AD-A207 654 GROUND-BASED RADAR (GBR): ENVIRONMENTAL ASSESSMENT(U) 1/2
ARMY STRATEGIC DEFENSE COMMAND HUNTSVILLE AL MAR 89

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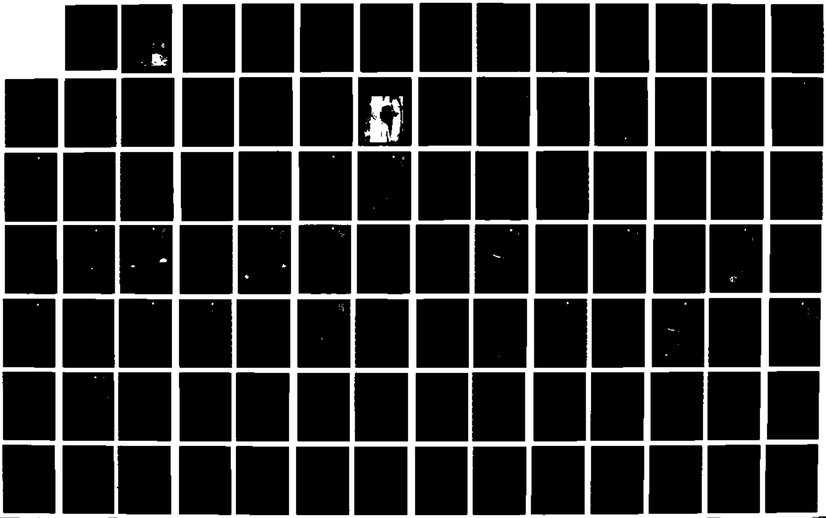

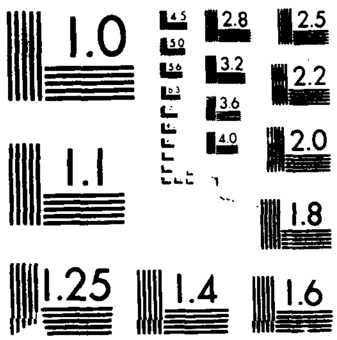
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GROUND-BASED RADAR (GBR)

MARCH 1989

U.S. ARMY SDC

ENVIRONMENTAL ASSESSMENT

FINDING OF NO SIGNIFICANT IMPACT

STRATEGIC DEFENSE INITIATIVE ORGANIZATION

U.S. DEPARTMENT OF DEFENSE

AGENCY: Department of Defense
Strategic Defense Initiative Organization

ACTION: Conduct Demonstration/Validation testing of the Ground-Based Radar (GBR) technology

BACKGROUND: Pursuant to Council on Environmental Quality Regulations for implementing the procedural provisions of the National Environmental Policy Act (40 CFR Parts 1500-1508), and Department of Defense (DOD) Directive on Environmental Effects in the United States of DOD Actions, the DOD has conducted an assessment of the potential environmental consequences of Demonstration/Validation testing of the GBR technology by the Strategic Defense Initiative Organization. A no action alternative was also considered.

SUMMARY: The current GBR concept is a large, complex, phased-array, X-band radar system. It is a long-range radar that will be used to perform surveillance, acquisition, tracking, and discrimination of multiple targets; it also provides ballistic firing data for the interception of submarine-launched ballistic missiles or intercontinental ballistic missiles. The basic thrust of the efforts already accomplished in Concept Exploration has been to assess the technical feasibility of GBR in the context of a complete strategic defense system.

Demonstration/Validation would involve four types of tests: analysis, simulations, component/assembly tests, and validation tests. The locations of test activities for the GBR are:

INSTALLATION	TEST TYPE
California	
Vandenberg Air Force Base/ Western Test Range	Target Launches
Colorado	
National Test Facility Falcon Air Force Base	Analysis, Simulation Tests
Massachusetts	
Raytheon Company, Equipment Division	Component Assembly, Analysis, Simulation Tests

Republic of the Marshall Islands	
U.S. Army Kwajalein Atoll	Component Assembly, Analysis, Validation Tests
Utah	
Hill Air Force Base	Target Vehicle Refurbishment

To determine the potential for significant environmental impacts of Demonstration/Validation testing of the GBR technology, the magnitude and frequency of the tests that would be conducted at the proposed test locations were compared to the current activities at those locations.

The proposed test activities were evaluated to assess impacts in the following areas: air quality, biological resources, cultural resources, hazardous waste, infrastructure, land use, noise, public health and safety, socioeconomics, and water quality. As a result of that evaluation, consequences were assigned to one of three categories: insignificant, mitigable and non-significant, or potentially significant.

The following methodology was used. Environmental consequences were determined to be insignificant if no serious concerns existed regarding impacts to the affected area. Consequences were deemed mitigable and non-significant if concerns existed but it was determined that all of those concerns could be readily mitigated through standard procedures or by measures recommended in existing environmental documentation. If serious concerns were identified that could not be readily mitigated, the activity was determined to represent potentially significant consequences.

FINDINGS:

Insignificant environmental consequences were found for all of the test activities at Vandenberg AFB, The National Test Facility at Falcon AFB, Hill AFB, and the Raytheon Company at Wayland, MA.

Mitigable and non-significant consequences resulting from component/assembly and validation testing were found at USAKA. Potential cultural resources impacts are mitigated by an archaeological monitoring, sampling and data recovery program to be implemented during construction. Potential public health and safety impacts involve the exposure of personnel to electromagnetic radiation (EMR) and inadvertent ignition of fuel, detonation of electroexplosive devices and ordnance (ammunition); and, interference to critical aircraft electronic systems of aircraft landing on Kwajalein Island.

EMR impacts are mitigated by designed-in limitations on radar beam elevations and power densities. In addition, independent monitoring will be established to validate EMR exposure limits. Other potential public health and safety impacts identified are mitigated by ensuring that electromagnetic field intensities are within applicable guidelines and through routine scheduling and coordination with U.S. Army Kwajalein Atoll range personnel of GBR operations and any fueling, explosive/ordnance, aircraft, and meteorological rocket arming operations.

Overall, no significant impacts would result from the GBR technology demonstration/validation program because it was determined that all of the concerns could be readily mitigated through standard procedures or by measures recommended in existing environmental documentation. Therefore an environmental impact statement will not be prepared for the GBR Demonstration/Validation test program.

POINT OF CONTACT: A copy of

Ground-Based Radar
Demonstration/Validation Program,
Environmental Assessment,
March 1989

is available from

SDIO/S/PL-CE
Room 1E149, The Pentagon
Washington, DC 20301-7100

Dated 29 Mar 89

GEORGE L. MONAHAN, Jr.
Lieutenant General, USAF
Director

GROUND BASED RADAR ENVIRONMENTAL ASSESSMENT

(JANUARY 1989)

Lead Agency: Department of the Army
Strategic Defense Command

Title of Proposed Action: Demonstration/Validation Testing of Ground-Based Radar (GBR) Technology

Affected Jurisdictions: U.S. Army Kwajalein Atoll, Republic of the Marshall Islands; Hill Air Force Base, UT; National Test Facility, Falcon Air Force Base, CO; Vandenberg Air Force Base, CA/Western Test Range; and the prime contractor facility, Raytheon Company, Equipment Division, Wayland, MA.

PROPONENT: DATE: 1 FEB 89

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Colonel, FA
Project Manager, GBR

APPROVED BY: DATE: 9 Feb 89

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Lieutenant General, USA
Commander
U.S. Army Strategic Defense Command

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT UNLIMITED
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION US Army Strategic Defense Command 6b. OFFICE SYMBOL (If applicable) CSSD-H-SSP	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) P.O. Box 1500 Huntsville, AL 35807	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)

GROUND BASED RADAR (GBR) ENVIRONMENTAL ASSESSMENT (U)

12. PERSONAL AUTHOR(S)

GBR Environmental Assessment Team, Mr. Dru Barrineau, Chairman.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
FINAL	FROM ______ TO ______	1989 March	140

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP
24		
17	09	

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

Environmental Assessment, Ground Based Radar (GBR), Radar Technology.

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This Environmental Assessment documents the results of an assessment of the potential for and the magnitude of impacts from Demonstration/Validation activities of the Ground Based Radar (GBR).

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. Dru Barrineau	22b. TELEPHONE (Include Area Code) (205) 895-3632 22c. OFFICE SYMBOL CSSD-H-SSP

DD Form 1473, JUN 86 — Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

24 Environmental Impact

17/09 Radar

EXECUTIVE SUMMARY

The President's Strategic Defense Initiative (SDI), announced on March 23, 1983, initiated an extensive research program to determine the feasibility of developing an effective ballistic missile defense system. The technological progress that has been made on the SDI research program since 1983 has advanced at an unexpectedly fast pace and is still accelerating. Recognizing that no strategic defense system could be deployed all at once, the Strategic Defense Initiative Organization is using an evolutionary approach to strategic defense known as the concept of phased, or incremental, development/deployment. This concept addresses the question of how to deploy strategic defenses in the event a decision is made in the future. It does not constitute a decision to develop or deploy. In September 1987, some technologies were advanced from the Concept Exploration phase of the material acquisition process to the Concept Demonstration and Validation phase under this approach, because they were judged to be mature enough in concept definition to warrant further evaluation.

The Ground-Based Radar (GBR) technology is currently in the Concept Exploration phase. However, as a result of rapid technical progress, GBR is being considered for advancement to the Demonstration/Validation phase. The purpose of this environmental assessment is to analyze the environmental consequences of Demonstration/Validation activities for the GBR technology development program in compliance with the National Environmental Policy Act, the Council on Environmental Quality regulations implementing the Act, and Army Regulation 200-2.

The GBR will be a large, complex, phased-array, X-band radar system. It will be a long-range radar that will be used to perform surveillance, acquisition, tracking, and discrimination of multiple targets; it will also provide ballistic firing data for the interception of submarine-launched ballistic missiles or intercontinental ballistic missiles. The basic thrust of the efforts already accomplished in Concept Exploration has been to assess the operational utility of GBR in the context of a complete strategic defense system.

The GBR Demonstration/Validation program will consist of a number of test activities to be conducted at five different testing sites. These activities are categorized as analyses, simulations, component/assembly testing, and validation testing. This environmental assessment, submitted in accordance with applicable directives and policies and made available to the public, provides information on the potential environmental effects of conducting the testing activities as described.

In particular, the environmental assessment examines the proposed sites for testing activities. For each site, the assessment evaluates potential impacts on the environment. To assess the potential for and significance of any impact, a two-step methodology has been utilized. The first step was the application of assessment criteria to identify test activities deemed to present no potential for significant environmental consequences. If a proposed activity was determined to present some potential for impact, no matter how slight, the second step in the methodology was undertaken. This step consisted of evaluating the activity in terms of potential for significant impacts on a number of broad environmental attributes, such as air quality, biological resources, cultural resources, hazardous waste, socioeconomic, and public health and safety issues.

Based on the application of this methodological approach, the following determinations on the environmental consequences of GBR Demonstration/Validation testing were made:

- Raytheon Company, Equipment Division, Wayland, MA - insignificant consequences
- Hill AFB, UT - insignificant consequences
- National Test Facility, Falcon AFB, CO - insignificant consequences
- U.S. Army Kwajalein Atoll, Republic of the Marshall Islands - mitigable and non-significant consequences
- Vandenberg AFB, CA/Western Test Range - insignificant consequences

No significant impacts would result from the GBR. Analyses and simulations of the GBR will have insignificant environmental consequences at all of the test locations identified. Mitigable and non-significant impacts resulting from component/assembly and validation testing were found at the U.S. Army Kwajalein Atoll, Republic of the Marshall Islands. This component/assembly testing at the U.S. Army Kwajalein Atoll will have mitigable and non-significant environmental consequences for cultural resources. In addition, component/assembly and validation testing will have mitigable and non-significant environmental consequences for public health and safety. Potential cultural resource issues, that can be mitigated, involve construction of trenches for power and utility lines; construction of a septic tank and associated drain field; and potential construction of trenches for utilities supporting the sensors that will record electromagnetic radiation exposure levels, all of which will be mitigated by an archaeological monitoring, sampling, and data recovery program to be implemented during construction.

Potential public health and safety issues, that can be mitigated, involve the exposure of personnel to electromagnetic radiation. This exposure will be mitigated by (1) establishment of a minimum radar beam elevation limit (2 degrees above horizontal), (2) control of power density levels through the computer software, and (3) validation of power densities by independent evaluation. Electromagnetic radiation generated by the GBR could potentially interfere with existing emitters and communications systems at U.S. Army Kwajalein Atoll. An Electromagnetic Compatibility Analysis Center analysis will recommend any corrective actions, if needed. Only when these corrective actions are coordinated with U.S. Army Kwajalein Atoll and procedures are in place to incorporate them, can the frequency assignment allocation be granted by the National Telecommunications and Information Administration through the DOD. Potential, but extremely remote, public health and safety impacts from: inadvertent ignition of fuel, detonation of electroexplosive devices and ordnance (ammunition), and aircraft personnel exposure can be mitigated. Mitigation measures will include: ensuring that electromagnetic field intensities are within applicable guidelines and that there will be routine scheduling and coordination through the U.S. Army Kwajalein Atoll range personnel of GBR operations with any fueling and explosive/ordnance operations as well as with aircraft activities within the range of the control tower on Kwajalein Island and control tower personnel. Mitigation measures will also include the publishing of an appropriate Notice to All Airmen, in order to avoid GBR operations. Overall, no significant impact from GBR Demonstration/Validation testing would result.

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1.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The National Environmental Policy Act (NEPA), Council on Environmental Quality regulations implementing the Act (40 CFR 1500-1508), Department of Defense (DOD) Directive 6050.1, and Army Regulation (AR) 200-2, which implements these regulations, direct that DOD and Army officials take into account environmental consequences when authorizing or approving major Federal actions in the United States. Accordingly, this Environmental Assessment (EA) analyzes the potential environmental consequences of Demonstration/Validation activities for a proposed Ground-Based Radar (GBR). Because the proposed action would involve the U.S. Army Kwajalein Atoll (USAKA), Republic of the Marshall Islands (RMI), the Compact of Free Association (107) and related agreements between the RMI and the United States also apply.

GBR is one of the technologies being considered in the Strategic Defense Initiative program. The tests and evaluations associated with Demonstration/Validation would be in compliance with the Antiballistic Missile Treaty. A decision to proceed to Demonstration/Validation for GBR would not indicate that GBR would be developed or deployed, nor would it preclude the possibility of advancing other technologies in the acquisition process.

This section describes the purpose and need for the action, the proposed GBR Demonstration/Validation program and alternatives, and the related environmental documentation. Section 2.0 describes the affected environment at those installations where Demonstration/Validation activities would be conducted. Section 3.0 assesses the potential environmental consequences of the proposed action at these installations, and Section 4.0 discusses measures that would be taken to minimize impacts at affected installations.

1.1 BACKGROUND

The President's Strategic Defense Initiative (SDI), announced on March 23, 1983, initiated an extensive research program to determine the feasibility of developing an effective ballistic missile defense system. Subsequently, the Strategic Defense Initiative Organization (SDIO) was established to plan, organize, coordinate, direct, and enhance the research and testing of technologies applicable to strategic defense.

The acquisition process for defense programs is divided into distinct phases separated by major milestone decision points. They are: Milestone 0 - Program Initiation/Mission-Need Decision (Concept Exploration), Milestone I - Concept Demonstration/Validation Decision, Milestone II - Full-Scale Development Decision, Milestone III - Full-Rate Production Decision, Milestone IV - Logistics Readiness and Support Review, and Milestone V - Major Upgrade or System Replacement Decision. Each of these decision points establishes program goals that the program manager is expected to meet and the information required for the next decision point.

Central to the conduct of the SDI research program and determination of feasible technologies that could be applicable to an effective ballistic missile defense system are the Concept Exploration and Demonstration/Validation activities. As part of the acquisition process, Concept Exploration activities assess such things as program alternative tradeoffs, performance/cost and schedule tradeoffs, and the operational utility of the prototype concept. Demonstration/Validation activities then examine operational suitability and effectiveness by testing to determine the technology's ability to meet the specified requirements. These activities would provide the necessary information required for future acquisition decisions regarding a Strategic Defense System (SDS).

The technological progress that has been made on the SDI research program since 1983 has advanced at an unexpectedly fast pace and is still accelerating. Recognizing that no SDS could be deployed all at once, the SDIO is using an evolutionary approach to strategic defense known as the concept of phased, or incremental, development/deployment. This concept addresses the question of how to deploy strategic defenses in the event a decision is made in the future. It does not constitute a decision to develop or deploy. In September 1987, some technologies were advanced into the Demonstration/Validation phase under this approach because they were judged to be mature enough in concept definition to warrant further evaluation. They are Boost Surveillance and Tracking System (BSTS), Space-Based Surveillance and Tracking System (SSTS), Space-Based Interceptor (SBI), Exoatmospheric Reentry Vehicle Interception System (ERIS), Ground-Based Surveillance and Tracking System (GSTS), and Battle Management/Command, Control, and Communications (BM/C^3) (14, 15, 16, 17, 18, 19). EAs were prepared for these six technologies in the SDI Demonstration/Validation Program in August 1987. An SDI Demonstration/Validation Program Environmental Assessments Summary (20) was also prepared.

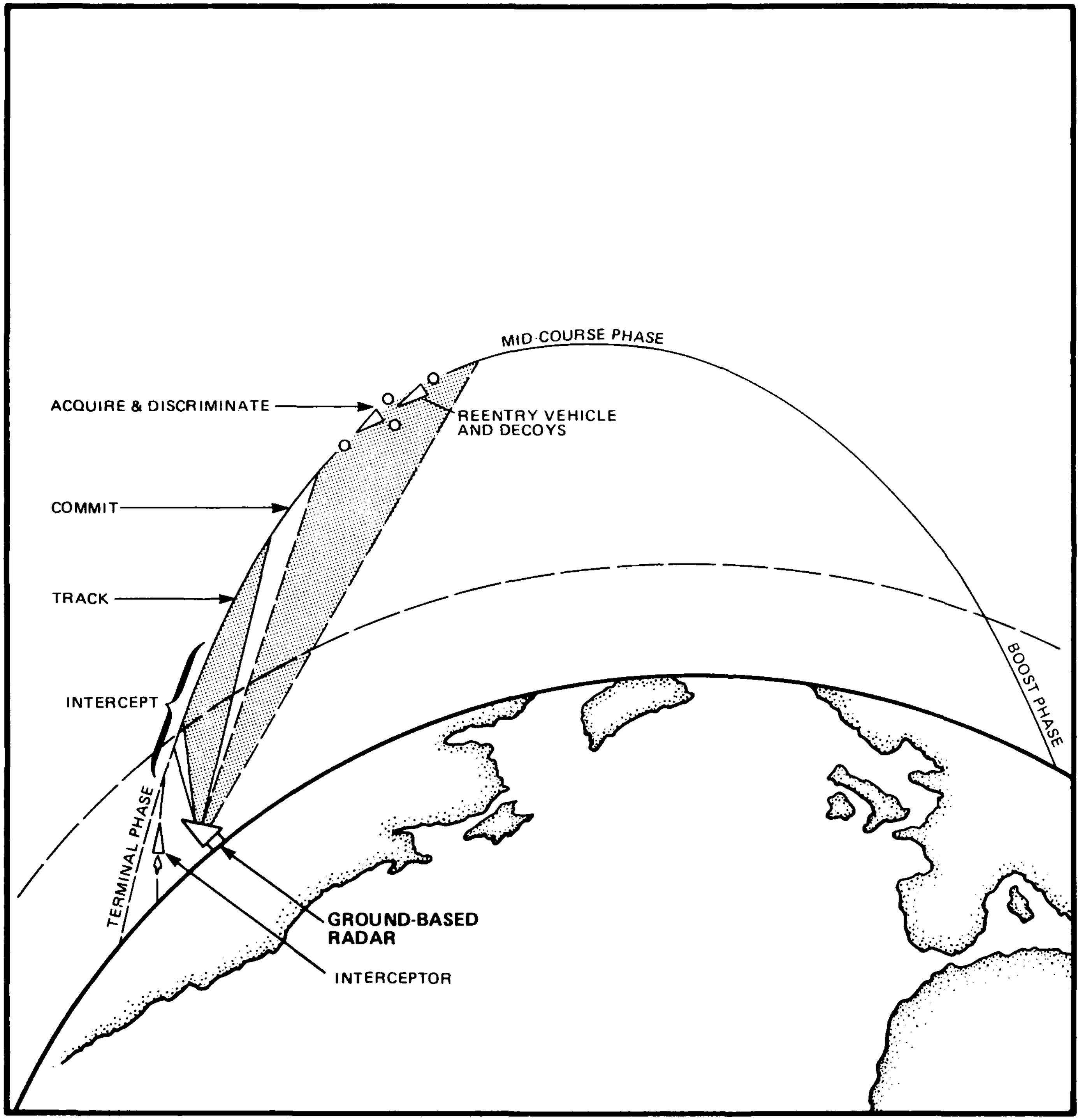
1.2 PURPOSE AND NEED FOR THE ACTION

The GBR technology is one more concept being considered for Demonstration/Validation. This technology is presently in the Concept Exploration phase, which determines the operational utility of the concept in an SDS. Activities in this phase have included evaluation of existing large phased-array radar technology and associated improvements or modifications needed to use a system in a ground-based role to supplement other SDI technologies in detecting and tracking hostile inbound missiles.

Phased-array technology, which has been used in radar systems for a number of years, refers to the use of multiple radiating (transmitting) elements to make up an antenna system. The system has carefully controlled (by computer) power levels and electrical phase relationships (timing and angles) for electronic beam steering that are delivered to each of the array elements. This technology has been used primarily as a warning device - to provide time to launch or protect offensive systems - and has served as a deterrent to hostile nations' offensive systems.

The GBR, although generally based on this proven phased-array technology, exhibits significant advances. The GBR has been modified from the designs of earlier, successful large phased-array systems and will be a long-range radar whose purpose will be surveillance, acquisition, tracking, and discrimination of multiple targets. The GBR will also provide ballistic firing data for the interception of submarine-launched ballistic missiles (SLBMs) or intercontinental ballistic missiles (ICBMs) (Figure 1-1).

This advancement, combined with a different mission scenario, emphasizes the need for the technology's advancement to the Demonstration/Validation phase; this phase will test the technology's ability to perform the task. Of the technologies currently being researched under SDI, GBR is the only one that is designed to detect and track potentially



Functional Concept of Ground-Based Radar

Figure 1-1

hostile ballistic missiles through their midcourse, into the endoatmosphere (altitudes below 33,500 meters [110,000 feet]).

The decision to proceed with Demonstration/Validation activities for the GBR does not preclude the possibility of advancing other technologies in the acquisition process, nor is it a decision that indicates that GBR or an SDS will be developed and deployed. Further advancement of GBR in the acquisition process will be supported by additional documentation of the environmental impact analysis process, in compliance with NEPA. The purpose of this EA is to analyze the environmental consequences of Demonstration/Validation activities for the GBR technology development program in compliance with all pertinent regulations and agreements.

1.3 SYSTEM DESCRIPTION

The GBR will be a large, complex, phased-array, X-band radar system designed in a single-faced, dual-field-of-view (DFOV) configuration. The system is functionally described below, followed by a discussion of the environmental concerns associated with the effects of electromagnetic radiation (EMR). Figure 1-2 is an illustration of the GBR unit.

1.3.1 Ground-Based Radar Component Description

The DFOV radar system consists of two separate antennas, one that provides a limited field of view (LFOV) and one that provides a full field of view (FFOV). Only one of these antennas will be operating at any particular time. The LFOV antenna provides high-gain, long-range, limited electronic scan capability for exoatmospheric (extremely high) and endoatmospheric operations, while the FFOV antenna provides larger scan volume and lower gain for closer, endoatmospheric operations.

The DFOV radar system allows the selection of antennas, mounted on the same antenna support structure (a plane), and employs phased-array technology, which combines many smaller elements (called phase shifters) to function as a single antenna. The FFOV antenna has a circular aperture with a diameter of 3.2 meters (10.4 feet) that is mounted in the center of the larger, square LFOV antenna, which is 10 meters (32.8 feet) on a side. These two antennas operate in the X band of the microwave spectrum and employ 43,008 phase shifters (21,504 in each antenna). The GBR dual antennas will be mounted on a turret rotating in azimuth and elevation, and a large spherical radome will encompass the entire antenna system for protection against the effects of rain and wind. Through mechanical and electronic control of the antenna's radiation pattern, the narrow, pencil-shaped main beam can be directed essentially instantaneously at incoming targets in any direction.

The three parameters of a phased-array antenna - power level, frequency, and commanded steering angles - are monitored by computer programs (software) that control the antenna's radiation pattern, the way the antenna radiates the pulsed microwave signal in various directions. This control minimizes the potential for EMR hazards. Targets at different locations can be discriminated by controlling the direction in which the radar transmits the microwave signal. Radars commonly use mechanical beam steering to change the transmitted direction of the beam. Because the GBR phased-array antenna can be rapidly steered electronically and will be coupled with mechanical turret steering and electronic and mechanical elevation control, the GBR provides an effective horizontal coverage of 360 degrees and a vertical coverage of 90 degrees. Because nothing mechanical has to move, electronic beam steering is instantaneous. The

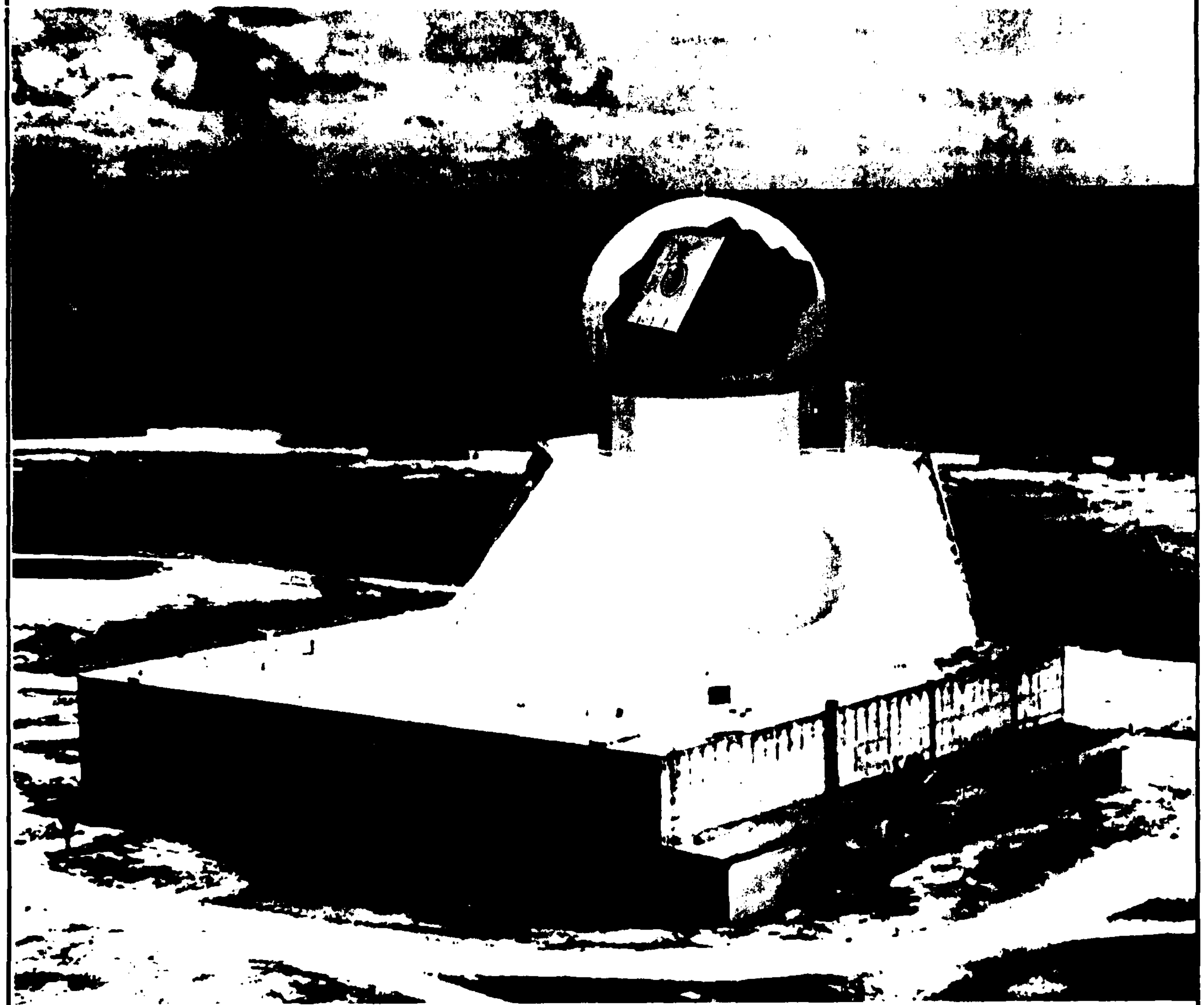


Illustration of Ground-Based Radar Unit

Figure 1-2

maximum operational duty cycle for GBR will be 20 percent (i.e., during operation, the radar will be actually transmitting a maximum of 20 percent of the time). A schematic of the antenna systems is depicted in Figure 1-3.

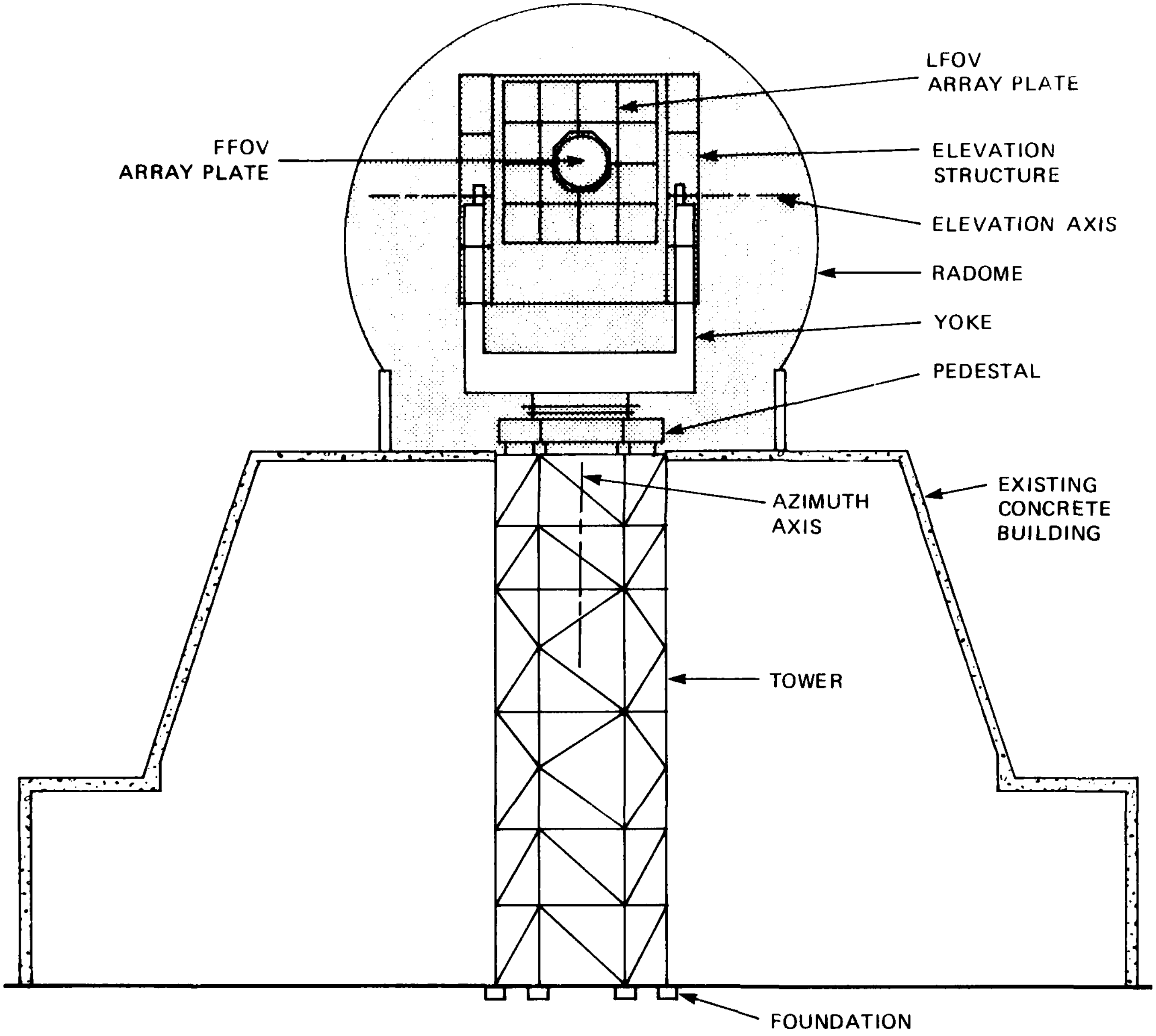
1.3.2 Electromagnetic Radiation Concerns

The radiation patterns of the GBR antennas spatially describe how the microwave energy is radiated into space; these patterns consist of the main beam of radiation as well as secondary beams (side lobes) of radiation. The particular design of the GBR LFOV antenna produces a class of side lobes referred to as grating lobes. EMR concerns result from exposure from the main beam and exposure from grating or side lobes outside of the main beam.

The main beam will normally be operated at a positive 2 degrees or more in elevation above the horizontal. This means that the main beam EMR hazard, under normal conditions, will only occur well above earth and water surfaces. Figure 1-4 illustrates that, at a distance of 1,524 meters (5,000 feet) the main beam is at least 100 meters (328 feet) above sea level. It is possible that the GBR, under certain range operations such as missile transponder acquisition for range safety and splashdown observation, will operate the main beam below the normal minimum of positive 2 degrees. GBR activities during these range operations are restricted to only using the FFOV antenna at a greatly reduced duty cycle. Grating lobes are secondary beams which occur at angles in the range of 30 to 90 degrees with respect to the main beam only during LFOV operations. While grating and side lobes are undesirable and variable under normal conditions, they are predictable given a fixed set of operational conditions. The far-field power density in the grating and side lobes varies with positions and operational variables but never exceeds a strength of one-fourth to one-sixteenth of the main beam at the same distance. An artist's conception of the main beam and the grating and side lobes is shown in Figure 1-5.

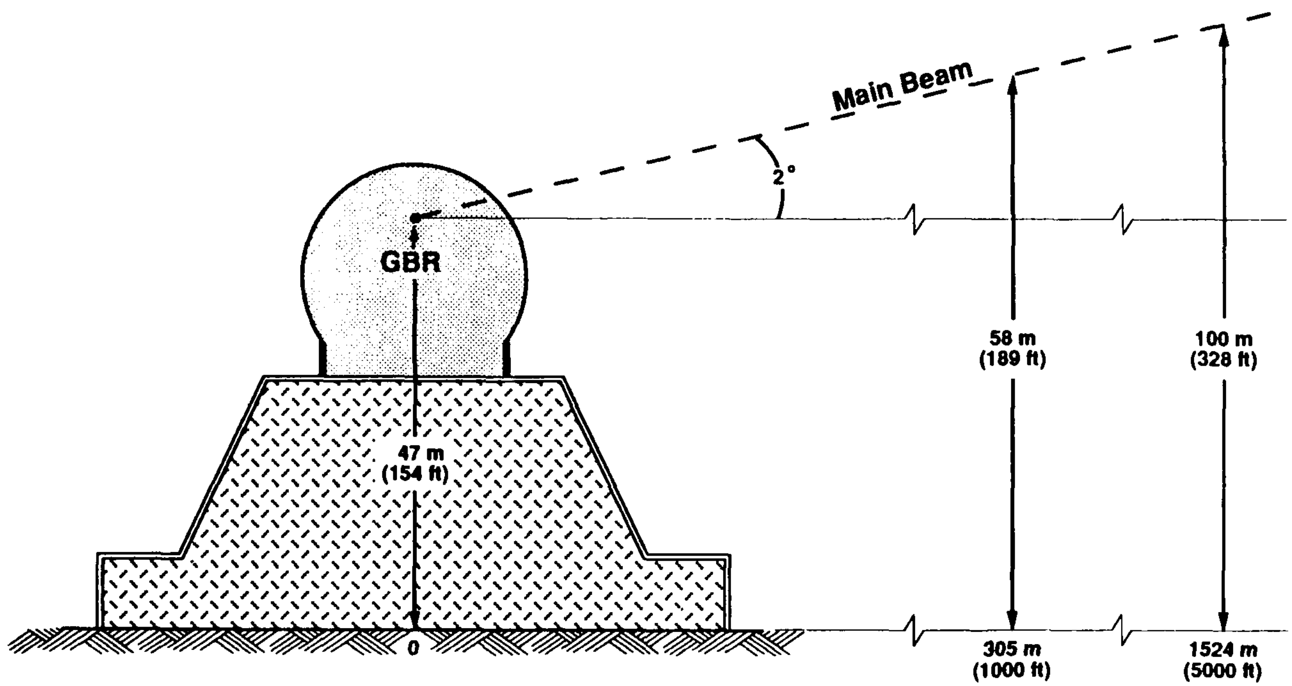
When an individual is exposed to EMR fields, the rate at which the body absorbs a portion of the incident energy (energy absorption rate) is a complex function of body dimensions, shape, EMR frequency, and orientation of the body with respect to the EMR field. Extensive research has been conducted to determine the possible adverse health effects that may occur to individuals exposed to intense microwave radiation. Most of these studies, conducted with laboratory animals, have demonstrated that the most severe effects on tissue from exposure to high-intensity microwave fields are caused by excessively high, energy absorption rates in the tissue (Appendix A). Several extensive literature reviews conducted during the last several years (5, 6, 7) include technical studies of the biological effects of EMR on the following: cellular and subcellular organization; blood and immunologic systems; reproductive and nervous systems, and behavior; eyes, such as the possibility of cataract development; endocrine, physiological, and biochemical systems; genetics and mutagenesis; life span and carcinogensis. These extensive literature reviews also included various epidemiological studies of human populations.

To reduce the potential for adverse effects occurring in individuals exposed to EMR, protective limits which set maximum recommended exposure values for EMR fields have been established. These limits incorporate information from many of the studies noted above and include a margin of safety factor of 10 or greater in translating the energy absorption rates that represent a threshold for observed hazardous effects to acceptable exposure levels (Appendix A). For evaluating possible exposure levels, this EA and the GBR project uses a derivative of the American National Standards Institute (3) recommendations reflected in U.S. Army Technical Guide No. 153 (Guidelines for



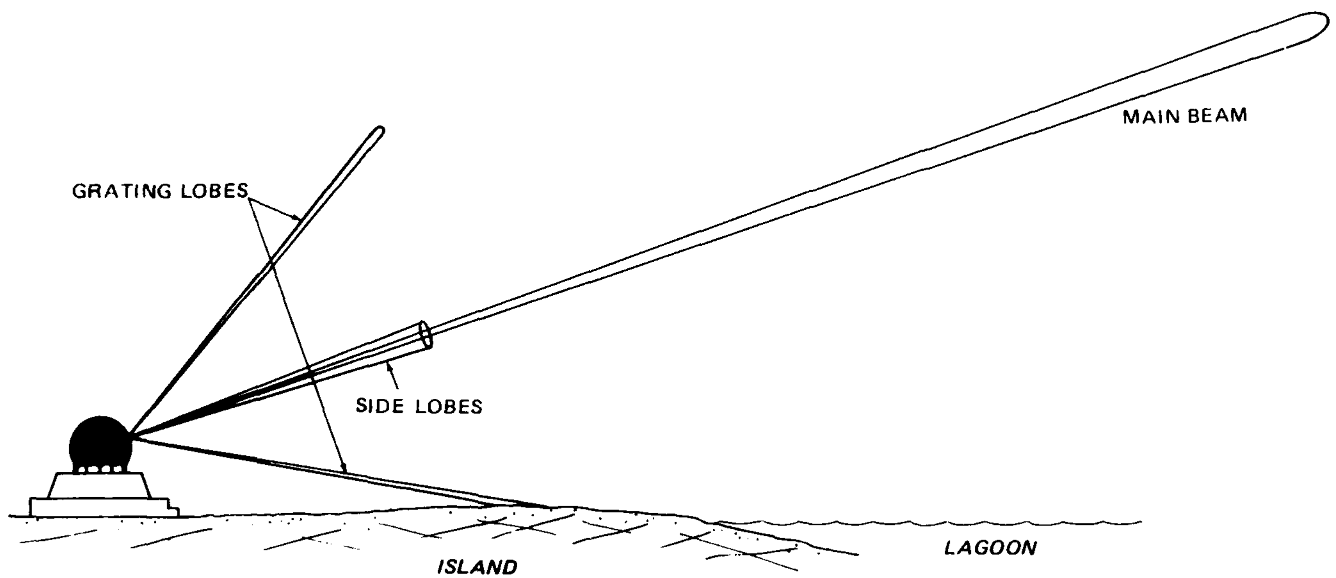
Ground-Based Radar Schematic

Figure 1-3



Normal Ground-Based Radar Operating Condition

Figure 1-4



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Artist's Conception of Typical Ground-Based Radar Radiation Pattern (LFOV Antenna)

Figure 1-5

Controlling Potential Health Hazards from Radio Frequency Radiation) and the USAKA KMR Range Safety Manual (8, 105). A maximum EMR power density of 5 milliwatts per centimeter squared (mW/cm^2) (32.25 milliwatts per inch squared [mW/in^2]) averaged over a 6-minute period applies to the emission frequency associated with the GBR project. Other EMR concerns are potential ignition during fueling operations, the inadvertent detonation of electroexplosive devices (EEDs) and ordnance (ammunition), and interference to critical communications and electronic systems.

- Fuel ignition can become a concern when radio frequency (RF) currents, which can be induced in metallic objects by intense RF fields, lead to possible arcing/sparks. This phenomenon is extremely rare but has been observed under contrived test conditions during refueling operations. Ignition may occur if the proper mixture of fuel vapor and air exists at the point where the spark occurs; this is considered extremely unlikely.

- Possible EED detonation (e.g., inadvertent firing of meteorological rockets during arming operations) is also related to the electromagnetic field-induced currents that flow in the electrical leads connected to the explosive device.

- Possible interference to critical communications and electronic systems (i.e., navigation, communication, and radar systems) could lead to system malfunction.

1.4 PROPOSED ACTION

The proposed action is the implementation of the Demonstration/Validation program for the GBR technology. This program would demonstrate whether GBR can meet the following specific requirements:

- Demonstrate successful integration of hardware and software

- Prove discrimination capabilities

- Validate the functional technology against real targets.

This EA addresses the Demonstration/Validation program only. Any decision to advance beyond the Demonstration/Validation stage will be further analyzed under NEPA. In addition, this EA will be reevaluated if the GBR program changes.

The GBR Demonstration/Validation program will consist of a number of different test activities to be conducted at several different testing sites. These activities are categorized as analyses, simulations, component/assembly testing, and validation testing. Table 1-1 delineates the various activities and the locations associated with each activity; the locations are shown in Figures 1-6 and 1-7. The Demonstration/Validation test activities will be conducted in three phases: (1) contractor fabrication and testing; (2) installation, integration, and testing at the USAKA, RMI; and (3) functional technology validation of the GBR system against real targets. These testing phases are described in more detail below.

TABLE 1-1. GBR TEST ACTIVITIES AND LOCATIONS

TEST ACTIVITIES	ANALYSIS	SIMULATIONS	COMPONENT/ASSEMBLY	VALIDATION	LOCATIONS
Analyze test failure	X				Raytheon Company, Equipment Division, Wayland, MA
	X				U.S. Army Kwajalein Atoll, RMI
Demonstrate real-time waveform generation	X		X		Raytheon Company, Equipment Division, Wayland, MA
	X			X	U.S. Army Kwajalein Atoll, RMI
Test unique software	X	X	X		Raytheon Company, Equipment Division, Wayland, MA
	X			X	U.S. Army Kwajalein Atoll, RMI
Analyze antenna ability to survive environmental stress	X	X			Raytheon Company, Equipment Division, Wayland, MA
	X			X	U.S. Army Kwajalein Atoll, RMI
Evaluate subsystem maintainability	X		X		Raytheon Company, Equipment Division, Wayland, MA
	X			X	U.S. Army Kwajalein Atoll, RMI
Verify discrimination schema performance	X		X	X	U.S. Army Kwajalein Atoll, RMI
	X			X	Vandenberg AFB, CA/ Western Test Range
Demonstrate target acqui-sition and real-time signal processing	X			X	U.S. Army Kwajalein Atoll, RMI
	X			X	Vandenberg AFB, CA/ Western Test Range
Refurbishment of Minuteman I missile rocket motors	X		X		Hill AFB, UT
Simulate exercise test missions	X	X			National Test Facility, Falcon AFB, CO

EXPLANATION

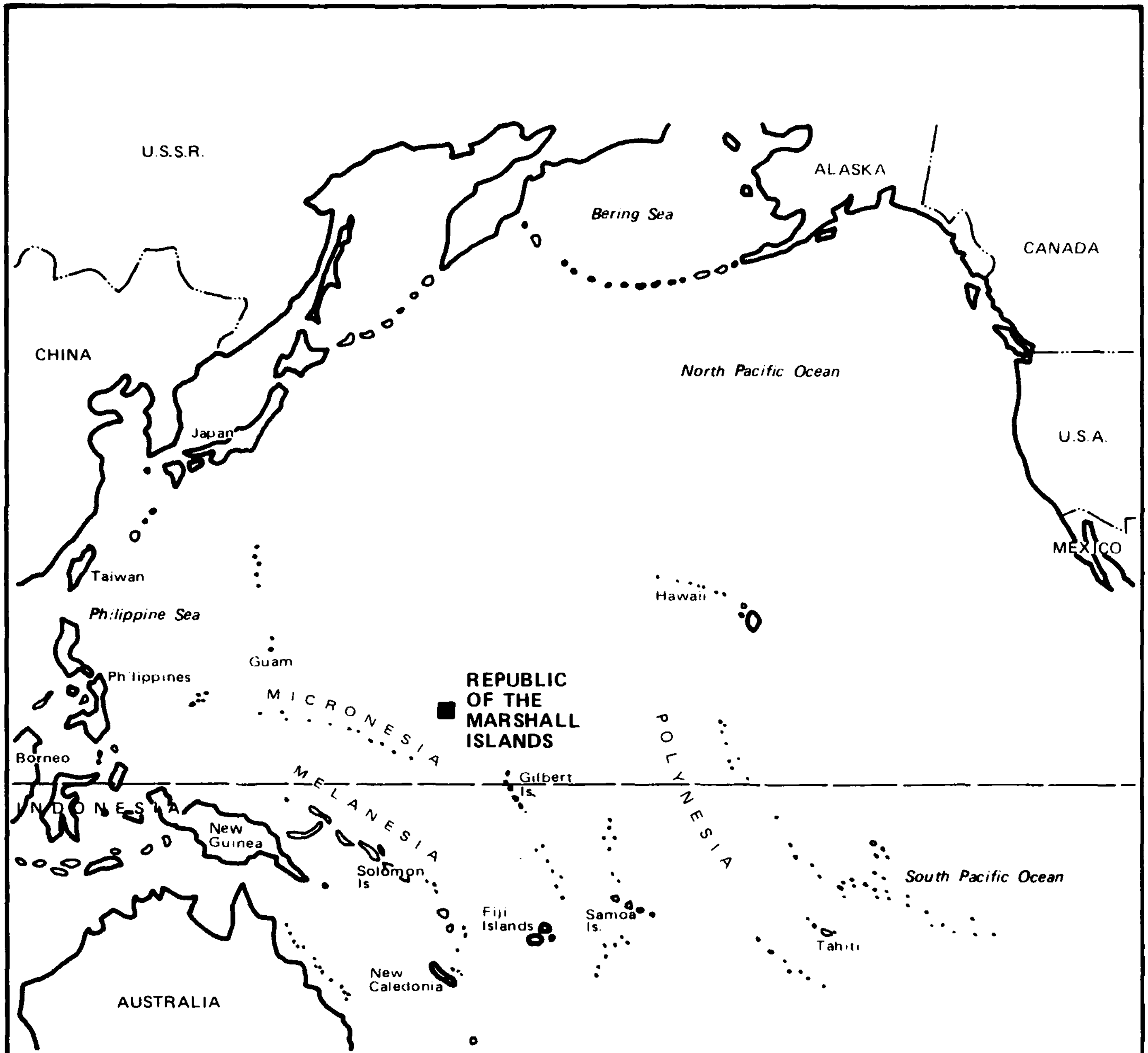
1. RAYTHEON COMPANY, EQUIPMENT DIVISION
2. NATIONAL TEST FACILITY, FALCON AFB
3. HILL AFB
4. VANDENBERG AFB
5. WESTERN TEST RANGE
6. KWAJALEIN ISLAND, U.S. ARMY KWAJALEIN ATOLL

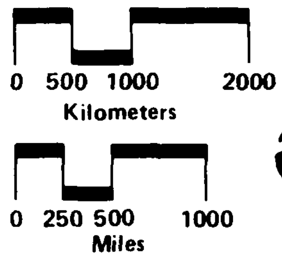
0 150 300 600
Kilometers

0 100 200 400
Miles

Ground-Based Radar Demonstration/ Validation Facilities

Figure 1-6





Location Map of the Republic of the Marshall Islands

Figure 1-7

Phase 1 - Contractor fabrication and testing - Raytheon Company, Equipment Division, Wayland, MA.

The fabrication and component testing of the GBR will take place in existing contractor facilities at Raytheon Company, Equipment Division, in Wayland, MA. Raytheon Company routinely fabricates and tests radars and radar subsystems at this site. Fabrication and testing will be conducted within the main building except for antenna subarray component tests which will use test facilities located on the roof of the main building where beam propagation can be carefully controlled and directed. Fabrication and testing for the GBR will involve the following tasks:

- Analyzing test failures to evaluate why they occur, with the goal of eliminating future problems
- Demonstrating real-time waveform generation to evaluate the portion of the GBR system that produces the microwave energy at the frequency and strength needed for its operation
- Testing unique software to verify that computer programs will control the radar system as planned
- Analyzing the antenna's ability to survive projected environmental stress by simulating the operating environment of the component equipment or software as it will be employed at USAKA
- Evaluating subsystem maintenance requirements to ensure that the equipment can be cared for by normal maintenance and supply routines.

Phase 2 - Installation, integration, and testing - USAKA, RMI.

Final testing will require that the prototype GBR components be moved to and installed at the USAKA, RMI. After this installation, the components and assemblies that were tested as individual items at the Raytheon Company will be retested and then tested as an integrated radar system in order to confirm system functioning.

Phase 3 - Functional technology validation of GBR against actual targets - USAKA, RMI; Vandenberg Air Force Base, CA/Western Test Range.

This phase of the GBR program will take advantage of targets of opportunity that will be launched from Vandenberg Air Force Base (AFB) for other programs. Additionally, three GBR-dedicated missions will be launched from Vandenberg AFB. This phase of testing will validate system performance using real targets and a full-scale prototype radar to evaluate discrimination schema performance and demonstrate target acquisition and real-time signal processing.

The remaining Demonstration/Validation activities shown in Table 1-1 will be conducted prior to or concurrent with the GBR validation tests. These activities, which will take place at Hill AFB, Utah, and the National Test Facility, Falcon AFB, Colorado, include the following:

- Refurbishing existing Minuteman I missile rocket motors at Hill AFB, to prepare them for use as target launch vehicles for GBR validation testing

- Simulating the exercise test mission, which involves developing and using computer programs that will simulate the expected test scenario at the National Test Facility.

The following sections describe more fully the types of test activities that will take place and the pertinent information regarding each test location.

1.4.1 Analyses

Analysis activities for the GBR program will consist of the evaluation of data generated by the other test program activities. By necessity, this analysis occurs after each testing phase. Analysis is a scientific exercise conducted to determine the cause of, or reasons for, simulated or real phenomena noted during testing and/or evaluation. This analysis will be used to eliminate potential problems and/or to enhance positive results. GBR analysis activities are scheduled at all of the locations where test activities will be conducted (Table 1-1) and will be undertaken by the staff that performs these test program activities. No additional personnel will be required for any analysis activity.

1.4.2 Simulations

Some of the GBR technical and operational performance characteristics will be demonstrated using simulations. Simulations involve the testing of a physical entity (machine, system, component, etc.) by developing a computer model or by using a specially designed simulation installation (e.g., an RF test chamber). Simulations will be used in all phases of the GBR program to validate and quantify test results and to evaluate system performance under test conditions that would not be practical to create in the real world. Emphasis will be placed on building the qualifications history and databases starting with the component level testing to permit cost-effective, well-planned, and coordinated GBR element testing. Types of simulations will include developing and implementing models of individual GBR subsystem functions (e.g., searching, tracking, discrimination, etc.) and models of the entire GBR system that include the operating environment. Table 1-1 delineates the location of each simulation activity. Unique software simulations and antenna simulations are scheduled by Raytheon Company, Equipment Division, Wayland, MA. Exercise test mission simulations incorporating data from GBR are scheduled at the National Test Facility, Falcon AFB, CO. These simulation activities are described in more detail below.

RAYTHEON COMPANY, EQUIPMENT DIVISION

The effectiveness of the unique software that is required for the GBR technology will be evaluated by simulation by Raytheon Company, Equipment Division. These activities will include analyzing the antenna's ability to survive operational and environmental stress and simulating field conditions to evaluate system and component operations (36). Approximately 50 persons will be involved in these simulation activities (33). There will be no new construction or modifications to existing facilities, and no additional personnel will be required (33).

NATIONAL TEST FACILITY, FALCON AIR FORCE BASE

The computer simulations at Falcon AFB, which serves as a repository for all SDIO technical information, will be part of a larger, overall SDI simulation effort. This effort will take advantage of data from all of the SDI technologies. These simulations will take place in the existing interim facility (the Consolidated Space Operations Center) and the new National Test Facility, but will not involve or require any building modifications to the Consolidated Space Operations Center. When the National Test Facility, which is still under construction, is fully operational, it will employ approximately 2,700 of Falcon AFB's estimated work force of 6,000 employees (65, 66, 68, 73, 75). Other than these already scheduled people, no additional personnel will be required (75).

1.4.3 Component/Assembly Tests

Component/assembly testing for the GBR will demonstrate the performance of the assembled GBR components in a test environment in which some or all of the aspects of the physical environment are controlled. The primary objective of these tests is to provide validation of design and performance level benchmarks prior to validation testing. The scope of this testing will range from single components to major subassemblies. Table 1-1 delineates the locations of each component/assembly test. Real-time waveform generation demonstration, unique software, and subsystem maintainability component/assembly tests are scheduled at Raytheon Company, Equipment Division, Wayland, MA. Discrimination schema component/assembly tests are scheduled at the USAKA, RMI. Refurbishment of Minuteman I missiles is also scheduled at Hill AFB, UT. These component/assembly activities are described in more detail below.

RAYTHEON COMPANY, EQUIPMENT DIVISION

Initial component/assembly testing will occur at Raytheon Company, Equipment Division, in Wayland, MA. The testing at Raytheon can be subdivided into two categories: testing inside the building and rooftop testing. Existing facilities at Raytheon Company, Equipment Division, will be used, and no modifications to existing structures will be required. Although the number of people actively working on the GBR project at any given time will vary, the estimated peak staff required to design, build, assemble, and test the GBR system is 200 (32). Raytheon Company, Equipment Division, has a workforce of approximately 10,000 people and constructs and tests approximately 85 electronic component systems per year at Wayland. No additional personnel will be required for GBR activities (32, 33).

Testing inside the building includes component matching and assembly, physical alignment, and electrical continuity testing. The following components would be tested: one transmitter group, a beam steering generator, a receiver/exciter test target generator, timing and control equipment, a signal processor with high-speed recorder, a turret controller, array equipment, data processing equipment, and radar emissions controls and monitor systems. This testing does not involve EMR generation.

The testing on the roof of the Wayland facility will involve the generation of EMR, but will occur under very controlled conditions. Massachusetts' laws regulate EMR testing through permits which are required to insure public safety.

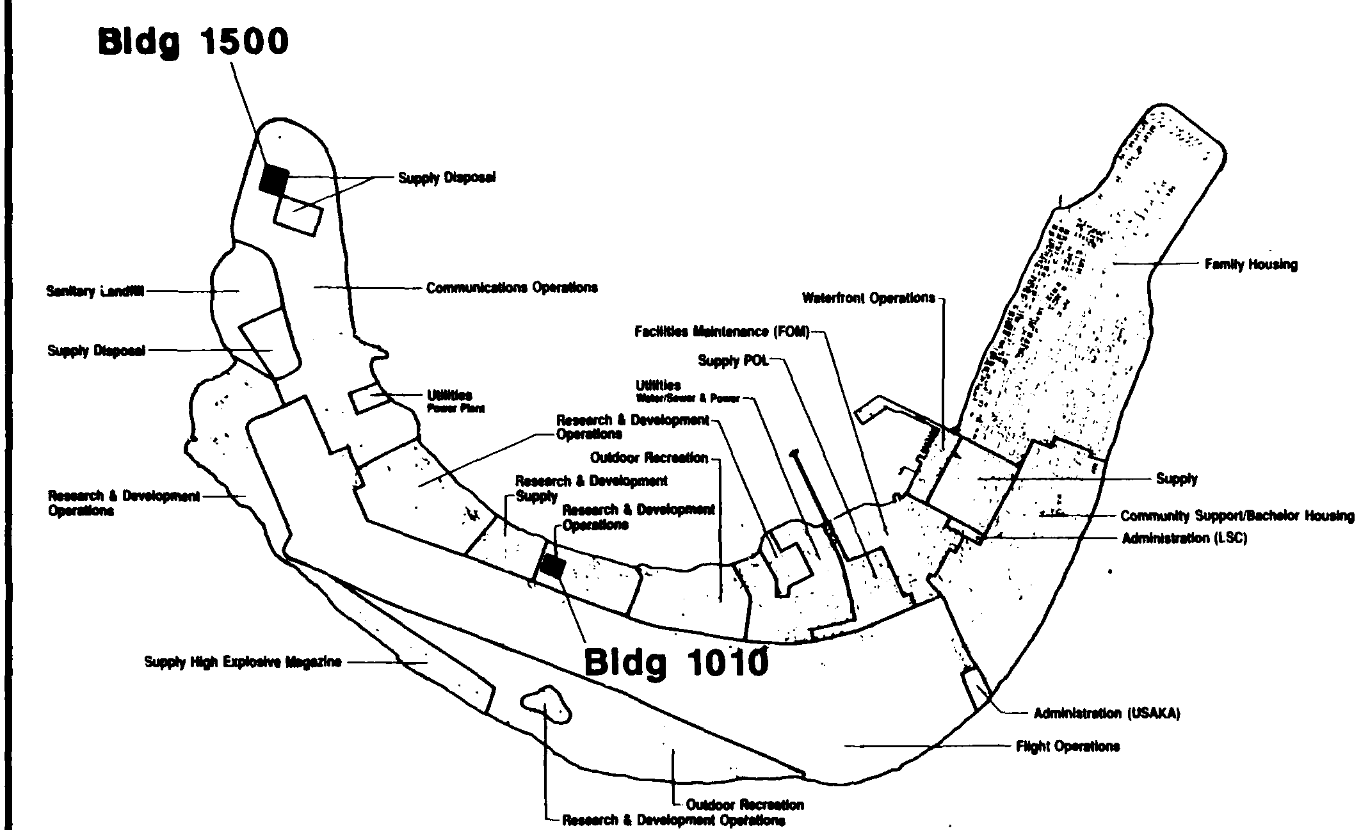
Elements of the FFOV and LFOV array antennas will be tested in Raytheon's rooftop facility. High-power testing of these antenna elements will be limited to evaluating only 1/32 of the array at any one time; specialized test equipment (a modified Aegis transmitter set) will provide complete control of the test. During this testing, the beam will be pointed in the vertical direction with zero degrees electronic scan or broadside radiation; broadside radiation will preclude the development of antenna grating lobes during the test. The combination of specialized test equipment, test procedures, and vertical broadside radiation will insure that exposure to EMR will be less than the Massachusetts Department of Labor and Industries exposure limit of

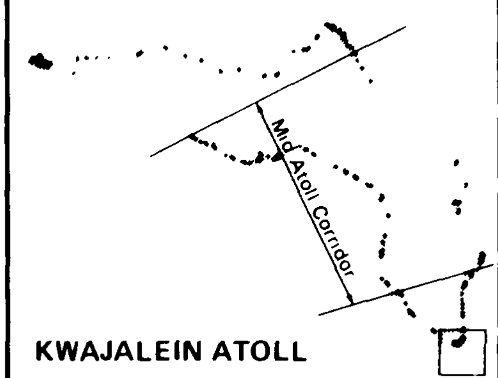
5 mW/cm^2 (32.25 mW/in^2) and the Massachusetts Department of Public Health exposure limit of 1 mW/cm^2 (6.5 mW/cm^2). There is also a lower power test of the entire FFOV array during which the antenna receives very low power signals from an instrument range that is located on the Raytheon property approximately 1,000 feet from the roof. The low-power signals used for this test will also be less than the above exposure limits. Approximately 66 tests will be performed over a 2 1/2 year period. Some tests are completed in just a few minutes, while others may continue for hours in order to reach the required test temperatures and allow the determination of the cumulative effect on the subsystems.

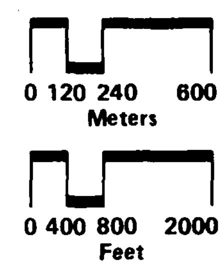
U. S. ARMY KWAJALEIN ATOLL

Upon completion of the testing at the Raytheon Company installation, the GBR components will be installed at the USAKA, RMI. The components to be tested at this location will be transported from the United States by air and water and assembled on top of and inside of Building 1500, situated at the western end of Kwajalein Island (Figure 1-8). Building 1500 is an existing structure that was originally built to hold a large radar, but is currently used for temporary storage. Installing GBR components will require structural improvement of Building 1500, including the construction of an internal support tower and foundation to support the gravity, wind, dynamic, and seismic loads acting on the radar (Figure 1-3). A radome and supporting structure will be installed on the roof of the building to shelter the radar. Within Building 1500, electrical power substations, power distribution equipment, air conditioning and ventilating units, and compressed air and fire protection equipment will be installed on various floors. Computer facilities, office space, a mission control room, and storage rooms will be constructed within the building, and an elevator will be added in a shaft extending through the existing roof to provide access to the radar unit. Additional modifications will be required for utilities, communications, fire protection, security, and air conditioning. A temporary structural frame will also be built outside and next to Building 1500. The frame will be built under the largest and heaviest GBR component (the turret) in order to raise the turret 32 meters (106 feet) to the level of the top of the building. This temporary frame will be removed after the turret is installed on top of Building 1500.

The GBR equipment must also be connected to existing power and utility lines. This involves connecting a 400-foot potable water line to an existing line, connecting a 2,000-foot non-potable seawater line to an existing line, and placing 7,000 feet of underground electrical feeder lines as shown in Figure 1-9. In addition, a 1,500-gallon septic tank with distribution box and associated drain field will also be constructed. Soil will be temporarily placed along one side of each of the utility line right-of-ways during construction. Although approximately 60 percent of the construction will take place in previously disturbed areas created by the placement of fill material, construction of these trenches in areas other than landfill may result in exposing skeletal and/or material remains associated with the Marshallese habitation or the World War II battle for Kwajalein Island. The installation of the power, and utility lines and the septic tank and associated drain field, have the potential for cultural resource impacts. The impact of the construction activity will be mitigated by an archaeological monitoring, sampling, and data recovery program to be implemented during construction. The scope of work for this program is being coordinated with the Historic Preservation Officer (HPO) of the RMI, and any comments will be incorporated into the program prior to construction.



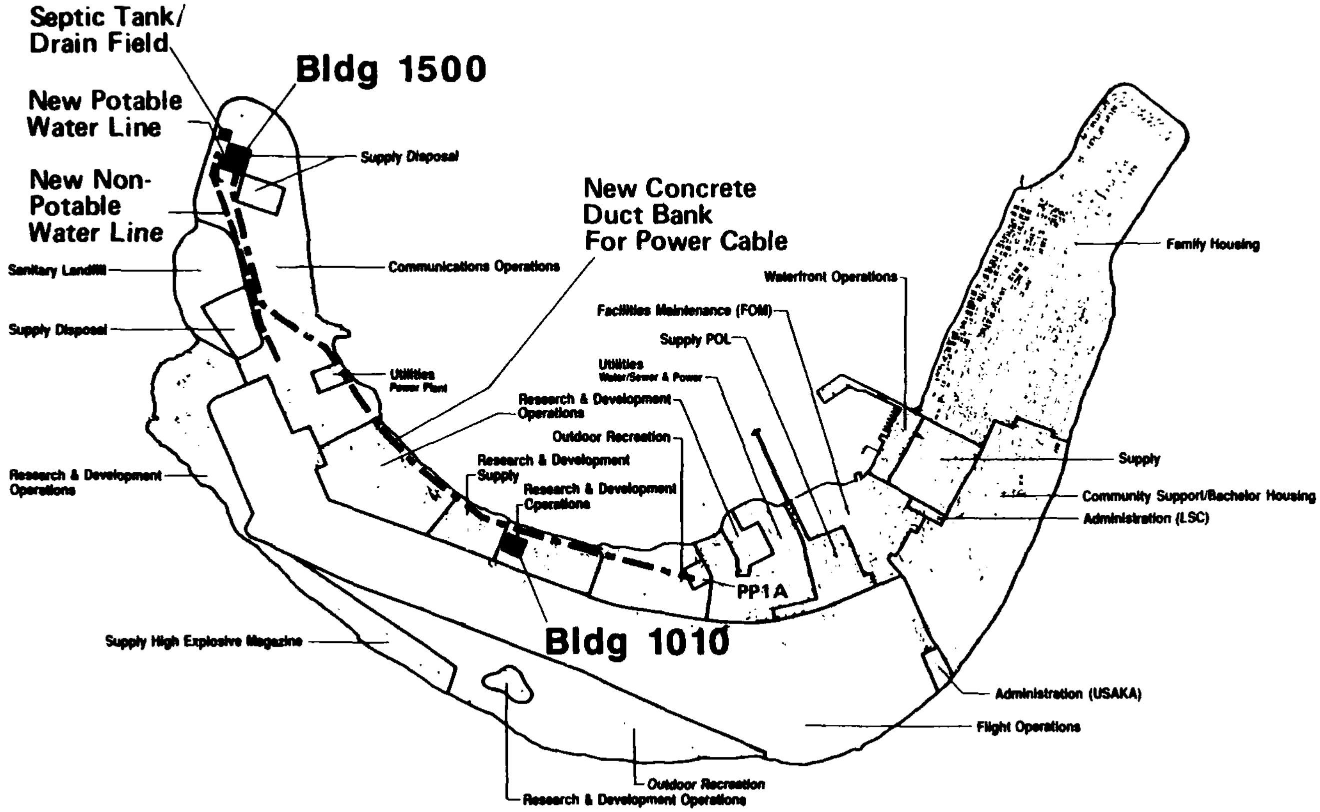


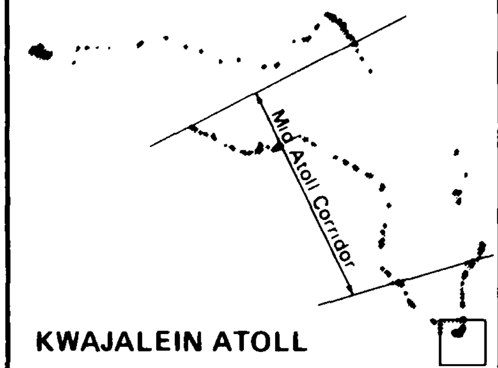


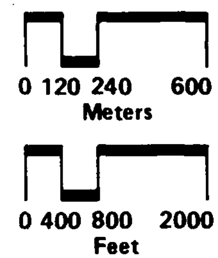
Reference: US Army Kwajalein Atoll (Draft) Master Plan 1988

Ground-Based Radar Facility Location, Kwajalein Island, USAKA

Figure 1-8







Reference: US Army Kwajalein Atoll (Draft) Master Plan 1988

New Water and Power Lines to Building 1500, for Ground-Based Radar, Kwajalein Island, USAKA

Figure 1-9

Sensors to record EMR exposure levels will be sited in the vicinity of the GBR at locations, where possible, to maximize the use of available structures, power sources, and previously disturbed areas for placement of sensor equipment and utilities. If construction of trenches for these utilities becomes necessary, the disturbance of a new area may have the potential for cultural resource impacts, but will be mitigated as described in the above power and utility connection discussion.

A USAKA Digital Microwave System (DMS) terminal is located on Kwajalein Island. This radio equipment supports a Kwajalein Island - Meck Island link and a Kwajalein Island - Ennylabegan Island link. The USAKA DMS terminal consists of the multiplex equipment in Building 1010 (Figure 1-8) and the radios and antennas at Building 1500. Two fiber-optic transmission lines connect the multiplex equipment to the radio equipment at Building 1500. Because the GBR unit will be located on top of this building, the communications equipment at Building 1500 will have to be relocated because GBR construction and operation will interfere with their operations.

The proposed relocation of the DMS radios and antennas was coordinated with USAKA in accordance with existing or planned land use on Kwajalein Island. In order to minimize land use impacts, a previously disturbed area near Building 1010 will be used for construction of the antenna tower. The final tower configuration/orientation will be based on line-of-sight communication requirements, airfield clearance criteria for USAKA, and continuing electromagnetic compatibility analysis as discussed below. Because Building 1010 houses the multiplex equipment needed to interface with the radios, only about 6 meters (20 feet) of fiber-optic cable will be needed to connect the equipment within Building 1010 with the relocated radios.

Once installed, GBR components and assemblies will be re-tested, both as individual items and as an integrated radar system; this testing will include re-testing critical elements of support equipment as well. After integration testing, a series of system tests using known satellites and balloon-launched calibration spheres will demonstrate and quantify performance prior to entering into total system performance (validation) testing. Component assembly and testing at the USAKA is expected to last approximately 12 months, with a planned start during the second quarter of 1992 (83).

Safety of the GBR operation will be verified before it is fully utilized. The GBR is being designed to ensure that personnel are not exposed to EMR power densities exceeding 5 mW/cm^2 (32.25 mW/in^2) averaged over a 6-minute period. To insure that exposure levels are in accordance with the above standard, the following positive actions will be taken in GBR design and testing:

- Main beam radar power densities will be controlled by establishing a minimum beam elevation limit of 2 degrees above horizontal for normal operations of the LFOV and FFOV antennas. If, during FFOV antenna operations (without the LFOV), the radar beam is required to go below an elevation of 2 degrees to gather data on the splashdown of impacting objects or to assist in range operations, the radar will operate at a low duty cycle of no greater than 0.2 percent (contrasted with a maximum duty cycle of 20 percent) so that the resulting power densities will not exceed permissible exposure levels. Computer operating rules will be incorporated into the main data processor to assure that RF power densities are in accordance with prescribed safety standards. The controls implemented in the computer operating rules are such that permissible exposure limits will not be exceeded at heights less than 6 meters (20 feet) above water or land surfaces or below the height of any existing structures.

- Power densities from antenna grating and side lobes from the LFOV antenna will be controlled by implementing the following two procedures, based on analytical predictions of the power density patterns from the grating and side lobes in relation to the main radar beam. First, computer operating rules will be incorporated into the main data processor to assure that RF power densities are in accordance with prescribed safety standards. Before each mission, simulations will be used to verify the adequacy of the computer operating rules. Second, a separate computer will be used to make explicit, real-time calculations that will automatically inhibit GBR radiation, ensuring that specific segments of land and sea are not subject to RF power densities that exceed the specified limits.

- To insure personnel safety and eliminate the need for a controlled access zone, independent evaluations by Raytheon Company and USAKA safety personnel will verify the GBR design's ability to control power densities on land and sea. Testing will be supported by sensors placed in the vicinity of the GBR. To insure personnel exposure limits are not exceeded, testing will proceed in a step-by-step manner, initially using low duty-cycles to perform limited radar operations. Only when measurements successfully verify the predicted operational conditions will increases in power levels for testing be allowed.

To insure the safety of aircraft personnel, aircraft activity within the 278 km (173 mile) range of the control tower at Kwajalein Island will be coordinated with GBR test activities, USAKA operations, and control tower personnel in order to avoid GBR operations. In addition, safety measures will include the publishing of an appropriate Notice to All Airmen (NOTAM), which reflects the need for special coordination between the aircraft control tower and approaching aircraft.

Initial indications show the mitigations for controlling possible human exposure will reduce any impact of the GBR electromagnetic fields on possible fuel hazards or inadvertant detonation of EEDs or ordnance. Potential hazards from fuel ignition or inadvertent detonation of explosives and ordnance will be examined by calculating the potential EMR levels at the locations involved (hot pads, meteorological rocket launcher, fueling points, etc.) and comparing the EMR levels with all applicable safety criteria. Before activities involving the use of explosive devices and/or fueling operations during GBR activities, measurements will be taken at the selected sites using the USAKA Mobile Radio Frequency surveillance system. If measurements indicate a potential hazard, operational constraints will be implemented to eliminate that potential hazard by coordinating USAKA and GBR operations.

EMR generated by the GBR could potentially interfere with existing emitters and communication systems at USAKA: avionics, communications, and navigation aids on USAKA and transient aircraft as well as communications and navigation aids on lagoon shipping. Additionally, EMR could potentially interfere with air traffic navigation aids (Tactical Air Navigation and Non-Directional Beacon) at USAKA Bucholz Army Airfield. A preliminary electromagnetic compatibility (EMC) analysis by the Electromagnetic Compatibility Analysis Center (ECAC), Annapolis, MD, was performed in January 1989 (82) to determine what interferences could exist. The final analysis will be completed by May 1989 and will recommend any corrective actions, if needed. The National Telecommunications and Information Administration (NTIA) will evaluate the corrective actions before allocating a frequency assignment through the DOD. Only when these corrective actions are coordinated with USAKA and procedures are in place to incorporate them, can the frequency assignment allocation be granted by NTIA.

Operation of the GBR at USAKA for this component/assembly testing will require large amounts of electrical power. The maximum anticipated demand load (during either component/assembly or full validation testing) is 4.1 megawatts (MW), which includes power for the building and all supporting equipment as well as power supplied to the radar. Dedicated electrical power generation will not be provided for GBR. The new Power Plant 1A, now under construction, will increase the existing capacity of 18.3 MW by 10 MW for a total of 28.3 MW. Installation of 7,000 feet of new electrical feeder lines will connect GBR equipment at Building 1500 to Power Plant 1A (Figure 1-9), scheduled to be operational in mid-1990. This power generation upgrade should satisfy anticipated new users, including GBR, and increases capacity and reliability for current users (81). The component/assembly activities on USAKA will require a maximum permanent support staff of 48 engineers and technicians (2nd quarter of 1992 through 1st quarter of 1993), plus 57 dependents. A maximum of 24 transient engineers and technicians will also be required to support the Demonstration/Validation activities on USAKA. Existing facilities will be utilized to house these additional personnel (78).

HILL AIR FORCE BASE

Component/Assembly tests at Hill AFB will involve the refurbishment of three Minuteman I three-stage missiles that will be used for dedicated launches from Vandenberg AFB to support the GBR program. This refurbishment for GBR will be a part of an ongoing routine operation for providing refurbished Minuteman missiles. Minuteman I refurbishment is a multistage process. Refurbishment procedures include removing and inspecting the nozzle for cracks; reworking the thrust termination ports and igniter port; verifying nozzle alignment; overhauling actuators, motors, and pumps; installing operational raceway covers; physically inspecting the throat, cone, and housing on all stages; X-raying the nozzle boot; and conducting numerous electrical tests (41, 42). Solvents, in quantities of less than 30 milliliters (less than one ounce), are used in this process; explosive safety quantity-distances (ESQDs) have been established around the missile maintenance areas (40, 41). Approximately 15 personnel are involved in the refurbishing process, which takes place in the refurbishing bays of Building 2114. This procedure is a routine operation for Hill AFB; no additional personnel or modifications to the existing facilities will be required (41).

1.4.4 Validation Testing

Validation testing is that portion of the program that involves real-world conditions. GBR validation testing evaluates the ability of the radar system to operate using actual reentry vehicles as targets at a distance and in a time mode that duplicates the expected operational conditions.

Table 1-1 delineates the type and location of each validation test, all of which are scheduled at the USAKA. As part of the target discrimination and acquisition and real-time signal processing validation demonstrations, GBR will take advantage of targets of opportunity launched from Vandenberg AFB/Western Test Range, as well as utilizing three dedicated launches from Vandenberg AFB. These validation activities are described in more detail below.

U. S. ARMY KWAJALEIN ATOLL

GBR validation testing at USAKA will test the ability of the total radar system to demonstrate correct waveform generation, test unique software, evaluate response to thermal and environmental stresses, and check the maintainability of the overall system. It will, as well, evaluate discrimination schema performance and demonstrate target acquisition and signal processing.

GBR validation testing at USAKA will have the same requirements for equipment, facilties, and personnel as component/assembly testing. Validation testing is expected to take approximately 6 months (2nd quarter 1993 through 3rd quarter 1993).

VANDENBERG AIR FORCE BASE/WESTERN TEST RANGE

Validation testing for GBR will involve the use of targets of opportunity launched for other programs from Vandenberg AFB. In addition, three dedicated Minuteman I missions will be launched in support of the GBR program. These dedicated launches, which will occur over a 6-month period, will use Minuteman I missiles from Hill AFB, where they will be refurbished as previously described.

After the missiles are delivered to Vandenberg AFB, they will be transported to the Destruct Package Installation Facility (DPIF), where the inflight destruct system will be installed. The missiles will then be delivered to Launch Facility 03 (LF-03), which is the only facility at Vandenberg AFB currently capable of launching the Minuteman I missile. This launch facility consists of a launch tube, a bi-level launch equipment room, and a launcher equipment vault. The missile instrumentation, range safety system, and payload deployment system will be assembled in Building 6523 and then installed on the missile at LF-03 (136).

Approximately 15 existing personnel will be required over each 30- to 40-day Minuteman launch cycle; an additional 10 contractor personnel will be required for payload assembly (136). Because these types of launches are routine for Vandenberg AFB, no additional permanent personnel and no facility modifications are required for GBR activities (136).

1.5 ALTERNATIVES OTHER THAN THE PROPOSED ACTION

No other alternative locations were considered reasonable for the proposed action because it was desired to maximize the use of existing programs and facilities in order to minimize cost and to minimize the potential environmental impacts of new construction.

The Raytheon Company, Equipment Division, was selected as a result of the competitive procurement process. They proposed use of their Wayland, MA, facility for GBR testing since these facilities are routinely utilized for similar fabrication, assembly, and test activities.

Hill AFB was chosen as the site of rocket motor refurbishment in order to take advantage of an ongoing Minuteman I refurbishment program at Hill AFB.

Falcon AFB was the only reasonable site for simulation activities due to previous SDIO selection of the NTF as the focal point for all SDIO integrated simulations.

Demonstration of the ability of the GBR to acquire, track, and discriminate ICBM payload objects during the midcourse (exoatmospheric) and terminal (endoatmospheric) phases of the trajectory requires realistic targets on a time line with viewing geometries that represent real-world conditions. The Western Test Range is the only available range that provides these conditions. The selection of Vandenberg AFB as the target launch site was based on taking advantage of the existing Minuteman I Launch program for dedicated targets and of other ongoing programs for targets of opportunity.

The selection of USAKA as the location for the GBR was based on the fact that USAKA is the primary downrange splashdown zone for ballistic missiles launched in the Western Test Range. Given the necessary use of the Western Test Range for testing realism, USAKA is the only reasonable location for the GBR because of the need to locate the radar at the terminus of the target trajectory and because of the need to rely on existing programs to provide target objects. Within USAKA, siting of the radar on Kwajalein Island was done because such siting provides the best viewing geometries for the vast majority of possible targets with minimal impact on radar design (tracking rates, field-of-view, etc.) and also minimizes the possible impacts of new construction. Use of other USAKA locations would result in less advantageous viewing geometries, more serious land use impacts, major new construction requirements (i.e., a new power plant and technical facilities), and major transportation requirements (daily inter-island transport).

On Kwajalein Island, two sites were determined feasible. Both sites were on Building 1500, an existing structure at the western end of the island. Location on the top of Building 1500 was selected over the alternative location at the first roof level, 13 meters (42 feet) above ground level, because the former allows less restrictive operation and has the potential for greater utility as a range safety radar after completion of GBR testing.

1.6 NO-ACTION ALTERNATIVE

The no-action alternative is to continue with Concept Exploration activities, as defined in Section 1.1, without progressing to the Demonstration/Validation stage at this time. Failure to progress to the Demonstration/Validation phase could result in an expanded, restructured program and cost increases. The no-action alternative would preclude timely validation of GBR technology and risk the loss of important information required for future decisions regarding an SDS.

2.0 AFFECTED ENVIRONMENT

The test activities of the GBR Demonstration/Validation program and the installations where they would be conducted were identified in Section 1.0. Section 2.0 describes the environmental setting of each installation in terms of physical and operational characteristics, permit status, and previous environmental documentation. Specific physical characteristics include installation size, support and test facilities, and environmental and public health and safety conditions. Operational characteristics include the socioeconomic variables of staffing, payroll, and housing; the characteristics of the surrounding communities; and the infrastructure characteristics of electricity, solid waste, sewage treatment, transportation, and water supply. Referenced permits are those that relate to air quality, water quality, and hazardous waste. Previous environmental documentation includes records of environmental consideration, EAs, and environmental impact statements.

For each of the installations that will be used in the program, available literature such as EAs, environmental impact statements, and base master plans was acquired and data gaps (i.e., questions that could not be answered from the literature) were identified. To fill the data gaps, all of the installations were visited and follow-up telephone calls were made to installation personnel. Information collected through site visits and telephone interviews and other appropriate references are presented in the list of References, Section 7.0. The following subsections describe the environmental setting of each of the installations where Demonstration/Validation activities are planned.

Ten broad environmental attributes were considered and addressed to (1) provide a context for understanding the potential effects of the proposed action and (2) to provide a basis for assessing the significance of any potential impacts. The data presented are commensurate with the importance of the potential impacts, with attention focused on the key issues. These areas of environmental consideration are (1) air quality, (2) biological resources, (3) cultural resources, (4) hazardous waste, (5) infrastructure, (6) land use, (7) noise, (8) public health and safety, (9) socioeconomics, and (10) water quality.

Several of these broad environmental attributes are regulated by Federal and/or state environmental statutes, many of which specifically set standards (see Appendix B). These Federal- and/or state-mandated standards provide a benchmark that aids in determining the significance of environmental impacts under NEPA. Where mandated standards do not exist, qualitative evaluations were made. The ten areas of environmental consideration are discussed briefly below.

Air Quality - Air quality at each installation was reviewed with particular attention paid to background ambient air quality compared with the primary National Ambient Air Quality Standards and whether the installation was located in an attainment or non-attainment area. Existing air emissions sources at each installation were evaluated to determine compliance with the emissions standards contained in the associated State Implementation Plan. Possible new air emissions sources, such as those associated with expansion of facilities and new construction, were evaluated using the New Source Performance Standards (see Appendix B).

Biological Resources - Existing flora and fauna at each installation were reviewed with particular attention paid to the existence of any protected species, and Federal- and state-listed threatened or endangered species, to determine if there were any significant biological resources in proximity to the facilities that could be affected by test activities.

Cultural Resources - Existing cultural and historical resources at each installation were reviewed with particular attention paid to known National Register of Historic Places sites and Native American sacred sites to determine if there were any significant cultural resources in proximity to the facilities that could be affected by test activities.

Hazardous Waste - Existing hazardous waste management practices and the record of compliance were reviewed to determine the installation's capability to handle any additional wastes and to determine any potential problems with hazardous waste use, handling, treatment, or disposal.

Infrastructure - Electricity, solid waste, sewage treatment, water supply, and transportation are examples of infrastructure requirements that ultimately limit the capacity for growth. Capacity and current demand were examined for each installation.

Land Use - Base master plans, environmental management plans, and other documentation were reviewed to determine any known conflicts between each installation and any planned expansions that could be affected by GBR test activities.

Noise - Existing environmental documentation was reviewed to determine if noise concerns were an issue at any of the installations.

Public Health and Safety - Existing environmental documents were reviewed to determine if public health and safety concerns were an issue at any of the installations, including RF radiation at Kwajalein Island, USAKA.

Socioeconomics - Key socioeconomic indicators (population, housing, employment, and income data) for the supporting region of each installation were examined to evaluate the potential consequences of increased population, expenditures, and employment.

Water Quality - Water quality concerns at each location were identified and the installation's record of compliance with permits was examined.

The following sections present a brief description of each installation where GBR Demonstration/Validation test activities are planned. The text emphasizes the affected environment - that is, the nature of the environmental characteristics that may be changed by the proposed action - and includes detailed information only where it is relevant to understanding the potential impacts. Appendix C contains tables with more detailed descriptions of each installation's physical and operational characteristics, permit status, and additional environmental information.

2.1 RAYTHEON COMPANY, EQUIPMENT DIVISION

Raytheon Company, Equipment Division, is located in Wayland, Massachusetts, 24 kilometers (15 miles) west of Boston (Figure 2-1). This installation existed at the time the support contract was awarded for GBR. Approximately 10,000 people are employed by Raytheon Company, Equipment Division, in Wayland, MA, some 200 of whom will be involved in GBR activities (32). The facilities where these 200 individuals will work already exist, house many other activities (governmental and commercial), and require no modification or refurbishment for the planned GBR activities (33).

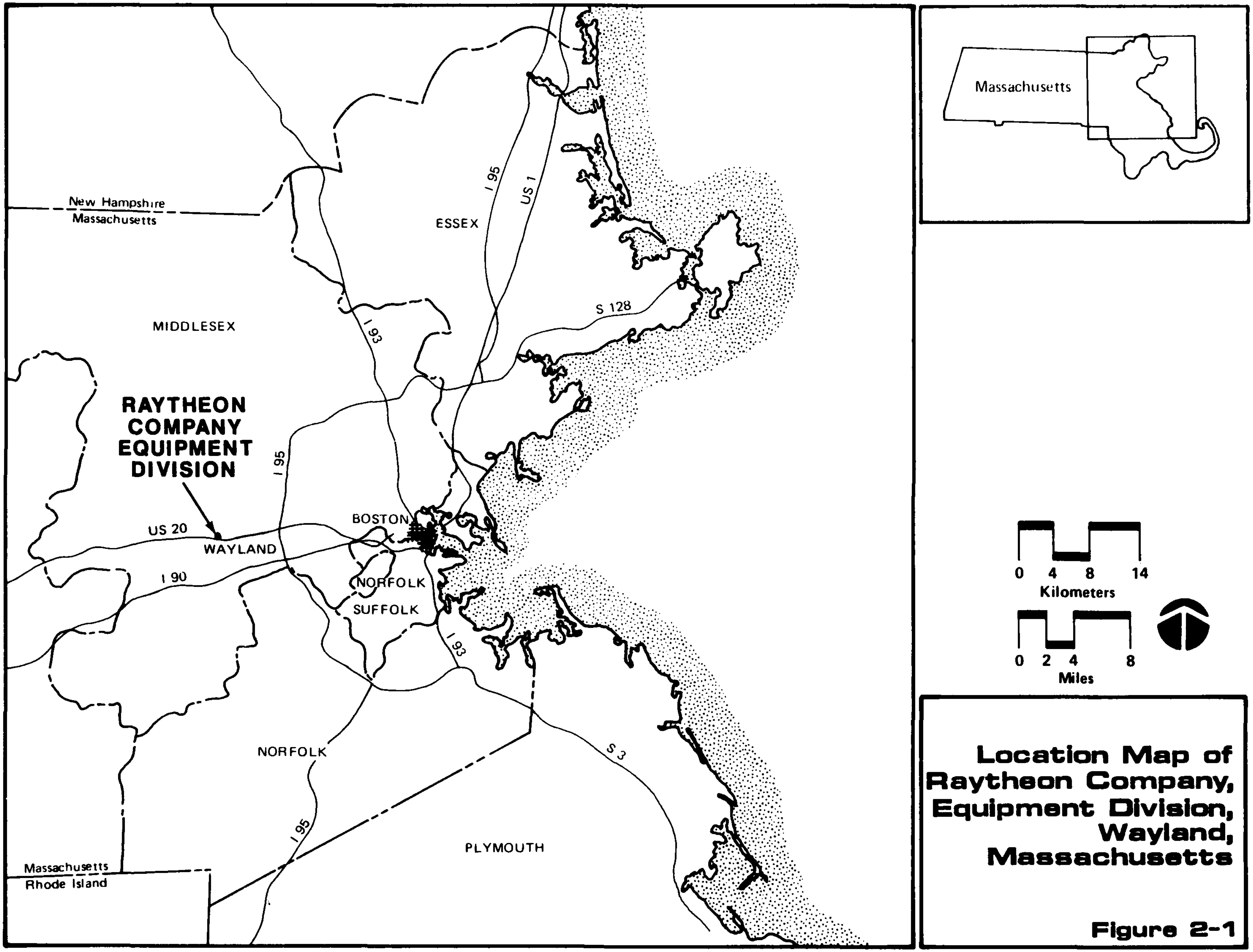
The Raytheon Company, Equipment Division, possesses all applicable Federal, state, and local permits and authorizations necessary for operation of the Wayland installation as part of the conditions of the GBR contract (37). All Federal and state approvals required for specific GBR test activities will be obtained at the appropriate time using established procedures.

There are no known Federal- or state-listed threatened or endangered species, and there are no recorded historic or archaeological sites. No public health and safety issues have been identified, and noise is not an issue. Installation infrastructure is primarily supported by the adjacent municipalities; demand is well within capacity (35). Land use is in accordance with the local zoning ordinances (35). The surrounding communities in the Boston metropolitan area have a combined population in excess of 2.7 million.

2.2 HILL AIR FORCE BASE

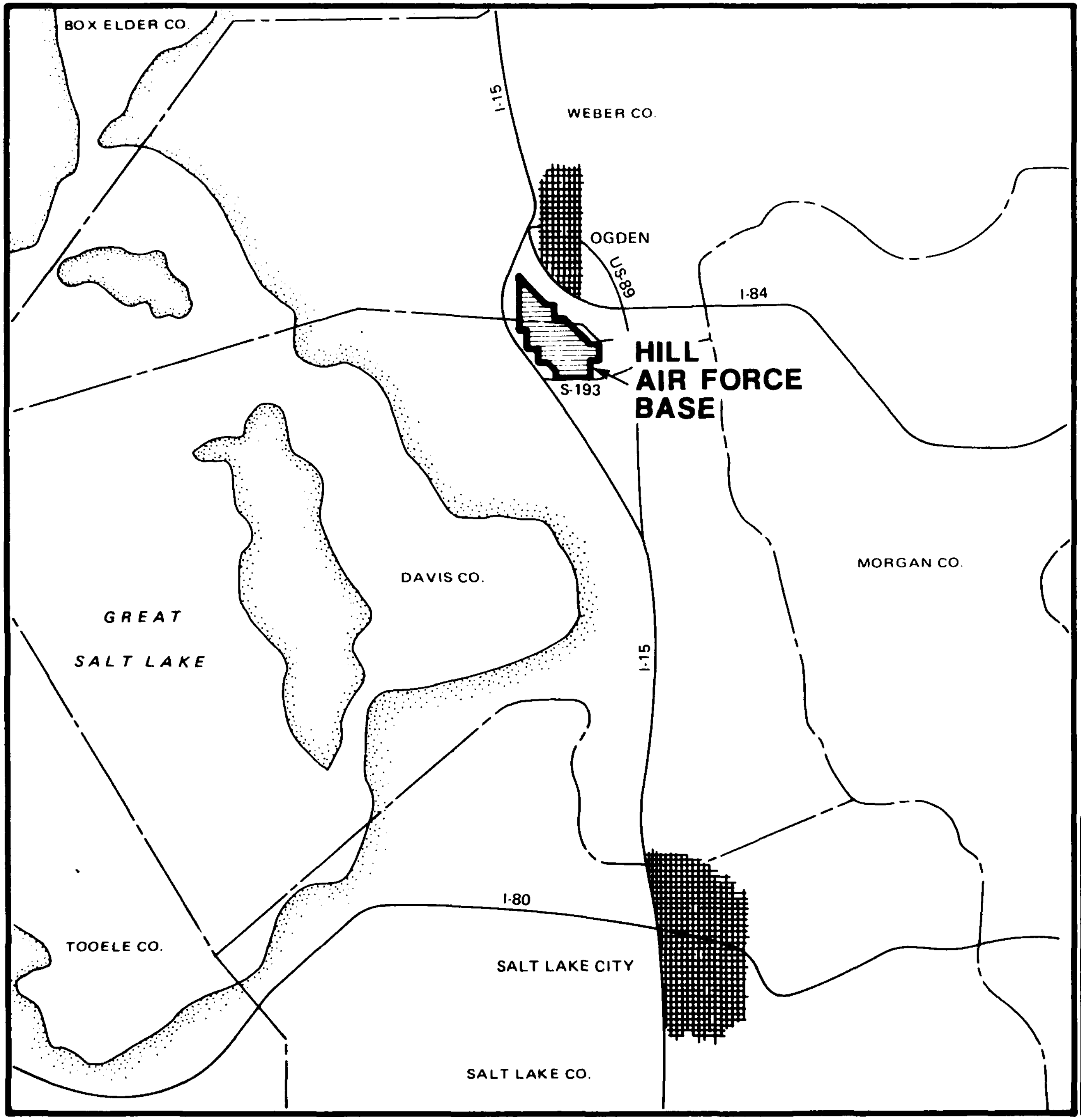
Hill AFB is 8 kilometers (5 miles) south of Ogden, Utah (Figure 2-2). The base furnishes logistics support and system management for Minuteman and Peacekeeper missiles, laser and electro-optical guided bombs, F-4 and F-16 aircraft, air munitions, aircraft landing gear, and photographic and aerospace training equipment. The base also manages the Utah Test and Training Range (2). A description of Hill AFB and its environment is presented in Table C-1, Appendix C.

The installation complies with Federal standards for water quality and air quality, although Hill AFB is located within a non-attainment area for ozone and carbon monoxide (40, 61). The base was placed on the National Priorities List on October 9, 1984 for potential threat of hazardous waste (55). The listing currently cites ten areas of hazardous waste disposal that cover a total area of 22 hectares (54 acres). The base is participating in the Installation Restoration Program (IRP), which identifies, evaluates, and controls the migration of hazardous contaminants from hazardous waste sites (54, 55). Two Federally listed threatened and two endangered species occur in the area; one of the endangered species (the bald eagle) has been sighted at the base (44, 60). No known cultural resources exist (61). Facility infrastructure (Figure 2-2) is generally adequate (56, 60, 61), and land use is in accordance with the Base Master Plan (40). Noise levels are consistent with air base operations with specified attenuation goals (40, 58); no significant public health and safety issues have been identified. The surrounding communities in Davis and Weber counties have a combined population of 340,000 (11, 12).



Location Map of Raytheon Company, Equipment Division, Wayland, Massachusetts

Figure 2-1



Location Map of Hill Air Force Base, Utah

Figure 2-2

2.3 NATIONAL TEST FACILITY, FALCON AIR FORCE BASE

The National Test Facility is under construction at Falcon AFB in El Paso County, Colorado, about 19 kilometers (12 miles) east of Colorado Springs (Figure 2-3) (68). An interim facility is operating out of the existing Consolidated Space Operations Center, also at Falcon AFB. The present mission of the Consolidated Space Operations Center is to provide support for military space operations through communications centralization and data link operations (14).

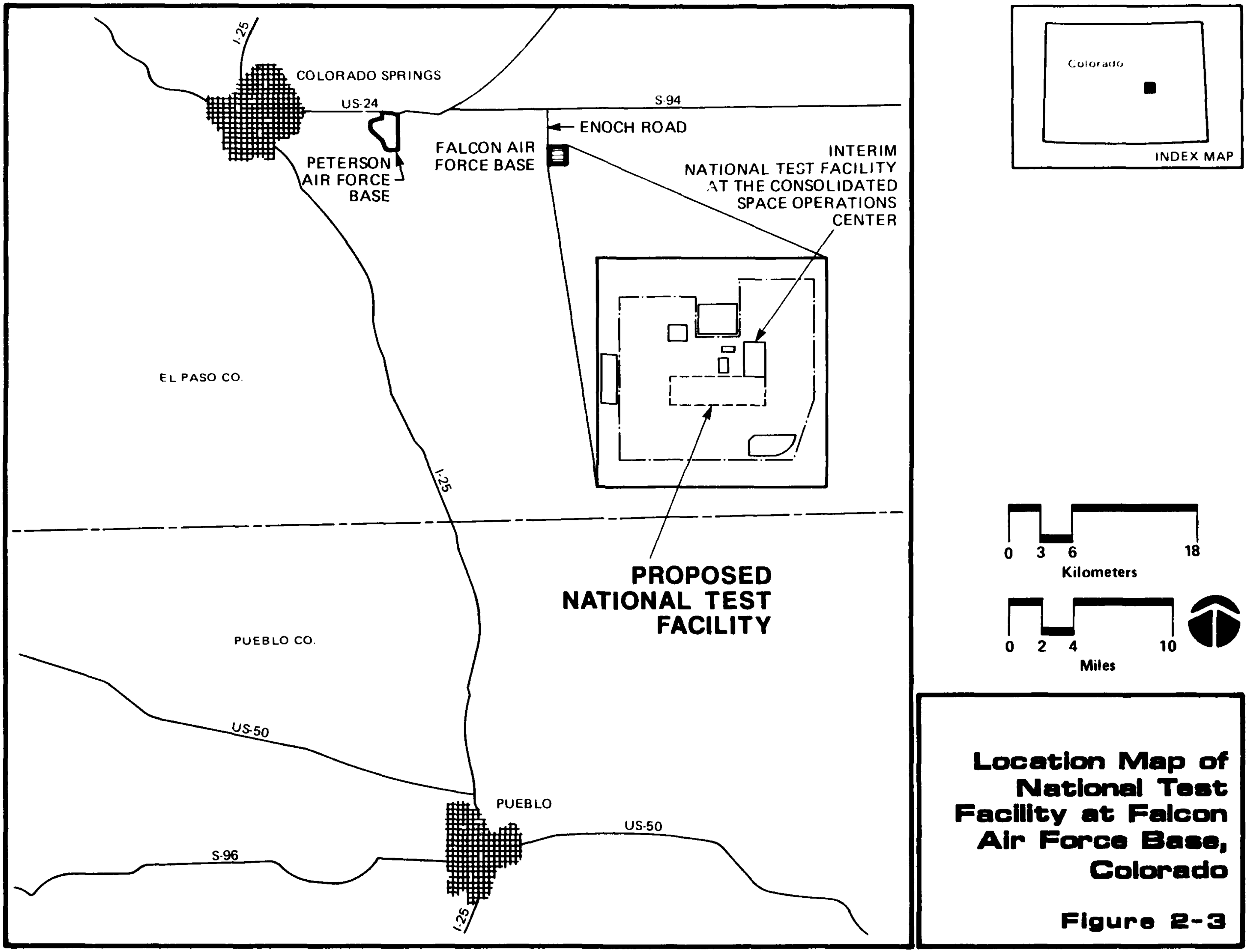
The Consolidated Space Operations Center was built to house the Satellite Operations Center and the Space Shuttle Operations Center (66). The former performs command, control, and communications service functions for orbiting spacecraft. The latter conducts DOD Shuttle flight planning, readiness, and control functions. The interim National Test Facility is located at the Consolidated Space Operations Center because adequate support facilities are available (67). The permanent location of the National Test Facility will be next to the Consolidated Space Operations Center; construction should be complete in late 1989 (65). A description of the National Test Facility, Falcon AFB, and its environment is presented in Table C-2, Appendix C.

Falcon AFB, including the Consolidated Space Operations Center and the proposed location of the National Test Facility, is in compliance with Federal standards for air quality, water quality, and hazardous waste (65, 68, 69, 70, 72). No known threatened or endangered species exist on the base, and no significant cultural resources have been identified (68). Installation infrastructure demands overall are within capacity (65, 68, 69, 70), and no land use or zoning conflict issues have been identified. Noise levels are within acceptable limits, and no significant public safety and health issues have been raised (65, 68, 70). The surrounding communities in El Paso County have a combined population of 380,000 (11, 12).

2.4 U.S. ARMY KWAJALEIN ATOLL

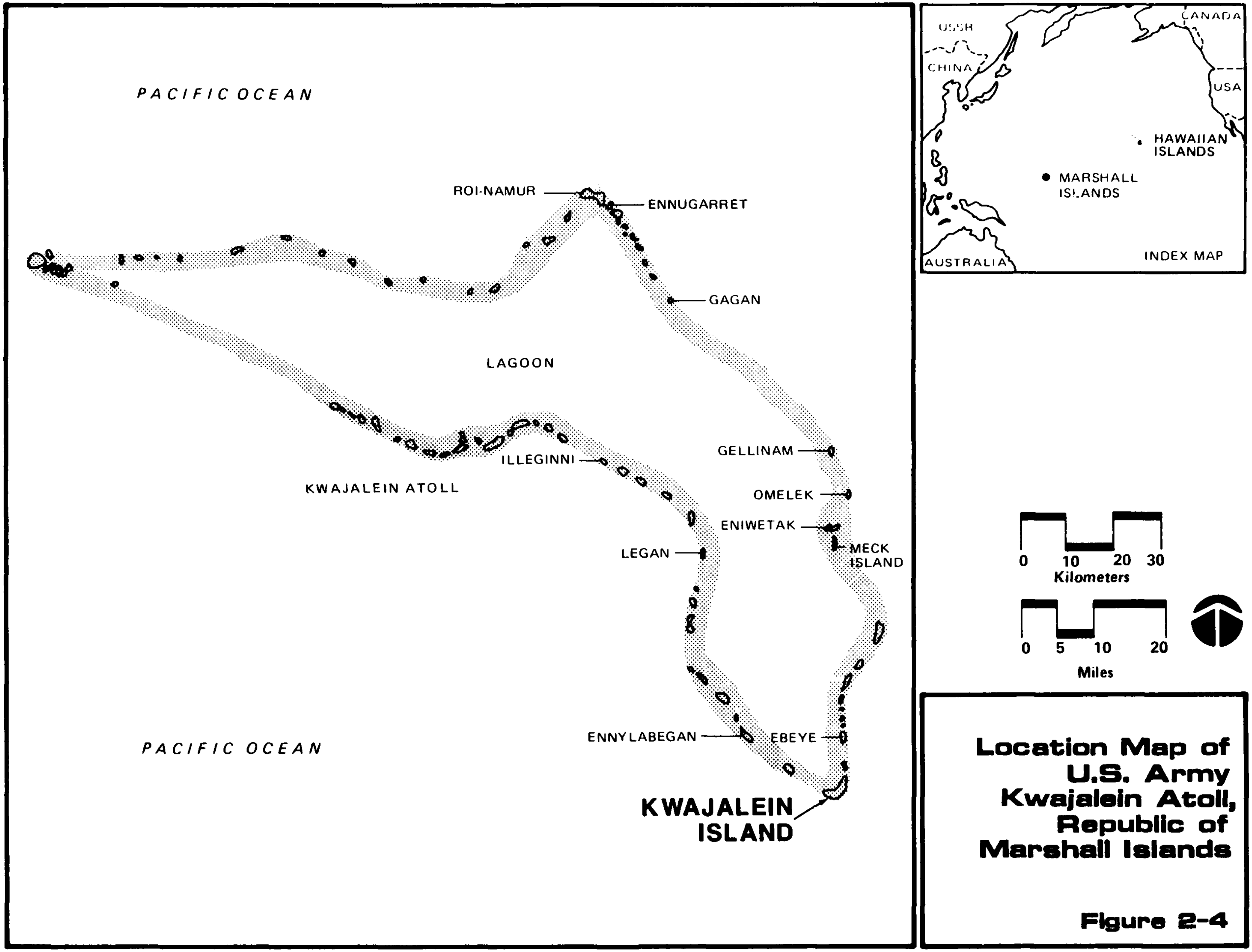
U.S. Army Kwajalein Atoll is a northern atoll within the Ralik Chain in the western part of the RMI, in the west-central Pacific Ocean southwest of Hawaii (Figure 2-4). The Marshall Islands were previously administered by the United States under a strategic trust established by the United Nations (89). The Compact of Free Association between the United States and the RMI (U.S. Public Law 99-239) was bilaterally implemented by the signatories on October 21, 1986. The Compact created the sovereign nation of the RMI. Additionally, the Compact provides that the United States, in the conduct of its activities in the RMI, will continue to comply with standards embodied in the United States Federal environmental statutes: in particular, the Endangered Species Act, Clean Air Act, Clean Water Act, Ocean Dumping Act, Toxic Substances Control Act, and the Resource Conservation and Recovery Act.

Kwajalein Atoll consists of a very large interior lagoon (2,850 square kilometers [1,100 square miles]) surrounded by approximately 100 component islands/islets. USAKA includes eleven leased islands (Kwajalein, Roi-Namur, Ennylabegan, Meck, Gagen, Gellinam, Omelek, Eniwetak, Legan, Illiginni, and Ennugarret) and a Mid Atoll Corridor. This corridor and the islands/islets it includes has certain restrictions on access during range up-time for safety reasons. All USAKA-leased islands, except Ennugarret, have facilities on them. United States citizen populations are located on Kwajalein and Roi-Namur. Marshallese resident populations are located on several islands within the atoll. However, all are outside the Mid Atoll Corridor.



Location Map of National Test Facility at Falcon Air Force Base, Colorado

Figure 2-3



Location Map of U.S. Army Kwajalein Atoll, Republic of Marshall Islands

Figure 2-4

The primary mission of USAKA is to support missile flight testing for DOD research and development efforts. Technical facilities on USAKA include multiple launch facilities and numerous supporting elements such as tracking radar, optical instrumentation, satellite communications, and telemetry stations (90). A description of the installation and its environment is presented in Table C-3, Appendix C.

Efforts are currently underway to establish permits in the areas of NPDES (132), ocean dumping (84), and point source air emissions (94). Studies have been initiated to assess waste management practices and potable water quality. A Hazardous Waste Management Plan has been issued and is currently being implemented. These efforts are sufficient to bring Kwajalein Island and the other islands under USAKA control into full compliance (94). Noise is not a problem (104, 132). One Federally listed endangered species, the Hawksbill turtle, and one threatened species, the green sea turtle, have been observed off the southwestern end of Kwajalein Island (113). In compliance with the Fish and Wildlife Coordination Act and the Endangered Species Act, the GBR project will be coordinated with state and Federal agencies. The project description was submitted to the U.S. Fish and Wildlife Service. This correspondence is included as Appendix D. There are some known prehistoric sites on Kwajalein Island, and the entire island is listed as a World War II battlefield on the National Register of Historic Places (96, 97, 104). The Kwajalein Battlefield is, as well, a National Historic Landmark (95).

The installation's infrastructure demands are within capacity (84, 90, 104, 113, 126, 132). Fresh water is readily available during the rainy season (normally June through November); however, during the dry season, fresh water consumption exceeds the amount of rainfall obtainable from catchments. In order to not deplete the supply of stored water from which day-to-day needs are drawn, it is necessary to obtain fresh water by extracting it from lens wells or by distilling sea water. Current projects are underway to improve water treatment capabilities and allow supplemental water supplies through desalination. Land use is in accordance with the installation's Base Master Plan (104). As an island dedicated to military missions and populated by United States residents, the normal concept of describing the surrounding community's ability to support and absorb project-related immigration is not valid. Military and contractor personnel and their dependents are not allowed to reside on the island unless approved housing is available. Construction of new housing units for the families of United States personnel was addressed in a 1986 study by the United States Army, and construction of additional housing units is underway (115). During the August site visit and early data contacts, potential concerns were identified regarding GBR's effect on cultural resources, land use, and public health and safety. For this reason, additional background regarding these topics is presented in the following paragraphs.

2.4.1 Cultural Resources

Cultural resource impacts could occur as a result of the power and utility lines trench construction needed to connect the GBR equipment to existing power and utilities. A 1,500-gallon septic tank with distribution box and associated drain field will also be constructed. The sensors needed to record EMR exposure levels will be sited in the vicinity of the GBR at locations, where possible, to maximize the use of available structures, power sources, and previously disturbed areas for placement of sensor equipment and utilities. Archaeological and historic resources on Kwajalein date from circa 350 BC. Although little archaeological and cultural exploration has been done on the island, the possibility exists for both prehistoric period resources (350 BC to 1500 AD) and historic period resources (1500 AD to present). The potential for cultural resource impacts do not exist on the entire island; since 1944, the island's size has been considerably enlarged by dredging and filling at its west and north ends and along its lagoon side (Figure 2-5).

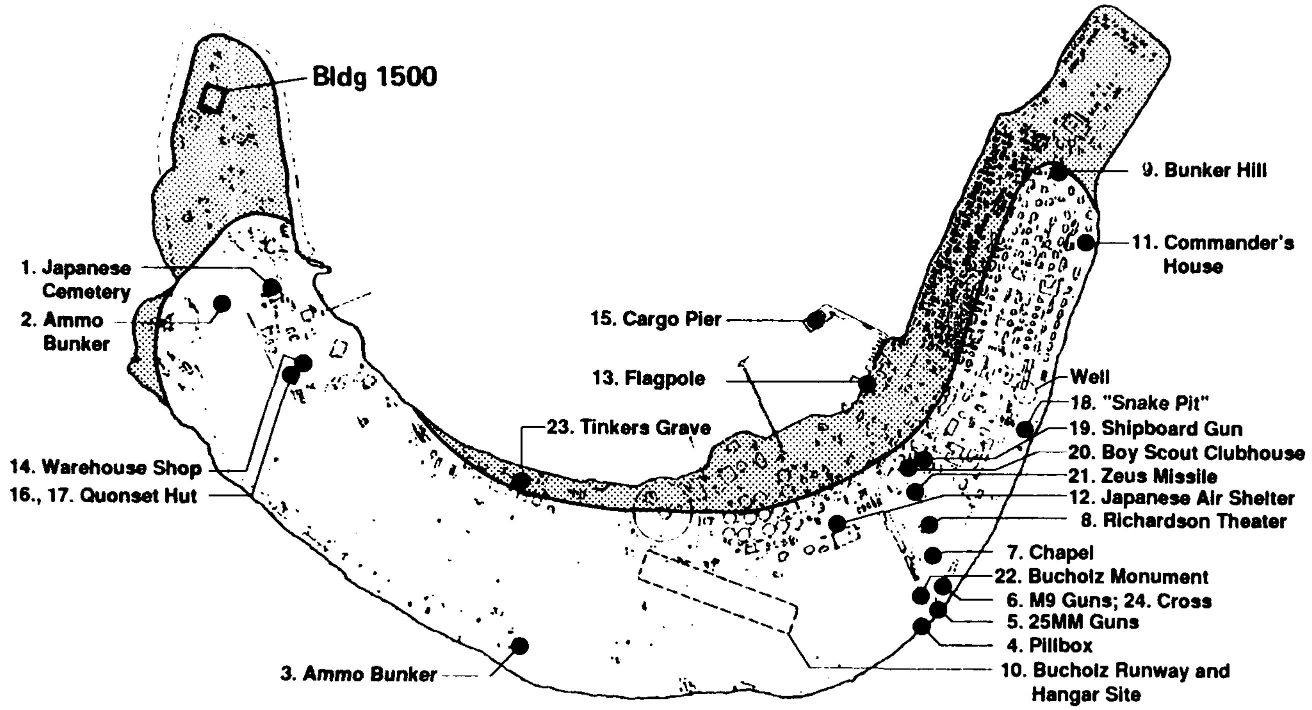
Possible prehistoric resources include permanent living sites, subsistence sites, and temporary occupation-exploitation sites (104). Possible historic resources could include sites and artifacts from various Spanish explorers of the 16th century, and from the German and Japanese occupation periods of 1870 to 1914, and 1914 to 1944, respectively. The main study areas that have been examined for archaeological resources are located on the present taxiway and aircraft maintenance hanger sites, and along a saltwater-lined trench that parallels Ocean Road on Kwajalein. Some of the archaeological and historical findings on Kwajalein are shown in Figure 2-5 and described in Table 2-1. The Kwajalein Island Battlefield is listed on the National Register of Historic Places for its military significance in 1944 (96, 97, 104) and is also listed as a National Historic Landmark (95).

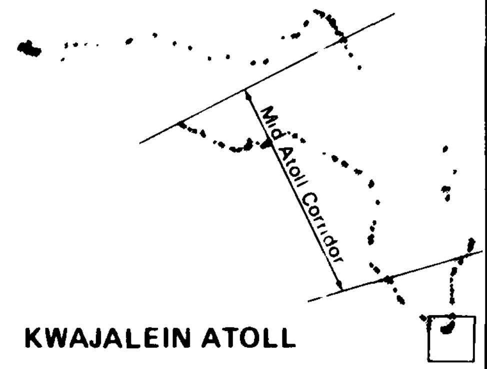
2.4.2 Land Use

Occupied building height restrictions around the radar unit has been identified as a potential impact to land use as a result of GBR activities. At the present time, the majority of existing structures on USAKA are less than three stories (11 meters [36 feet]) in height and there are no current plans to construct or modify existing structures to heights greater than five stories (18 meters [60 feet]). Existing land use on Kwajalein Island falls into three principal categories: (1) housing/community services on the eastern end of the island, (2) air operations in the center of the island, and (3) research and development (range operations) in the center and western end of the island (Figure 2-6). These land use categories are described below.

The housing/community services area is subdivided into a family housing area, a community support/bachelor housing area, an administration area, and a supply area. The family housing area located on the northeast quadrant of the island consists of approximately 128 permanent concrete block structures, which contain 259 family units, and 254 temporary trailers primarily located on the lagoon edge of the family housing area. Additionally, 24 townhouse structures consisting of 136 family units are under construction in the family housing area. The community support/bachelor housing area consists of support facilities (entertainment, medical/dental, shopping, etc.) just south of the family housing area and unaccompanied personnel housing (eight bachelor quarter buildings, a transient billeting facility, and six temporary trailers [90, 104]). None of these occupied buildings is more than three stories high, approximately 11 meters (36 feet).

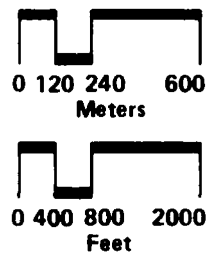
The air operations area in the center of the island consists principally of Bucholz Field's runway, connecting taxiways, and apron pavements, along with several buildings dedicated to airfield operations (104). The tallest occupied structure in this area is the USAKA Administration Building with the control tower on top, which is approximately 21 meters (70 feet) high. The aircraft maintenance hanger is also in the air operations area and is 19 meters (65 feet) high; the majority of buildings in the air operations area are less than 11 meters (36 feet) high.





EXPLANATION

- ARCHAEOLOGICAL SITES
- HISTORIC SITES
- NEW LAND CREATED BY DREDGING AND FILLING



References: Modified from US Army Kwajalein Atoll (Draft) Master Plan 1988
National Register of Historic Places Inventory Nomination Form/ Kwajalein Island Battlefield, 1984

Existing Archaeological and Historic Resources, Kwajalein Island, USAKA

Figure 2-5

TABLE 2-1. KWAJALEIN ARCHAEOLOGICAL AND HISTORIC RESOURCES

ARCHAEOLOGICAL

1. From a cultural layer, two charcoal samples that date back to A.D. 40 to 355 and to 140 B.C. to A.D. 255, respectively.
2. Charcoal flecks.
3. Fauna remains (possibly those of a turtle).
4. Possible remnants of a taro swamp.
5. A shell weaving implement.

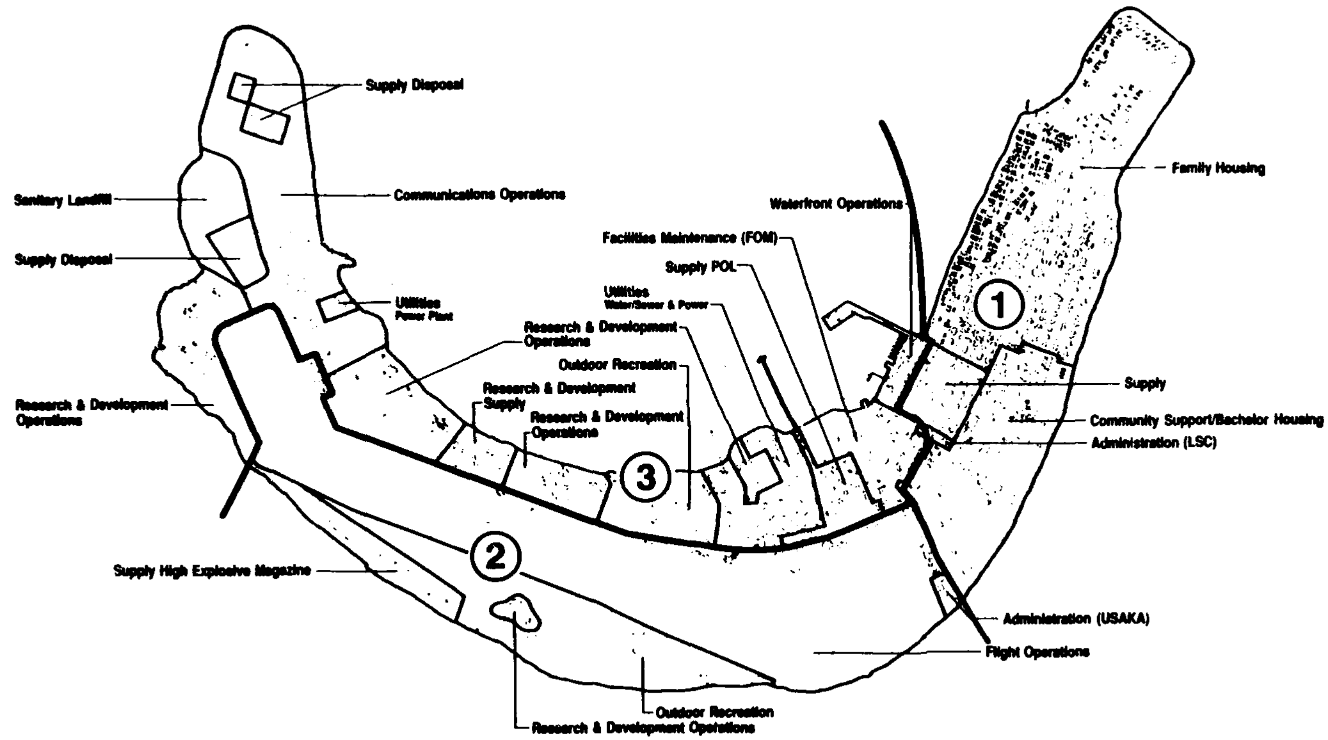
Source: Shun & Athens 1987:7-12

HISTORIC RESOURCES

1. A Japanese cemetery built in 1969--a reminder of Kwajalein's Japanese defense.
2. 7th Infantry Division landing monument/ammo storage bunker--this is one of the few Japanese fortifications that still stands on Kwajalein. It is a monument to the 7th Infantry Division landing.
3. Ammo storage bunker (adaptive reuse as weather satellite antenna)--this is a uniquely structured ammo bunker (a vaulted constructed and having a window in the ammo room that is case-matted).
4. Beach defense fire control post pillbox--this is the only example of a fire control post on Kwajalein. The structure possibly could have been moved to this locale at an earlier time.
5. 25 mm AA gun emplacement.
6. Two 3" M-9 field guns (Rock Island arsenal, 1943).
7. Island Memorial Chapel--this structure was built in 1944 to 1945. The chapel, along with the commander's house and a shed of the Richardson Theater are the only three structures that have survived since that period under American presence. The chapel has been dedicated to the men who gave their lives in the fight for Kwajalein.
8. Richardson Outdoor Theater--of the structure, the stage and screen/restroom elements date from 1945.
9. "Bunker Hill", 12.7 cm AA dual purpose type 89 gun position--some believe that this flag raising site marked the final victory of Kwajalein, although this has not been confirmed.
10. Bucholz Army Airfield Runway--current runway marks the approximate position and location of the previous Japanese runway, taxiway, and apron.
11. Commander's house, Building 241
12. "Japanese Air Shelter" at fuel tank farm.
13. Marina Beacon Flagpole.
14. "Warehouse Shop" Butler-type building (S-1309)
15. Cargo Pier--built by the Japanese in 1944.
16. Quonset Hut (S-1336).
17. Quonset Hut (S-1337).
18. Ocean View Club, "Snake Pit"--built in 1945, this cultural landmark on Kwajalein has been recommended for Inclusion in the National Register of Historic Places.
19. Shipboard gun, static display.
20. Boy Scout Clubhouse. (No longer in existence)
21. Zeus Missile.
22. Bucholz Monument--this monument has been erected for PFC Bucholz, who died during battle on Kwajalein on February 4, 1944.
23. Tinker's Grave and Monument.
24. Cross.

Source: Duane Denfeld, 1981:22-32

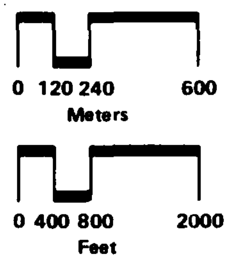
U.S. Army Kwajalein Atoll (Draft) Master Plan 1988



EXPLANATION

LAND USE CATEGORIES

1. HOUSING/COMMUNITY SERVICES
2. AIR OPERATIONS
3. RESEARCH AND DEVELOPMENT



Reference: Modified From US Army Kwajalein Atoll (Draft) Master Plan 1988

Existing Land Use, Kwajalein Island, USAKA

Figure 2-6

Range operations, which comprise research, development, and communications operations, are conducted on the western end of the island and north of the air operations area on the lagoon side. Supply disposal and sanitary landfill sites are on the western tip of the island; the utilities (power plant and water/sewer), outdoor recreation, supply, maintenance, and waterfront operations are north of the air operations area on the lagoon side (Figure 2-5). Building 1500, at 32 meters (106 feet), is the tallest structure in the research and development area, with most of the buildings less than 11 meters (36 feet) high.

Land use will not be affected by the GBR modifications to Building 1500 or by relocating the DMS antenna to the already disturbed area near Building 1010. Restricted areas will be discussed in the public health and safety section below and are illustrated in Figure 2-7.

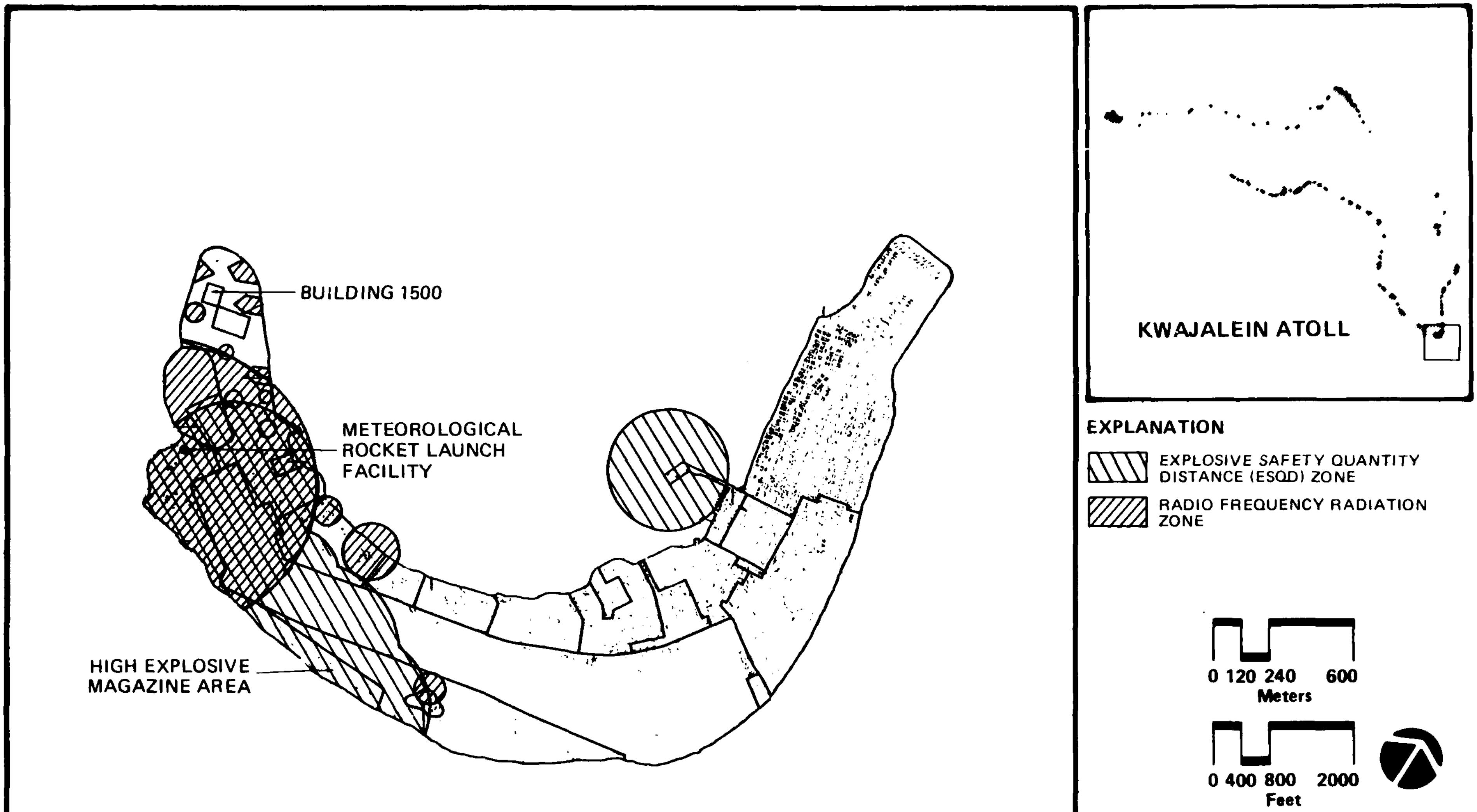
2.4.3 Public Health and Safety

Public health and safety areas of concern on Kwajalein Island, USAKA, have been identified for the island's explosive storage and launch facilities, the EMR environment, and aircraft restrictive zones. There are six explosive storage areas currently in use on Kwajalein Island; bunkers are located along the ocean shoreline, south of the runway. The meteorological rocket launch facilities are located at the western end of the island. The explosive storage and launch facilities and the aircraft restriction zones have explosive safety quantity-distance (ESQD) restrictive radii or clear zone spaces identified (Figure 2-7) (104).

Electromagnetic Radiation Environment - RF sources on USAKA are radar installations, microwave communications stations, and other communication equipment that emit electromagnetic radiation (EMR), such as high-frequency (HF) short-wave communication antennas. Protection standards and a listing of RF hazards are contained in USAKA Regulation 385-3 (January 9, 1989) (98). The restrictions (e.g., tower height, exclusionary zones) placed on the RF sources, in accordance with the USAKA Regulation 385-3 are such that the emitters create no hazard if activities on USAKA adhere to these restrictions. Figure 2-6 shows the RF radiation hazardous restriction areas. There are currently 17 identified sources of microwave and RF radiation on Kwajalein Island with RF hazard restrictions; these include HF communications and microwave communications (104); details are included below.

High-Frequency Communications: There are 11 HF communications antennas, which have a lower elevation height restriction of 11 meters (36 feet) above the ground surface. There is also a fenced electrical hazard area at the ground surface around each antenna. All of the HF antennas are on the northwest tip of the island, near Building 1500 (FN1500).

Microwave Communications and Other Systems: There are three sources of microwave emissions: the Command Control Transmitter (two antennas, at FN1062 and FN1011), with a hazard area radius of 112 meters (367 feet) and a lower height limit restriction of 4.3 meters (14 feet); the AN/FSC-78 Satellite Communications Transmitter (FN845), with a radiation hazard restricted to the interior of the radome; and the Global Positioning System (FN890), also with a radiation hazard restricted to the interior of the radome (104).



Reference: Modified from US Army Kwajalein Atoll (Draft) Master Plan 1988

Existing Radio Frequency Radiation Sources, ESQDs, and Their Restrictive Areas, Kwajalein Island, USAKA

Figure 2-7

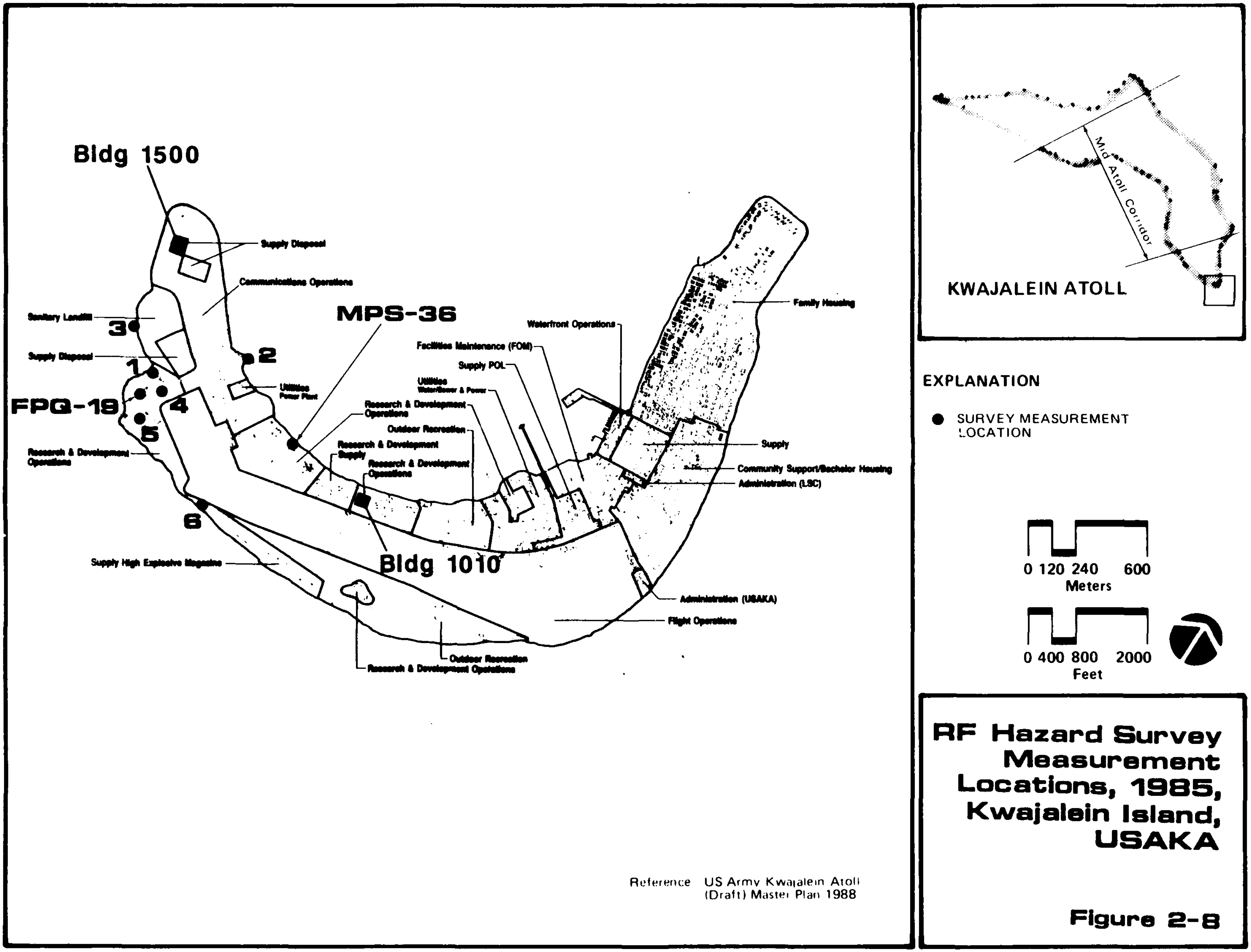
Kwajalein Island Radars: There are three RF radar systems currently operating on Kwajalein Island with hazard restrictions: FPQ-19 radar (FN1099) has a structural height restriction of 4.3 meters (14 feet) on top of the mound at the transmitter and a lower level restriction of 30 meters (98 feet) within a radius of 600 meters (1,968 feet); WRS-74S weather radar (FN907), on the golf course, has a height restriction of 4.3 meters (14 feet) within a radius of 51 meters (167 feet) of the transmitter; and MPS-36 radar (FN1040) has a height restriction of 4.3 meters (14 feet) within a radius of 110 meters (360 feet). The composite background RF power densities from the above emitters are presented in Table 2-2. The data were obtained from an RF hazard survey conducted at USAKA (80) and are representative of worst case background RF power densities levels produced when all existing RF emitters are simultaneously operating and directional emitters (radars) are pointed in the direction of the measurement location. The measurement locations are shown in Figure 2-8.

TABLE 2-2. BACKGROUND RF POWER DENSITY MEASUREMENTS

MEASUREMENT LOCATION	RF POWER DENSITY (mW/cm^2)	FRACTIONAL CONTRIBUTION TO PERMISSIBLE EXPOSURE LEVEL
1	0.178	0.036
2	0.050	0.010
3	0.050	0.010
4	0.050	0.010
5	0.146	0.029
6	0.065	0.013

As shown in Table 2-2, the worst case composite background RF power density measurement of 0.178 mW/cm^2 (1.15 mW/in^2) was obtained at location 1 of the sites measured and was less than 4 percent of the permissible exposure level.

The existing RF emitters on Kwajalein Island pose no personnel hazard at ground level due to the existence of the identified hazard restrictions and the incorporation of elevation and azimuth beam stops within the operating software. These stops ensure exposure to radiation levels remain well below the permissible exposure levels identified in the U.S. Army Environmental Hygiene Agency's Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation (8) (Appendix A). Verification of these stops/limits is part of the ongoing radiation protection program in existence on USAKA.



RF Hazard Survey Measurement Locations, 1985, Kwajalein Island, USAKA

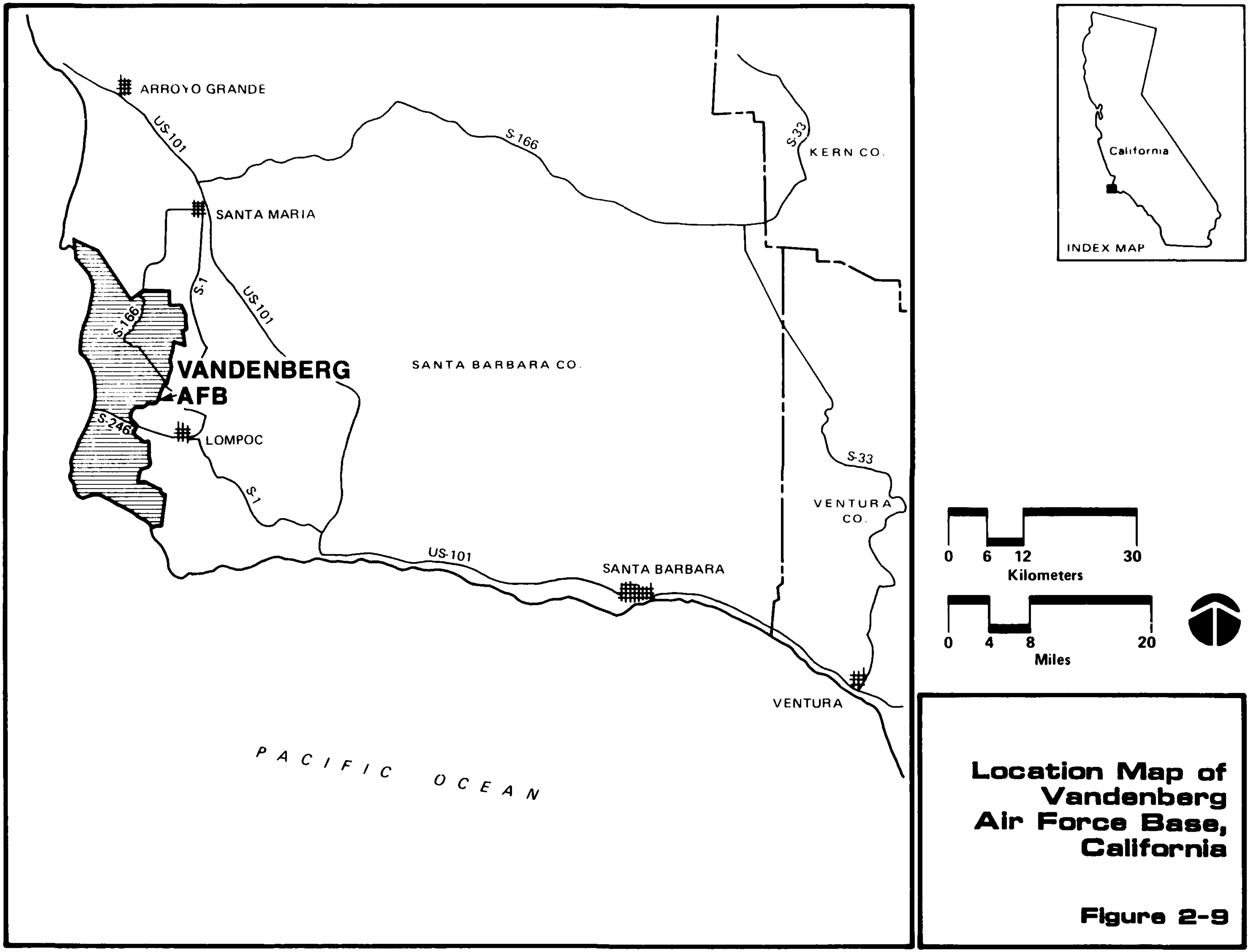
Figure 2-8

2.5 VANDENBERG AIR FORCE BASE/WESTERN TEST RANGE

Vandenberg AFB is on the coast of California about 89 kilometers (55 miles) northwest of Santa Barbara (Figure 2-9). As the third largest air base in the United States, it occupies approximately 39,800 hectares (98,344 acres) along 56 kilometers (35 miles) of Pacific coastline within Santa Barbara County (154). Vandenberg AFB is the Strategic Air Command's pioneer base and the headquarters of the 1st Strategic Aerospace Division and the Space and Missile Test Organization (154). Facilities house DOD, government, and civilian contractor personnel and provide the necessary support for missile test launches. Existing launch facilities are scheduled to test-launch ICBMs, including the Minuteman, Peacekeeper, and Atlas (145). Approximately 17 to 28 missiles are launched into the Western Test Range annually (136). A description of the installation and its environment is presented in Table C-4, Appendix C.

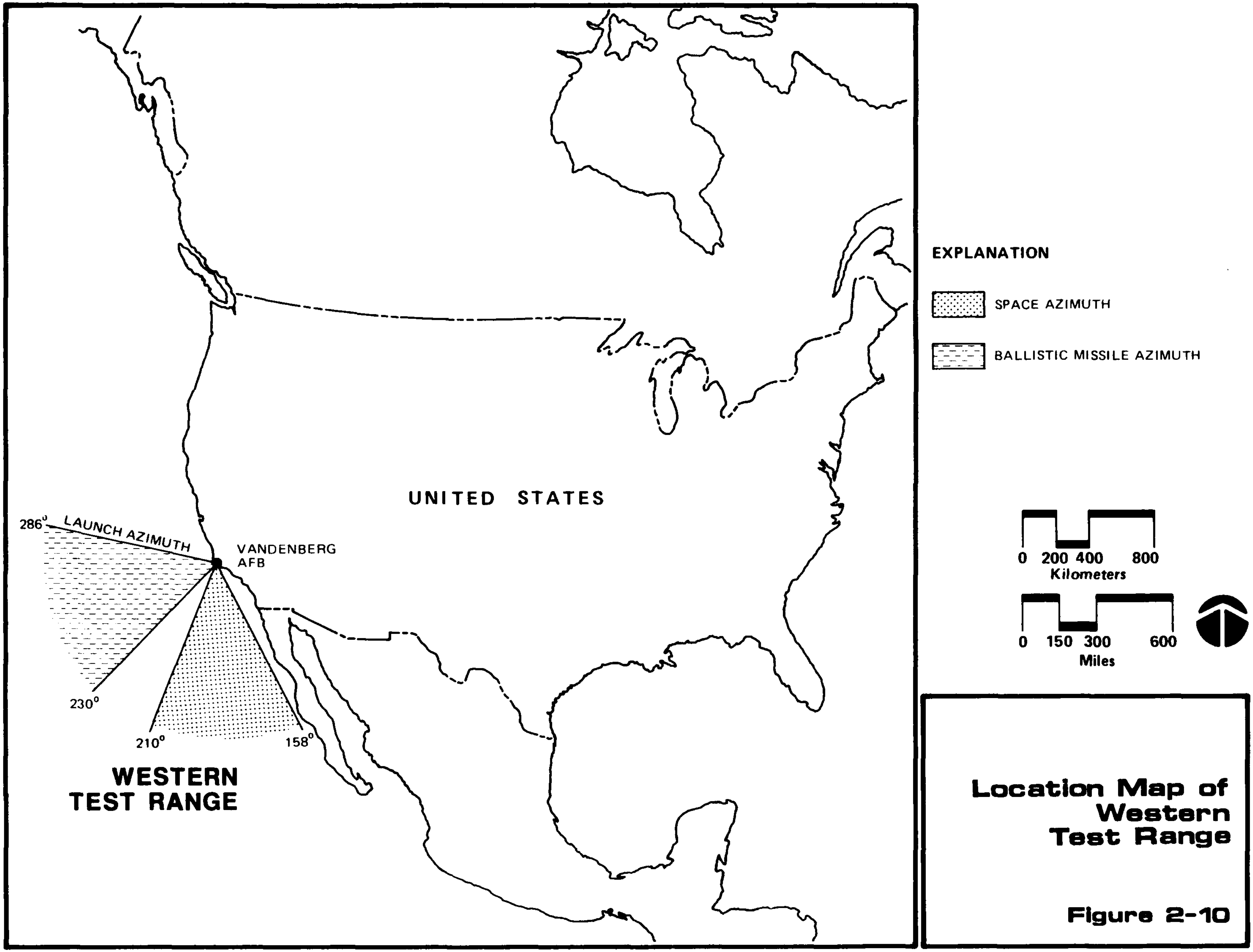
The Western Test Range includes a broad area of the Pacific Ocean that extends offshore from Vandenberg AFB on the coast of California (Figure 2-10) to the Indian Ocean. The range functions as the test area for space and missile operations. It includes a network of tracking and data gathering facilities throughout California, Hawaii, and the South Pacific, supplemented by instrumentation on aircraft (175). Only that portion of the range affected by a launch is usually activated; activation consists of instructing ships and airplanes to stay out of the affected area and either sheltering or evacuating people living in the activated area. Launch and spacecraft operations are monitored and supported by the Air Force Satellite Control Facility, the Consolidated Space Operations Center, and the MILSTAR Satellite Communication system.

Vandenberg AFB complies with all Federal standards for air quality, water quality, and hazardous waste (169, 170, 172, 173, 176). Recently, all of north Santa Barbara County (where Vandenberg AFB is located) was declared a nonattainment area for ozone and particulate matter. There are five Federally listed endangered and two threatened animal species on the base; there are no Federally listed threatened or endangered plants (146). There are many designated wetlands on the base (136). Over 600 known cultural resources, mostly archaeological sites, exist on the base (146); one of these is listed on the National Register of Historic Places, and others may qualify (161). Installation infrastructure demands are within capacity (136, 142, 146, 165, 166, 168, 173); however, water is supplied by on-base wells from two aquifers that are currently being overdrawn (146). Land use is in accordance with the Base Master Plan. Noise levels have not been identified as a problem, although they are monitored closely (143, 147); no significant public health and safety issues have been identified (147). The surrounding communities in Santa Barbara County have a combined population of almost 340,000 (11, 12).



Location Map of Vandenberg Air Force Base, California

Figure 2-9



Location Map of Western Test Range

Figure 2-10

3.0 ENVIRONMENTAL CONSEQUENCES

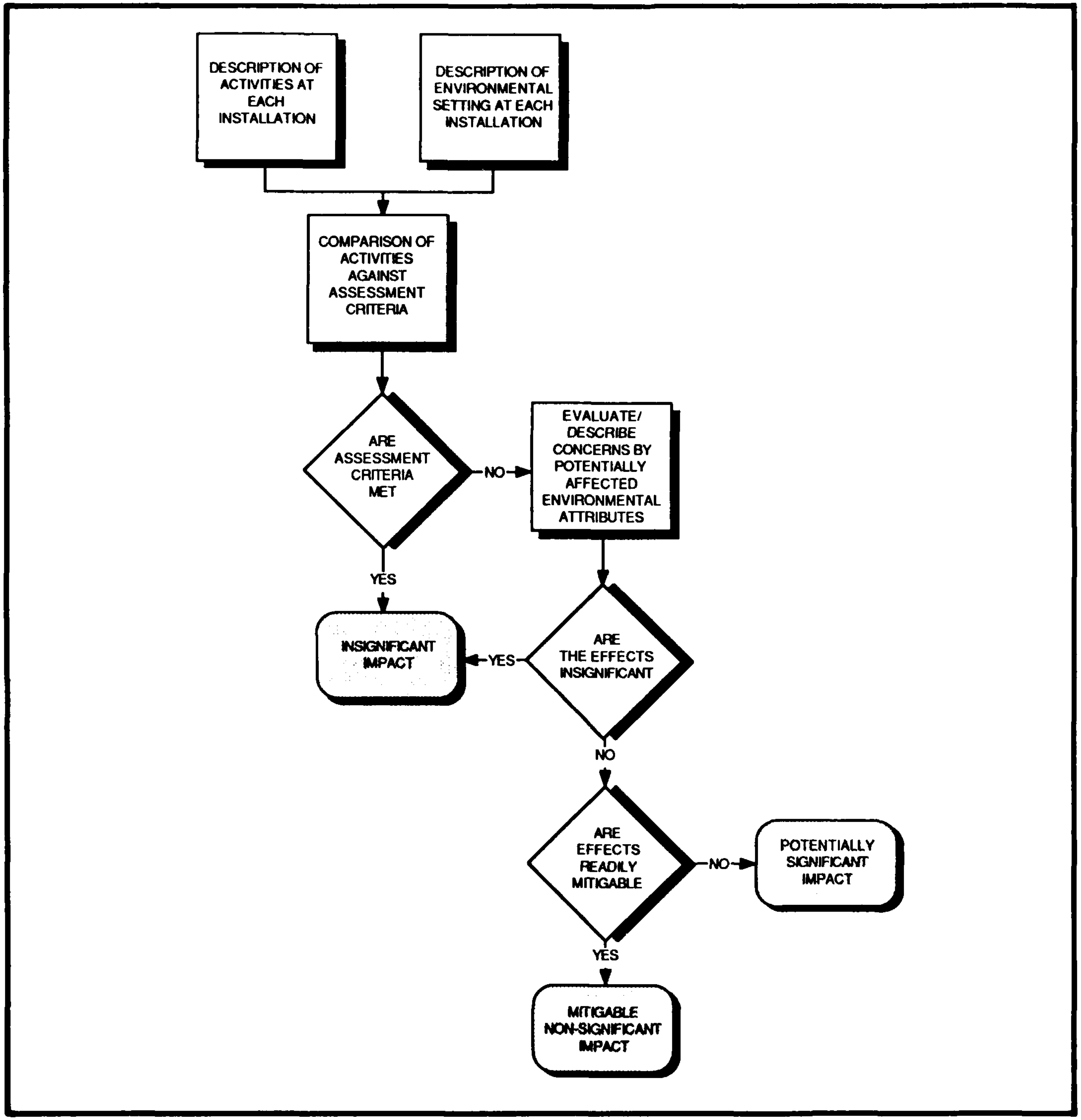
This section assesses the significance of potential environmental consequences of the proposed GBR Demonstration/Validation tests. It is based on a comparison of the test requirements described in Section 1.0 with the facilities to be utilized at proposed test locations and their affected environments, as described in Section 2.0. Any environmental documentation that addresses the types of activities proposed for the installations is incorporated by reference.

To assess the potential for and significance of the impacts from Demonstration/Validation activities for GBR at each installation, a two-step methodology was utilized (Figure 3-1). The first step was the application of assessment criteria developed by the EA team to identify activities deemed to present no potential for significant environmental consequences. Activities were deemed to present no potential for significant environmental consequences, provided they met all of the following criteria:

- The installation and its associated infrastructure are deemed adequate for the proposed activity (i.e., the tests can be conducted without new construction, excluding minor modifications)
- The current installation staffing is adequate to conduct the test(s), excluding minor staff level adjustments
- The resources of the surrounding community are deemed adequate to accommodate the proposed testing
- The activities do not threaten a violation of Federal, state, or local laws or regulations imposed for the protection of the environment (see Appendix B)
- The activities do not adversely affect public health or safety
- The activities do not adversely affect or result in the loss of unique environmental, scientific, cultural, or historical resources
- The activities are not highly uncertain and do not involve unknown risk
- The activities do not result in irreversible and irretrievable commitments of unique or important environmental resources.

GBR activities proposed for each installation were also reviewed against existing environmental documentation on current and planned actions, anticipated future projects, and existing conditions at each installation to determine the potential for cumulative impacts.

If a proposed Demonstration/Validation activity was determined to present a potential for impact (i.e., if one or more of the above criteria are not met), the second step in the methodology was implemented. In this step, the potential that the proposed activities would cause significant impacts was evaluated for one or more of the following broad environmental attributes: air quality, biological resources, cultural resources,



Method for Assessing Potential Environmental Consequences

Figure 3-1

hazardous waste, infrastructure, land use, noise, public health and safety, socio-economics, and water quality. As a result of that evaluation, consequences were assigned to one of three categories: insignificant, mitigable and non-significant, or potentially significant.

Environmental consequences were determined to be insignificant if, in the judgment of the preparers of this document or as concluded in existing environmental documentation of similar actions, no potential for significant environmental impacts exists. Consequences were deemed mitigable and non-significant if concerns exist, but it was determined that all potential consequences could be readily mitigated through standard procedures, or by measures recommended in existing environmental documentation. In this EA, mitigation includes: (1) avoiding the impact altogether by not taking action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or (5) compensating for the impact by replacing or providing suitable resources or environments. If consequences exist that could not be readily mitigated, the activity was determined to present potentially significant environmental impacts.

Subsection 3.1 provides a discussion of the potential environmental consequences for each location proposed for the GBR Demonstration/Validation program. The amount of detail presented in the following environmental consequences subsections is proportional to the potential for impacts. Subsections 3.2 through 3.8 end with a discussion of the following: environmental consequences of the no-action alternative; any conflicts with Federal, regional, state, local, or Indian tribe land use plans, policies, and procedures; energy requirements and conservation potential; natural or depletable resource requirements; adverse environmental effects that cannot be avoided; the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and any irreversible or irretrievable commitment of resources that would accompany GBR Demonstration/Validation activities.

3.1 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

3.1.1 Raytheon Company, Equipment Division

The GBR analysis, simulations, and component/assembly tests to be conducted at Raytheon Company, Equipment Division, will use several existing facilities to analyze test failures, demonstrate real-time waveform generation, test unique software, analyze the antenna's ability to survive environmental stress, and evaluate subsystem maintainability. This type of activity is routine at this installation and requires no additional personnel; thus, no infrastructure or socioeconomic impacts will occur. The installation is in compliance with environmental standards, and there are no significant biological or cultural resources (35, 37).

Raytheon complies with regulations issued by both the Massachusetts Department of Labor and Industries and the Massachusetts Department of Public Health (28, 29, 30) Testing inside the building includes component matching and assembly, physical alignment, and electrical continuity testing; this testing does not involve EMR generation. The rooftop testing, however, will involve the generation of EMR, within the Massachusetts' exposure limits, and will occur in a controlled environment that includes automatic door interlocks to prevent unauthorized entry to the roof during test activities. Massachusetts' laws regulate EMR testing, and a permit is required to ensure public safety. Antenna component tests will be conducted within the applicable guidelines established by the Commonwealth of Massachusetts (29) and the Federal Communications Commission (FCC). To gain civilian and military frequency approval for rooftop testing at Raytheon, Raytheon will complete DD Form 1494 and forward it to the USASDC, which will submit it to the Military Communications Electronics Board (MCEB) for test authorization (frequency allocation). The permits required in Massachusetts for component testing will be requested using established procedures. GBR component testing will be conducted within the approved testing range for similar tests routinely conducted at Raytheon.

Based on meeting all of the assessment criteria, the environmental consequences of testing for GBR are considered to be insignificant. GBR activities were reviewed against current and planned actions and anticipated future projects, and no cumulative impacts were identified as a result of the GBR testing (35).

3.1.2 Hill Air Force Base

The GBR activities at Hill AFB will involve the refurbishment of the Minuteman I motor systems. This activity is routine at Hill AFB, well within the capability of existing facilities, and requires no additional personnel (41); thus, no infrastructure or socioeconomic impacts will occur. The installation is in compliance with Federal standards for water quality and air quality, although Hill AFB is located within a non-attainment area for ozone and carbon monoxide (40, 61). Because the GBR activities at Hill AFB will not emit pollutants into the atmosphere and no additional personnel will be involved, GBR activities will not contribute to or exacerbate the current ozone and carbon monoxide problem.

Solvents will be used in the refurbishment of the Minuteman I motor systems, but the quantities are small (less than 30 milliliters [1 ounce]). Current waste handling activities are in compliance with IRP remedial actions and will not exacerbate the hazardous waste situation (54, 55). Similarly, although one endangered species, the bald eagle, has been sighted at the base (44, 60), GBR activities will be part of the routine mission of Hill AFB and will not pose any new or additional threats to the bald eagle.

Based on the above analysis, the environmental consequences of GBR activities at Hill AFB will be insignificant. GBR activities were reviewed against existing environmental documentation (43, 44, 47) on current and planned actions and anticipated future projects, and no cumulative impacts were identified as a result of the GBR activities.

3.1.3 National Test Facility, Falcon Air Force Base

The National Test Facility will be used for the storage, analysis, and application of data from validation tests of the GBR in simulation exercises. The functions of the National Test Facility in storing and utilizing data obtained from the GBR tests are consistent with its overall mission. Environmental effects of construction and operation of the National Test Facility are presented in the National Test Facility Environmental Assessment (68), which resulted in a Finding of No Significant Impact (FNSI).

Until the National Test Facility is constructed, the staff is operating in an existing interim facility, the Consolidated Space Operations Center at Falcon AFB. The environmental consequences of the proposed use of these existing facilities were addressed in a Request for Environmental Impact Analysis (67), which concluded that the action qualified for a Categorical Exclusion and that no significant impact to the environment would result.

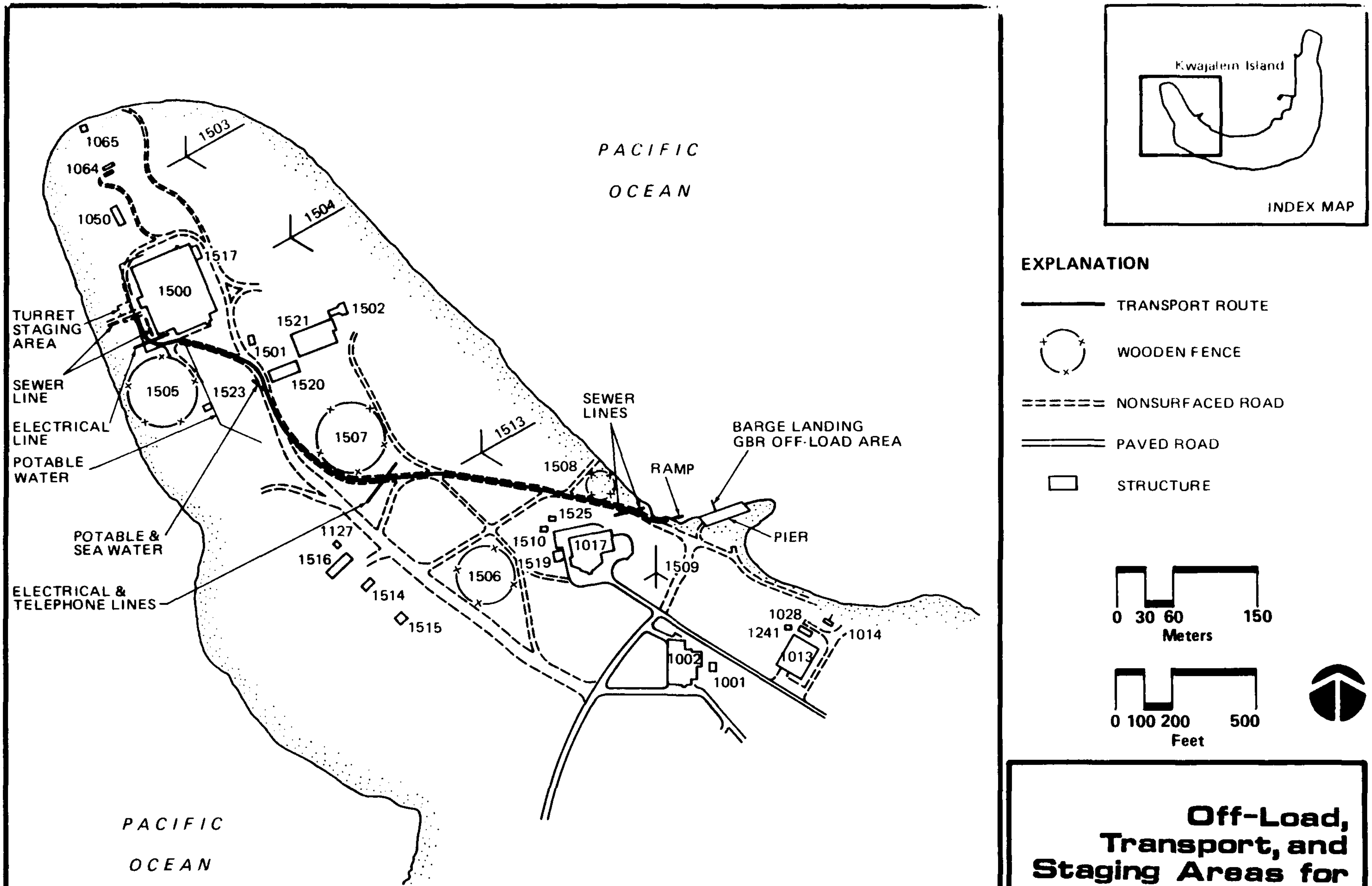
Because GBR testing will be part of the National Test Facility's overall SDI activities, which have already been assessed and found to have insignificant impacts, impacts from the GBR Demonstration/Validation activities are considered insignificant. GBR activities were reviewed against existing environmental documentation (66, 68) on current and planned actions and anticipated future projects, and no cumulative impacts were identified as a result of GBR testing.

3.1.4 U.S. Army Kwajalein Atoll

Analysis and validation testing to evaluate subsystem maintainability and antenna survivability, verify software and discrimination performance, and demonstrate target acquisition and tracking will be performed at USAKA. Use of the USAKA facilities is consistent with the current mission and operation of those facilities, but would also involve the unloading, transporting, and mounting of the GBR unit on the top of Building 1500 at the northwestern end of Kwajalein Island (Figure 3-2). The structural modifications required for Building 1500 (Figure 1-3), as well as provisions within the building for utilities, communications, fire protection, security, air conditioning, and air flow systems were addressed in a Record of Environmental Consideration (77), which determined that the action qualified for a Categorical Exclusion and that no significant impact to the environment would result.

Additional staff requirements over the scheduled two-year installation, checkout, component/assembly test, and validation test phases will peak at an estimated 48 engineers and technicians, with 57 dependents, plus a maximum of 24 transient engineers and technicians. These additional personnel and their dependents (a maximum of 129 individuals) will constitute a 5 percent increase in Kwajalein Island's January 1989 population of 2,515 (94). This increase in population will not exceed the island's infrastructure capacity. Water consumption is currently within the average daily supply ceiling, and wastewater generation is currently within the current design capacity. Addition of a new desalination plant would provide additional capacity (104). No socioeconomic impacts should occur. Non-USAKA contractor housing requirements are routinely supported by alternative means on Kwajalein Island (e.g., lease of existing substandard trailers or by contractor-provided trailers) if existing permanent housing is not available during GBR testing. No additional housing will be constructed to accommodate transient or permanent (accompanied or unaccompanied) personnel supporting GBR (78).

Electrical power required for GBR operations at USAKA (4.1 MW) will be supplied by Kwajalein Island's power generation facilities. Dedicated electrical power generation will not be provided for GBR. The new Power Plant 1A, now under construction, will increase the existing capacity of 18.3 MW by 10 MW for a total of 28.3 MW. Installation of 7,000 feet of new electrical feeder lines will connect GBR equipment at Building 1500 to Power Plant 1A (Figure 1-9), scheduled to be operational in mid-1990. This power generation upgrade should satisfy anticipated new users, including GBR, and increase capacity and reliability for current users. Power plant construction is covered by Revision 1 to the EIA of Kwajalein Missile Range Operations, Kwajalein Atoll Marshall Islands (August 1980), which resulted in a finding of no significant impact. The maximum demand on Kwajalein was determined to be 11.6 MW in the most recent study of electrical power published in May 1988 (81). The Kwajalein Master



Reference: Ground Based Radar - Experimental (GBR-X)
Facilities Requirements Document
Raytheon Company Equipment Division 1988

Off-Load, Transport, and Staging Areas for Ground-Based Radar

Figure 3-2

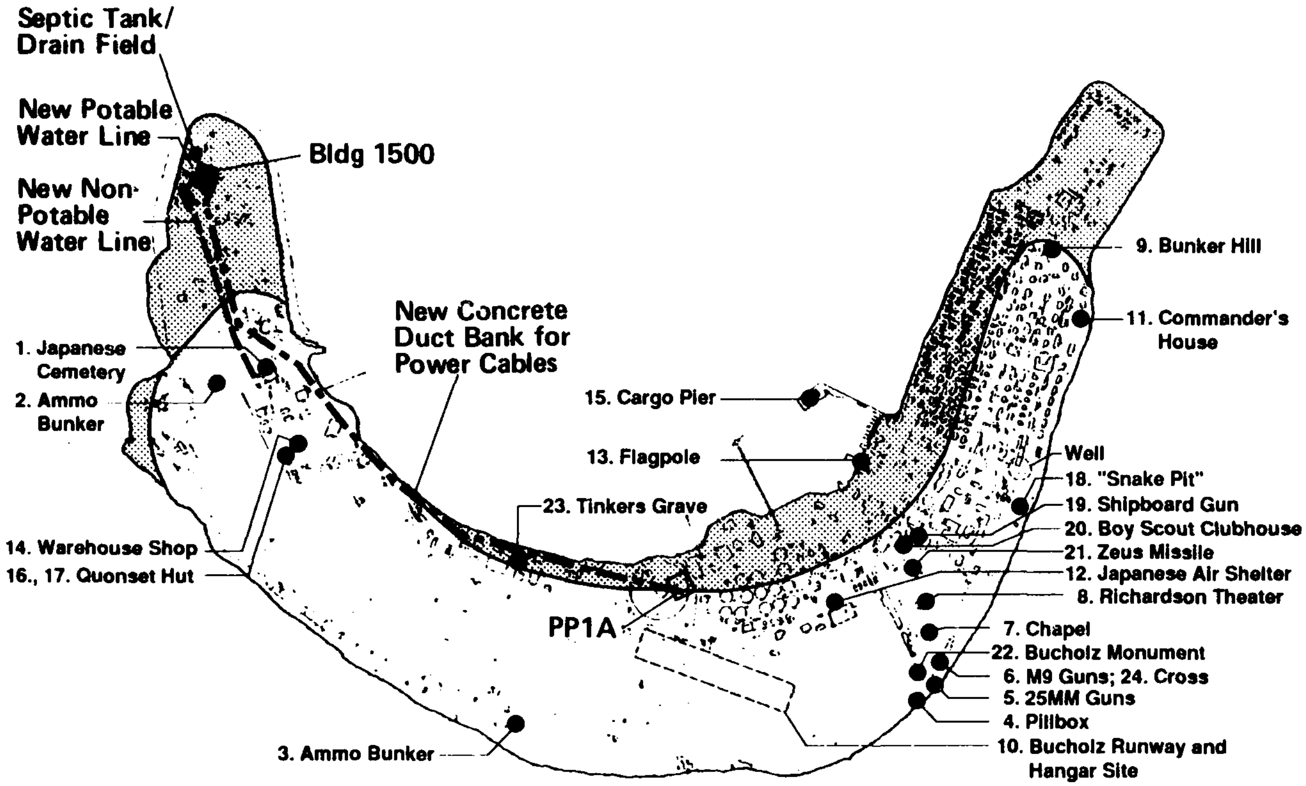
Plan Study predicts that future load demand will increase to 22.6 MW by the end of 1993 (104). With the completion of Power Plant 1A, the available capacity on Kwajalein (28.3 MW) will exceed predicted demand during GBR testing activities. However, Power Plant 1 is expected to go off line in 1993 (the end of the normally scheduled operation), decreasing the available capacity to 15 MW. A new 13.3 MW plant (Power Plant 1B) is in the 1992 Military Construction Authorization (MCA) program. If Power Plant 1B will not be built in sufficient time to help satisfy total USAKA power demands, then Power Plant 1 capacity will be kept available to meet those demands. Therefore, GBR Demonstration/Validation activities will not adversely impact the electrical power situation on Kwajalein Island.

Applying the assessment criteria against the test activities and considering the previous environmental documentation covering modification of Building 1500, all of the criteria for the no significant impact determination are met, except in the areas of cultural resources, land use, and public health and safety. Because construction of utility trenches and the septic tank may impact cultural resources, these resources are investigated. The GBR will be a radar system that uses a pulsed microwave beam to detect and track targets. Because the antenna may point in directions within a few degrees of horizontal, GBR's potential impact on land use and public health and safety is investigated in more detail below. A general discussion of EMR, technical details of the GBR antenna and phased array technology, and EMR standards for human exposure are contained in Appendix A.

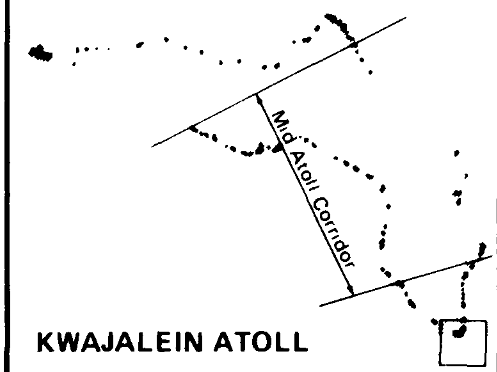
3.1.4.1 Cultural Resources

Although approximately 60 percent of the construction will take place in previously disturbed areas created by the placement of fill material (Figure 3-3), construction of the trenches for the 400-foot potable waterline, the 2000-foot non-potable seawater line, and the 7,000 feet of underground electrical feeder lines and installation of a septic tank and associated drain field (Figure 1-3, 1-9) may result in exposing skeletal and/or material remains associated with the Marshallese habitation or the World War II battle for Kwajalein Island. The impact of the construction activity will be mitigated by an archaeological monitoring, sampling, and data recovery program during construction. Special attention will be paid during construction of the electrical line to avoid the Tinker's Grave historical site. The scope of work for this program is being coordinated with the HPO of the RMI, and any comments will be incorporated into the program prior to construction. Based on similar previous construction programs, and considering that the majority of the construction area is recent fill material, the result of the mitigation program (via coordination with the HPO of the RMI and U.S. Advisory Council on Historic Preservation) is expected to be a Determination of No Adverse Effects on the Kwajalein Battlefield National Historic Landmark or other cultural remains.

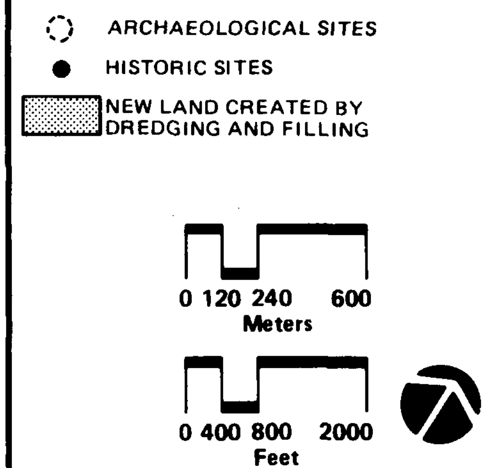
Sensors to record EMR exposure levels will be sited in the vicinity of the GBR at locations, where possible, to maximize the use of available structures, power sources, and previously disturbed areas for placement of sensor equipment and utilities. If construction of trenches for these utilities becomes necessary, the disturbance of a new area may have the potential for cultural resource impacts, but will be mitigated as described above. Overall, potential impacts for GBR Demonstration/Validation activities are considered mitigable and non-significant.



References: Modified from US Army Kwajalein Atoll (Draft) Master Plan 1988
National Register of Historic Places Inventory Nomination Form/ Kwajalein Island Battlefield, 1984



EXPLANATION



Cultural Resource Sites and New Power and Utility Lines, Kwajalein Island, USAKA

Figure 3-3

3.1.4.2 Land Use

There are several potential land use impacts of GBR Demonstration/Validation testing on Kwajalein Island, with the impact of an occupied building height restriction being the principal issue.

The land use impacts of assembling the GBR unit on top of and in Building 1500 and adding new utility connections are considered to have insignificant environmental consequences. Building 1500 is an existing structure, the modifications and additions to which have already been addressed in a Record of Environmental Consideration (77), which concluded that no significant impacts to the environment would result. Similarly, the proposed relocation of the DMS antenna to a previously disturbed area near Building 1010 will have insignificant environmental consequences. In both instances, no change in land use is involved.

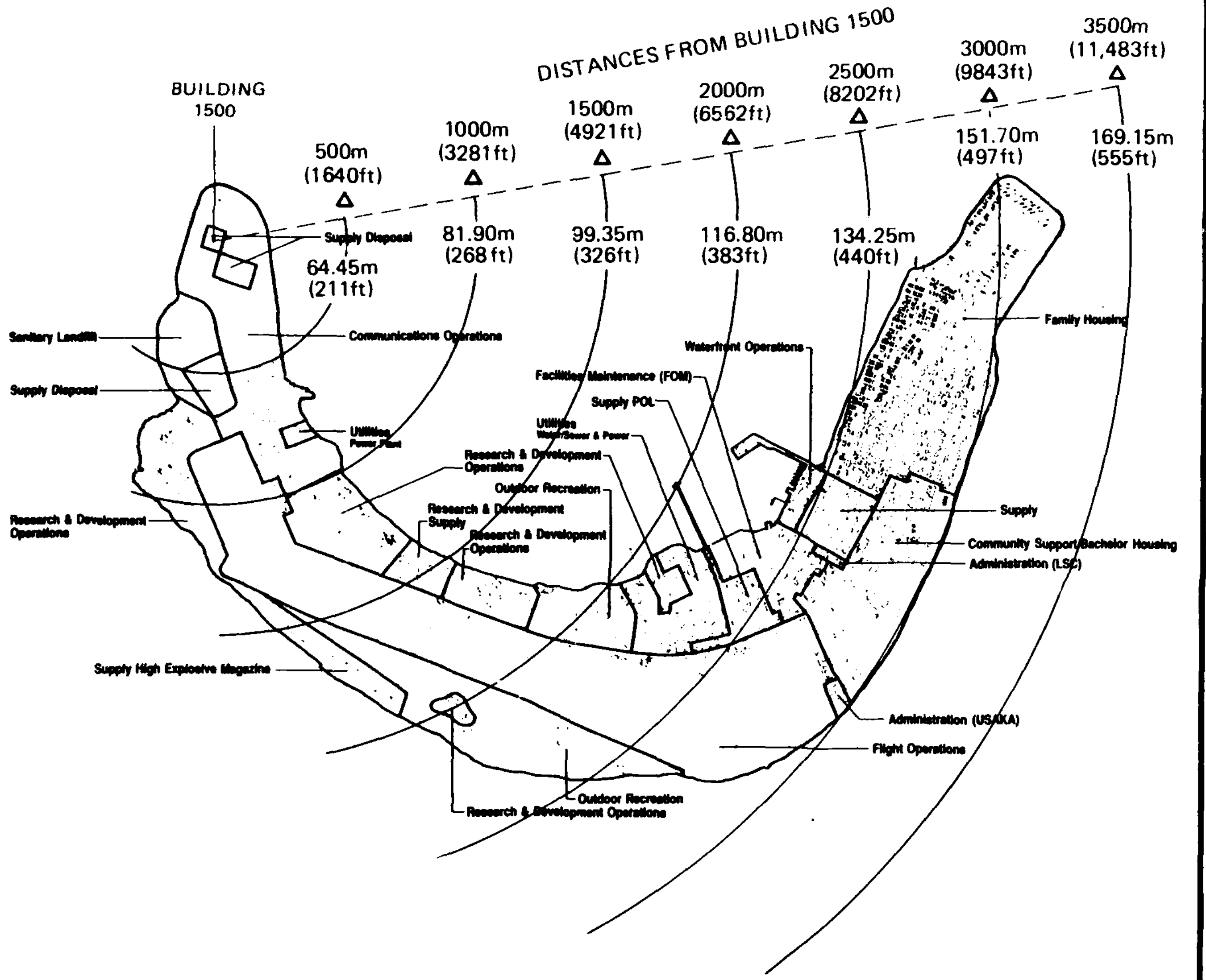
Another impact would be the possible deviation from the Obstructions to the Air Navigation Criterion of Army Technical Bulletin TB 5-803-4, because of the height increase to Building 1500, even though the building is not located within the approach corridor to Bucholz Field. Currently, the maximum height of an obstruction allowed in the aircraft approach envelope is 46 meters (150 feet). A waiver of this criterion to allow GBR to extend up to 64 meters (209 feet) was requested in November 1988. Because the GBR is on top of Building 1500 and will not be an obstruction, the wavier will be granted (131). With this waiver, the possible obstruction of air navigation is considered an insignificant impact.

The main beam RF radiation hazard from the GBR will effectively impose an occupied building height restriction on much of the western portion of Kwajalein Island. The GBR's dual antennas will be mounted in a rotating turret with the center of the antenna 47 meters (154 feet) above the ground, and the GBR design will establish a minimum beam elevation limit of 2 degrees above horizontal; the resulting occupied building height restrictions are shown in Figure 3-4. For example, to avoid the main beam RF radiation hazards, occupied building heights will be restricted to less than 64.5 meters (211 feet) 500 meters (1,640 feet) from Building 1500 and to less than 116.8 meters (383 feet) 2,000 meters (6,562 feet) from Building 1500. Since most existing buildings are below 11 meters (36 feet) in height and no occupied building of more than 5 stories (18 meters [60 feet]) has been, or is likely to be, proposed, this building height restriction, while real, is considered to represent an insignificant impact on future land use.

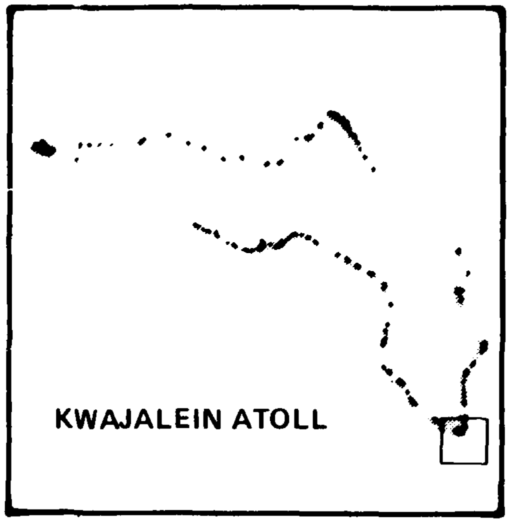
Overall, potential impacts on land use for GBR Demonstration/Validation activities are considered to be insignificant.

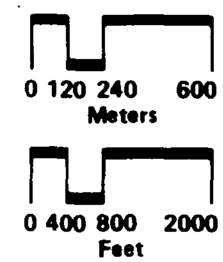
3.1.4.3 Public Health and Safety

Personnel exposure to the primary beam of the GBR represents a potential radiation hazard that can be easily avoided by controlling the direction and elevation of the main beam. Exposure to grating or side lobes of radiation can also be a hazard to personnel. Grating and side lobes are predictable given a fixed set of operational conditions for a given location, but they routinely change in duration and incidence with the operation of the antenna. Of the two phased-array antennas used in the GBR, only the LFOV antenna presents the possibility of grating and side lobe illumination of ground or sea areas around the radar. The presence of grating lobes in the LFOV antenna necessitates a requirement for more control over possible personnel exposure. An analysis of the LFOV maximum grating lobe power densities at ground/sea level near the GBR demonstrates



Reference: Modified From US Army Kwajalein Atoll (Draft) Master Plan 1988





Occupied Building Height Restriction Contours, Kwajalein Island, USAKA

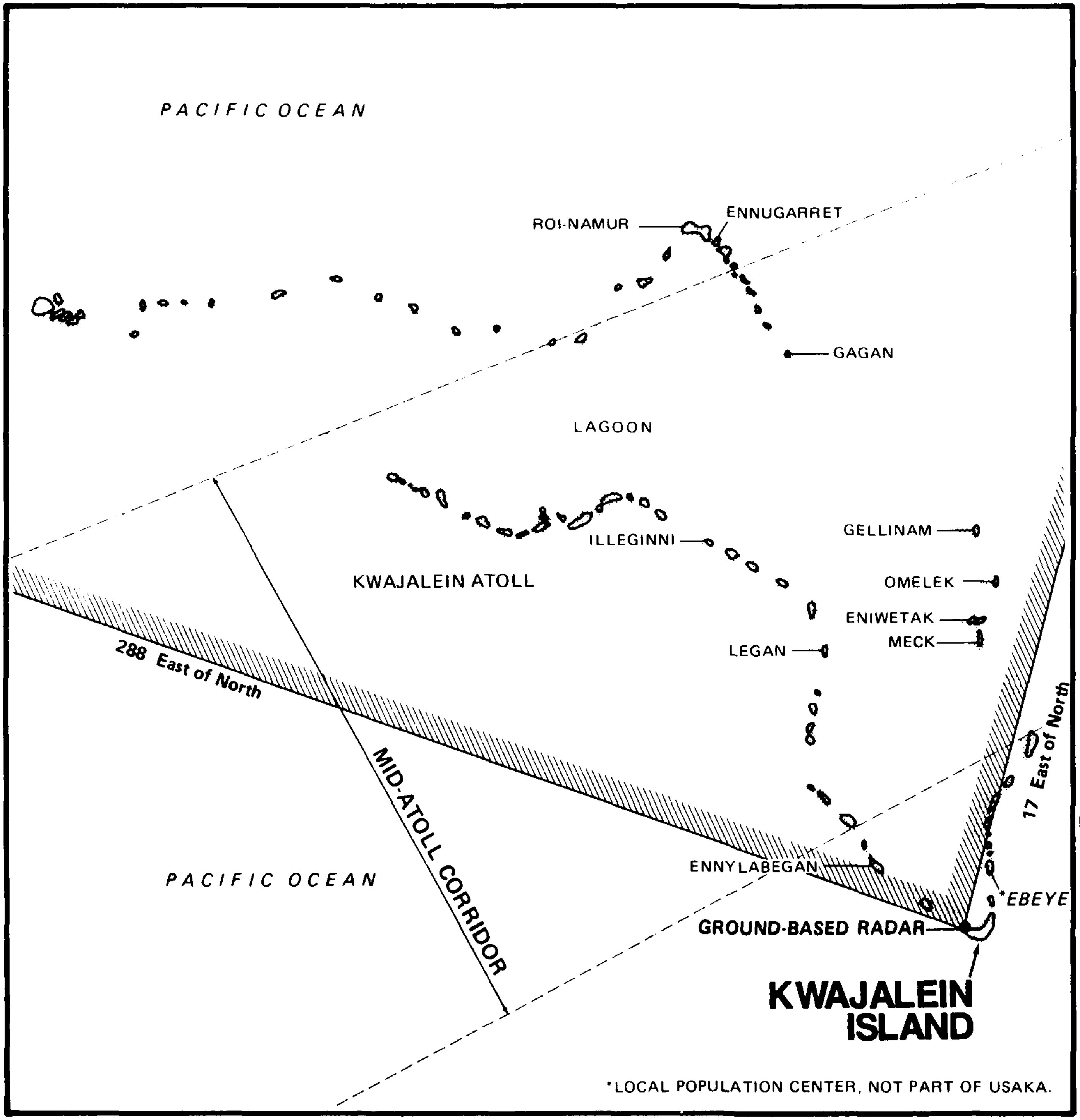
Figure 3-4

that it would be possible for ground/sea level power densities to reach or exceed 5 mW/cm^2 (32.25 mW/in^2) near the GBR antenna if no safety procedures were incorporated. As a result, computer-operated controls and procedures are incorporated into the GBR design to ensure that personnel are not exposed to radiation power densities exceeding 5 mW/cm^2 (32.25 mW/in^2) averaged over a 6-minute period. This power density is in compliance with permissible exposure levels outlined in the U.S. Army Environmental Hygiene Agency's Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation (8) (Appendix A).

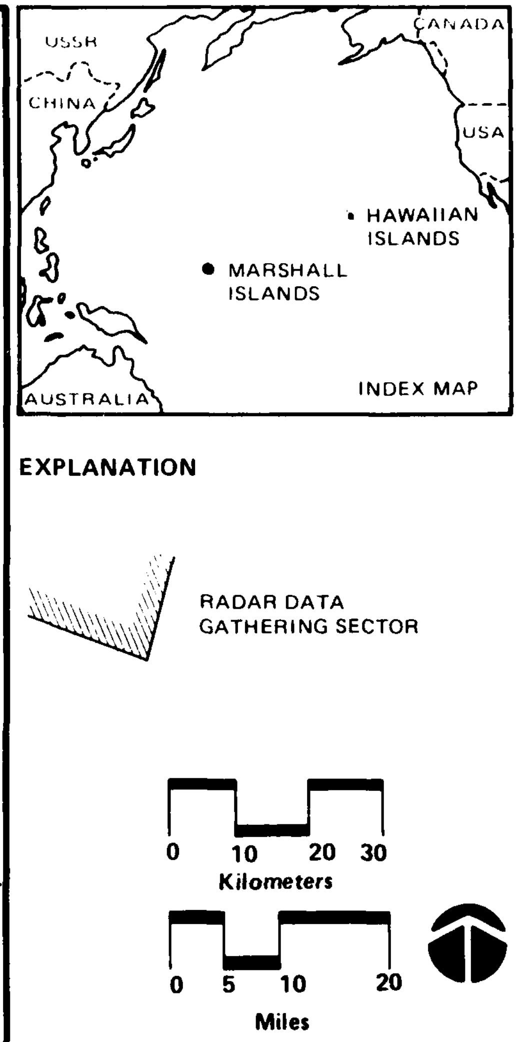
Consequently, grating and side lobe illumination from the LFOV antenna has been determined to represent a mitigable and non-significant impact on public health and safety based on the implementation of the mitigation measures (design features) outlined in Section 4.0 and incorporated as part of the Proposed Action in Section 1.4. The FFOV antenna has a different design than the LFOV antenna and uses much more closely spaced elements that do not generate grating lobes. Analysis of the FFOV antenna, based on its radiation patterns in both the far and near fields, shows that ground/sea level power densities during normal test operations will not exceed 0.1 mW/cm^2 (.65 mW/in^2) at any point around the GBR, regardless of the physical (mechanical) pointing direction of the antenna at elevations (angles) greater than 2 degrees above the horizontal and independent of the electronic elevation scanning of the beam from 2 to 75 degrees relative to the physical orientation of the pointing direction of the beam. This ground/sea power density level is well below the accepted standard of 5 mW/cm^2 (32.25 mW/in^2).

Normal GBR operation will keep the main beam 2 degrees above the horizontal. This insures that the power densities generated in the FFOV mode at the maximum operational duty cycle of 20 percent would be maintained at less than those power densities specified in Army and ANSI radiation protection guides. The accepted power density requirement will be incorporated in the overall system-controlling software and is included in the Raytheon Company, Equipment Division, proposed EMR hazard control plan. If, during FFOV antenna operations (without the LFOV), the radar beam is required to go below an elevation of 2 degrees to gather data on objects tracked to splashdown or to assist in range operations, the radar will operate at a low duty cycle of no greater than 0.2 percent (contrasted with a maximum duty cycle of 20 percent) so that the resulting densities will not exceed permissible exposure levels. Computer operating rules will be incorporated into the main data processor to assure that RF power densities are in accordance with prescribed safety standards. The controls implemented in the computer-operating rules are such that permissible exposure limits will not be exceeded at heights less than 6 meters (20 feet) above water or land surfaces or below the height of any existing structures. FFOV operation at less than 2 degrees elevation will normally occur in a sector bounded by an azimuth of 288 degrees on the west and 17 degrees on the east as illustrated in Figure 3-5. The restriction of operations to this sector and the reduction of the duty cycle at elevations of less than 2 degrees will be controlled by the system operating software. Consequently, illumination from the FFOV antenna operations at less than 2 degree elevation within this sector has been determined to represent a mitigable and non-significant impact on public health and safety based on the implementation of the mitigation measures (design features) outlined in Section 4.0 and incorporated as part of the proposed action in Section 1.0.

To insure personnel safety exposure limits are not exceeded and to eliminate the need for a controlled access zone, independent evaluations by Raytheon Company and USAKA safety personnel will verify the GBR design's ability to control power densities on land and sea. Validation testing will proceed in a step-by-step manner, initially using low duty cycles



*LOCAL POPULATION CENTER, NOT PART OF USAKA.



Ground-Based Radar Approximate Splashdown Area Coverage, U.S. Army Kwajalein Atoll, Republic of the Marshall Islands

Figure 3-5

to perform limited radar operations. Testing will be supported by sensors placed in the vicinity of the GBR. Only when measurements successfully verify the predicted operational conditions will increases in power levels for testing be allowed.

To insure safety of aircraft personnel, aircraft activity within a 278 km (173 mile) range of the control tower at Kwajalein Island will be coordinated with GBR test activities, USAKA operations, and control tower personnel, and will also include the publishing of an appropriate NOTAM in order to avoid GBR operations.

Other Considerations of Intense Electromagnetic Fields - In addition to a concern over human exposure to potentially hazardous electromagnetic fields caused by the GBR, consideration has been given to several other possible side effects, including potential ignition during fueling operations and the inadvertent detonation of EEDs and ordnance. Fuel ignition can become a problem when RF currents, which can be induced in metallic objects by intense RF fields, lead to possible arcing and sparks.

This phenomenon is an extremely rare event and has been observed under contrived test conditions during refueling operations. Ignition may occur if the proper mixture of fuel vapor and air exists at the point where the spark occurs, but this is considered extremely unlikely. EED detonation (e.g., inadvertent firing of meteorological rockets during arming operations) is also related to the electromagnetic field-induced currents that flow in the electrical leads connected to the explosive device. DOD standards (88, 110) provide guidelines for maximum permissible electromagnetic field intensities to avoid these hazards. These standards will continue to be rigorously adhered to, thus avoiding any potential problems. GBR operational restrictions may be required during meteorological rocket arming operations. This will be determined through actual measurements at the launch location and, if necessary, restrictions will be implemented through routine range scheduling and coordination at USAKA.

Initial indications show the mitigations for controlling possible human exposure will reduce any impact of the GBR electromagnetic fields on possible fuel ignition hazards or inadvertent detonation of EEDs or ordnance. If a hazard is determined to exist after a completed on-site test evaluation, mitigation measures to be implemented will include the possible rescheduling/modifying of GBR, fueling, or explosive/ordnance operations. Because the potential rescheduling/modifying of these operations will be implemented through routine range scheduling and coordination at USAKA, these potential hazards are deemed to have mitigable and non-significant consequences.

Another possible side effect is the RF interference that GBR may have on existing emitters and communications systems at USAKA. There is always the potential for RF interference in an environment where multiple high-power emitters are collocated. An independent EMC analysis will be conducted by the ECAC to evaluate the EMR generated by the GBR against existing emitters and communications at USAKA. This analysis is the first step in obtaining a frequency assignment allocation through DOD from the NTIA. ECAC is a government-owned, contractor-operated center that has analyzed potential new sources of RF interference since 1960. A preliminary report from ECAC in January 1989 provided initial results in three areas: high-power effects on civilian and military electronic equipment in the vicinity of USAKA; possible in-band/adjacent-band interference on aircraft, marine, and other radars; and the compatibility of the proposed DMS relocation site with the GBR. Preliminary findings on the proposed DMS relocation site indicate no interference from GBR operations. Further analysis on high-power effects and in-band/adjacent band interference will be available in May 1989. Based on this extensive analysis and computer modeling, ECAC will determine what interferences could exist and will recommend corrective actions, if needed, such as routine range scheduling and/or minor adjustments to operations. The NTIA will evaluate the corrective actions before allocating a frequency assignment through the DOD. Only when these corrective actions are coordinated with USAKA and procedures are in place to incorporate them, can the frequency assignment allocation be granted by NTIA. Because these corrective actions will control any predicted RF interference with existing emitters and communications at USAKA, these potential interference impacts are deemed to have mitigable and non-significant consequences.

One additional potential effect is the cumulative impacts of EMR exposure in the overlap areas of multiple RF emitters (e.g., HF communications systems and radars). The GBR unit is located in the vicinity of the majority of the RF emitters located on Kwajalein Island. The data contained in Table 2-2 are representative of the composite background of RF power densities produced when all existing RF emitters are operating at the same time and directional emitters (radars) are pointed toward the measurement location. These data were obtained from an RF hazard survey conducted at USAKA (80) and are representative of worst case background RF power density levels. Measurement locations are shown in Figure 2-8.

Of the measured sites shown in Table 2-2, the worst case composite background RF power density measurement of 0.178 mW/cm^2 (1.15 mW/in^2) was obtained at location 1 and was less than 4 percent of the permissible exposure level. Analysis of the LFOV operation of the GBR reveals that the grating lobe power densities at ground level will not exceed 86 percent of the permissible exposure level of 5 mW/cm^2 (32.25 mW/in^2). In order to assess GBR's impact on the existing cumulative EMR power densities, a worst case scenario was evaluated. This worst case consists of the following: a reentry vehicle trajectory that maximizes the beam dwell time in a near constant direction, holds the frequency constant at the center of the band, and maximizes electronic steering for maximum grating lobes. This case assumes that the GBR is operating at full duty cycle (20 percent) with the LFOV used until splashdown. The maximum power density from this scenario was calculated to be 4.3 mW/cm^2 (27.74 mW/in^2) averaged over a 6-minute time period (86 percent of the allowable standard). Therefore, when the GBR is added to the Kwajalein RF environment, even under the unlikely circumstance that a single point would be simultaneously illuminated by multiple emitters, the power densities at ground level will be less than 90 percent of the permissible exposure levels in the composite worst case scenario. Accordingly, the cumulative impact of exposure in the overlap areas is considered insignificant.

Overall, potential impacts on public health and safety from GBR Demonstration/Validation activities are considered mitigable and non-significant.

In addition, GBR activities were reviewed against existing environmental and planning documentation (77, 89, 100, 112, 113, 114, 117) on both current projects and anticipated future projects, and no significant cumulative impacts were identified as a result of that review. There will be cumulative impacts on housing and infrastructure caused by the projected population increase on Kwajalein Island due to GBR and other projects. However, the latest projections indicate a peak population increase of approximately 18 percent over current levels, occuring in late 1992. This would bring Kwajalein's population to approximately 3,000, which can be accommodated by USAKA (90, 104). Because existing facilities will be utilized to house these additional personnel, the cumulative impacts are considered insignificant.

Control of the Kwajalein population is exercised by the USAKA Commander. Military and contractor personnel and their dependents are not given authorization to locate at USAKA unless approved housing is available. Recently completed facilities requirements and master planning documentation is available to assist the Commander with housing and infrastructure planning and projection (90, 104). Additionally, an environmental impact statement is being prepared for the U.S. Army Strategic Defense Command (USASDC) by the Pacific Ocean Division of the U.S. Army Corps of Engineers, Fort Shafter, Hawaii, which will assess the environmental impact of ongoing operations and SDI activities at USAKA.

3.1.5 Vandenberg Air Force Base/Western Test Range

The GBR validation testing would involve tracking launches of Minuteman missiles from Vandenberg AFB and would fulfill the need to evaluate radar performance. This testing would include use of some targets of opportunity and three currently scheduled launches dedicated to GBR. Regularly scheduled launches of Minuteman missiles and the three dedicated launches for GBR require no new construction or additions to staff (136). The launches are a continuation of activities that are within the existing operational limits of Vandenberg AFB. No new construction or additions to staff will be required (136); thus, no infrastructure or socioeconomic impacts will occur. Environmental effects of Minuteman and Thor missile launches at Vandenberg AFB have been addressed in an EA (156), which concluded that there would be no adverse environmental impacts.

Although there are five Federally listed endangered species (the California brown pelican, California least tern, least Bell's vireo, American peregrine falcon, and the unarmored three-spine stickleback), two threatened species (the southern sea otter and the Guadalupe fur seal), and over 600 known cultural resources (one site is on the National Register of Historic Places for Vandenberg AFB) (136, 146), GBR activities will be part of the routine mission activities of Vandenberg AFB and will not pose new or additional threats to the threatened and endangered species nor disturb the archaeological sites. Because no additional permanent personnel will be required, GBR Demonstration/Validation activities will not contribute to or exacerbate the aquifer overdrawal problem and the non-attainment status of north Santa Barbara County for ozone and particulate matter.

All of the criteria for the no significant impact determination are met when the assessment criteria is applied to the test activities at Vandenberg AFB. The Western Test Range also meets all the assessment criteria. GBR activities were also reviewed against existing environmental documentation (133, 137, 140, 142, 143, 144, 146, 147, 148, 150, 151, 152, 156) on current and planned actions and anticipated future projects, and no cumulative impacts were identified as a result of GBR testing.

3.2 ENVIRONMENTAL CONSEQUENCES OF NO ACTION

If the no-action alternative is selected, no additional environmental consequences are anticipated. Concept exploration would continue at current installations with no change in operations; however, the no-action alternative would preclude the validation of the GBR technology.

3.3 CONFLICTS WITH FEDERAL, REGIONAL, STATE, LOCAL, OR INDIAN TRIBE LAND USE PLANS, POLICIES, AND CONTROLS

All of the Demonstration/Validation activities at all locations will take place in existing, modified, or refurbished facilities. Consequently, no conflicts with land use plans, policies, and controls exist.

3.4 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

Anticipated energy requirements of the Demonstration/Validation activities at all locations are well within the energy supply capacity of each installation (Appendix C), as validated by site visits. No new power generation capacity will be required for any Demonstration/Validation activities at any of the identified locations, because the activities will be compatible with the installations' ongoing missions. It should be noted that, at USAKA, if Power Plant 1B will not be built in sufficient time to help satisfy total USAKA power demands, then Power Plant 1 capacity will be kept available to meet those demands. Therefore, GBR Demonstration/Validation activities will not adversely impact the electrical power situation on Kwajalein Island. Energy requirements will be subject to the routine energy conservation practices at each installation.

3.5 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS

Other than the various metallic and nonmetallic structural materials and fuel resources used in the Demonstration/Validation test activities, there will be no significant natural or depletable resource requirements associated with the program.

3.6 ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

Other than an increase in potential RF radiation exposure levels at USAKA, there will be no known adverse environmental effects that cannot be avoided for any of the Demonstration/Validation activities at any of the identified locations.

3.7 RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Demonstration/Validation activities at all of the locations involved in the proposed action will take advantage of existing facilities and infrastructure or modified or refurbished facilities. GBR activities at USAKA, RMI, will require the installation of the GBR unit on top of and in an existing structure, Building 1500. Therefore, the proposed action will not eliminate any options for future use of the land, except for Kwajalein Island, USAKA, RMI, where RF hazards will impose a height restriction on buildings.

3.8 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed action will result in no loss of habitat for plants or animals, no loss or impact on threatened and endangered species, and no loss of cultural resources such as archaeological or historical sites. However, although there will be no changes in land use nor preclusion of development of underground mineral resources that were not already precluded, the proposed action will limit future land use by imposing an occupied building height restriction on much of the land of the western portion of Kwajalein Island.

The amount of materials required for any Demonstration/Validation-related construction during the project utilization will be small. However, development of the GBR through the Demonstration/Validation phase would result in irreversible and irretrievable commitment of resources such as electronic components, various metallic and nonmetallic structural materials, fuel, and labor. This commitment of resources is not different from that necessary for many other aerospace research and development programs; it is similar to the activities that have been carried out in previous aerospace programs over the past several years.

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4.0 MITIGATION MEASURES

Environmental consequences of GBR activities are deemed to be insignificant for all installations except USAKA. At USAKA, they will have mitigable and non-significant environmental consequences for cultural resources and public health and safety.

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Cultural Resources

The GBR equipment must be connected to existing power and utility lines. In addition, a 1,500-gallon septic tank with distribution box and associated drain field will also be constructed. The installation of the power and utility lines and the septic tank and associated drain field have the potential for cultural resource impacts. Approximately 60 percent of the construction will take place in previously disturbed areas created by the placement of fill material. Trench construction in areas other than landfill may result in exposing skeletal and/or material remains associated with the Marshallese habitation or the World War II battle for Kwajalein Island. The impact of the construction activity will be mitigated by an archaeological monitoring, sampling, and data recovery program to be implemented during construction. Special attention will be paid during construction of the electrical line to avoid the Tinker's Grave Historical Site. The scope of work for this program is being coordinated with the HPO of the RMI, and any comments will be incorporated into the program prior to construction.

Sensors to record EMR exposure levels will be sited in the vicinity of the GBR at locations, where possible, to maximize the use of available structures, power sources, and previously disturbed areas for placement of sensor equipment and utilities. If construction of trenches for these utilities becomes necessary, the disturbance of a new area may have the potential for cultural resource impacts, but will be mitigated by an archaeological monitoring, sampling, and data recovery program to be implemented during construction.

Public Health and Safety

Safety of the GBR operation will be verified before it is fully utilized. The GBR is being designed to ensure that personnel are not exposed to EMR power densities exceeding 5 mW/cm^2 ($32.25\ mW/in^2$) averaged over a 6-minute period. To ensure that exposure levels are in accordance with the above standards, the following positive actions will be taken in GBR design and testing:

- Main beam radar power densities will be controlled by establishing a minimum beam elevation limit of 2 degrees above horizontal for normal operations of the LFOV and FFOV antennas. If, during FFOV antenna operations (without the LFOV), the radar beam is required to go below an elevation of 2 degrees to gather data on the splashdown of impacting objects or to assist in range operations, the radar will operate at a low duty cycle of no greater than 0.2 percent (contrasted with a maximum duty cycle of 20 percent) so that the resulting power densities will not exceed permissible exposure levels. Computer operating rules will be incorporated into the main data processor to assure that RF power densities are in accordance with prescribed safety standards. The controls implemented in the computer operating rules are such that permissible exposure limits will not be exceeded at heights less than 6 meters (20 feet) above water or land surfaces or below the height of any existing structures.

- Power densities from antenna grating and side lobes from the LFOV antenna will be controlled by implementing the following two procedures, based on analytical predictions of the power density patterns from the grating and side lobes in relation to the main radar beam. First, computer operating rules will be incorporated into the main data processor to assure that RF power densities are in accordance with prescribed safety standards. Before each mission, simulations will be used to verify the adequacy of the computer operating rules. Second, a separate computer will be used to make explicit, real-time calculations that will automatically inhibit GBR radiation, ensuring that specific segments of land and sea are not subject to RF power densities that exceed the specified limits. This second control procedure will give the operator the ability to override GBR transmitter output.

- To insure personnel safety and eliminate the need for a controlled access zone, independent evaluations by Raytheon Company and USAKA safety personnel will verify the GBR design's ability to control power densities on land and sea. Testing will be supported by sensors placed in the vicinity of the GBR. To insure personnel exposure limits are not exceeded, testing will proceed in a step-by-step manner, initially using low duty cycles to perform limited radar operations. Only when measurements successfully verify the predicted operational conditions will increases in power levels for testing be allowed.

To insure the safety of aircraft personnel, aircraft activity within the 278 km (173 mile) range of the control tower at Kwajalein Island will be coordinated with GBR test activities, USAKA operations, and control tower personnel and will also include the publishing of an appropriate NOTAM in order to avoid GBR operations.

Inherent to the overall EMR hazard control plan will be a measurement verification phase in which, after the GBR is installed on Kwajalein Island, power density measurements will verify that ground/sea level time-averaged power densities do not exceed 5 mW/cm^2 (32.25 mW/in^2) averaged over a 6 minute time period.

EMR generated by the GBR could potentially interfere with existing emitters and communication systems at USAKA. An EMC analysis by the ECAC will be completed by May 1989 and will recommend any corrective actions, if needed. The NTIA will evaluate the corrective actions before allocating a frequency assignment through the DOD. Only when these corrective actions are coordinated with USAKA and procedures are in place to incorporate them, can the frequency assignment allocation be granted by NTIA.

In addition, positive action will be taken to ensure that EMR from GBR will not interfere with fuel handling and EEDs or ordnance storage. Positive actions to be taken for GBR activities will be as follows:

- To avoid hazards of fuel ignition or inadvertent detonation of explosives and ordnance (e.g., meteorological rocket arming), there will be routine coordination through USAKA range operations personnel to possibly reschedule/modify GBR operations, if necessary. These potential hazards will be examined by calculating the potential EMR levels at the locations involved (hot pads, meteorological rocket launcher, fueling points, etc.) and comparing the EMR levels with all applicable safety criteria. Before activities involving the use of explosive devices and/or fueling operations during GBR activities, measurements will be taken at the selected sites using the USAKA Mobile Radio Frequency surveillance system. If measurements indicate a potential hazard, operational constraints will be implemented to eliminate the potential hazard by coordinating USAKA and GBR operations.

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5.0 GLOSSARY

AFB. Air Force Base.

Ambient Air Quality Standards: Standards established on a state or Federal level that define the limits for airborne concentrations of designated "criteria" pollutants to protect public health with an adequate margin of safety (primary standards) and to protect public welfare, including plant and animal life, visibility, and materials (secondary standards).

ANSI: American National Standards Institute.

Aquifer: The water-bearing portion of subsurface earth material that yields or is capable of yielding useful quantities of water to wells.

Archaeology: A scientific approach to the study of human ecology, cultural history, and cultural processes, emphasizing systematic interpretation of material remains.

Arc(ing): The band of sparks formed when an electric discharge is conducted from one conducting surface to another.

Attainment Area: An air quality control region that has been designated by the U.S. Environmental Protection Agency and the appropriate state air quality agency as having ambient air quality levels better than the standards set by the National Ambient Air Quality Standards (NAAQS).

Azimuth: A distance in angular degrees in a clockwise direction from the north point.

Boost Phase: The first phase of a ballistic missile trajectory during which it is powered by its engines. During this phase, which usually lasts 3-5 minutes for an ICBM, the missile reaches an altitude of about 200 km (124 mi), whereupon powered flight ends.

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act.

Concept Exploration: Provides the research to determine whether a technology can meet a mission need. After reviewing the status of Concept Exploration, a decision will be made regarding advancement of the technology to Demonstration/Validation.

Cultural Resources: Prehistoric and/or historic districts, sites, structures, or other physical evidence of human use considered of some importance to a culture, subculture, or community, for scientific, traditional, religious, or other reasons.

Demonstration/ Validation Program: Its purpose is to determine the ability of the technology to perform its intended function, and to provide the information necessary to make an informed decision whether to proceed with Full-Scale Development.

DFOV: Dual Field of View.

DMS: Digital Microwave System.

DOD: Department of Defense.

DOPAA: Description of Proposed Action and Alternatives.

Duty Cycle: The time that the radio frequency field is on divided by the sum of the time the radio frequency is on and off during the operation cycle.

ECAC: Electromagnetic Compatibility Analysis Center

EED: Electroexplosive device.

Electromagnetic Field: The field of force associated with an electric charge in motion, having both electric and magnetic components and containing a definite amount of electromagnetic energy.

Electromagnetic Wave: A wave generated by an oscillating electric charge.

EMC: Electromagnetic Compatibility.

EMR: Electromagnetic Radiation.

Endangered Species: A species that is threatened with extinction throughout all, or a significant portion, of its range.

Endoatmosphere: Within the earth's atmosphere, generally altitudes below 33,500 meters (110,000 feet).

Environmental Assessment (EA): A concise public document in which a Federal agency provides sufficient analysis and evidence for determining the need for an Environmental Impact Statement (EIS) or a Finding Of No Significant Impact (FNSI). EAs provide agencies with useful data regarding compliance with the NEPA and are an aid in the preparation of an EIS.

EPA: Environmental Protection Agency.

ESQD: Explosive safety quantity distance. Requirements for which hazard zones have been established by the DOD for various quantities and types of explosives. Minimum distances are prescribed for separating explosives from inhabited structures, from public roads, and from other explosives.

Fauna: Animals: organisms of the animal kingdom of a given area taken collectively.

FFOV:	Full field of view.
Flora:	Plants: organisms of the plant kingdom taken collectively.
FN:	Facility Number.
FNSI:	Finding of No Significant Impacts (also FONSI).
FY:	Fiscal Year.
Grating (Side) Lobe:	The principal source of electromagnetic radiation from the GBR antenna in directions not necessarily intended for the antenna's application.
Groundwater:	All the water derived from percolation of rainwater, from water trapped in sediment at its time of deposition, and from magmatic sources lying under the surface of the ground above an impermeable layer, but excluding underground streams.
Hazardous Waste:	Resource Conservation and Recovery Act (RCRA) defines hazardous waste as any discarded material that may pose a substantial threat or potential danger to human health or the environment when improperly handled. Some of the characteristics of these wastes are toxicity, ignitability, *corrosivity, and reactivity.*
HF:	High frequency.
HPO:	Historic Preservation Officer.
ICBM:	Intercontinental Ballistic Missile.
Impact:	An assessment of the meaning of changes in all attributes being studied for a given resource; an aggregation of all the adverse effects, usually measured by a qualitative and nominally subjective technique.
IRP:	Installation Restoration Program.
Kwh:	Kilowatt-hour.
Landfill:	Land waste disposal site that is located to minimize water pollution from runoff and leaching; waste is spread in thin layers, compacted, and covered with a fresh layer of soil each day to minimize pest, aesthetic, disease, air pollution, and water pollution problems.
Ldn:	The 24-hour average-energy sound level expressed in decibels, with a 10-decibel penalty added to sound levels between 10 P.M and 7 A.M.
LFOV:	Limited field of view.

Low-Duty Cycle:	A decreased time that the radiofrequency field is on.
Main Beam Illumination:	Electromagnetic radiation from the main beam of the GBR.
MCEB:	Military Communications Electronics Board.
Megawatt:	One million watts (MW).
Midcourse Phase:	The second phase of a ballistic missile trajectory during which it is outside of the earth's atmosphere; the phase between the boost phase and the terminal phase.
Milliwatt:	One one-thousandth of a watt (mW).
Mitigation:	A method or action to reduce or eliminate program impacts.
NAAQS:	National Ambient Air Quality Standards.
National Priorities List:	U.S. Environmental Protection Agency designation for areas with violations of hazardous waste standard practices.
NCO Housing:	Housing for non-commissioned officers.
NEPA:	National Environmental Policy Act.
NOI:	Notice of Intent.
Nonattainment Area:	An air quality control region that has been designated by the U.S. Environmental Protection Agency and the appropriate state air quality agency as having ambient air quality levels below the primary standards set by the National Ambient Air Quality Standards (NAAQS).
NPDES:	National Pollutant Discharge Elimination System. Regulates discharges into the nation's waters with a Federal permit program designed to reduce the amount of pollutants in each discharge.
NTIA:	National Telecommunications and Information Administration.
PCBs:	Polychlorinated biphenyls, a colorless, odorless, viscous liquid considered in industrial wastes as a pollutant.
PSD:	Prevention of Significant Deterioration regulations. Prevents degradation of air that is already cleaner than that required by the National Ambient Air Quality Standards (NAAQS).
QDRZ:	Quantity Distance Requirement Zones.

RCRA:	Resource Conservation and Recovery Act. Established in 1976 to protect human health and the environment from improper waste management practices.
Reentry Vehicle (RV):	The part of a ballistic missile that carries the nuclear warhead to its target. The reentry vehicle is designed to reenter the earth's atmosphere in the terminal portion of its trajectory and proceed to its target.
RF:	Radio frequency; any frequency between normally audible sound waves and the infrared light portion of the spectrum, lying between approximately 10 kilohertz and approximately 1,000,000 megahertz.
RMI:	Republic of the Marshall Islands.
SAR:	Specific Absorption Rate.
SDI:	Strategic Defense Initiative.
SDIO:	Strategic Defense Initiative Organization.
Side Lobes:	(As in side [grating] lobes of radiation.) They are the principle source of electromagnetic radiation radiated by an antenna in directions not necessarily intended for the antenna's application.
SLBM:	Submarine-Launched Ballistic Missile.
Tactical:	(As in tactical missiles.) Of or pertaining to the technique of securing the objectives designated by strategy.
Terminal Phase:	The final phase of a ballistic missile trajectory during which warheads and penetration aids reenter the atmosphere. This phase follows the end of the midcourse phase and continues until impact or arrival of the missile in the vicinity of the target.
Threatened Species:	Taxa likely to become endangered in the foreseeable future.
TS:	"Temporary Storage" facility in regard to hazardous waste.
TSD:	"Temporary Storage and Disposal" facility in regard to hazardous waste.
TSCA:	Toxic Substance Control Act (1976).
USAKA:	U.S. Army Kwajalein Atoll.
USASDC:	U.S. Army Strategic Defense Command.

Wetlands: Areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil, including swamps, marshes, bogs, and similar places.

6.0 AGENCIES CONTACTED

U.S. DEPARTMENT OF THE ARMY

U.S. Army Kwajalein Atoll
APO San Francisco, California 96555-2526

U.S. Army Strategic Defense Command
P.O. Box 1500
Huntsville, Alabama 35807-3801

U.S. Army Strategic Defense Command
Crystal Mall #4, Suite 900
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Crystal City, Virginia 22215

U.S. DEPARTMENT OF THE AIR FORCE

Hill AFB
Environmental Office
2849 ABG/DEV
Hill Air Force Base, Utah 84056

Vandenberg AFB
1 STRAD/ET
Vandenberg AFB, CA 92437-5000

National Test Facility
Consolidated Space Operations Center
Falcon AFB
1003 SSG/DEEV
Peterson AFB, Colorado 80914

U.S. DEPARTMENT OF THE INTERIOR

U.S. Fish and Wildlife Service
2800 Cottage Way, Room #1803E
Sacramento, California 95825

U.S. Fish and Wildlife Service
Pacific Islands Office
P.O. Box 50167
Honolulu, Hawaii 86850

OTHER FEDERAL AGENCIES

Environmental Protection Agency (EPA)
401 "M" Street, S.W.
Washington, DC 20460

Environmental Protection Agency (EPA)
215 Fremont Street
San Francisco, California 94105

Environmental Protection Agency (EPA)
Hazardous Waste Division
Superfund Office - Remedial Branch
999 -18th Street, Suite #200
Denver, Colorado 80202

CONTRACTORS

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Equipment Division
430 Boston Post Road
Wayland, Massachusetts 01778

Teledyne Brown Engineering
Cummings Research Park
300 Sparkman Drive
Huntsville, Alabama 35807-5301

STATE AGENCIES

Department of Health
Bureau of Air Quality
288 North, 1460 West
Salt Lake City, Utah 84116

Department of Environment
Division of Air Monitoring/Engineering
Air Management Administration
201 West Preston Street
Baltimore, Maryland 21201

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NATIONAL TEST FACILITY

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AD-A207 654 GROUND-BASED RADAR (GBR): ENVIRONMENTAL ASSESSMENT(U) 2/2
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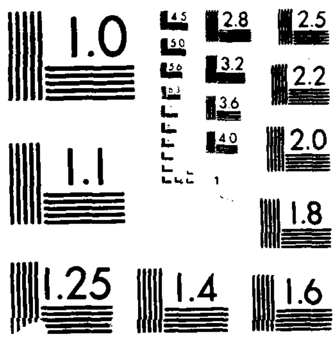
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APPENDIX A

ELECTROMAGNETIC RADIATION AND PERMISSIBLE EXPOSURE LIMITS

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ELECTROMAGNETIC RADIATION AND PERMISSIBLE EXPOSURE LIMITS

The Ground-Based Radar (GBR) is a high-powered radar system using a pulsed microwave beam to detect and track targets. High transmitter power levels combined with state-of-the-art antenna technology provide the system with increased performance characteristics for the detection of targets at long range, moving with high velocities. Because of the relatively high transmitted power and antenna pointing directions that may, depending on the mission, be within a few degrees of horizontal, it is of practical interest to examine the potential for high intensity electromagnetic fields that will be produced by the GBR. These electromagnetic radiation (EMR) levels have been addressed through extensive analyses. This section provides a brief technical description of the GBR system, the issues relative to possible EMR hazards that have been addressed, applicable standards, and the results of the pertinent analyses.

The GBR Antenna

The GBR antenna system consists of two separate antennas, one that provides a so-called limited field of view (LFOV) and one that provides a full field of view (FFOV). The GBR system permits selection of antennas, mounted on the same antenna support structure (a plane), employing phased-array technology wherein many smaller elements (called phase shifters) are combined to function as a single antenna. The FFOV antenna has a circular aperture with a diameter of 3.2 meters (10.4 feet). The FFOV antenna is mounted in the center of the larger square LFOV antenna, which is 10 meters (32.8 feet) on a side. Together, the two antennas employ a total of 43,008 phase shifters (21,504 in each antenna). Both antennas will operate in the X-band of the microwave spectrum.

The GBR dual antennas will be mounted in a rotating turret, with the center of the antenna 47 meters (154 feet) above ground. The antenna will be mounted on the roof of Building 1500 on the very west end of Kwajalein Island and will become the highest structure on the Kwajalein Island. A large spherical radome will encompass the entire antenna system for protection against the effects of rain and wind. The antenna assembly will allow mechanical rotation in azimuths of up to +/- 178 degrees and in elevation from 2 to 75 degrees above horizontal. Through a combination of mechanical and electronic control of the antenna's radiation pattern, the radiated microwave beam may be directed essentially instantaneously at incoming targets.

Phased-Array Technology

The GBR will use a phased-array antenna for radiating the pulsed microwave signal. Phased-array technology refers to the use of multiple radiating elements to make up the antenna system, with carefully controlled power levels and electrical phase relationships of the transmitter signals delivered to each of the array elements. By controlling these parameters, power and phase, the radiation pattern of the antenna can be controlled. The radiation pattern of an antenna is related to the manner in which the antenna radiates the radar signal in various directions. By controlling the direction in which the radar transmits, targets at different locations can be discriminated. Commonly, radars use mechanical beam steering to change the transmitted direction of the beam. The GBR will make use of both mechanical and electronic beam steering. A major advantage to electronic beam steering is that it is essentially instantaneous; nothing mechanical has to move, and thus beam direction can be changed extremely rapidly, a desirable characteristic for target detection and tracking. The control of a phased-array antenna is performed through computer programming (software). Thus, significant engineering work has been expended in the development of specialized software for operating the GBR, and it is, to a large extent, through the application of specific algorithms that the EMR levels in the vicinity of the GBR can be controlled.

Any microwave antenna can be characterized by describing its radiation pattern in terms of the so-called main beam of radiation, the beam of the transmitted energy intended for use in communications, or target identification, as in the case of radars. The radiation pattern of the antenna also includes side lobes of radiation. Side lobes consist of EMR radiated by the antenna but at directions not intended for the antenna's application. The design approach used in the GBR antenna, which produces a better cost-to-performance ratio in overall system performance, introduces the presence of a particular category of side lobes, caused largely by the selection of the spacing distance between the many elements (phase shifters) that make up the entire phased-array antenna. These grating (side) lobes are the principal source of EMR to which the analyses summarized below have been directed, because main beam illumination (radiation) will not be directed at the ground or sea near the GBR. The main beam of the GBR will diverge from the antenna in a conical pattern having a half-power beam width of about 0.2 degrees for the LFOV mode of operation and about 0.6 degrees for the FFOV mode. The GBR will not normally be used for radiation at less than 2 degrees above horizontal.

Electromagnetic Radiation Hazard Issues

High-intensity electromagnetic fields must be evaluated for compliance with applicable standards for human exposure and the possibility of fuel ignition or inadvertent detonation of explosives and ordnance. Analyses have been conducted to determine the expected intensities of electromagnetic fields to evaluate the potential for excessive exposure to the GBR emissions and to help identify, where necessary, appropriate mitigating techniques.

Electromagnetic Radiation Standards for Human Exposure

Analytic assessments of the potential for EMR hazards to individuals were performed by comparing computed values of electromagnetic field intensities to those values specified by the U.S. Army (Technical Guide No. 153, Guidelines for Controlling Potential Health Hazards from Radio Frequency Radiation). This document (1), which reflects the most recent revisions to the American National Standards Institute (ANSI) radio frequency radiation protection guide (2), specifies a maximum microwave radiation power density exposure level of 5 mW/cm^2 (32.25 mW/in^2) for continuous exposure.

The 5 mW/cm^2 (32.25 mW/in^2) power density value is based on limiting the energy absorption rate in the body to a value of 0.4 watts per kilogram (W/kg) (0.15 watts per pound [W/lb]) of body mass. This specific absorption rate (SAR) was derived from biological effects research demonstrating that SARs of 4 W/kg (1.49 W/lb), if maintained for long times, could be hazardous in laboratory animals, (i.e., it represents the threshold for hazard effects). The radiation protection guide, thus, incorporates a safety factor of 10 based on these observations.

The Army- and ANSI-recommended microwave exposure limits are probably the most widely recognized in the U.S. In recent years, other more stringent recommendations have been developed, such as those proposed by the National Council on Radiation Protection and Measurements (NCRP) (3), the International Radiation Protection Association (IRPA) (4), and the Commonwealth of Massachusetts (5). Each of these organizations has suggested a maximum power density for public exposure of 1 mW/cm^2 (6.5 mW/in^2), five times lower than the ANSI radiation protection guide. These more stringent guidelines, however, are based on the same data base of technical information on biological effects research showing hazardous effects in animals with SARs of about 4 W/kg, the same as the Army and ANSI limits. The difference in recommended exposure levels apparently arises from differences in the margin of safety.

No Federal standard has as yet been promulgated for public exposure to electromagnetic fields. The U.S. Environmental Protection Agency has attempted to decide on an acceptable exposure limit. These levels ranged from as low as 0.5 mW/cm^2 to 5 mW/cm^2 (3.23 mW/in^2 to 32.25 mW/in^2), the same as the ANSI and Army limits.

The Army and ANSI guides, as well as most all microwave protection guides, are based on the time-averaged value of exposure, i.e., the value of power density when averaged over any 6-minute time period. Thus, while 5 mW/cm^2 (32.25 mW/in^2) is permitted for 6 minutes or greater, the so-called continuous limit, higher values are acceptable if the exposure time can be limited to less than 6 minutes. For example, if the exposure time is only 3 minutes long, then 10 mW/cm^2 (65 mW/in^2) is acceptable; if the exposure duration is only 1 minute, then 30 mW/cm^2 (195 mW/in^2) would be acceptable. The concept of time averaging is important in consideration of the potential exposures that might occur at the GBR installation on Kwajalein Island. Because the beam moves rapidly, depending on the particular mission, it is very unlikely that environmental exposures will ever consist of continuous, constant values of power density. Rather, almost universally, exposures will be intermittent and, when the GBR is transmitting, the electromagnetic fields will be constantly changing in intensity. Thus, microwave exposure analyses for the GBR system that do not take into account the fact that the beam will be almost constantly moving about will generally significantly overestimate the actual power densities that will occur during normal operation.

Permissible Exposure Limits (1)

a. The PEL [permissible exposure limits] for all personnel is 0.4 watts per kilogram (W/kg) whole body specific absorption rate (SAR) as averaged over any 6-minute period. Averaging is done over the 6-minute period of maximum exposure potential. Exposures separated by more than 6 minutes are considered separate physiological events under American National Standards Institute (ANSI) Standard C95.1 and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values Booklet. Sufficient evidence exists to indicate that a fetus is at no greater risk than the mother during pregnancy. A fetus will not receive any greater exposure than the mother and cannot be shown to be more radiosensitive.

b. For the purpose of determining compliance with the 0.4 W/kg whole body SAR power limit, the derived equivalent PELs appear in Tables 1 and 2. These derived equivalent PELs, which were determined experimentally and theoretically, will ensure that individuals exposed in a uniform RFR field at those levels will receive a whole body SAR of less than 0.4 W/kg. Derived equivalent PELs are provided for exposures that may occur in restricted areas (Table 1) [A-1] and in nonrestricted areas (Table 2) [A-2]. These two distinct derived equivalent PEL categories will ensure that personnel do not receive exposures greater than 0.4 W/kg while operating in restricted and nonrestricted areas.

c. The derived equivalent power density PELs in Tables 1 and 2 are for far-field (plane wave) conditions and apply only where a strict far-field relationship between both electric and magnetic fields exists. In radiating near-field and reactive near-field conditions or at low frequencies (10 KHz to 3 MHz), the electric and magnetic field strength limits in Tables 1 and 2 must be used to determine PEL compliance.

d. RFR equipment which radiates at frequencies below 1,000 MHz and delivers less than 7 watts of RF (radio frequency) power to the radiating device is considered nonhazardous.

e. All exposures should be limited to a maximum (peak) electric field intensity of 100,000 volts/meter (V/m) in a single pulse.

f. For mixed or broadband fields at a number of frequencies for which there are different PEL values, the fraction of the PEL incurred within each frequency interval should be determined, and the sum of all such fractions should not exceed unity. When multiple transmitters are in use in the same frequency interval, the total field from all transmitters emitting simultaneously will not exceed the PEL.

g. The derived equivalent PELs in Tables 1 and 2 may be increased under special circumstances provided that:

(1) The SAR does not exceed 0.4 W/kg when averaged over the whole body over any 6-minute period.

(2) The spatial peak SAR (hot spot) does not exceed 8.0 W/kg averaged over any 1-gram of tissue.

Table 1 [A-1] Derived equivalent PELs for restricted areas[1]

Frequency (f) (MHz)	Power Density (mW/cm^2)	Electric Field Strength Squared (V^2/m^2)	Magnetic Field Strength Squared (A^2/m^2)
0.01-3	100.0	400,000	2.5
3-30	$900/f^2$	4,000 ($900/f^2$)	0.025 ($900/f^2$)
30-100	1.0	4,000	0.025
100-1,000	f/100	4,000 (f/100)	0.025 (f/100)
1,000-300,000	10.0	40,000	0.25

Table 2 [A-2] Derived equivalent PELs for nonrestricted areas [2, 3, 4, 5]

Frequency (f) (MHz)	Power Density (mW/cm^2)	Electric Field Strength Squared (V^2/m^2)	Magnetic Field Strength Squared (A^2/m^2)
0.01-3	100.0	400,000	2.5
3-30	$900/f^2$	4,000 ($900/f^2$)	0.025 ($900/f^2$)
30-300	1.0	4,000	0.025
300-1,500	f/300	4,000 (f/300)	0.025 (f/300)
1,500-300,000	5.0	20,000	0.125

[1] Restricted areas are those areas to which access is controlled for the purpose of excluding entry of persons of less than 140 centimeters (55 inches) in stature per ANSI C95.3.

[2] Unrestricted areas are those areas where access is not controlled to exclude persons of less than 140 centimeters (55 inches) in stature. The precedent for this is ANSI C95.1.

[3] Values in these tables were derived using a value of the impedance of free space of 400 ohms. This value is rounded up from the generally accepted value of 377 ohms to allow for ease of calculations under ANSI C95.1.

[4] When both the electric and magnetic fields are measured, both values must be equal to or less than their applicable derived equivalent PEL.

[5] Tables apply only to whole body exposures and are based on the overall PEL of 0.4 W/kg.

(3) Personnel are adequately protected from electric shock and RFR burns through the use of electrical safety matting, electrical safety shoes, or other isolation techniques.

(4) The maximum (peak) electric field intensity does not exceed 100,000 V/m.

(5) The provisions of paragraph h below are met.

h. The use of PELs greater than those in Tables 1 and 2 and requires --

(1) The RFR levels be measured and evaluated by (United States Army Environmental Hygiene Agency) USAEHA personnel.

(2) The evaluation findings be documented and maintained.

(3) Management, employees, and employee representatives be briefed on the evaluation findings and the reasons for the exception.

(4) The affected area should be posted to notify all personnel of the exception to the PELs and what additional protective measures must be taken.

i. No practice will be adopted or operation conducted involving planned overexposure to RFR.

References

1. U. S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, 1987. Guidelines for Controlling Potential Health Hazards from Radiofrequency Radiation, Technical Guide No. 153, April.

2. American National Standards Institute, 1982. Safety Levels with Respect to Human Exposure to Radiofrequency Electromagnetic Fields, 300 kHz to 100 GHz. American National Standard C95.1-1982, September 1.

3. National Council on Radiation Protection and Measurements. Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields. NCRP Report No. 86.

4. International Non-Ionizing Radiation Committee, International Radiation Protection Association, 1988. Guidelines on limits of exposure to radiofrequency electromagnetic fields in the frequency range from 100 kHz to 300 GHz, Health Physics, Vol. 54, No. 1.

5. 105 CMR 122.000, Regulations Governing Fixed Facilities Which Generate Electromagnetic Fields in the Frequency Range of 300 kHz to 100 GHz and Microwave Ovens, Commonwealth of Massachusetts.

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APPENDIX B

ENVIRONMENTAL ATTRIBUTES, APPLICABLE FEDERAL LAWS, REGULATIONS, AND COMPLIANCE REQUIREMENTS

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ENVIRONMENTAL ATTRIBUTES, APPLICABLE FEDERAL LAWS, REGULATIONS, AND COMPLIANCE REQUIREMENTS

AIR

AIR QUALITY ACT (1967) 42 USC 7401 et seq., Pub. L. 90-148 81 Stat. 485

Protects and enhances the quality of the nation's air.

PREVENTION OF SIGNIFICANT DETERIORATION (PSD) REGULATIONS
39 Fed Reg 42510 (1974)
Amended by 44 Fed Reg 51924 (1979)

Prevents degradation of air that is already cleaner than that required by the National Ambient Air Quality Standards (NAAQS).

CLEAN AIR ACT (1963) 42 USC 7401 et seq., as amended Pub. L. 95-95 91 Stat. 685-796

Regulates air pollution by means of (1) air quality control, which sets a maximum allowable level of air pollution for the surrounding air and determines the emission levels for conformity to a maximum allowable ambient level, and (2) emission control of certain pollutants by national standards.

Clean Air Act (amendments) 1977, Section 111. Pub. L. 91-604, 84 Stat. 1676-1713, Title 42. New Source Performance Standards.

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)
Section 109 Clean Air Act

Public health and the public welfare are protected by national primary and secondary ambient air quality standards for "criteria" pollutants (ozone, carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, particulate matter, and hydrocarbons).

BIOLOGY

FISH AND WILDLIFE COORDINATION ACT (1965)
16 USC 662 Pub. L. 89-72 79 Stat. 216

This law requires that the U.S. Fish and Wildlife Service be consulted when water bodies, including wetlands, greater than 10 acres in area are to be modified, controlled, or impounded It further requires action to be taken to prevent loss and damage to these resources and provision for their development and improvement.

THE BALD AND GOLDEN EAGLE ACT (1940)16 USC 668-668(d), Chapter 278 54 Stat. 250

Under this Act, activities that have the potential to disturb these birds and/or their nests require prior consultation with the U.S. Fish and Wildlife Service regarding mitigation measures.

THE MIGRATORY BIRD TREATY ACT (1918)16 USC 703-712, Chapter 128 40 Stat. 755

This Act prohibits the pursuit, hunting, taking, capture, possession, or killing of such species or their nests and eggs. Also potential impacts of a proposed action on migrating birds have to be discussed with the U.S. Fish and Wildlife Service.

ENDANGERED SPECIES ACT (1973) 16 USC 1531-1543, Pub L 93-205, 87 Stat. 884 (1973)

Section 7 requires every Federal agency to inquire of the Fish and Wildlife Service whether any threatened or endangered species may be present in the area of a proposed agency activity before that activity can be taken.

Amended by Pub L 95-632, 92 Stat. 3571 (1978)
Amended by Pub L 97-304, 96 Stat. 1411 (1982)

Protects species of fish and wildlife that are either in danger of extinction or are likely to become an endangered species within the foreseeable future throughout all or a significant part of their range.

All Federal agencies are directed to carry out programs for the conservation of endangered and threatened species, and to take such actions as necessary to insure that their actions will not jeopardize the continued existence of such species (16 USC 1532[2]).

Federal agencies must also see to it that their actions do not result in destruction or modification of the habitats of such species determined to be "critical".

CULTURAL RESOURCES

ANTIQUITY ACT (1906) Pub L 59-209, 34 Stat. 225, 16 USC 431-433

Provides for the protection of all historic and prehistoric ruins or monuments on Federal lands.

HISTORIC SITES ACT (1935) Pub L 74-292, 49 Stat. 666, 16 USC 461-467

Declares as national policy the preservation for public use of historic sites, buildings, and objects. Established the National Historic Landmarks program (the beginning of the National Register program).

NATIONAL HISTORIC PRESERVATION ACT (1966) 16 USC 470, Pub. L. 89-665, 80 Stat. 915-919 as amended.

Provides for an expanded National Register of Historic Places to register districts, sites, buildings, structures, and objects significant to American history, architecture, archaeology, and culture. Section 106 requires that the President's Advisory Council on Historic Preservation be afforded an opportunity to comment on any undertaking that adversely affects properties listed on the National Register.

EXECUTIVE ORDER 11593: PROTECTION AND ENHANCEMENT OF THE CULTURAL ENVIRONMENT (1971) 16 USC 470

Requires that Federal plans and programs contribute to the preservation and enhancement of sites of historic, architectural, and archaeological significance.

ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACT (1974) 16 USC 469, Pub. L. 93-291 88 Stat.

Directs the preservation of historic and archaeological data that would otherwise be lost as a result of Federal construction or other Federally licensed or aided activities.

HAZARDOUS WASTES

RESOURCE CONSERVATION AND RECOVERY ACT (1976) 42 USC 6901-6987, Pub. L. 94-580, 90 Stat. 2795

Regulates the disposal of discarded materials and hazardous wastes. RCRA mandated the EPA to promulgate criteria for identifying hazardous waste (42 USC 6921), and establish standards to apply to waste generators (42 USC 6922) and transporters (42 USC 6923), as well as owners or operators of treatment, storage, or disposal facilities for hazardous wastes (42 USC 6924).

Regulates disposal with a Federal and state permit program.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA), OR "SUPERFUND ACT" (1980) 42 USC 9601-9615, 9631-9633, 9641, 9651-9657; 26 USC 4611-4612, 4661-4662, and 4681-4682; 33 USC 1364, Pub. L. 96-510 94 Stat. 2767.

Amended by Pub. L. 99-499, Title I, Para. 101, 114 (B), 127 (A).

Requires notification of any release into the environment of substances that may present substantial danger to public health or welfare or the environment (42 USC 96002[a]). It is the primary mechanism for governmental response actions to spills, discharges, or release of any substance designated toxic or hazardous by other environmental Statutes.

NOISE

NOISE CONTROL ACT (1972) 42 USC 4901-4918, Pub. L. 92-574, 86 Stat. 1234

Establishes noise emission performance standards for certain noise source products and subjects Federal facilities to state and local noise emission standards that apply to stationary sources.

WATER

CLEAN WATER ACT (1977) 33 USC 1251 et seq., 1311 et seq., Pub. L. 95-217, 91 Stat. 1566.

Restores and maintains the chemical, physical, and biological integrity of the nation's waters.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

Regulates discharges into the nation's waters with a Federal permit program designed to reduce the amount of pollutants in each discharge via control point discharge. The primary requirement is compliance with effluent limitations for each point discharge source. The act contains provisions that (1) require that the best available technology (BAT) be utilized by discharge applicants to prevent water pollution, (2) encourage conservation of nutrients and other natural resources, and (3) establish maximum levels for pollutants.

ENVIRONMENT (GENERAL)

NATIONAL ENVIRONMENTAL POLICY ACT (1969) 42 USC 4321, 4331-4335, 4341-4347, Pub. L. 91-190, 83 Stat. 852

Amended by Pub. L. 94-475, 90 Stat. 2071 (1976)

Requires Federal agencies to consider environmental issues under NEPA just as they consider other matters within their mandate. Environmental issues must be considered in the decision-making process.

COUNCIL ON ENVIRONMENTAL QUALITY REGULATIONS ON IMPLEMENTING NATIONAL ENVIRONMENTAL POLICY ACT PROCEDURES (1978) 40 CFR 1500-1508; 43 FR 55990

Corrected by 44 FR 873 (1979)
Amended by 51 FR 15625 (1986)

Regulations are binding on all Federal agencies, replacing earlier sets of agency regulations, and provide uniform standards applicable throughout the Federal government for conducting environmental reviews. Regulations are designed to ensure that the action-forcing procedures of Section 102(2) of NEPA are used by agencies to fulfill the requirements of the policy set forth in Section 101 of the Act.

Section 101 states that "it is the continuing policy of the Federal Government, in cooperation with state and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans".

Section 102(2)(C) states that all agencies of the Federal Government shall include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on:

(i) the environmental impact of the proposed action,
(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
(iii) alternatives to the proposed action,
(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

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APPENDIX C

SELECTED ENVIRONMENTAL CHARACTERISTICS AT PROPOSED GBR TEST INSTALLATIONS

TABLE C-1

SELECTED ENVIRONMENTAL CHARACTERISTICS
HILL AIR FORCE BASE, UTAH

				REFERENCES
PHYSICAL CHARACTER-ISTICS	FACILITIES	BASE SIZE	2.692 hectares (6,654 acres)	41
		BASE FACILITIES	Storage and maintenance facilities, work facilities to open and rework missiles. There is a single 4,115-m (13,500 ft.) class B runway. There are 1,284 buildings, including maintenance shops and hangars, administration, operations, warehouses, training, community, recreation, housing, testing and fuel storage, a 35 bed hospital, exchanges and shops. 70% of Hill AFB is reserved for munitions storage and flight line/airfield related activities.	2, 4, 40, 50
		TEST FACILITIES	Test firing range is approximately 161 kilometers (100 miles) from the base. Ogden Air Logistics Center, 2701st Explosive Ord. Disposal, 6514th test squadron	4, 50
	ENVIRON-MENTAL CONDITIONS	NATURAL RESOURCES	No known minerals, oil or gas reserves, or forest land. Land use: grazing, agriculture, recreation.	44, 61
		PUBLIC HEALTH AND SAFETY	No significant public health and safety issues have been identified.	40
		SPECIAL STATUS	No known cultural resources. There are four threatened or endangered species within a 20-kilometer (12-mile) radius of Hill AFB. Endangered: the peregrine falcon and the bald eagle. Threatened: the spotted bat and the steptoe dace.	44, 60, 61
		NOISE	There are no noise problems.	40, 44, 58
OPERATIONAL CHARACTER-ISTICS	SOCIO-ECONOMICS (BASE)	STAFFING	Military: 5,100 Civilian: 15,300 (as of 1988)	2, 4
		PAYROLL	Total payroll: $586 million (1988)	2
		HOUSING	Housing on-base is available for military personnel: 263 officer, 882 NCO, 45 transient. Additional housing is also available in the Ogden area.	2, 4
	SOCIO-ECONOMICS (REGIONAL)	POPULA-TION/EM-PLOYMENT	Davis County has an estimated 1986 population of 180,100 persons, which is an almost 23% increase over 1980 population totals of 146,450 persons. Davis County had a 1982 total civilian labor force of 66,793 persons and a 5.9% unemployment rate. Weber County has an estimated 1986 population of 158,800 persons, which is almost a 10% increase over 1980 population totals of 144,616 persons. Weber County had a 1982 total civilian labor force of 67,860 persons and an 8.6% unemployment rate.	12
		INCOME	Davis County has a per capita income of $8,761 (1985) which is almost a 40% increase over the 1981 figure of $6,275 and, presumably there is a similar increase over the 1979 median family income of $21,948. Weber County has a per capita income of $9,250 (1985) which is almost a 41% increase over the 1981 figure of $6,585 and, presumably there is a similar increase over the 1979 median family income of $19,748.	12
		HOUSING	Davis County has a total of 41,549 year-round housing units. Weber County has a total of 50,294 year-round housing units.	11

TABLE C-1
page 2 of 2

SELECTED ENVIRONMENTAL CHARACTERISTICS
HILL AIR FORCE BASE

				REFERENCES
OPERATIONAL CHARACTERISTICS (Cont.)	INFRASTRUCTURE	ELECTRICITY	Capacity: 192,928,000 kwh/month	56
		SOLID WASTE	On the average 11,100 tons/year is removed to the North Davis County landfill off base.	47, 56
		SEWAGE TREATMENT	The North Davis County Sewage District treats the 832,286,000 gallons/year of sewage generated by Hill AFB. Industrial waste is pretreated in an Industrial Waste Pre-treatment Plant so that it is brought up to standards prior to being released into the municipal system.	40, 43, 47, 56, 61
		TRANS-PORTATION	There are five gates; three are open 24 hours and two are open during shift hours. The main gate is accessed from Interstate 15. Most people travel by car, although the Utah Transit Authority does provide public transportation between the base and the Ogden/Salt Lake City area; car and van pools are popular.	56
		WATER SUPPLY	Most water is pumped from wells on base. Some water is purchased.	43, 45, 56, 61
PERMIT STATUS		AIR	Hill AFB is in a non-attainment area for ozone and carbon monoxide. There are no PSD permits. The State has a monitoring system off base.	40, 51, 60, 61
		WASTE WATER	Base has NPDES permits. Water released into local sewage systems must meet water quality standards.	40, 61
		HAZARDOUS WASTE	Hill AFB was placed on the National Priorities List on October 1984. The listing currently cites ten areas of hazardous waste disposal which cover a total area of 22 hectares (54 acres). The base is participating in the Installation Restoration Program (IRP) which identifies, evaluates, and controls the migration of hazardous contaminants from hazardous waste sites.	53, 54, 55, 57, 60, 61
ADDITIONAL ENVIRONMENTAL INFORMATION		No environmental compliance plan available Base Master Plan (under contract for revision), Bed Down EIS- for F16 at Hill AFB-'78 EIS to establish Gandy super sonic air space at UTTR- Oct. '82		44, 60
COMMENTS				

TABLE C-2
page 1 of 2

SELECTED ENVIRONMENTAL CHARACTERISTICS
FALCON AFB (NATIONAL TEST FACILITY)

				REFERENCES
PHYSICAL CHARACTERISTICS	FACILITIES	BASE SIZE	259 hectares (640 acres)	2
		BASE FACILITIES	Administrative offices, communications network, medical aid station.	2, 4, 68
		TEST FACILITIES	Advanced communications network capabilities	68
	ENVIRONMENTAL CONDITIONS	NATURAL RESOURCES	There are no known minerals, ores, forests, or other natural resources on the National Test Facility. The facility does overlie the Laramie-Fox Hills aquifer.	68, 70
		PUBLIC HEALTH AND SAFETY	No significant public health and safety issues have been identified.	65
		SPECIAL STATUS	No threatened or endangered species have been reported at the National Test Facility. Although three prehistoric isolated finds were made at the National Test Facility, none were considered significant by the Colorado State Office of Historic Preservation. No other cultural resources have been identified.	68, 70, 72
		NOISE	The current ambient noise level is within acceptable limits.	68, 69
OPERATIONAL CHARACTERISTICS	SOCIO-ECONOMICS (BASE)	STAFFING	Military = 1,200 (active duty); Civilian = 2,088 (1988, at Falcon Air Force Base) Upon completion, the new National Test Facility will employ approximately 6,000 people.	1, 72
		PAYROLL	Available payroll figures are for the Peterson AFB complex as a whole (Peterson AFB, Falcon AFB, Cheyenne Mountain, and the Federal Building in downtown Colorado Springs). Payroll data for individual units are not kept.	74
		HOUSING	There is no housing at Falcon Air Force Base. Nearby Peterson AFB has available on-base housing. Housing is also provided off base in the Colorado Springs area.	4, 68
	SOCIO-ECONOMICS (REGIONAL)	POPULATION/EMPLOYMENT	El Paso County has an estimated 1986 population of 380,400 persons, which is almost a 23% increase over 1980 population totals of 309,424 persons. El Paso County had a 1984 total civilian labor force of 163,883 persons and an unemployment rate of 5.4%.	12
		INCOME	El Paso County has a per capita income of $10,855 (1985), which is a 54% increase over the 1981 figure of $7,027 and presumably there is a similar increase over the 1979 median family income of $18,729.	12
		HOUSING	El Paso County has a total of 116,770 year-round housing units.	11

TABLE C-2

SELECTED ENVIRONMENTAL CHARACTERISTICS
FALCON AFB (NATIONAL TEST FACILITY)

				REFERENCES
OPERATIONAL CHARACTER-ISTICS (Cont.)	INFRASTRUCTURE	ELECTRICITY	The peak daily demand of the Consolidated Space Operations Center and the National Test Facility is 13,110 kwh/day. The existing substation on Falcon AFB is capable of providing 15,000 kwh/day, with the capacity to expand to 25,000 kwh/day. The Colorado Springs area is more than capable of supplying additional demands expected by facility expansion.	68, 72
		SOLID WASTE	Solid waste is disposed offsite at a licensed landfill by a private contractor. Additional solid waste generation is expected to be minor.	68, 69, 72
		SEWAGE TREATMENT	Design Capacity = 0.069 million gallons/day; designed to support 2,300 base personnel. Modification of the sewage facility will be necessary for the increased staff. Current waste water facilities need to be expanded by 0.124 million gallons/day to accommodate the additional waste generated by the new facility. Sewage treatment plant expansion will begin in the spring of 1989.	65, 68, 69, 72
		TRANS-PORTATION	Access to Falcon AFB provided by State Highway 94 and Enoch Road. Current traffic at SH94 = 3,500 vehicles/day, capacity = 16,000 vehicles/day (as of 1987). Current traffic at Enoch Road = 1,550 vehicles/day, capacity = 11,300 vehicles/day.	68
		WATER SUPPLY	The Cherokee Water District 's contract with Falcon AFB limits the delivery of water to 0.479 million gallons per day. Existing peak water demands at the installation are estimated at 0.409 million gallons per day. Presently supporting approximately 2,500, the existing water supply could support 6,000.	65, 68, 72
PERMIT STATUS		AIR	This area is in attainment by Colorado standards (Falcon AFB is outside the Colorado Springs non-attainment areas for carbon monoxide and total suspended particulates).	68, 72
		WASTE WATER	NPDES permit under revision; the present waste water treatment plant is being modified.	65, 68, 72
		HAZARDOUS WASTE	Potential hazardous wastes: electrolytes, sodium hydroxide, sodium sulphide, dichlorodifluoromethane, sulfur dioxide, SSP-55, all in very small amounts; offsite disposal by Defense Reutilization Management Office.	69, 71, 72
ADDITIONAL ENVIRONMENTAL INFORMATION	Environmental Compliance Assessments and Management Program, 1988. The Base Comprehensive Plan is being developed and is expected to be completed in 1989. Current EA: National Test Bed Program, 1987; Final Environmental Impact Statement, Consolidated Space Operations Center, January , 1981.			65, 66, 68, 70
COMMENTS	National Test Facility has a categorical exclusion for the interim National Test Facility as stated in document 813 (control #AFSPC 86-1) dated 8-12-86. Data are for Falcon Air Force Base, unless otherwise noted.			67, 75

TABLE C-3
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SELECTED ENVIRONMENTAL CHARACTERISTICS
U.S. ARMY KWAJALEIN ATOLL

				REFERENCES
PHYSICAL CHARACTER-ISTICS	FACILITIES	BASE SIZE	Approximately 100 component islands in Kwajalein Atoll, total land area = 1,450 hectares (3,583 acres); Kwajalein Island = 303 hectares (749 acres)	104
		BASE FACILITIES	Operational facilities (Communication/Navigation/Liquid Fueling/Helicopter Pad) airfield with 2,057x 60 meter (6,750 x 200 foot) runway; maintenance facilities; utilities and grounds improvements; supply facilities; medical facilities; housing - accompanied and unaccompanied; administrative facilities; marine terminal facilities; schools.	90, 95
		TEST FACILITIES	Research and Development and Test Facilities that include: tracking radar, optical instrumentation, telemetry facilities, multiple launch facilities, satellite communications.	90, 108
	ENVIRON-MENTAL CONDITIONS	NATURAL RESOURCES	Coconut harvesting and operation of fisheries. Mineral deposits of limited quantity exist on the Marshall Islands, but not on Kwajalein Island.	89, 92
		PUBLIC HEALTH AND SAFETY	Radar and microwave installations are governed by Technical Bulletin: Medical 523 (July 1980), as amended by Technical Guide No. 153, U.S. Army Environmental Hygiene Agency (April 1987) and by KMR 385-3. Aircraft landing sites have a clear zone that extends 152 meters (500 feet) from the runway center line.	104
		SPECIAL STATUS	One endangered species, the hawksbill turtle, and one threatened species, the green sea turtle. Turtles have been observed at the southwestern end of Kwajalein Island but they have not been seen nesting on Kwajalein Island. Existing parks and sanctuaries are either privately owned or operated by the local/state authorities. A Marine survey now in draft form addresses the marine habitat. The entire Island of Kwajalein is on the National Register of Historic Places and is also listed as a National Historic Landmark. Prehistoric sites on the Island are up to 2000 years old. Separate USAKA EIS studies will address the marine habitat and cultural resources in detail.	89, 95, 104, 113, 114, 115
		NOISE	The primary noise sources on USAKA are aircraft, generators, and heavy equipment. The locations of facilities and their distance from possibly affected areas precludes noise problems. Workers in noise-risk facilities are required to wear hearing protection.	104, 132
OPERATIONAL CHARACTER-ISTICS	SOCIO-ECONOMICS (BASE)	STAFFING	As of June 1988: Total USAKA Population: 2,560 Military: 39 Civilian Contractors: 1,180 Civil Service: 78 Dependents: 977 As of January 1989: Total USAKA Population: 2,891 Kwajalein Island Population: 2,515	90, 95, 132
		PAYROLL	Total USAKA payrol as of June 1988: $4,501,000 annually	95, 124
		HOUSING	136 2-3 bedroom units are presently being added to the existing 549 family housing units. There are1,240 barracks/dormitory spaces, 150 transient units on base, and 254 trailers.	84, 90, 132
	SOCIO-ECONOMICS (REGIONAL)	POPULATION/ EMPLOYMENT	Ebeye has a 1985 population of 7,875 persons and in 1982 had a full-time employment level of 996 persons.	12
		INCOME	Not available.	
		HOUSING	Ebeye has a total of 602 housing units. 1988 Ebeye housing data are presently being analyzed.	11, 95

SELECTED ENVIRONMENTAL CHARACTERISTICS
U.S. ARMY KWAJALEIN ATOLL

				REFERENCES
OPERATIONAL CHARACTER-ISTICS (Cont.)	INFRA-STRUCTURE	ELECTRICITY	Electricity is supplied by diesel generators; Power Plant #1 capacity = 13.5 MW, Power Plant #2 capacity = 4.8 MW. Peak demand on Kwajalein Island = 11.6 MW. A new power plant is being built (Power Plant 1A) that will increase capacity by 10 MW by 1990. A new 13.3 MW plant (Power Plant 1B) is in the fiscal year 1992 Military Construction Authorization (MCA) program.	81, 92, 94, 116, 126
		SOLID WASTE	Metal wastes are transported by barge to an authorized deep water dumping site 2.1 miles off shore. Wastes are dumped into 1,000 fathoms of water. The last deep water dump was in 1984, the next dump is expected within 3 to 6 months; an EPA permit for deep water dumping is pending. Other solid waste is incinerated within EPA standards or placed in sanitary landfills. Wet waste is taken to a landfill where it is carried out to sea at high tide. A Solid Waste Disposal Plan is now being developed as a part of the forthcoming 1988 EIS.	84, 94, 104, 126
		SEWAGE TREATMENT	The design capacity of the sewage treatment plant on Kwalajein Island is 450,000 gallons/day. The current average flow rate is 330,000 gallons/day. The treatment plant capacity is more than adequate to meet increasing demands.	90, 94, 126
		TRANS-PORTATION	The sea transportation network provides inter-island movement of cargo and passengers, and logistical support from the major governmental centers to all inhabited outer islands. On Kwajalein Island, there are 21 kilometers (13 miles) of paved road and 300 vehicles with no vehicular congestion. Workers from Ebeye are brought over by ferry. Air transportation is available on Kwajalein Island. Bicycles are the principal mode of personal transportation.	90, 95, 132
		WATER SUPPLY	Potable water systems on Kwajalein Island include two primary water sources, a rainwater catchment system, and a groundwater lens well system. Reverse osmosis units have been used in the past and a desalination facility is scheduled for completion in 1990. The average supply of catchment water is 8.8 million gallons per month (assuming 100% capture in the catchment areas) and the estimated monthly sustainable yield from the groundwater lens well system is 4.2 million gallons per month (when average rainfall occurs [105 inches]). Because the amount of rainfall can vary, droughts can occur; during these droughts, stringent water conservation measures are employed. Total water supply is approximately 433,000 gallions per day; average water consumption per day is 250,000 gallons. Most of the outer islands are too small to provide additional water, but Meck, Roi Namur, and Ennylabegan have small catchment systems that can provide water, if needed.	84, 90, 94, 95, 104, 126
PERMIT STATUS		AIR	Air pollution is currently not a problem because of the constant tradewinds, the island's low profile, and lack of constraining factors. Air pollutants are generated from air transportation, range operations, power plant generators, dust, and waste incineration. Power plant generators are the major source for particulates, sulfur oxides, and nitrogen oxides. In 1979, estimates of power plant emissions showed emissions approaching the limits of EPA Standards for nitrogen oxides. Six of the nine diesel engines of Power Plant 1 have been rebuilt to help decrease these levels.	84, 89, 94, 101, 113, 123
		WASTE WATER	Kwajalein is in full compliance with EPA water standards and is awaiting an updated NPDES permit.	94, 104, 132
		HAZARDOUS WASTE	Known hazardous wastes on Kwajalein: PCB's, solvents, asbestos, hydrazine fuel. The base hazardous waste plan has been issued and is currently being implemented.	84, 94, 122
ADDITIONAL ENVIRONMENTAL INFORMATION	EIA, Kwajalein Missile Range Operations, 1980; EA, Family Housing Dwellings, 1986; Environmental Consideration, HEDI, Meck Island, 1987; Environmental Consideration, Airborne Optical Adjunct, 1985; Environmental Consideration, TIR, 1987; Draft Master Plan Report, May, 1988. Analysis of Existing Facilities, 1988; Facilities Requirement Evaluation, May 1988.			85, 86, 90, 100, 103, 104, 113, 115
COMMENTS	U.S. operations on the Kwajalein Atoll must comply with all NEPA standards; however, there is no formal permitting procedure or monitoring. It is the responsibility of the user agency to make sure standards are met. Any reentry debris from Western Test Range activities that lands in the Kwajalein Lagoon must be removed in compliance with the "clean bottom" policy (155).			109, 118, 122

TABLE C-4

SELECTED ENVIRONMENTAL CHARACTERISTICS
VANDENBERG AIR FORCE BASE

				REFERENCES
PHYSICAL CHARACTERISTICS	FACILITIES	BASE SIZE	39,822 hectares (98,400 acres)	2
		BASE FACILITIES	45-bed hospital, 6 on base electrical power plants, 2,428-hectare (6,000-acre) cantonment area, 35 missile launch sites, 4,572-meter (15,000-foot) runway.	2, 146, 177
		TEST FACILITIES	Missile assembly buildings, missile launch pads, missile control building, tracking stations	177
	ENVIRONMENTAL CONDITIONS	NATURAL RESOURCES	Proven on-base oil and gas reserves	146
		PUBLIC HEALTH AND SAFETY	Potential safety risks have been significantly reduced by setting up safety clear zones around storage and operations areas.	146
		SPECIAL STATUS	There are over 600 known cultural resources, mostly archaeological sites. One site is listed on the National Register of Historic Places and others may qualify. Federally listed endangered species include: the California brown pelican, California least tern, least Bell's vireo, American peregrine falcon, and the unarmored three-spine stickleback. The southern sea otter and the guadalupe fur seal are threatened species. There are no known threatened or endangered plant species on base. There are approximately 2,070 hectares (5,100 acres) of wetlands. The base also contains 56 kilometers (35 miles) of coastline, 267 kilometers (166 miles) of streams, 3,642 hectares (9,000 acres) of dune habitat, and 1,670 hectares (4,126 acres) of woodland.	146, 148, 161
		NOISE	The north part of the base is affected by missile launches, maintenance activities, and traffic. Noise levels in the cantonment area are typical of a residential area. The south part of the base is affected by launch facilities, traffic, and the Southern Pacific Railroad. There is a noise monitoring network on base. Noise reduction measures include rerouting project-related traffic and avoiding conducting flight tests during sleep hours.	142, 146
OPERATIONAL CHARACTERISTICS	SOCIO-ECONOMICS (BASE)	STAFFING	Military = 3,824 Civilian = 1,479 Contractor = 4,992 (1988)	2
		PAYROLL	Military and civilian $121.1 million; contractors $181.3million (1988)	2
		HOUSING	On base housing is provided for military personnel: Officer = 511 NCO = 1,567 Transient = 400 Mobile housing = 172. Off- base housing is available in the nearby communities of Lompoc and Santa Maria, and within surrounding Santa Barbara County.	2, 146
	SOCIO-ECONOMICS (REGIONAL)	POPULATION/EMPLOYMENT	Santa Barbara County has an estimated 1986 population of 339,400 persons, which is almost a 14% increase over 1980 population totals of 298,694 persons. Santa Barbara County had a 1984 total civilian labor force of 167,921 persons and a 5.9% unemployment rate.	12
		INCOME	Santa Barbara County had a per capita income of $12,611 (1985), which is an increase over the 1981 figure of $8,400 and presumably there is a similar increase over the 1979 median family income of $21,630.	12
		HOUSING	Santa Barbara County has a total of 123,476 year-round housing units.	11

TABLE C-4
page 2 of 2

SELECTED ENVIRONMENTAL CHARACTERISTICS
VANDENBERG AIR FORCE BASE

				REFERENCES
OPERATIONAL CHARACTER-ISTICS (Cont.)	INFRASTRUCTURE	ELECTRICITY	Electricity is supplied by the PG&E Power Co. Peak demand is 550,000 kwh/day. Capacity is 580,000 kwh/day.	166, 173
		SOLID WASTE	Volume = 25,000 tons/year, capacity = 95,000 tons/year; disposed of at a class III landfill on base.	136, 165, 166
		SEWAGE TREATMENT	The design capacity of the off-site facility (serving the city of Lompoc, unincorporated areas surrounding Lompoc, and Vandenberg AFB) is 5 million gallons/day. An on-site system with a capacity of 3 millions gallons/day treats waste from the cantonment area. In 1986 approximately 1 million gallons of sewage/day was produced on base.	142, 146
		TRANS-PORTATION	The road network on base has considerable excess capacity. The road network leading to the base is near or at capacity during peak traffic periods. Access to launch sites is restricted for several hours prior to launches.	146, 168, 173
		WATER SUPPLY	Ten on base wells supply all of Vandenberg's water needs. Demand = 6 million gallons per day The highest quality potable water is drawn from San Antonio Creek aquifer which is currently being overdrawn by 11,000 acre feet/year. The base is currently pulling out 3,400 acre feet/year of the overdraw. Current water usage rate will deplete this local source in 50 years.	136, 146
PERMIT STATUS		AIR	Permits in place from the Air Pollution Control District authorize on-base construction and operations. The north portion of Santa Barbara County, which contains Vandenberg, is currently in attainment of air quality standards. There are two PSD monitoring stations on-base.	136, 169, 176
		WASTE WATER	NPDES permits are in place for 15 on-base sewage discharge locations.	172
		HAZARDOUS WASTE	Approximately 700 tons of hazardous waste are generated per year; all is disposed at an off-site facility by private contractor. Vandenberg has a short-term hazardous waste storage RCRA Part B permit issued by the California Department of Health Services.	136, 169, 170
ADDITIONAL ENVIRONMENTAL INFORMATION	There is a recent (1987) Draft EIS on oil and gas exploration at Vandenberg and existing EIS documents (1983, 1978) for MX missile and space shuttle launches from Vandenberg. Various quantity distance requirement zones are part of safety regulations that restrict land use development on base.			142, 143, 144, 146, 148
COMMENTS	Missile launches have relatively little impact on air quality. Further drawdown of the aquifer could have an impact on aquatic and biologically dependent species of Barka Slough and San Antonio Creek.			146, 176

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APPENDIX D

CORRESPONDENCE

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS OFFICE
P.O. BOX 50187
HONOLULU, HAWAII 96850

JAN 19 1989

Mr. Dru Barrineau
C-SSD-H-SSP
U. S. Army Strategic Defense Command
P. O. Box 1500
Huntsville, Alabama 35807

Dear Mr. Barrineau:

This follows up on our telephone conversation of earlier today regarding the possible impact of the Army's Ground Based Radar X project on endangered and threatened species. The project will require the construction of a radar antenna on Building 1500 at the Army's Kwajalein Atoll Facility, Kwajalein, Republic of the Marshall Islands.

To the best of our knowledge, no listed or proposed species of plants or animals under our jurisdiction would be affected by the project. Only two listed species are found in the vicinity of the project, the threatened green sea turtle and the endangered hawksbill sea turtle, and these have been observed in the water only, not on the land. Especially in consideration that the project is to be constructed in an area already used for other purposes by the Army, we do not believe the project will affect the turtles in any way.

If we can be of any additional assistance, please call us again.

Sincerely yours,

William R. Kramer

William R. Kramer
Deputy Field Supervisor
Office of Environmental Services

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APPENDIX E

DISTRIBUTION LIST

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The Judge Advocate General
The Pentagon
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Office of the Chief Legislative Liaison
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HSHB-MR-LM
Aberdeen Proving Grounds, MD 21010-5442

U.S. Army Strategic Defense Command
CSSD-H-SSP
Huntsville, AL 35807-3801

Related Activities

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Wayland, MA 01778

Teledyne Brown Engineering
Cummings Research Park
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Germantown, MD 20545

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Alele Museum/Library
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