm^2 Average Power Density (feet)	Bearing (degrees)	Edge of Mainbeam below Horizon (degrees)	Height above Sea Level (feet)	Touchdown Distance (feet)
FCS MK 92 CAS-CWI	10-20	35.5	670	14	1	670	451	142 - 92	1.200	95	4,535
FCS MK 92 CAS-Track	8-10	35	159,243	208	1	159	208	142 - 92	1.200	95	4,535
FCS MK 92 CAS Search	8-10	35	501,187	368	0.0039	501	23	0 - 360	0.950	85	5,126
FCS MK 92 STIR-CWI	10-20	42	1,114	39	1	1,114	1230	151 - 257	0.500	80	9,167
FCS MK 92 STIR-Track	8-10	41.5	199,526	491	1	200	491	151 - 257	0.600	80	7,639
MK 86 SPG-60	8-10	41	3,314	60	1	497	732	152 - 261	0.600	65	6,207
MK 86 SPQ-9A	8-10	37.5	1,200	24	0.0042	58	11	0 - 360	0.375	65	9,931
MK 74 MOD 14 (TARTAR SM2/NTU)-CWI	10-20	42.5	986	39	1	986	1226	138 - 263	0.500	65	7,448
MK 74 MOD 14 (TARTAR SM2/NTU)-Track	5-6	39.6	29,646	152	1	949	861	138 - 263	0.800	65	4,655
MK 23 TAS	1-2	21	200,000	46	0.0092	5,600	24	117 - 269	6.000	117	1,113
MK 57 NSSMS Radar A	10-20	36.5	1,800	26	1	1,800	830	137 - 255	1.000	65	3,724
MK 57 NSSMS Radar B	10-20	36.5	1,800	26	1	1,800	830	117 - 260	1.000	95	5,443
TARTAR MK 74 MOD 6/8/A/N/SPG-51C-Track	4-6	39.5	38,454	171	1	846	804	133 - 184	0.800	40	2,865
AN/SPQ-9B	8-10	43	10,000	131	0.0042	300	46	0 - 360	0.500	70	8,021
FCS MK 99	10-20	43	6,779	108	1	6,779	3404	0 - 360	-4.500	65	no touchdown

RECORD PACKET COPY **Tu 11a**

REPORT TO THE CALIFORNIA COASTAL COMMISSION

Re: Technical Panel Review of Present Radar Operations of the Surface Warfare Engineering Facility (SWEF), Port Hueneme, Ventura County.

Submitted by: The Citizen Observer, Lee Quaintance March 24, 2000

Introduction:

> ***'Cheshire-Puss,' she began,... 'Would you tell me, please which way I ought to go from here?' 'That depends a good deal on where you want to get to,' said the Cat.***
> Lewis Carroll, *Alice's Adventure in Wonderland*

The need for a purpose and direction was implicit in the question asked several times by Commissioner Dettloff during the months when the informal mediation rules were being hammered out. She asked whether convening a technical panel would, after all, put the Commission in a better position to make substantive decisions about application of the Coastal Act to operations of the Surface Warfare Engineering Facility (SWEF). The Commission's staff responded that they thought it would, by giving the Commission access to independent technical knowledge on the complex subject of radio frequency radiation (RFR) and present SWEF operations. This is where the Commission needed to "get to".

The panelists are experts in their respective fields. Each brought to the process somewhat different scientific and philosophical views regarding environmental effects of RFR. A consensus report was not sought; each expert was asked for an independent report. This gives the Commission an array of expert technical opinion.

The "serious" disagreement" between the Commission and the Navy that led to creation of the technical panel is simply whether a consistency determination is required as a baseline for present operations. The Navy failed to make a Coastal Commission filing of any kind when it constructed the facility and declined to recognize that an after-the-fact consistency determination was necessary. The requirement for a consistency determination hinges on whether the federal action may have spillover adverse impacts on the coastal zone. Pursuant to the Coastal Zone Management Act (CZMA), a consistency determination is required unless there are <u>no</u> adverse effects of the federal action on the coastal zone. The Navy maintained that there are no such effects and suggested (letter of LCDR Boika to Mr. Douglas dated July 13, 1998) that the failure to "resolve our differences or ease concerns" was a consequence of "the technical nature of the subject." Thanks to the panelists, both parties now possess an independent technical review to serve as a basis to decide anew whether a consistency determination is required. This is where the CCC needed to "get to."

Citizen Observer Comments on Panelist Findings and Recommendations

1. SWEF Operations Do Potentially and Actually Impact the Coastal Zone

The Office of Ocean and Coastal Resource Management (OCRM) Report describes (p. 2) a general panelist view that safe operations of the SWEF depends on operational and safety guidelines that must be "carefully adhered to and monitored." Mr. Mantiply (Mantiply p.2) crystallizes this concept in his comment: "The SWEF facility is not intrinsically safe."

It is apparent throughout the panelist reports that SWEF impact on the coastal zone is a variable dependent on voluntary and changing Navy restraints on its operation. The consequence of a failure of self imposed restraints is illustrated by Mr. Mantiply. The SWEF Command states that it presently aims emitters only at elevations at or above the horizon and never below the horizon. This restraint is counterintuitive because these devices are designed to operate on shipboard directed (Mantiply p.2) "as much as 30 degrees below the deck plane." Mr. Mantiply describes (p. 4) what would happen if one of the powerful SWEF emitters pointed down 17 degrees below the horizon and illuminated a small boat in the public water area in front of the SWEF. People on the illuminated boat would be exposed to a level of RF radiation 200 times the appropriate standard. This level of human exposure for about an hour might result (Mantiply p.5) in effects "such as cataracts, testicular damage, skin burn, brain or other organ damage."

When all the present voluntary restraints are in place, SWEF operations may not *"generally"* impact coastal resources (OCRM Report p. 2). However, **even with all restraints in place,** panelists identify important coastal zone impacts that *specifically* occur. Specific impacts include:

- Impact on the Operation of the Port of Hueneme. All five panelists reported actual or potential RFR exposure in excess of the Navy standard to vessels utilizing the Port of Hueneme. Only one panelist (De Andrea at p. 3) accepted the Navy theory that movement of the vessel would obviate this hazard. The California Coastal Act (Sec. 30701) designates commercial ports, specifically including the Port of Hueneme, as "...one of the State's primary economic and coastal resources..."

- Impact on Ocean Use. One panelist (Adey p. 9) recommends that a general warning be issued to mariners not to remain in a sector extending two miles seaward from the SWEF. This would affect Port operations, recreational boating, commercial fishing, kayaking, surfing, diving, and beach use activities in the public coastal zone.

- Impact on Wildlife. Three panelists comment that there is a potential for RFR emissions to detrimentally affect wildlife, particularly birds.

2. Inappropriate Exposure Standards Are Utilized for the Uncontrolled Environment

Three panelists question the appropriateness of using the IEEE standard adopted by the Navy as the exposure standard for public RFR exposure outside their facility.

Dr. Adey (p. 1) analyses "this relaxed and outmoded DoD standard" and determines it is "irrelevant in light of current biomedical knowledge." He describes current science and the recognition by national and international authorities of athermal effects rather than merely thermal effects considered by the IEEE standard. Because operations at the SWEF are continuing and expandable, Dr. Adey cites the need to apply a standard that, unlike IEEE, takes account of cumulative dose exposure and peak power.

Two other panelists, Dr. Elder and Mr. Mantiply, suggest than in public areas outside federal facilities, it is appropriate to apply the more protective standard adopted by the Federal Communications Commission (FCC). They note that FCC jurisdiction does not extend to radar installations, and, if operations always conform with all present self imposed Navy restrictions, the higher FCC standard might not be exceeded.

The Coastal Commission should apply a more protective threshold in considering RFR coastal zone impact outside federal property. It is particularly prudent to do so where, as here, a federal facility has been sited so close to pre-existing public use and wildlife areas, where safety depends on adherence to internally set operating restrictions, and when there is a present and evolving worldwide recognition of the need for stricter exposure standards.

3. A Comprehensive and Validated Exposure Assessment is Lacking

Dr. Elder's (p. 2) "...strongest criticism of the Navy reports is that public exposure data is the minimum necessary to reach these conclusions on the public health impact with my confidence rating of 'adequate.'" He calls for an evaluation worthy of a high confidence level of "very good" to "excellent" to be undertaken by the Navy and release to the public within six months.

Dr. Elder defines a "well designed" evaluation as one based primarily on measurement and not mere calculations of exposure, inclusive of worst case exposure scenarios, and created with participation and validation by a non-DoD measurement expert.

Mr. Mantiply too notes the desirability (Mantiply p.5) of additional offsite measurements that would quantify and document the highest fields even if they are at low levels. He suggests instruments and methodologies for such measurements.

4. Present Operating Restrictions Are Inadequately Documented and Controlled

The only Navy documentation seen by the panelists of current operating restrictions is a to-scale-map (map) of hazard zones and the attached final February 18, 2000 version of a table of Technical Parameters for SWEF Emitters (table). The Navy created the map and the table for the panel.

I compared the map and table created by the Navy for the panel to the latest, July 27, 1999, Navy Standard Operating Procedures for Radar Systems, High Power Illuminators, and Launching Systems at the Surface Warfare Engineering Facility, PHDNSWCINST 3120.1A. This handbook was obtained pursuant to the Freedom of Information Act. The handbook (p. ES-1) states that it : "Promulgates...policy and standard operation procedures related to SWEF equipment and systems operations." The handbook contains less restrictive operating rules for certain emitters than those portrayed in the map and table created for the panel.

In an e-mail of January 25, 2000 to the OCRM moderator, David Kaiser, I detailed the discrepancies and requested that the handbook be provided to the panelists. Mr. Kaiser replied, on January 27th, that the handbook is "in need of an update" and "is not being provided." In a January 28th e-mail, Mark Delaplaine, the Coastal Commission Federal Consistency Supervisor, stated he felt "strongly" that the handbook should be provided to the panelists, and in an e-mail of the same day I renewed my request. On February 6, 2000, the OCRM moderator again declined to distribute the handbook except if requested by individual panelists. He transmitted a Navy statement listing "corrections" to "errors" in its July 27, 1999 handbook and disclaiming the handbook as a control document. Actual control of "operational parameters" is said to reside in individual "reference notebooks" for each emitter. (Copies of these e-mails are attached.) The lack of a continuously updated central control document undermines my confidence in the implementation of restrictions. The table created by the Navy and relied upon by the panelists as the definition of SWEF operating restrictions, needs to be designated as the baseline for present operations.

A related issue raised by Mr. Mantiply (p.2) is the need for a specific person dedicated to compliance responsibility. Mr. Mantiply recommends a full time "designated microwave safety officer" be employed. This position will centralized accountability and be responsible for implementing engineering and procedural controls and for initiating and keeping physical inspection records to determine compliance. Reasons cited by Mr. Mantiply for this position include the impracticality of placing hardware blocks "since the SWEF mission requires pointing a dish in any direction while transmission is off" and the need to assure that mechanical cutoff switches are not deactivated.

Dr. Adey (p.9) recommends significant additional controls over SWEF emitters including the prevention of 360 degree rotation, the limitation of antenna mobility to seaward sectoring and the prohibition of beams traversing adjoining coastal areas. He calls for providing a detailed log of all operations to the National Oceanic and Atmospheric Administration (NOAA) or to another cognizant federal agency.

Recommendations of the Citizen Observer to the Coastal Commission:

1. Affirm the prior staff determination that SWEF operations may adversely impact coastal resources and the requirement of an after-the-fact consistency determination for present SWEF operations.

2. Adopt the FCC or a more protective threshold for assessing RFR exposure impacts on coastal zone resources outside the perimeter of the federal facility.

3. Recommend to the Navy that to satisfy the CZMA requirement for complete information its after-the-fact consistency determination should include:

   - An evaluation and response to each recommendation in the OCRM Report.

   - The completion and inclusion of a well designed and comprehensive public exposure study created with participation and validation of a non-DoD expert.

   - Designation of the table of Technical Parameters for SWEF Emitters created by the Navy for the panel as the baseline control document for SWEF operations.

   - A proposed method of monitoring compliance with the baseline control document including criteria for triggering new consistency determination filings regarding any proposed changed operations.

4. Determine that Navy submission and Commission concurrence in an after-the-fact consistency determination for present SWEF operations <u>must be completed before</u> the Commission will concur in any proposal for modification or expansion of SWEF operations.

Technical parameters for SWEF emitters

18 February 2000

SWEF EMITTER NAME	ANTENNA GAIN (dBi)**	SYSTEM LOSS(GAIN) INCLUDES COUPLING FACTOR LOSS (dB)	APPROXIMATE TRANSMITTER PEAK POWER (WATTS)	POWER USED IN CALCULATION (AVERAGE-WATTS)	RANGE OF TRANSMITTER PULSE REPETATION FREQUENCIES (PULSES PER SECOND)	Antenna Sidelobe Levels (dBc - referenced to mainbeam) Angle from Boresight Elevation	Antenna Sidelobe Levels (dBc - referenced to mainbeam) Angle from Boresight Azimuth	Beam Width (Degrees)	Antenna Dimensions (Feet)	COMMENTS
; MK 92 CAS-CWI	35.5	8.73	5000	5000	N/A-CW SYSTEM	Less than -13 $0° \leq \theta \leq 6°$	Less than -13 $0° \leq \theta \leq 6°$	2.4	4 ft-diameter	Sidelobe data from sample antenna pattern
; MK 92 CAS-Track	35	4	400,000	400	2210-2770	-20 $0° \leq \theta \leq 10°$	-20 $0° \leq \theta \leq 10°$	2.4	4 ft-diameter	
; MK 92 CAS Search	35	3	1,000,000	1000	2210-2770	-18 $0° \leq \theta \leq 30°$	-24 $0° \leq \theta \leq 10°$	1.4-horiz 4.7-vert	5 ft-horiz 3 ft-vert	ROTATING SYSTEM DUTY CYCLE = 0.0039
; MK 92 STIR-CWI	42	6.52	5,000	5000	N/A-CW SYSTEM	Less than -15 $0° \leq \theta \leq 6°$	Less than -15 $0° \leq \theta \leq 6°$	1.0-horiz/vert	7 ft-diameter	Sidelobe data from sample antenna pattern
; MK 92 STIR-Track	41.5	7	1,000,000	1000	1105-1385	-16 $0° \leq \theta \leq 6°$	-20 $0° \leq \theta \leq 6°$	1.2-horiz/vert	7 ft-diameter	
86 SPG-60	41	2.2	5,500	825	25K – 35K	CLASSIFIED	CLASSIFIED	1.2-horiz/vert	7 ft-diameter	
86 SPQ-9A	37.5	0	1,200	57.6	3K	CLASSIFIED	CLASSIFIED	1.5 horiz 0.75-vert	6.8 ft-horiz 2.7 ft-vert	ROTATING SYSTEM DUTY CYCLE = 0.0042
74 MOD 14 (TARTAR 2/NTU)-CWI	42.5	1.82	1,500	1500	N/A-CW SYSTEM	***Not spec'd for maximum sidelobes	***Not spec'd for maximum sidelobes	1-horiz/vert	9 ft-diameter	
74 MOD 14 (TARTAR 2/NTU)-Track	39.6	2.27	50,000*	1600	4.1K Surface 9.5 K– 18.1 K Air	CLASSIFIED	CLASSIFIED	1.6-horiz/vert	9 ft-diameter	
23 TAS	21	0	200,000	5600	636.5 – 749.4	Gain vs Elevation 18.4dBi @ -6° 20.0dBi @ 0° 21.0dBi @ 10°	CLASSIFIED	3.3-horiz -6 to + 75 –vert	2 ft- vert 14 ft-hriz	ROTATING SYSTEM DUTY CYCLE = 0.0092
57 NSSMS Radar A	36.5	0	1,800	1800	N/A-CW SYSTEM	-23 $6° < \theta < 12..0°$	-23 $6° < \theta < 12..0°$	2-horiz/vert	3 ft-diameter	
57 NSSMS Radar B	36.5	0	1,800	1800	N/A-CW SYSTEM	-23 $6° < \theta < 12..0°$	-23 $6° < \theta < 12..0°$	2-horiz/vert	3 ft-diameter	
₹TAR MK 74 MOD A/N/SPG-51C-Track	39.5	(1.87)	25,000	550	4.1K Surface 9.5 K– 16.7 K Air	[illegible]	[illegible]	1.6-horiz/vert	9 ft-diameter	

Technical parameters for SWEF emitters

18 February 2000

TARTAR MK 74 MOD 6/8/A/N/SPG-51C-CWI	45	0.68	4,000	4000	N/A-CW SYSTEM	[illegible]	[illegible]	0.8-horiz/vert	9 ft-diameter	
AN/SPQ-9B	43	0	10,000	300	2660 – 35K	-15 0°≤θ≤2.5°	-15 0°≤θ≤2.5°	1.5-horiz 1.0-vert	9 ft-horiz 6.75 ft-vert	ROTATING SYSTEM DUTY CYCLE 0.0042
FCS MK 99	43	2.48	12,000	12000	N/A-CW SYSTEM	[illegible]	[illegible]	1-horiz/vert	7.9-diameter	

* Peak power is reduced significantly due to an imposed power restriction on this transmitter.
** dBi is antenna gain in decibels referenced to an isotropic radiator
*** Antenna sidelobes are not specifically addressed in specification. Specification for these systems focuses on nulls ('holes') in the spectrum rather than maximum sidelobe levels.
General Note: Peak power is equivalent to average power for continuous wave (CW) systems.
Effective Radiated Power (ERP) is Equal to transmitter output power minus system losses (or plus system gains) x antenna directive gain
Total radiate time for all radar systems in Fiscal Year 98 is approximately 214 hours

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To: David Kaiser, INTERNET:david.kaiser@noaa.gov
To: Ed Mantiply, INTERNET:mantiply.edwin@epa.gov
From: Lee Quaintance, 112327,3200
Date: 1/25/2000, 5:29 PM
Re: SWEF Handbook of Operating Procedures

To David Kaiser.
New material in the Chuck Hogle 1/24/00 e-mail and the 1/14/00 deliverable packet conflict with the July 27, 1999 SWEF Complex Handbook PHDNSWCINST 3120.1A ("Handbook"). The Handbook was promulgated by the SWEF command after its December 14, 1998 Response to the Questions that form the basis for the technical panel review. As the subsequent and official operating source document, and in view of the discrepancies, panel access to the Handbook is necessary to fulfill the panel's charge. The Handbook is unclassified. I obtained a copy pursuant to the Freedom of Information Act.

The inconsistencies are material. If a to-scale map were drawn using the official Handbook restrictions and permitted activities the hazard zone for the two devices noted below would include the shipping lane of the Harbor. The panelist's expert review of the Handbook may reveal other discrepancies.

The Handbook states (page 1) that it is the "standard operating procedure" for operations of the SWEF and was prepared to "provide requirements and specific guidance for operating equipment and system operations". If there have been amendments, they too should be provided to the panel. If there have been no pertinent amendments, the latest Navy deliverables portray restrictions not found in the officially authorized SWEF standard operating procedure.

MK 74 Mod 6/8 CWI. The Chuck Hogle e-mail of 1/24/00 says flatly that "radiation is not permitted out of the antenna" in the CWI mode. This contradicts the Handbook (page E-3) specific provision that CWI operation is authorized above 5.0 elevation "out the antenna" at full rated power. The Handbook shows rated power to be 5,000 watts rather than the 4,000 watts depicted in the Table provided with the 1/24/00 e-mail.

MK 74 MOD 14. The 1/24/00 Table states that this device does not operate in CWI mode above 1,500 watts or in the Track mode above 1,600 watts Not disclosed is the Handbook specific provision (page D-3) that above 5.0 degrees there is no restriction on operating power levels in either mode.

Please provide the technical panel members with the Handbook. Regards. Lee Quaintance

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To: "John D'Andrea", INTERNET:john.dandrea@navy.brooks.af.mil
To: Robert Beason, INTERNET:beason@uno.cc.geneseo.edu
To: Ross Adey, INTERNET:radey43450@aol.com
To: Lee Quaintance, Quaintance
From: "David Kaiser", INTERNET:David.Kaiser@noaa.gov
Date: 1/27/2000, 11:21 AM
Re: Re: SWEF Handbook of Operating Procedures

To the SWEF Group:

In response to the concerns raised by Lee, see below, regarding the Navy's "Handbook", the Handbook that is referred to (and that was not provided to the panel) is in need of an update. The information provided to the panel is correct and current as well as being the data that is actually used by the operators and maintainers of the radar systems. Thus, the outdated Handbook would not provide the panel with useful information and is not being provided. The information that Lee refers to had previously been noted as needing to be updated to reflect the current operating constraints.

To: Ed Mantiply, INTERNET:mantiply.edwin@epa.gov
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To: Ross Adey, INTERNET:radey43450@aol.com
To: "'David Kaiser'", INTERNET:David.Kaiser@noaa.gov
To: Lee Quaintance, Quaintance
From: Mark Delaplaine, INTERNET:mdelaplaine@coastal.ca.gov
Date: 1/28/2000, 9:30 AM
Re: RE: SWEF Handbook of Operating Procedures

David - I feel strongly, for several reasons, that the Handbook should be provided to the panelists. Here are my reasons:

1. As you will recall, one of the charges to the panel members is to look at not only the "as operated" power, but also maximum potential power based on the equipment's capabilities (See Attachment 1 to the panelists' packet, Questions 3a, 3c, and 3e). If the Handbook represents past actual or legally usable power levels at the SWEF, then I think it is relevant to the panel's review, both in terms of potential power but past usage. Also, if the Handbook has not been formally changed, isn't the SWEF legally able to rely on it? If not, where (i.e., in what document) are the facility's operational restrictions contained?

2. If the Handbook has been the guideline in the past, then past usage could have caused concerns (if it true that usage within the guidelines of the handbook could cause concerns). If past usage has been a problem I think this is relevant for the panel, if for no other reason than to figure out how to avoid future problems. If, on the other hand the Handbook has never been the standard for the SWEF, then the Navy should be able to explain why and explain the Handbook's significance.

3. I see no harm in the panel members having this information - it is a short document, would take a minimum of time to review, and the Navy is fully capable of explaining why, if such is the case, it differs from past, current, or future use of the facilities.

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To: David Kaiser, INTERNET:david.kaiser@noaa.gov
To: Ed Mantiply, INTERNET:mantiply.edwin@epa.gov
From: Lee Quaintance, 112327,3200
Date: 1/28/2000, 4:23 PM
Re: SWEF Handbook

The operating SWEF Handbook is being called "outdated" and with probably " little bearing on todays operations". It was issued on July 27, 1999 -- only six months ago. It was issued under the signature of the SWEF Commanding Officer as "a complete revision" and as the site specific radar control document. How can there be confidence in technical conclusions drawn without even considering this unclassified key document? The Handbook must not be dismissed based on speculation that it no longer applies.

When it was pointed out that the to-scale-map and new Navy deliverables conflict with the Handbook, David Kaiser told us the Handbook is "in need of an update." If the to-scale-map were drawn using the Handbook, two additional powerful devices would have hazard zones including shipping channel and other public use areas. Surely, this is information relevant to the panel's charge. If the Handbook is now inoperative -- if it has been officially withdrawn or officially amended since July 27th, the panel is entitled to hear this from the Navy with such explanation as the Navy may choose to provide.

No one is asking the panel to revise the Navy Handbook. If that is necessary, it is obviously a Navy responsibility. This Handbook needs to be given to the panel for such consideration as individual members wish to afford it.

More time and effort is being spent endeavoring to foreclose access to this document than it would take to read it.

Regards. Lee Quaintance.

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To: Joe Elder, INTERNET:ELDER.JOE@epamail.epa.gov
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To: Mark Delaplaine, INTERNET:mdelaplaine@coastal.ca.gov
To: Lee Quaintance, quaintance
From: "David Kaiser", INTERNET:David.Kaiser@noaa.gov
Date: 2/6/2000, 7:55 AM
Re: Handbook

Greetings all,

Earlier, Lee made reference to the SWEF "Handbook" and inconsistencies with the Handbook and information provided by the Navy. Lee asked that the Handbook be provided to the Panel. I had replied that the Handbook needed revising and that the information provided to the Panel contains the relevant information, and therefore, the Handbook would not be provided. Subsequently, none of the Panel members asked for the Handbook, two of the Panel members specifically asked that we NOT send them the Handbook and another Panel member has given me his findings (and so, obviously, does not want or need the Handbook either). However, to more fully respond to Lee's request, the Navy has made a statement regarding the Handbook, provided below. If a Panel member asks for the Handbook, it will be provided, otherwise the Handbook will not be sent to the Panel.

Please let me know if you have any questions. Thanks, David.

NAVY'S STATEMENT REGARDING THE HANDBOOK:

The SOP or handbook is officially titled: PHDNSWCINST 3120.1A, Subject; STANDARD OPERATING PROCEDURES FOR RADAR SYSTEMS, HIGH POWER ILLUMINATORS, AND LAUNCHING SYSTEMS AT THE SURFACE WARFARE ENGINEERING FACILITY COMPLEX. This instruction defines organizational roles and responsibilities and defines safety and operational procedures associated with SWEF radar systems, high power radio frequency (RF) illuminators and launching systems. This is a living document and will change as new requirements are
established and as new equipment is installed.

It should be noted that PHDNSWCINST 3120.1A is not intended to be the document that defines the operational parameters, but rather it defines roles and responsibilities of personnel involved in the operation of SWEF. For example, the safety office is responsible for annual safety training that includes operational restrictions, equipment change process, and a review of the controls that are in effect. Operational and power level restrictions for SWEF equipment are developed based on the knowledge of SWEF
subject matter experts (SMEs) and validated by Space Warfare Systems Command
(SPAWAR). Each equipment area maintains a reference notebook for employees to refer to that lists the operational and power level restrictions for each piece of equipment. The reference notebooks are kept up to date to reflect the current configuration of the equipment and any controls or restrictions. The process to modify SWEF equipment & operations is documented in the flowchart, Figure 20 in the Navy's responses to the CCC's questions. This process ensures that any modification is reviewed by the appropriate officials and all necessary

safety or environmental actions are taken.

When an equipment modification or operational change is proposed, the SME initiates an assessment with SPAWAR. SPAWAR personnel determine if an on-site Radiation Hazard (RADHAZ) Survey is required. SPAWAR may determine that a RADHAZ Survey is not necessary if the power level of the new equipment is equal to or below the power level the equipment it is replacing. In some cases, the SME and equipment operators may determine that the RF power limits or RF radiation zones defined by SPAWAR exceed mission requirements and may decrease the permitted RF power levels or RF radiation zones. These reduced levels would then become the authorized operational levels for the equipment and would be incorporated into the appropriate reference notebooks. An example of this is the MK 74 MOD 14 track radar, where the RADHAZ Survey established the power limit at 5000 watts and NSWC Port Hueneme has reduced authorized operational levels to 1600 watts.

For reference the following corrections to PHDNSWCINST 3120.1A have been submitted to the cognizant authority by SWEF employees (this list includes the errors identified by Mr. Quaintance):

Page D-2, paragraph 7.b - modify sentence to read: "Additionally, the MK 74 contains hardware and software may be used to restrict RF transmissions into a dummy load."

Page D-3, paragraph 11.a.(1) - delete subparagraph (b).

Page D-3, paragraph 11.a.(1) - Correct subparagraph (c) to read: "0.0 - +83 degrees (with power <1,500 watts for J-band CWI).

Page D-3, paragraph 11.a.(1) - delete subparagraph (d)

Page D-3, paragraph 11.b.(1) - Correct subparagraph (a) to read: 1600 watt max between 0 and +5 degrees in elevation.

Page D-3, paragraph 11.b.(1) - Delete subparagraph (b)

Page D-3, paragraph 11.b.(2) - Correct subparagraph (a) to read: 1 600 watt max between 0 and +5 degrees in elevation.

Page D-3, paragraph 11.b.(2) - Delete subparagraph (b)

Page E-3, paragraph 11.a.(1) - Delete current text in subparagraph (b) and replace with: "No power may be emitted in J-Band CWI mode."

Page E-3, paragraph 11.b. - Delete current text in subparagraph (2) and replace with: "No power may be emitted in J-Band CWI Transmitter mode."

Page E-5 (diagram) - delete blue line circling Building 5186.

Page E-6 delete pictorial circle, RF Emission cutout box, delete the 3D picture and associated wording.

An updated version of PHDNSWCINST 3120.1A is scheduled for release in summer 2000.

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