

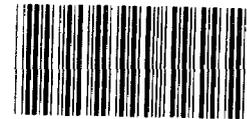
GAO

Report to the Honorable Don Young,
House of Representatives

November 1985

RADIATION ACCIDENT

Incident at Clear Air Force Station, Alaska



128544

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United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-217674

November 7, 1985

The Honorable Don Young
House of Representatives

Dear Mr. Young:

As requested in your March 8, 1984, letter and in subsequent discussions with your office, we have investigated the September 14, 1983, radiation accident at Clear Air Force Station, Alaska. This report examines the conduct of the Air Force and the contractor, FELEC Services, Inc., as it relates to the accident.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 5 days from its issue date. At that time, we will send copies to Senator David L. Boren at his request; interested committees and other Members of Congress; the Secretaries of Defense, the Air Force, and Labor; the Director, Office of Management and Budget; the Commissioner of the Department of Labor in the State of Alaska; and the contractor, FELEC Services, Inc. Copies will also be made available to other parties upon request.

Sincerely yours,

A handwritten signature in cursive script that reads 'Frank C. Conahan'.

Frank C. Conahan
Director

Executive Summary

On September 14, 1983, six workers (four contractor and two Air Force civilians) at Clear Air Force Station, Alaska, were exposed to radiofrequency radiation in excess of established safety standards. Much controversy exists concerning the exact nature and extent of injury that may result from any overexposure. (See pp. 8 to 10.)

Representative Don Young requested that GAO investigate the conduct of the Air Force and the contractor—FELEC Services, Inc.—as it relates to the accident. Specifically, Congressman Young asked GAO three questions about what happened before and after the accident:

- Has the contractor totally fulfilled all contractual obligations?
- Were Air Force actions in administering the FELEC contract beyond reproach?
- Have the affected employees been afforded the best medical evaluation, treatment, and follow-up entitled to them by law?

Background

Clear Air Force Station is one of three sites which together comprise the nation's Ballistic Missile Early Warning System. The mission of this system is to provide the national military command centers early warning of an intercontinental ballistic missile attack directed toward North America and accurate satellite detection and tracking data. FELEC Services, Inc., is the contractor responsible for the operation and maintenance of the system at Clear. (See pp. 10 and 11.)

According to Air Force and contractor investigation reports, a FELEC technician accidentally energized a radar which exposed the workers to its radiation. These reports attributed the accident to the inadvertent actions of a contractor technician. (See pp. 15 to 18.)

The radars at Clear radiate energy in the radio band of the electromagnetic spectrum. Such energy can cause injury by heating body fluids. The effect is analogous to microwave cooking.

Results in Brief

The technician's action resulted in the workers' exposure because the equipment at Clear was not laid out and operated as required by the contract. Contractor noncompliance with contract specifications and systemic problems in Air Force contract management practices allowed the accident to happen and to go undetected for 8 minutes.

There was some delay in providing medical evaluations to the victims immediately following the accident. However, the victims have received extensive medical evaluations by Air Force and private physicians since the day after the accident. GAO is not in a position to evaluate the differences in medical judgments regarding the extent of injury sustained by or treatment provided to the individual victims of the accident.

Principal Findings

Before the accident the contractor did not change existing key interlock safety systems, designed to protect employees from accidental exposures, to conform to the contract specifications. Those interlocks that were installed were not used in an effective manner. (See pp. 18 and 24.)

Also prior to the accident neither the Air Force nor the contractor made necessary changes to the waveguide layout and transmitter switching equipment which would have properly aligned the tracker radar with its primary transmitters. (See pp. 22, 24, and 37.)

On the day of the accident, the contractor had reduced staffing in key control rooms below the minimum manning required. Maintenance technicians on duty were not fully qualified to perform in their assigned positions. (See p. 25.)

Air Force quality assurance evaluators monitoring the FELEC contract were neither technically trained in radar operation and maintenance nor did they have prior training or experience in procurement procedures or contract administration. GAO believes the evaluators lack of adequate training permitted the contractor's noncompliance to go undetected. (See pp. 32 to 36.)

Recommendations

In order to reduce the likelihood of another radiation accident at Clear Air Force Station, GAO recommends that the Secretary of the Air Force direct the Commander of Space Command to

- conform the key interlock safety system with design specifications and ensure all safety procedures are properly used,
- make necessary configuration changes to properly align prime transmitters with corresponding radars,
- require the contractor to comply with minimum staffing requirements and ensure that technicians are fully trained and qualified, and
- assign only adequately trained and experienced personnel as quality assurance evaluators.

GAO also recommends that the Secretary conduct a survey to determine if similar problems exist at other radar installations. (See p. 48.)

Comments

GAO solicited comments on a draft of this report from the State of Alaska, the Department of Defense (DOD), the Department of Labor and the contractor. The State of Alaska and DOD concurred with GAO's report. (See app. II and III.) The Department of Labor had no comments. The Air Force has proposed actions which should be fully responsive to all but one of GAO's recommendations. The actions proposed in response to the recommendation concerning the waveguide layout and transmitter switching would not correct the underlying problem. The Air Force now recognizes this and is restudying the matter. (See p. 48.)

The contractor believes GAO's report misrepresents the true facts of the case and circumstances surrounding the accident. In general, the contractor stated it had no responsibility for failure of the safety system, waveguide layout or transmitter switching equipment to conform to specifications, and that in any event the accident was not the result of these equipment configuration deficiencies. Furthermore, the contractor contends that the maintenance technicians who it had assigned were fully qualified. The contractor's comments, which are included as appendix IV, have not led GAO to alter its conclusions. GAO's evaluation of the comments are in chapter 3. (See pp. 27 to 30.)

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Abbreviations

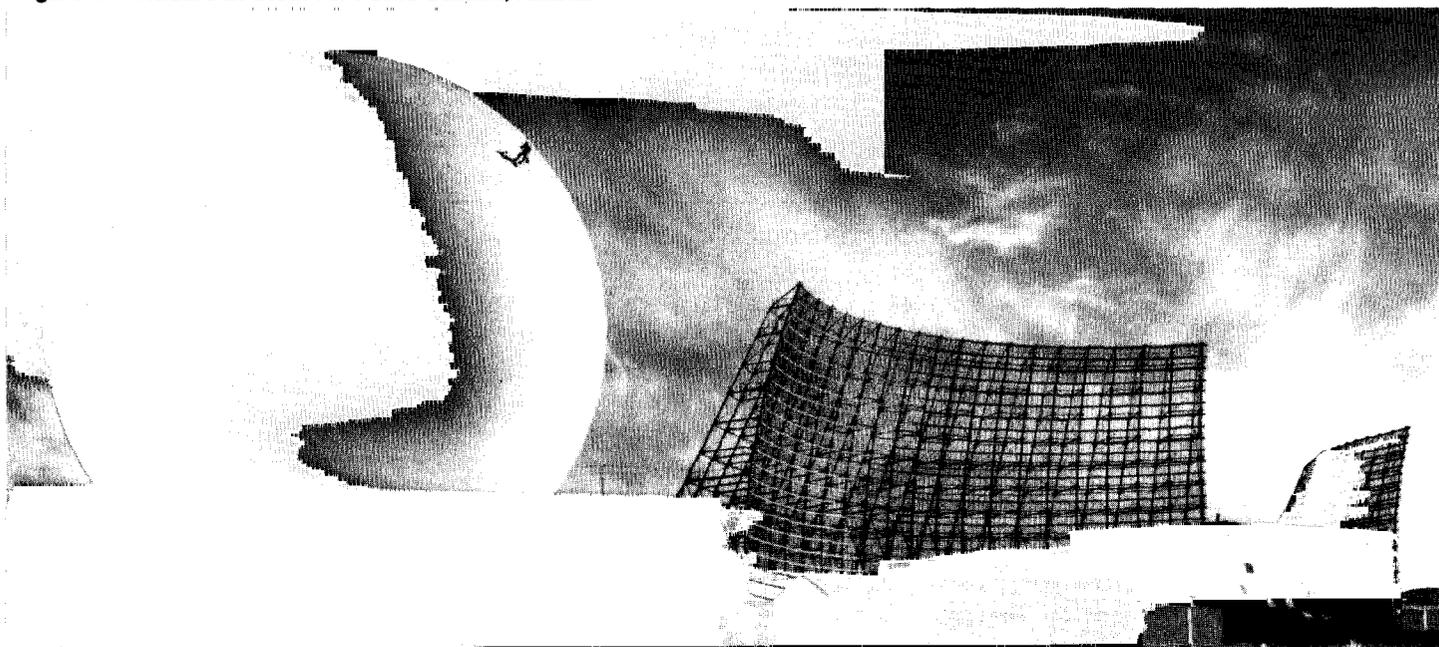
CSMR	Central System Monitoring Room
DOD	Department of Defense
DRAM	Detection Radar Automatic Monitoring
EPA	Environmental Protection Agency
FSI	FELEC Services, Inc.
GAO	General Accounting Office
OSHA	Occupational Safety and Health Administration
QAE	Quality Assurance Evaluator
RF	Radiofrequency
TRAM	Tracking Radar Automatic Monitoring
USAFSAM	U.S. Air Force School of Aerospace Medicine

Introduction

On September 14, 1983, six contractor employees and two Air Force civilian employees were exposed to radiofrequency (RF) radiation for about 8 minutes while working on a tracking radar antenna at Clear Air Force Station, Alaska. A maintenance technician accidentally turned on the radar as these employees performed routine maintenance work during a normal shutdown. Subsequent investigations showed that the six employees working on the antenna were exposed to RF radiation in excess of established safety standards. The other two employees were exposed to radiation within the permissible exposure level.

The tracking radar, where the accident occurred, is housed atop a building in a 140-foot diameter sphere, called a radome. (See fig. 1.1.) Six employees were on the antenna more than 50 feet above the radome floor, and two employees were working on the radome floor when another technician working elsewhere in the building inadvertently turned on the system. Six of the exposed workers—two radar technicians, two welders, and two electricians—were employed at FELEC Services, Inc. (FSI), the operation and maintenance contractor at Clear. The other two workers were Air Force civilian employees from the Air Logistics Center in Sacramento, California, inspecting repairs being made to the radar antenna.

Figure 1.1: Radars at Clear Air Force Station, Alaska



Health Effects of RF Radiation

RF radiation is a form of non-ionizing radiation commonly used for communication, national defense, and manufacturing. This form of radiation, contrasted to high energy ionizing radiation sources such as x-rays and nuclear energy, differs in how it affects the human body and its potential for causing harm. The extent to which exposure to RF radiation will produce any immediate adverse effects on human health is unknown. Moreover, there is much controversy concerning the long-term medical effects of any overexposure.

About 1 week after the accident, Air Force officials performed an RF radiation survey¹ at Clear in an attempt to reconstruct the events leading up to and during the accident. Radiation levels were taken to estimate employees' exposure levels at various work locations. In August 1984 officials from the Occupational Safety and Health Administration (OSHA) conducted a second radiation survey.² The findings and analysis of both surveys showed that six of the eight employees were exposed to excessive levels of RF radiation. The surveys did not address the question of whether the overexposure caused any adverse effects on the victims' health.

The level of exposure to RF radiation is dependent on (1) the distance of the individual from the source, (2) the intensity of the source, (3) the duration of exposure, and (4) the frequency or wavelength of the source. RF radiation loses energy as it is absorbed by human tissue because it has relatively long wavelength, low frequency, and low penetrating energy level. However, RF radiation produces heat, and, depending on the factors mentioned above, cell damage can occur. The effect is analogous to microwave cooking.

The growing number of radiation sources has led to an increased awareness of potential hazards. Common sources of non-ionizing radiation include

- radio and television antennas,
- visible light,
- satellite communication systems,
- radars, and

¹Department of the Air Force, Headquarters Alaskan Air Command, Elmendorf Air Force Base, Alaska, Subject: Investigation of RF Overexposure, Clear AFS, AK, 23 Nov. 1983.

²U.S. Department of Labor, Occupational Safety and Health Administration, Region X, Microwave Exposure Incident, Ballistic Missile Early Warning Site, Clear Air Force Base, Alaska, October 25, 1984.

- video display terminals.

The American National Standards Institute developed occupational standards in 1966, establishing permissible exposure levels to RF radiation. The Institute serves as a clearinghouse for nationally coordinated voluntary safety, engineering and industrial standards, and represents the United States in international standardization work. The Institute's standards were adopted in 1971 by OSHA. Air Force regulations have been consistent with OSHA standards. However, in October 1984, the Air Force revised the permissible exposure levels for RF radiation. It now uses standards established by the American Conference of Governmental Industrial Hygienists for occupational exposures and by the Institute for the general population. The exact nature and extent of injury that results from a particular degree of exposure to RF radiation is uncertain and continuing study by medical and scientific experts may suggest further changes in allowable exposure levels to RF radiation.

Studies have shown that the two organs at greatest risk of RF radiation injury are the testicles and eyes because of their inability to dissipate heat. One study prepared by the Congressional Research Service³ has shown that excessive heat can damage the cardiovascular system and can result in behavioral changes. The Environmental Protection Agency (EPA) recently made a critical review⁴ of the available literature on the biological effects of RF radiation. A principal finding of the EPA study was that no convincing evidence exists that exposure to RF radiation shortens the life span of human beings or that RF radiation is a primary cancer producing agent.

Clear Air Force Station: Its Role and Operation

Clear Air Force Station, located about 80 miles southwest of Fairbanks, Alaska, performs a significant and vital role in the nation's ballistic missile defense system. Clear, along with similar installations at Thule, Greenland, and Flyingdales Moor, England, comprises the nation's Ballistic Missile Early Warning System. The mission of Clear is to provide early warning of an intercontinental ballistic missile attack directed toward North America, and accurate satellite detection and tracking data. Clear's three massive detection radars and one tracking radar provide attack warning and assessment data to command centers at the

³Congressional Research Service, Non-ionizing Radiation: Health and Safety Issues in the 98th Congress, Issue Brief number 1B83112, updated January 20, 1984.

⁴Environmental Protection Agency, Health Effects Research Laboratory, Biological Effects of Radiofrequency Radiation, September 1984.

North American Aerospace Defense Command, the Strategic Air Command, and the National Military Command Center. Approximately 190 Air Force and civilian workers and approximately 200 contractor personnel work together to fulfill Clear's mission.

FSI, a subsidiary of Federal Electric Corporation and ITT Corporation, operates, maintains, and supports the mission at Clear under contract with the Air Force Space Command. FSI became the operation and maintenance contractor at two sites—Clear, Alaska, and Thule, Greenland—on September 1, 1975. The current contract, awarded in 1982, is a firm-fixed price contract with cost reimbursable elements. The contract includes provisions for the initial year and four option years, through fiscal year 1987. The total estimated contract amount for the 5-year period is \$266.5 million. Clear's portion of the estimated total cost for the same period is \$123.6 million.

Objectives, Scope, and Methodology

In a letter dated March 8, 1984, Representative Don Young requested us to perform a detailed investigation into the conduct of the Air Force and FSI in responding to the radiation accident at Clear, Alaska. Specifically, we were asked to determine whether:

- FSI has totally fulfilled all required services in compliance with the terms of the contract and the statement of work dated October 1, 1982.
- Air Force actions in administering the Ballistic Missile Early Warning System contract were beyond reproach.
- Affected employees have been afforded the best available medical evaluation, treatment, and follow-up entitled to them under law.

To accomplish our objectives, we interviewed officials and staff or obtained data from the following:

U.S. Air Force

- Headquarters, Space Command, Colorado Springs, Colorado
- Headquarters, 1st Space Wing, Peterson Air Force Base, Colorado Springs, Colorado
- 13th Missile Warning Squadron, Clear Air Force Station, Clear, Alaska
- Headquarters, Alaskan Air Command, Elmendorf Air Force Base, Anchorage, Alaska
- Eielson Air Force Base, Fairbanks, Alaska
- Office of the Surgeon General, Headquarters, U.S. Air Force, Bolling Air Force Base, Washington, D.C.

- Air Force School of Aerospace Medicine, Brooks Air Force Base, San Antonio, Texas
- Air Force Occupational and Environmental Health Laboratory, Brooks Air Force Base, San Antonio, Texas
- Air Logistics Center, McClellan Air Force Base, Sacramento, California

Contractor

- FSI Project Headquarters, Colorado Springs, Colorado
- FSI, Site II, Clear Air Force Station, Alaska

Other Agencies

- OSHA, U.S. Department of Labor, Seattle, Washington
- OSHA, Health Response Team, Salt Lake City, Utah
- OSHA, Area Office, Anchorage, Alaska
- Alaska Department of Labor, Division of Labor Standards and Safety, Anchorage, Alaska

We interviewed Air Force officials and FSI employees, obtained and reviewed records relating to each activity's involvement in investigating and following up the RF accident. This entailed reviews of the contract, correspondence, investigations, and reports related to the accident. We interviewed five of the six employees who were overexposed to RF radiation as a result of the accident. We did not meet with the two employees who were not overexposed or with the other employee who is no longer employed by FSI. Our Chief Medical Advisor reviewed medical records and interviewed Air Force and private physicians involved in the evaluation, treatment, and follow-up of the affected employees. We did not evaluate the differences in medical judgment regarding the extent of injury sustained by, or the treatment provided to, the victims of the accident. We also did not attempt to determine if any of the victims had or will be adequately compensated by the contractor or the government for relevant medical evaluations, treatment, or follow-up under state or federal law. It will ultimately be the prerogative of the courts to make such a determination. We did, however, look at the question of whether the victims received the medical care to which they were entitled under the terms of the contract. We performed our review between June 1984 and March 1985 in accordance with generally accepted government audit standards.

In September and October 1985 we revisited Space Command Headquarters and the installation at Clear to facilitate our evaluation of the comments we received from the Department of Defense (DOD) and the contractor on the draft of this report.

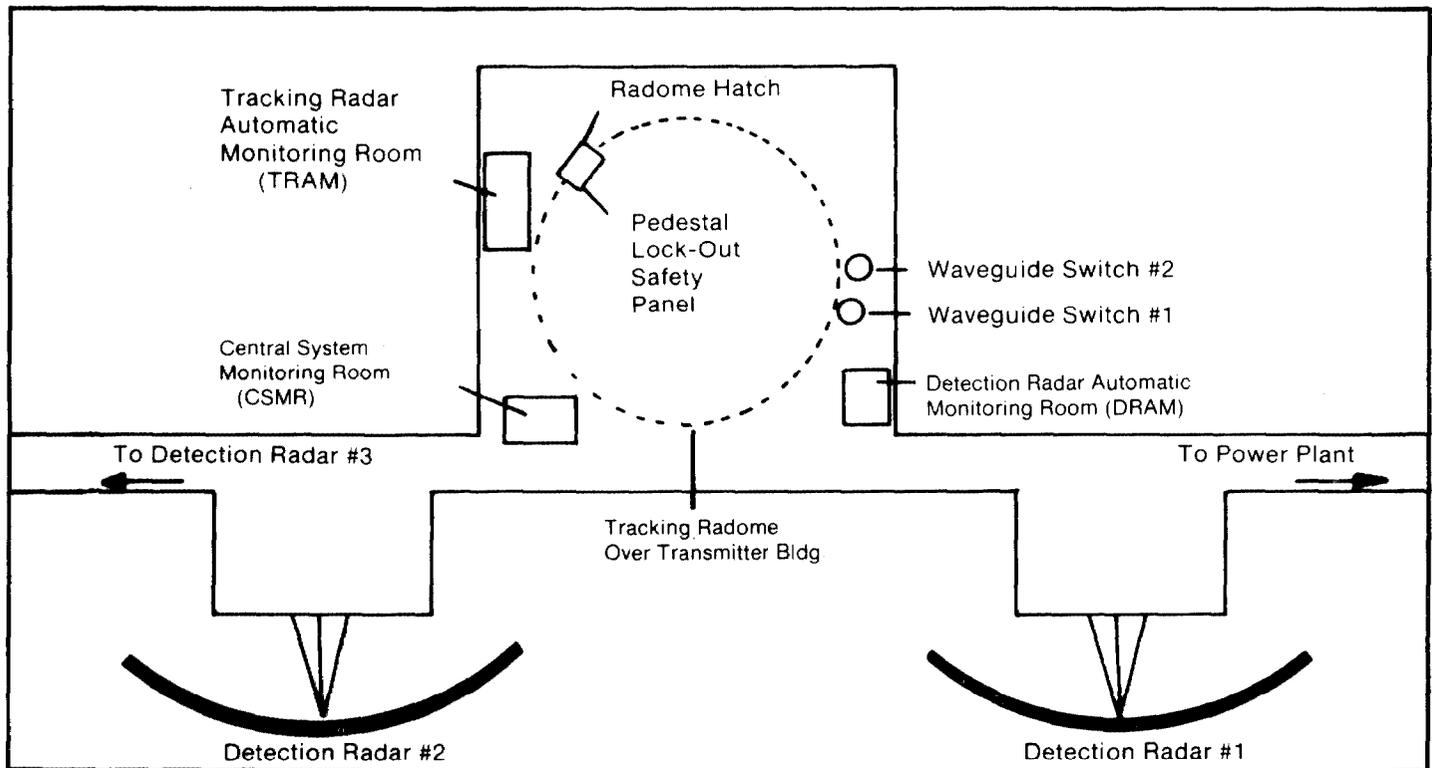
Technical Deficiencies Permitted the Accident to Occur

FSI and the Air Force issued investigation reports describing how the accident happened, identifying causes, and recommending actions to prevent future accidents. Both reports attributed the primary cause to the inadvertent actions of an FSI technician who allowed a transmitter to radiate RF energy onto the antenna where the employees were working. The reports did not note, however, that the technician's actions could not have produced that result if the tracking radar system had been configured and operated in conformance with applicable technical orders.

Key Control Elements Needed to Operate Radars Safely

The control facility at Clear houses rooms used to operate and oversee the tracker and detection radars. In conjunction with the Tracking Radar Automatic Monitoring (TRAM) room and the Detection Radar Automatic Monitoring (DRAM) room, there is also a Central System Monitoring Room (CSMR). (See fig. 2.1.) From these rooms, technicians routinely direct megawatts of power from a series of transmitters, through metal ducts called waveguides to energize the radars. As part of the

Figure 2.1: Technical Building Layout



technical design of the radar facility, a key interlock system is incorporated as a safety measure. The interlock system allows technicians to close the waveguide switches while carrying out preventive maintenance procedures, in order to protect personnel in the radome from hazards due to transmitter radiation.

Compliance with Air Force technical orders referenced in the contract and statement of work is mandatory. The technical order system is used to disseminate military orders of a technical nature to people or organizations with a need to know, such as contractors. Each individually numbered order provides the technical information, instructions, and safety procedures required to operate, install, maintain, inspect, or modify Air Force systems and equipment. All Air Force systems, subsystems, support equipment, and other equipment should be operated and maintained according to the procedures contained in relevant technical orders, unless excluded or waived in accordance with regulations.

Circumstances Leading to the Accident

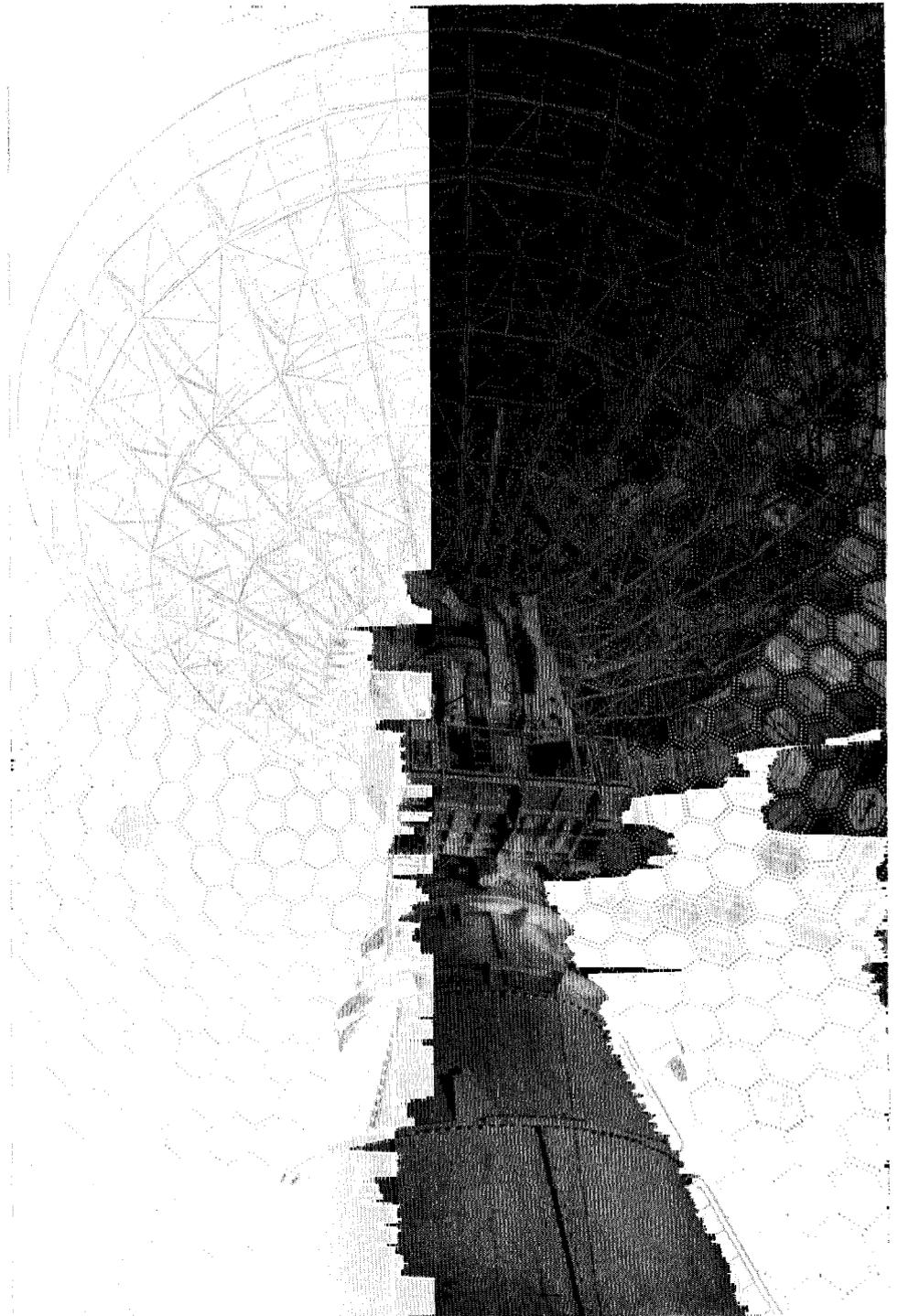
Air Force regulations require investigations and reports of all accidents for the purpose of determining their causes and implementing appropriate preventive actions. FSI issued its safety investigation report⁵ on the accident in November 1983. The Air Force issued an investigative report⁶ in December 1983 with essentially the same data as that reported by FSI. Both the FSI and the Air Force reports attributed the cause of the accident to human error. These reports described the circumstances surrounding the accident and some of the causes as follows:

About 9:45 a.m. on September 14, 1983, an employee shut off the tracking radar for routine scheduled inspection and repair of the antenna. (See fig. 2.2.) The tracking team leader (the senior maintenance technician on duty) turned off power to the two transmitters which supplied RF energy to the tracking radar and threw switches to close the waveguides, which confine and guide the RF radiation from the transmitter to the antenna. Closing these switches effectively cut the conductive path between the transmitters and the antenna. The switches could only be reopened with an interlock key, which was then deposited

⁵FELEC Services Inc., Report of Investigation - Tracker Radar Radiation Incident on 14 September 1983, Clear MEWS, Alaska (updated), Nov. 29, 1983.

⁶U.S. Air Force, 1 Space Wing, Peterson Air Force Base, Colorado, Ground HAP Supplemental/Final Report, Dec. 19, 1983.

Figure 2.2: Tracking Radar at Clear Air
Force Station, Alaska



in the Central System Monitoring Room (CSMR) by the team leader, in accordance with local procedures.

Throughout the rest of the morning and the early afternoon, the antenna was inspected by two Air Force employees from the Sacramento Air Logistics Center and repaired by two FSI welders. In order to make the best use of tracker downtime, two tracking radar technicians were assigned to assist the welders and other team members with inspection and repair. Two FSI electricians had also been assigned to install floodlights on the radome floor during the downtime.

About 2 p.m., as work proceeded in the radome, the team leader picked up the interlock key from the CSMR and began a preventive maintenance routine that involved checking the proper operation of the radar's safety system. While performing the routine, he reopened the waveguides. This restored the conductive path between two transmitters and the tracking antenna, but these transmitters, numbers 23 and 27, were not operating at the time because electrical power had been shut off.

Neglecting to close the waveguide switches, the team leader proceeded to the Tracking Radar Automatic Monitoring (TRAM) room and began drafting a revision to the instruction describing the maintenance routine. Approximately 3:20 p.m., while continuing to work on the revision, power to transmitter 28, which was supplying RF energy to the detection radar, was interrupted. Other personnel quickly restored power, and transmitter 28 resumed the supply of RF energy to the detection radar. However, this brief interruption caused the switching control mechanism to shift to the manual or "emergency" transmitter selection mode.

The team leader was sitting at the TRAM console rewriting the maintenance instruction when he noticed that the panel indicated the mode had changed to "emergency," and he went to the transmitter floor and pushed a switch to select the "normal" mode of operation. This action initiated a sequence of automatic control functions. Within 10 seconds, the RF output of transmitter 28 was switched from the detection to the tracking radar. Apparently, the team leader was returning to the TRAM by the time this sequence of operations was complete.

When the team leader returned to the console, the equipment controller in the CSMR called him and said he had an indication that transmitter 28 was radiating into the tracking radar. The team leader then returned to the switching cabinet and disconnected transmitter 28 from the tracking

radar. By this time, the transmitter had been radiating onto the tracking antenna for 8 minutes, from 3:40 p.m. to 3:48 p.m.

Work on the antenna had proceeded normally until approximately 3:40 p.m., when a team member went to inspect a point on the face of one of the antenna sections and noticed that his flashlight was blinking on and off, or "neoning." He then returned to the center of the antenna where he asked to borrow another flashlight to complete the job. The team member offered his flashlight and, while removing it from his pocket, noticed that the bulb was also neonning. He checked the flashlight to see if it was on and found that it was in the off position. At this point, one of the technicians and a welder both surmised that the tracking radar was radiating and signaled all personnel to leave the radome.

Safety System Interlock Deficiencies Permitted Accident to Occur

Configuration and operation of the tracking radar interlock system, in accordance with the applicable technical orders, would have prevented any RF energy from reaching the antenna even with the waveguide switches remaining open as they were when the accident occurred. However, configuration and operation was at variance with the technical order and defeated the interlock's function.

Figure 2.3 shows the key interlock system as required by the technical order and as operated on the day of the accident. The order and related specifications describe the following safety system procedures and key interlock mechanisms that must be followed before anyone can enter the radome:

- Rotate and remove the interlock key from the tracker maintenance console to initiate the first of the interlocks. This action disables transmitter radiation and antenna movement.
- Insert a second key, which is attached to the console key by a ring, into a lock on the first of the two waveguide switches in the system. This disables transmitter radiation and unlocks a handle which, when rotated, holds the first two keys captive. Rotating the switch handle also physically blocks the path of radiation between the transmitters and the antenna and exposes a third key.
- Use the third key to perform the same function on the second waveguide switch. Rotating the switch handle holds the third key captive, exposes a fourth key and lights a "SAFE TO ENTER" indicator above the radome door and a "RADIATION DISABLED" indicator in the area.
- Use the fourth key to unlock the radome hatch door. The design specifications for the door also include an interlock element, which was never

installed. The technical order calls for opening the door by depressing an "OPEN" pushbutton, which opens the door and further assures transmitter radiation is disabled.

- Insert the fourth key into the pedestal lock-out safety panel located near the door. Rotating this key to the "LIGHTS ON" position holds it captive, lights maintenance lamps in the radome, and provides final assurance that transmitter radiation is disabled.

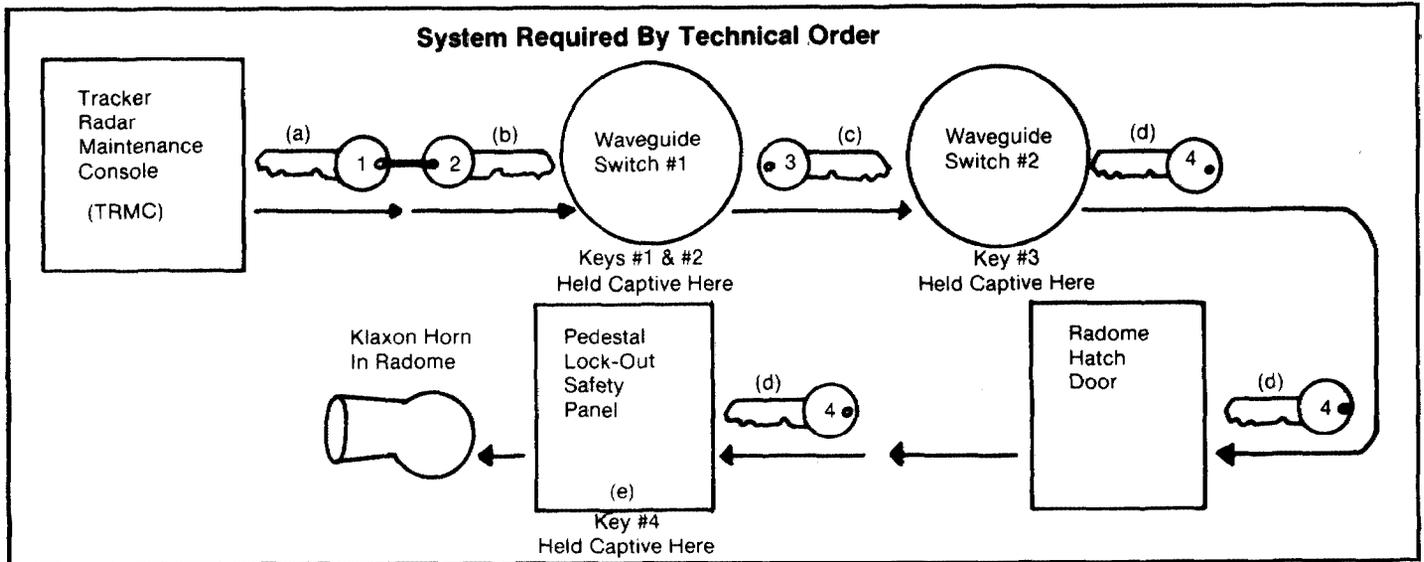
Radome exit procedures are exactly reversed from the order listed above.

Rotating key #4 in the pedestal safety panel to the "LIGHTS OFF" position and removing the key is the only method of obtaining keys for reopening the waveguide switches and recovering the tracker radar console key (#1) because this key is still held captive in the first waveguide switch. Removing key #4 causes maintenance lights in the radome to go out and sounds a klaxon horn-type alarm in the radome for 30 seconds.

This alerts personnel in the radome to immediately evacuate, because transmitter radiation and antenna movement could follow.

Even though the contract and related technical orders provide clear and extensive guidance on operation and use of the tracking radar safety system interlock, FSI instructions to employees, covering radome access procedures, omit significant elements of the system. FSI site instructions do not treat key #1 as a part of the interlock system. Consequently, on the day of the accident, this key was left in the console while the team leader performed the preventive maintenance routine, leaving the antenna operable and capable of emitting radiation. Key #2, which is the first waveguide switch key, and normally hung by the Tracking Radar Automatic Monitoring (TRAM) room door, along with the radome hatch door key (#5), had been separated from key #1.

Figure 2.3: Key Lock-Out System Design Specifications Versus FSI Procedures



^aRotation and removal disables transmitter radiation and antenna movement.

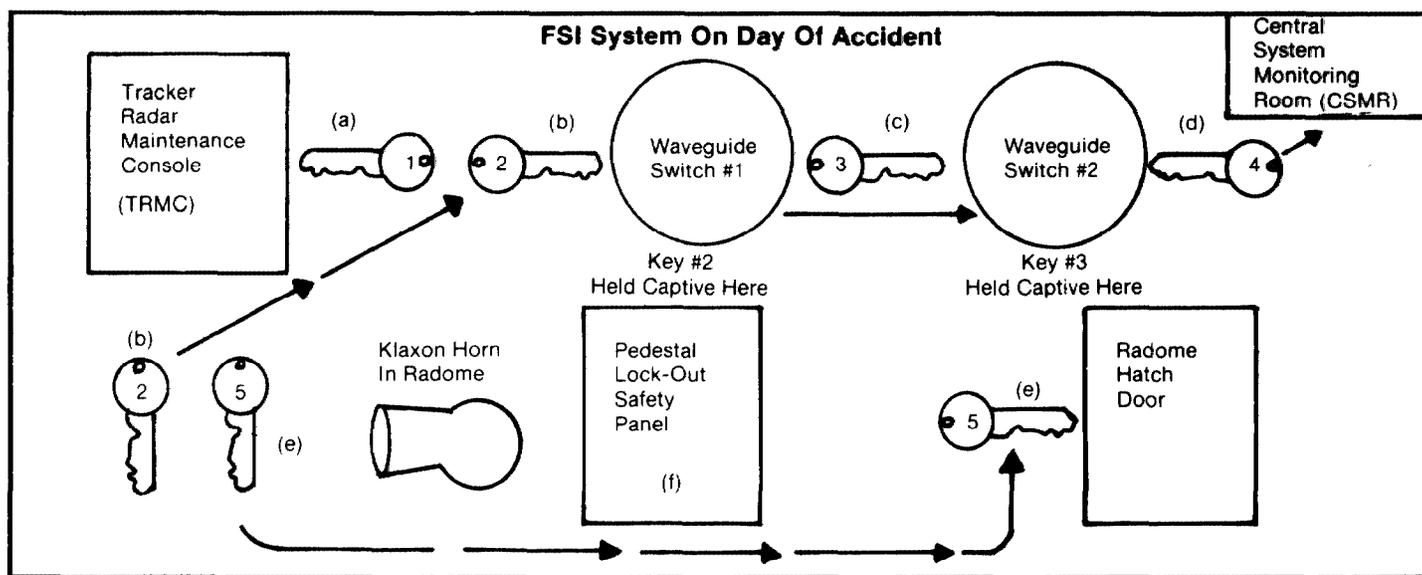
^bAttached to key #1. Unlocks waveguide switch, rotation of handle physically blocks transmitter radiation and exposes key #3.

^cPerforms functions in (b) above on waveguide switch #2, exposing key #4.

^dDesign specifications call for key #4 to open radome hatch door with an interlock to disable transmitter radiation, but this interlock has never been installed. Key #4 then goes in the pedestal lock-out safety panel which turns on maintenance lights in the radome and disables transmitter radiation.

^eRemoval of key #4 turns out maintenance lights and sounds klaxon horn in radome for 30 seconds.

**Chapter 2
Technical Deficiencies Permitted the
Accident to Occur**



^a FSI procedures did not consider this key as a part of the safety interlock system. It had been separated from key #2 and remained in the console.

^b Hangs on wall in Tracker Radar Automatic Monitoring (TRAM) room until needed to open waveguide switch #1. See (b) on page 20.

^c See (c) on page 20

^d Held by System Controller in CSMR.

^e Hangs with key #2 in TRAM.

^f FSI procedures did not consider or use this interlock.

FSI instructions state that when a technician removes key #4, after closing the second waveguide switch, the key should be delivered to the Central System Monitoring Room (CSMR). However, delivery of the key to the CSMR omits using the pedestal lock-out safety panel, which had been bypassed. If key #4 had been used in accordance with the specifications, the maintenance lights would have gone out and the klaxon horn would have sounded for 30 seconds before the team leader could have opened the second waveguide switch. Thus, the workers in the radome would have had a warning that they would no longer be protected from transmitter radiation or antenna movement.

Waveguide Layout and Transmitter Switching Deficiencies Also Permitted Accident to Occur

When the radars at Clear were constructed in 1961, waveguide layout, wiring, and automatic switches between transmitters and the detection and tracking radars were not installed in conformance to the original design and operating specifications in the technical order covering operation and maintenance of the tracking radar. Configuration and use of transmitters providing RF radiation to the tracking radar are not compatible with the monitoring and control equipment in the Detection and Tracking Radar Automatic Monitoring (DRAM and TRAM) rooms. If this equipment had been properly configured, the accident would not have occurred. When the team leader pushed the "normal" mode switch, automatic switching in the tracking radar console would have selected inoperative transmitters and RF energy would not have been supplied to the antenna.

There are three transmitters (designated as numbers 23, 27, and 28) which can be switched into the tracking radar. The tracking radar requires output from two transmitters to be fully functional; original design specifications designated transmitters 28 and 29 as the prime tracking radar transmitters, and 27 as backup tracking transmitter. Prior to installation of transmitters 28 and 29, however, the Air Force decided to use numbers 23 and 27 as the prime tracking transmitters, even though these transmitters had already been installed as primary detection radar transmitters. While the transmitters have been used in this way, no corresponding changes were made in the waveguide layout, wiring, and automatic switching functions. Furthermore, the transmitter monitoring and control equipment for the prime detection radar transmitters (28 and 29) are in the TRAM room, while those for the tracking radar transmitters (23 and 27) are in the DRAM room.

Technicians at the site told us that this normally does not present a problem when experienced, qualified technicians are manning the control rooms. Although the rooms are at opposite ends of the building, they are connected by phone and problems can usually be resolved. However, on the day of the accident, the TRAM room was unattended. FSI management had assigned unqualified and inexperienced technicians in the DRAM room and CSMR, and the System Controller was not on duty in the CSMR. (See p. 25.)

Despite these staffing problems and the errors attributed to the team leader, the accident would not have happened if either the contractor or the Air Force had corrected the transmitter layout design as required by contract provisions and regulations governing technical orders. If these

changes had been made, the automatic switching control, when energized by returning it to the "normal" mode, would have preselected a transmitter that had been turned off since 9:45 a.m. on the day of the accident.

Other Operative Factors

If control rooms had been fully staffed with qualified personnel, the transmitter switching error would likely have been quickly recognized and corrected, and the radiation exposure probably would not have continued as long as it did. This matter is discussed more fully in chapter 3.

Effective government contract management should have identified and led to correction of the problems discussed in this chapter. If the Air Force's quality assurance evaluators had been fully trained and had adequately performed their surveillance duties, conditions at the site should have prevented the accident from occurring. This matter is discussed more fully in chapter 4.

Contractor Compliance With Contract Terms Should Have Prevented the Accident or Substantially Reduced Radiation Exposure

FSI's noncompliance with its contract permitted the accident to occur and the radiation exposure to continue as long as it did. FSI never proposed, as required by the contract, to change the safety interlock system to conform to the technical order specification, nor did it use those interlocks that were installed. Similarly, FSI never proposed, as required by the contract, to correct transmitter and waveguide layouts to conform to the original design specifications. FSI also did not comply with contract terms relating to minimum staffing of fully qualified technicians in monitoring and control rooms on the day of the accident.

Contractor Should Have Reported That Equipment Layout Needed to Be Changed

FSI is obliged by its contract to operate the Clear installation in strict compliance with applicable technical orders. However, it is impossible for FSI to operate in accordance with the technical orders because the equipment at Clear is not installed in conformity with the design specifications on which the technical orders are based. When FSI assumed responsibility for the operation and maintenance at Clear, it did not notify the Air Force, as required by its contract, that the equipment layout did not conform to the technical orders and accordingly, did not propose the necessary changes.

The following contract requirements direct FSI to verify and use the safety interlocks and transmitter switching mechanisms in specific ways. Moreover, they oblige FSI to notify the Air Force and propose corrective action when design layout discrepancies exist.

- Technical Order 00-5-1, Air Force Technical Order System.
- Technical Order 31P1-2FPS49-2-1, Radar Set Group, Radomes, and Antenna Groups.
- Technical Order 31Z-10-4, Electromagnetic Radiation Hazards.
- Air Force Occupational Safety and Health Standard 161-9, Exposure to Radiofrequency Radiation.
- The contract Statement of Work.

A cursory inspection would have identified substantial nonconformity between the actual configuration of equipment and the design on which the technical orders were based. The safety interlock system was obviously compromised with keys #1 and #2 separated and with the pedestal lock-out panel bypassed and inoperative. The waveguide layout, wiring, and automatic switching problems were not latent discrepancies—particularly not with the improper location of the transmitter monitoring and control equipment in the Tracking and Detection Radar Automatic Monitoring (TRAM and DRAM) rooms. (See pp. 22 and 23.)

In violation of several technical orders in the contract and FSI's own safety manual, FSI management has routinely issued instructions to workers to bypass safety system interlock mechanisms covering radome entrance and exit procedures. Had the design compelled the tracker team leader to use all of the safety system interlocks according to the technical order for the operation and maintenance of the tracking radar and other contractual safety directives, he could not have performed the routine that ultimately initiated the accident. The lights in the radome would have gone out and the klaxon horn would have sounded, alerting workers that radiation and antenna movement could occur.

Contractor Did Not Comply With Minimum Staffing Requirements

On the day of the accident, FSI management had reduced staffing in the Central System Monitoring Room (CSMR) below the minimum essential manning required in the contract's Statement of Work. Maintenance technicians on duty in the CSMR and DRAM room were not fully qualified to perform in their assigned positions, as defined by the contract, and the TRAM room was left unattended. In our opinion, fully qualified technicians occupying the required positions would have immediately identified the problems associated with the equipment layout and taken corrective action to prevent, or at least minimize, the exposure of the personnel working on the tracking antenna.

The contractor must provide sufficient, fully trained staff on each shift to continuously monitor the information displayed on the maintenance consoles in the DRAM and TRAM rooms. The Statement of Work provides for a minimum manning level per shift to monitor tracking and detection radar information displayed in control rooms. It also requires that a minimum of one qualified system controller and two qualified equipment controllers be on duty in the CSMR, where all radars on the base are monitored, during each shift. Under certain circumstances, CSMR manning may be reduced to one qualified system controller and one qualified equipment controller, the minimum essential manning level per shift. In addition, the Statement of Work provides that the contractor shall ensure that all maintenance technicians, including multiple utilization technicians (technicians assigned to a variety of jobs on a rotating basis), are fully qualified on all assigned equipment. It defines "fully qualified" as that expertise necessary to predict, identify, and resolve equipment problems, and the ability to complete all maintenance actions quickly and accurately.

To implement the qualification requirement, the contractor has established a training philosophy, relying primarily on formal and informal

on-the-job training programs. Specific equipment proficiency training material has been developed and incorporated into formal training packages. Work center supervisors initiate the site training process by assigning maintenance technicians to a team leader upon their arrival at the site. The supervisors are responsible for ensuring that appropriate training packages are provided to the technicians for the equipment they will be operating or maintaining. For example, packages have been developed for the operation and maintenance of the detection radars, the tracking radar, and the Central System Monitoring Room (CSMR), among others. In addition, the contractor must maintain training records for all maintenance technicians, showing all training received and the degree of qualification attained.

On the day of the accident the system controller assigned to the CSMR reported for work, but FSI management gave him the day off. This left two equipment controllers on duty, one fully qualified in that position and the other not fully qualified, according to FSI training records. Neither employee was qualified as a system controller. One maintenance technician had been assigned to monitor the information displayed in the Detection Radar Automatic Monitoring (DRAM) room; however, FSI records show that he had not completed any of the 11 training packages necessary to qualify as a maintenance technician on detection radar equipment. FSI management had not assigned anyone in the Tracking Radar Automatic Monitoring (TRAM) room on that day.

A few minutes before the accident, the qualified equipment controller left the CSMR to deliver some documents to another work area. During this period, both the DRAM room and the CSMR were manned by untrained staff, neither of whom were able to identify or correct the transmitter switching between the detection and tracking radars. Only when the qualified equipment controller returned to the CSMR did he recognize the problem and take action to switch the operating transmitters from the tracking radar.

We interviewed the system controller who had been given the day off. He stated that it was unfortunate that the technicians on duty in the CSMR and DRAM room at the time of the accident had not been sufficiently trained to identify the transmitter changes occurring. He indicated that he, or any trained operator, would have taken immediate corrective action as a routine procedure. This should have limited the employees' exposure to only a few seconds, rather than the 8 minutes that occurred.

Contractor Comments and Our Evaluation

In comments on the draft of this report, the contractor argues that we were wrong to attribute the accident or the extent of the victims' overexposure to any deficiencies in the performance of the contract. (See app. IV.) In general the contractor denies any responsibility for the accident for the following reasons:

- The Air Force absolved him from responsibility for correcting any "deviate configuration" problems and either required or permitted him to follow local procedures at variance with the technical orders.
- The local procedures that the contractor had established would have been adequate to meet all safety requirements but for the team leader's human error.
- By having assigned fully qualified personnel in the DRAM room and CSMR the contractor was satisfying minimum essential manning requirements at the time of the accident.

We evaluated the contractor's argument and discussed each of the contractor's points with Air Force Space Command officials responsible for administering the contract. We also revisited the site of the accident in October 1985 and went over the circumstances of the accident with the contractor management personnel. We have found no basis on which to alter the substance of our message.

Substitution of Local Maintenance Instructions for Technical Orders

The contractor's comments acknowledge the "deviate configuration" of the Clear facility. The contractor states that on various occasions since 1962, it and previous contractors who operated at Clear, proposed changes to the technical orders. Those changes were proposed to conform the technical orders to local operating practices and requirements which in part, had been developed to accommodate the deviate configuration. According to the contractor, the Air Force disapproved these proposals, primarily because of economic considerations. The contractor states that records of these proposals are no longer available and that the proposals may not have addressed the tracker waveguide configuration deficiencies discussed on pages 22 and 23. To substantiate this, the contractor suggests that we take depositions from certain contractor employees and retired military personnel.

After acknowledging that the Air Force disapproved proposals to conform the technical orders to the local operating practices, the contractor comments go on to suggest that the Air Force approved the use of locally prepared site instructions in lieu of technical orders as contract specifications.

While we did not attempt to secure the depositions the contractor suggested, in October 1985 we visited the Clear installation to followup on this and other points. During the visit, the contractor's representative provided us copies of proposals prepared in 1967 and 1968 by a predecessor contractor. These proposals recommend changes that would enhance system reliability by changing the waveguide layout and transmitter switching, monitoring, and control configurations. The contractor representative acknowledged, however, that there was no documentation reflecting the disposition of these proposals.⁷ Air Force Space Command officials told us they know of no proposals that the contractor or its predecessors submitted to modify, correct, or accommodate the deficiencies in the interlock system, the waveguide layout, or transmitter switching equipment which were present when the accident occurred.

The Space Command officials also denied that the Command directed or authorized the contractor to deviate from the technical orders. The contracting officer has from time to time routinely approved "BMEWS Maintenance Operating Instructions." However, local, contractor-controlled, "Clear site instructions," to which the contractor presumably has referenced, are not similarly approved. The contracting officer notes that if a Maintenance Operating Instruction were to call for a procedure at variance with an applicable technical order, the "order of precedence" provisions in the statement of work would oblige the contractor to resolve such a conflict in favor of the technical order.

Adequacy of Local Instructions

The contractor asserts that its local interlock procedures, though at variance with the technical orders, would have adequately prevented the overexposure. The problem, according to the contractor, was the human error of the team leader. (The contractor does not explicitly identify the nature of this error, but, presumably, it was in not closing the waveguide switches more promptly.)

⁷By letter dated October 21, 1985 (see app. IV, p. 75), the contractor transmitted to GAO the two proposals mentioned above, and additional documentation including entries from a previous contractors' log book (1969-1972), and two Air Force memorandums dated 1967 and 1968 concerning proposed technical order changes. According to the contractor, this additional information supports its position that previous contractors at Clear submitted recommendations to reconfigure the detection and tracking radars and associated displays but were disapproved by the Air Force. We discussed this information with the contractor in an attempt to get clarification on the relevance of the additional information regarding FSI's contractual obligation with the Air Force. The contractor was not able to provide this clarification. It is the prerogative of the courts to determine the legal significance of the material presented.

In order to establish the adequacy of its local procedures, the contractor relies on the assertion that this 1983 incident was the first and only radiation safety mishap in 23 years of operation. In our review, however, we have identified four documented incidents which occurred at Clear between 1967 and 1985 whereby personnel were allegedly exposed to RF radiation. We have also seen other documentation involving lapses in the control of personnel access to RF hazardous areas.

The contractor's comments reflect an explicit appreciation for the fact that assuredly preventing RF radiation in the radome was critically dependent on positioning the waveguide switches 1 and 2. The comments go on to describe a local procedural instruction which authorizes the team leader to change the switch positions. This instruction effectively substituted the team leader's judgment for the interlock safeguards which were designed to prevent human error from permitting RF radiation to reach the radome without warning.

Minimum Staffing

The contractor states that because the tracker radar was scheduled to be shut down for maintenance, there was no need to assign anyone to man the Tracking Radar Automatic Monitoring (TRAM) room. For much the same reason, the system controller was given the day off. The contractor acknowledges this reduced the Central System Monitoring Room (CSMR) staff to two people, but states that this "minimum essential" level CSMR staffing is acceptable when a fully qualified "alternate system controller" and fully qualified equipment controller are on duty.

The contract calls for the TRAM room to be manned continuously, and makes no exceptions for instances when the tracker is scheduled to be shut down for maintenance. According to the contract, minimum essential manning of the CSMR is permissible only in "unpredicted and emergency circumstances" and only after Air Force operational personnel are notified and approve this reduced level of staffing. The contractor does not say that the Air Force approved the reduced CSMR staffing to the minimum essential level on the day of the accident, and we found no evidence of such approval.

In arguing that the two people assigned to the CSMR were fully qualified, the contractor proposes to substitute an employee's general work experience for system-specific proficiency training as the standard for determining whether that person qualifies as a system controller or an equipment controller. If this standard had been in effect, the contractor asserts that the two people assigned to duty in the CSMR would have

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been fully qualified, one as an alternate system controller and the other as an equipment controller on duty at the time of the accident.

The Statement of Work, in defining minimum essential staffing does not employ the term alternate system controller. In stating that the contractor did not satisfy the minimum essential manning requirement, we have used the qualification standard and training records in effect at the time of the accident.

The contractor also observes that there was no direct indication of the fact that transmitter 28 was feeding RF radiation into the tracker radar at the customary work stations in either the CSMR or in the DRAM room. We believe that a qualified equipment controller in the CSMR would have surmised what had happened when his instruments suddenly indicated that a portion of the detection radar antenna, previously served by transmitter 28, was not receiving RF energy. Indeed, it was precisely that indication which led the only fully qualified equipment controller to realize what had happened as soon as he returned to the CSMR.

Air Force Has Not Identified Nor Corrected Contractor Noncompliance With Contract Terms

Clear's resident Quality Assurance Evaluators (QAES) are Air Force personnel responsible for contract administration functions such as monitoring FSI's compliance with contract specifications. QAES assigned were neither technically trained in radar operation and maintenance nor did they have any prior training or experience in contract law and procurement procedures or general contract administration requirements. Because they serve only a 1-year tour of duty, QAES develop an insufficient familiarity with the extensive contract Statement of Work requirements and related technical data (more than 500 technical manuals, regulations, and technical directives) needed to effectively administer the contract. This lack of knowledge and experience compromised their effectiveness and permitted the contractor's noncompliance to go unnoticed.

Air Force contract performance evaluation teams and Air Force bioenvironmental engineers have also not identified and/or corrected instances of FSI's noncompliance with contract terms. In our opinion, an effective contract management team with adequate procedural guidance and training should have identified and corrected noncompliance problems cited in this and the preceding chapters before the accident occurred.

The Air Force also contributed to the accident by not verifying and validating the technical orders before awarding the contract to FSI. If this had been done, as required by Air Force regulations, the lack of conformity between the design described in the order and the actual configuration of equipment should have been identified and corrected. Thus, the accident could have been prevented.

On-Site Quality Assurance Evaluator Surveillance Program Did Not Effectively Monitor Contractor Performance

The QAE surveillance program at Clear did not identify contractor non-compliance with contract specifications because the QAES were untrained and inexperienced in the operation and maintenance of radars and the contract administration procedures. New QAES receive only a 2-day orientation at Space Command before assuming their positions. On 1-year assignments, QAES do not have sufficient time to gain the required knowledge of the procurement process or the technical directives relating to radar operations and maintenance. The checklist used to evaluate the contractor's performance was also incomplete, omitting several important points. Because of these deficiencies, the QAES did not effectively monitor contractor performance.

QAE Training Is Inadequate

QAES provide all on-site contract administration reviews for the Administrative Contracting Officer, located at the Space Command in Colorado Springs, Colorado. According to Air Force officials, trained and experienced contract administrators are not assigned at Clear because such positions are not authorized for a 1-year tour of duty at remote locations. Staff are selected for this assignment from a pool of Air Force personnel available for rotation to a 1-year assignment, regardless of prior training or experience in radar operations and maintenance or contract administration. Air Force officials told us that QAES with backgrounds in radar operations and maintenance are rarely assigned to Clear.

Prior to assignment to the site, new QAES are supposed to attend a 2-day orientation briefing at Space Command. The orientation familiarizes the new QAES with contracting; contract provisions, requirements, and the Statement of Work; QAE duties, responsibilities, reporting requirements, and recordkeeping; and conflict of interest and standards of conduct requirements.

While we did not interview the QAES assigned to Clear at the time of the accident, we did interview two QAES assigned at the time of our visit to the site. One of these evaluators had not received the 2-day orientation prior to being sent to Clear. Neither QAE had

- prior technical training or experience in the operations and maintenance of radar systems such as those at Clear,
- prior training or experience in contract administration,
- an understanding of the technical order requirements for operation and use of safety interlock mechanisms that must be used when entering the radome, or
- an understanding of the automatic switching and related equipment layout between the tracking and detection radars.

DOD, in its comments on our draft of this report (see app. III), stated that the Air Force is revising its QAE training program to improve the QAE's knowledge and understanding of both contractual and technical operations. In April 1984, the Air Force also revised its QAE assignment policy in order to select top caliber personnel who are technically qualified to fill future QAE positions. The new QAE assignment and training practices are positive steps to correct the problems identified in this report. However, the success of these new practices can only be determined after a period of actual assignment and rotation of new QAE personnel.

QAE Checklist Incomplete

Contract management staff at Space Command had developed a checklist to help QAEs evaluate contractor performance. Checklist questions relate to contract requirements and correspond to the Statement of Work or applicable regulations, technical directives and manuals incorporated by reference in the contract, or contract procedures which the government has accepted and made a part of the contract. The FSI contract contains more than 500 such directives, incorporated by reference. Space Command policy requires that QAEs be knowledgeable of all contract requirements, the Statement of Work, the technical proposal, directive publications, and approved contract procedures.

Checklist questions relating to radiation hazards are:

- Has a radiation hazards program been established in accordance with the technical order?
- Have all potential hazardous radiation sources been identified and appropriate signs posted in suitable locations?
- Are local procedures established for entry of personnel into hazardous areas?

We reviewed the QAE log book entries relating to the circumstances that caused the accident. In June and August 1983, and again in September 1983, 5 days prior to the accident, the QAE recorded the following in his log: "Reviewed Radiation Hazards. All checklist items were covered and found to be satisfactory."

In our opinion, the checklist is ineffective in assuring contractor compliance with the technical order because it does not include enough questions, and the questions it does include are not specific enough to accurately evaluate the contractor's performance. More specific questions are needed, such as:

- Does the contractor comply with the safety interlock system requirements in the technical order for radar operations and maintenance?
- Do Clear's procedures for operating and maintaining the safety interlock system comply with technical order requirements?
- Are all safety interlock mechanisms in place and regularly used by employees when entering the radome?

If these additional questions had been asked, the QAEs should have detected that (1) Clear's procedures for using the safety interlock system did not comply with technical order requirements, (2) all specified

interlock systems were not installed, and (3) site instructions to employees entering the radome bypassed, or did not use, all safety interlocks. Corrective actions to assure FSI compliance with contract specifications should have prevented the accident.

DOD's comments indicate that improved checklists had been distributed in March 1985. Our examination of those documents 6 months later, however, indicated the need for additional revisions. Space Command officials agreed and said appropriate corrections would be made promptly.

Other Air Force Monitoring Has Not Identified Contract Noncompliance

Other Air Force teams or individuals responsible for monitoring contractor compliance with contract safety specifications relating to RF radiation have not recognized noncompliance with safety specifications. This responsibility primarily rested with the contract performance evaluation team. However, Air Force bioenvironmental engineers also perform radiation surveys.

The team consists of Air Force staff members from Space Command activities involved in contract requirements and offices responsible for particular service contract requirements. The team, led by Space Command's contracting squadron, examines all facets of the contractor's on-site performance, against the Statement of Work.

In July 1983, 2 months before the accident, the team completed a 5-day review at Clear. They evaluated FSI's overall performance as marginal; however, most of the observations reported were not related to FSI's noncompliance with the major issues raised in this report (i.e., site instructions that did not comply with requirements on use of all safety interlock systems when entering the radome, unqualified staff in control rooms, and differences between design specifications and actual layout of equipment at the site). One observation did relate to violation of the Statement of Work—reducing the Central System Monitoring Room (CSMR) staff to one person without notifying personnel in the appropriate Air Force control room.

In August 1984, the team conducted another on-site review and concluded that FSI's performance was "satisfactory with deficiencies." The team's report observed that Clear's site instructions regarding radome access procedures did not comply with technical order procedures and recommended that FSI "correct" the safety system interlock technical order to conform to Clear's site instructions.

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The team leader assigned this area to the communications-electronics members of the team rather than the Inspector General-safety member, who had reviewed FSI's current instructions, procedures, and technical order requirements, and was completely knowledgeable of all safety interlock systems and their use. We interviewed the communications-electronics team members who wrote up the observation, and found that they

- had not read the current site instructions for radome access,
- had not reviewed the actual procedures used by the contractor in accessing the radome area, and
- did not know the procedures for using the safety interlock system when entering the radome.

The team members were unaware that the Alaska Department of Labor had issued citations in December 1983 to FSI for failure to provide adequate lockout procedures to prevent employee exposure to RF radiation. Thus, the team's recommendation that Clear's site instructions be used was in conflict with the State of Alaska citations that told FSI to use the Air Force technical order procedures.

Air Force bioenvironmental engineers have also performed RF radiation surveys on the tracking radar. The survey guidelines include review of the installation and use of the safety interlock system for entry into the radome. We reviewed several of their reports on radiation surveys performed since 1979, and found that none of these cited FSI's noncompliance with technical order requirements. As DOD comments point out, bioenvironmental engineers are not responsible for monitoring contractor compliance in their surveys. However, in the course of performing the survey duties listed in the DOD comments, these engineers certainly should be in an ideal position to identify significant noncompliance related to RF safety.

DOD comments indicate that in the future, periodic reviews of contractor compliance with technical orders will be performed by the Space Command Inspector General. Discussion of this change with Space Command officials in September 1985 indicated details remain to be resolved before improvement can confidently be predicted.

Improvements to Interlock System Still Under Consideration

In our opinion, the State of Alaska Department of Labor identified the primary cause of the accident and made appropriate recommendations to help prevent a similar accident in the future. Approximately 3 months after the accident, the State cited FSI for two serious violations of an Alaska statute regarding safety in the workplace. The citations indicated that workers had been exposed to an excessive amount of incident electromagnetic energy due to inadequate lockout procedures that allowed the equipment to energize while employees were performing maintenance operations. The State assessed FSI a penalty of \$420 for each violation, for a total of \$840.

FSI management protested the citations and, after several months of negotiations with State officials, reached a Settlement Agreement on October 26, 1984. The agreement reduced the total fine to \$420, and directed FSI to use all safety interlock mechanisms prior to entering the radome. The agreement also stipulated that FSI install safety interlocks on the personnel and freight access doors and use them as required by the technical order.

In a letter dated December 5, 1984, the Air Force Administrative Contracting Officer directed FSI to request a variance from the Settlement Agreement terms because they would interfere with Clear's mission; this was done and eventually, it led to a proposed amended Settlement Agreement which was distributed for comment to interested parties on May 20, 1985. On September 12, 1985, the state terminated further discussion of the amended agreement by ordering compliance with the original agreement. On September 27, 1985, the Air Force Contracting Officer directed FSI to comply with the State of Alaska settlement agreement by November 15, 1985.

Technical Orders Are Not Being Verified and Validated

Before the FSI contract was awarded, the Air Force should have identified and corrected many of the conditions which permitted the accident to occur. According to Air Force policy guidance, technical orders should not be delivered to the users until the accuracy of their contents and the compatibility with the equipment they support have been verified and validated. The technical order system provides for submission of improvement reports when specific changes to the orders are needed or when technical errors or omissions prevent the adequate performance of functions required for mission accomplishment. Also, unclassified technical orders which have not been changed, revised, or supplemented for

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3 years are to be reviewed by Air Force officials for currency. The Sacramento Air Logistics Center is responsible for furnishing Space Command with complete and accurate technical orders for inclusion in contracts to operate and maintain the Clear radars.

The Air Force contract with FSI included technical orders that did not conform to the equipment design (see p. 32). According to the Air Force System Manager, the tracking radar technical order accuracy has not been verified or validated. Until recently the Air Force has made no efforts to correct known deficiencies in the technical order system. In a March 1985 meeting, senior Space Command officials indicated to us that a team would be assembled to review and attempt to correct the technical order deficiencies we identified. Six months later, Space Command acknowledged that little progress had yet been made in this area. Further progress will await implementation of the Space Command's action outlined in DOD's response to our recommendation concerning the need to survey technical order compliance at other radar installations.

Medical Attention Provided Victims of the Accident

Employees involved in the accident at Clear are entitled to medical care as provided by the terms of the contract and may be eligible to claim costs incurred related to the accident under state and federal statutes. At the time of the accident, Air Force and contractor officials did not provide immediate medical attention to the accident victims when suspected overexposure was identified. The delay, in part, is attributable to a contractor manager who required some of the radiated employees to return to the antenna to complete their work and clean up the area prior to visiting the local aid station. In addition, approximately 24 hours passed before the affected employees were transported to the Fairbanks (Alaska) Memorial Hospital Emergency Room and examined by physicians. We cannot determine whether this delay aggravated any existing biological problems or created other symptoms related to the radiation accident. The employees have received extensive medical examinations by the Air Force and private physicians since the accident.

Employees Entitlement to Medical Services

According to the contract, FSI is responsible for operating a government-furnished medical aid station at Clear staffed with a minimum of two medical technicians. Medical services will be provided to military, government civilian, and contractor employees who are permanently or temporarily assigned to the site. The Air Force's medical responsibilities under the contract include providing "nonelective medical services"⁸ to contractor employees within the capability of the government medical facility at no cost to the patient.

In addition to the medical care that the employees are entitled to under the terms of the contract, employees may also claim their costs related to an accident under state or federal statutes. Contractor employees may claim such costs under the Alaska Worker's Compensation Act, Alaska Stat. 23.30 (1984). Air Force employees may claim their costs under the Federal Employees Compensation Act, 5 U.S.C. §8101 *et. seq.* (1982). Generally, contractor and federal employees may file claims under the appropriate statute even in the case of latent disability. Due to the exclusive remedy provisions of both the Alaska Worker's Compensation Act and the Federal Employees Compensation Act, employees

⁸Neither the contract nor Air Force Regulation 168-6 define "nonelective medical services." However, elective medical care is defined in the contract as "medical, surgical, or dental care desired or required by the individual or by a physician or dentist which in the opinion of the provider can be deferred or performed at another time or place without jeopardizing life, limb, or overall well-being of the patient." Air Force regulations define emergency care as "the immediate medical or dental care required to save the life, limb, or sight or to prevent undue suffering or loss of body tissue."

who claim under these statutes may be unable to claim against the Air Force under the Federal Tort Claims Act, 28 U.S.C. §2671 *et. seq.* (1982).

We did not attempt to determine if any of the victims has or will be adequately compensated for relevant medical evaluations, treatment, or followup under the state or federal statutes discussed above. It is ultimately the prerogative of the courts to make such determinations. We did, however, look at the question of whether the victims received the medical care to which they were entitled under the terms of the contract.

Medical Attention Delayed Immediately After Accident

According to Air Force standards incorporated by reference into the contract, personnel who may have been overexposed to RF radiation should be evaluated by a physician as soon as practical. Current Air Force health standards emphasize the need to take the exposed individuals "without delay to the emergency room of the medical facility which provides the unit emergency medical care." These standards require that every suspected or actual overexposure must be thoroughly investigated and evidence of injury thoroughly documented, primarily because technical exposure data and medical records are essential for future epidemiological and clinical followup studies.

A total of eight individuals were in the vicinity of the radome when the accident happened. Two were working outside the direct exposure area and were not radiated beyond the permissible exposure limits. When the employees suspected they were being exposed to radiation, they immediately left the antenna, reported the incident to FSI management, and requested medical attention. However, a management official directed employees to reassemble the radar antenna, clean up the work area, and pick up their tools. At first the employees refused, but eventually three employees followed the direction of FSI management.

In the interim, an FSI official notified the registered nurse on duty at the aid station that a radiation overexposure may have occurred. All eight employees visited the aid station at times varying from 1-1/2 to 4 hours after the radiation accident. According to the nurse, each employee was asked if any specific symptoms or problems existed as a result of the radiation exposure. In a few instances, the employees told the nurse that they felt warm, and one employee complained of a burn on his wrist.

The nurse at the aid station took the employees' temperatures and blood pressure and found several body temperatures elevated about one

degree or so, and several higher-than-normal blood pressure readings. Some warm, reddish areas were also found on two employees, but no skin burns. All of the victims expressed anxiety. According to the nurse, there was no urgent need to send the employees to the Fairbanks Memorial Hospital Emergency Room. However, after discussing the accident with Air Force officials, it was decided to send the employees to Fairbanks Memorial Hospital for a more thorough examination to document any symptoms that might exist.

In the afternoon of September 15, 1983, approximately 24 hours after the accident, all eight employees were transported to Fairbanks Memorial Hospital, where they were examined in the emergency room. Each received a physical examination, a chest X-ray, and complete blood count, and had vital signs taken. The employees were also examined by an ophthalmologist and each was later afforded a neurological examination. In no instance did an examining physician report that he or she had objectively identified a physiological abnormality. Two employees were admitted to the hospital because of subjective complaints of weakness, dizziness, and anxiety. These individuals remained in the hospital for 3 and 6 days. No significant medical condition was found during their stay at the hospital.

At Fairbanks Memorial Hospital, the physicians who examined the victims 24 hours after the accident found no significant condition to report, except anxiety. We cannot determine whether the victims were harmed by the delay in receiving medical care.

As stated in chapter 1, RF radiation produces heat and overexposure can increase body temperature. Depending upon the extent of overexposure, it can damage internal organs and the eyes and burn the skin. However, there is no convincing evidence that exposure to RF radiation shortens the life span or is a primary cancer producing agent. Much controversy exists concerning the long-term medical effects of RF exposures. Private physicians that some of the employees are seeing have determined that the employees were injured in the radiation accident. We are not in a position to evaluate the medical judgments regarding the extent of injury sustained by, or treatment provided to, individual victims of the accident.

The contractor in his comments contends that any more rapid response would not have had any bearing on the physical condition of the employees. As we point out in our report, we cannot determine whether

the delay in providing immediate medical attention to the accident victims aggravated any existing biological problems or created other medical problems. However, Air Force standards, incorporated by reference into the contract, emphasize the need for immediate medical attention for personnel who may have been exposed to RF radiation. These standards were not followed. In this regard, the DOD comments state that action is underway to insure that patients are promptly taken to the aid station following an accident.

Examination at the U.S. Air Force School of Aerospace Medicine

The U.S. Air Force School of Aerospace Medicine (USAFSAM) at Brooks Air Force Base, San Antonio, Texas, is the Air Force's designated central examining authority for all employees exposed to RF radiation. School officials conduct research, in cooperation with other educational and professional institutions, to determine the biological effects of exposure to RF radiation. Research findings are then used to recommend changes to the permissible exposure levels, and to provide expert opinions and advice on matters related to RF exposure.

Approximately 10 days after the accident, all eight exposed employees were offered the opportunity to visit the USAFSAM for a complete medical evaluation. Four employees accepted the offer and were evaluated in October 1983. The other four employees declined the offer at that time, but two of these four subsequently received medical evaluation at Brooks. Air Force officials recognized that there was little expertise in the public sector concerning the bioeffects of RF radiation. Therefore, they believed it appropriate to offer to evaluate the employees as part of their ongoing medical research in the area of RF radiation. The two government employees and four contractor employees were scheduled for physical examinations at USAFSAM at the earliest possible date. According to Air Force officials, the employees were offered the first available appointments at USAFSAM rather than immediate scheduling, because medical authorities at the Fairbanks Memorial Hospital determined that no medical emergencies or apparent life threatening medical conditions existed.

Each evaluation at the USAFSAM lasted from 7 to 9 days and was performed by specialists in aerospace medicine, neuropsychiatry, psychology, ophthalmology, dentistry, otolaryngology, audiology, internal medicine, and clinical nutrition. The evaluations included for each individual, present and past medical history, a physical examination, laboratory tests, and certain diagnostic procedures. In conducting the medical examinations, the specialists assumed that an overexposure had

occurred, and clinically evaluated everything which could possibly be attributed to RF exposures. According to Air Force officials, the degree of overexposure would not have changed the evaluation procedure. Following the medical evaluations, each individual was briefed on the findings and recommendations and were provided a written summary.

Air Force officials stated that the findings and recommendations included in the summaries reflect all significant diagnoses, whether related or unrelated to the exposure incident. Followup examinations for those diagnoses were recommended for all six employees. However, Air Force officials at USAFSAM indicated that adequate followup should be available at any medical facility with the appropriate specialists. The officials also stated that no specific RF radiation expertise would be necessary to perform the examinations. The Air Force intends that the contractor should assume direct responsibility for managing any necessary followup actions for its employees. USAFSAM personnel will be available on a consultant basis to the designated medical activity to discuss findings and suggested examinations, or to review any examination results. The Air Force will conduct any necessary followup actions on its two employees who were involved in the incident. To this end, USAFSAM officials conducted a followup examination in March 1985 on the two government civilians who were involved in the incident.

Conclusions and Recommendations

Conclusions

While the actions of one employee did initiate the accident, this simple explanation does not consider the basic problems that allowed the accident to happen and to go undetected for 8 minutes. In our opinion, the basic causes are varied, but relate primarily to contractor noncompliance with operational and safety specifications in the contract and systemic problems in Air Force contract management practices.

We identified problems in contractor noncompliance of contract terms and in Air Force contract management practices that allowed the accident to happen. FSI did not comply with contract requirements for operating safety system interlocks in the tracking radar or minimum staffing in control rooms. The Air Force furnished design and operating specifications in its contract with FSI that did not conform to the actual layout of equipment at Clear. Untrained and inexperienced Air Force contract administrators assigned to monitor FSI performance did not detect violations of contract specifications. Air Force contract management either did not identify or correct contractor noncompliance with contract terms. We believe the accident may have been prevented, or the duration of exposure could have been reduced, if

- FSI had complied with its contract by using all safety system interlock mechanisms as designed without bypass or change;
- the Air Force, as required by its regulations, or FSI, as required by the terms of the contract, had made appropriate changes in the waveguide layout, wiring, and automatic switching functions so that transmitters monitored and controlled by equipment in the TRAM room are those primarily dedicated to the tracker radar;
- FSI had complied with the contract's minimum staffing requirements in control rooms and had assigned fully qualified technicians to monitor the equipment;
- the Air Force had assigned staff to monitor contractor performance who were trained in the technical operation and maintenance of radars, and experienced in contract administration; and
- the Air Force teams and individuals responsible for monitoring contractor compliance with specifications, especially those related to RF radiation safety, had recognized contractor noncompliance and enforced compliance.

We believe that effective contract administration by qualified QAES would have identified contractor noncompliance with technical orders and the Statement of Work and initiated appropriate corrective action. We believe that fully qualified technicians would have identified the equipment problems immediately and taken corrective action to stop, or

at least minimize, the exposure of the personnel working on the tracker antenna.

Other Air Force teams or individuals responsible for monitoring contractor compliance with contract specifications, especially those related to RF radiation safety, have neither recognized noncompliance nor enforced compliance with contract specifications. Space Command staff members and other offices responsible for reviewing and assessing contractor compliance with contract requirements made two on-site reviews at Clear. Although the team first evaluated the contractor's performance as marginal, most of the observations reported did not relate to the contractor's noncompliance with contract terms discussed in this report. On the second visit, the team concluded that the contractor's performance was "satisfactory with deficiencies." The team's report observed that the contractor had changed radome access procedures for the safety interlock system to conform to Clear's site instructions. At the time, Clear's site instructions did not agree with technical order procedures.

The State of Alaska Department of Labor identified the primary cause of the accident and made appropriate recommendations to help prevent a similar accident in the future. The State issued two citations to the contractor for failing to follow safety system interlock procedures in technical orders. The State and the contractor reached a settlement agreement in October 1984, requiring the contractor to follow technical order procedures. After giving consideration to an amended agreement, the State on September 12, 1985, ordered the contractor to implement the original agreement by November 15, 1985.

Air Force and OSHA RF radiation surveys both confirmed that four contractor and two federal employees were exposed to RF radiation substantially exceeding established safety standards. Although there was some delay in providing medical evaluation to the victims in the 24 hours following the accident, the victims have received extensive medical evaluations since the accident. The Air Force intends for the contractor to assume responsibility for managing any necessary followup actions for its employees. The Air Force has conducted a followup examination on its two employees who were involved in the incident.

Much controversy exists surrounding the medical effects of RF overexposure. We are not in a position to evaluate the medical judgment regarding the extent of injury sustained by, or treatment provided to, individual victims of the accident.

Recommendations

The contract deficiencies pertaining to the operation and maintenance of Clear Air Force Station must be corrected and the administration of that contract improved in order to reduce the likelihood of another radiation accident. Accordingly, we recommend that the Secretary of the Air Force direct the Commander of the Space Command to

- conform the safety system interlocks to specifications and follow all technical order procedures for entering and exiting the radome;
- change the waveguide layout, wiring and automatic switching functions to properly align prime transmitters with corresponding radars;
- require the contractor to comply with minimum manning requirements in monitoring and control rooms, in accordance with the Statement of Work;
- review the contractor's technician assignment practices to ensure that technicians are fully trained and qualified in the monitoring and control rooms they are assigned to; and
- assure that only trained Quality Assurance Evaluators, fully qualified in evaluating contractor compliance with technical specifications are assigned, especially in highly technical areas such as the operation and maintenance of communication and electronic equipment.

We also recommend that the Secretary of the Air Force conduct a survey of technical order compliance and safety procedures at other radar installations to determine if similar problems may exist. If noncompliance with technical orders or other problems are identified, corrective actions should be taken.

Agency Comments

As shown in appendix III, DOD concurs in our recommendations and has outlined a series of actions to respond to them. Except with respect to the recommendation concerning waveguide layout and transmitter switching functions, we believe the actions DOD has described will be responsive when fully implemented.

In September 1985 we studied and discussed with Air Force Space Command officials, the details of the transmitter monitoring and control circuit changes which DOD's comments seem to endorse as an alternative to the action outlined in our recommendation. In that discussion, we pointed out that the proposed circuit changes would not correct the anomalous automatic switching function which permitted the accident to occur. The Space Command officials agreed with our views. Accordingly, the officials advised us that Space Command would restudy the

matter to determine the precise nature of what should be done to be responsive to our second recommendation.

Request Letter From Congressman Don Young

DON YOUNG
CONGRESSMAN FOR ALL ALASKA

WASHINGTON OFFICE
2331 RAYBURN BUILDING
TELEPHONE 202/725-5745

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AFFAIRS
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March 8, 1984

Mr. Charles A. Bowsher
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Bowsher:

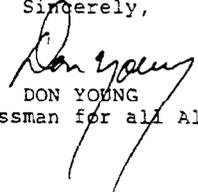
On September 14, 1983, an RF radiation accident, involving six technicians employed by FELEC Services, Inc., and two federal employees, occurred at Clear Air Force Station, Alaska.

I believe a detailed investigation by the General Accounting Office is warranted in as much as the conduct of the U.S. Air Force and FELEC Services, Inc., in responding to this accident, has created doubt and suspicion among the affected employees, the public, and members of this Congress.

My purpose in this request is to insure that the affected employees have been afforded the best available medical evaluation, treatment, and follow-up entitled to under law; that the U.S. Air Force actions in administering, supervising, and complying with the execution of contract number F05604-82-C-0060 P00075 is beyond reproach; and that FELEC Services, Inc., has totally fulfilled all required services in compliance with the terms called for under the forementioned contract and the "Statement of Work for Operation, Maintenance, and Support of the Ballistic Missile Early Warning System (BMEWS) (FY83-85)", dated October 1, 1982.

It is imperative that a full disclosure of this investigation be accomplished. With best regards,

Sincerely,


DON YOUNG
Congressman for all Alaska

DY:cd

Comments From the Commissioner, Department of Labor, State of Alaska

STATE OF ALASKA

DEPARTMENT OF LABOR

BILL SHEFFIELD, GOVERNOR

BOX 1149
JUNEAU, ALASKA 99802

PHONE:
(907) 465-4856

August 6, 1985

Mr. Frank C. Conahan
Director
National Security and
International Affairs Division
United States General Accounting
Office
Washington, D.C. 20548

Dear Mr. Conahan:

I would like to commend your organization for a very concise and complete report on the September 14, 1983, radiation accident at Clear Air Force Station, Alaska.

The report confirms our findings of the cause of the accident and accurately describes the State's activities in this matter. Moreover, if Felec Services, Inc. and the U.S. Air Force implement the recommendations made in your report, they would come into compliance with the State's previously negotiated settlement agreement.

Thank you for allowing us the opportunity to comment on the report. Please send us a copy of the final report when it has been completed.

Sincerely,



Jim Robison
Commissioner

Comments From the Acting Assistant Secretary of Defense (Force Management and Personnel)



FORCE MANAGEMENT
AND PERSONNEL

ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301-4000

27 SEP 1985

Mr. Frank C. Conahan
Director, National Security and
International Affairs Division
United States General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Conahan:

This is to provide Department of Defense (DoD) comments on the General Accounting Office (GAO) Draft Report, "Further Actions Needed Following Exposure of Employees To Radiofrequency Radiation At Clear Air Force Station, Alaska," dated July 17, 1985, (GAO Code 392058), OSD Case 6800.

The Department of Defense concurs with the report with some minor technical corrections that have been provided to your office under separate cover. It should be noted that the Air Force has already taken corrective action to greatly reduce the possibility of a recurrence of this accident. For example, the Ballistic Missile Early Warning Site (BMEWS) at Thule, Greenland, is now in compliance with technical order criteria and action is underway to ensure better quality control in contract administration.

The Department of Defense appreciates the opportunity to comment on this report.

Sincerely,


Jerry L. Calhoun
Acting Assistant Secretary of Defense
(Force Management & Personnel)

Attachment

Appendix III
Comments From the Acting Assistant
Secretary of Defense (Force Management
and Personnel)

GAO DRAFT REPORT - DATED JULY 17, 1985
(GAO CODE 392058) - OSD CASE 6800

"FURTHER ACTIONS NEEDED FOLLOWING EXPOSURE OF EMPLOYEES TO
RADIOFREQUENCY RADIATION AT CLEAR AIR FORCE STATION, ALASKA"

DoD RESPONSE TO THE GAO DRAFT REPORT

FINDING A: Circumstances Surrounding The Accident At Clear Air Force Station, Alaska. The GAO reported that Clear Air Force Station (Clear) is one of three sites which together comprise the nation's Ballistic Missile Early Warning System. FELEC Services, Inc. (FSI), is the contractor responsible for the operation and maintenance of the system at Clear. The GAO reported that on September 14, 1983, six workers at Clear were exposed to radiofrequency (RF) radiation in excess of established safety standards. According to Air Force and FSI investigation reports, the accident was attributed primarily to the inadvertent actions of an FSI technician who allowed a transmitter to radiate RF energy onto the antenna where the employees were working. However, the GAO found that the technician's actions could not have produced that result if the tracking radar system had been configured and operated in conformance with applicable technical orders. The GAO also found that all Air Force systems, subsystems, support equipment, etc., should be operated and maintained according to the procedures contained in the technical orders, unless excluded or waived. The GAO detailed the series of circumstances that led to the accident, and concluded that while the actions of one employee did initiate the accident, this simple explanation did not take into account the basic problems that allowed the accident to happen and to go undetected for 8 minutes. The GAO further concluded that the basic causes are varied, but they relate primarily to contractor noncompliance with operational and safety specifications in the contract and systemic problems in Air Force contract management practices. (pp. 9-15, 42, GAO Draft Report)

DoD POSITION: Concur.

FINDING B: Safety System Interlock Deficiencies Permitted Accident To Occur. The control facility at Clear houses critical monitoring rooms used to operate and oversee the tracker and detection radars. The GAO reported that as part of the technical design of the radar facility, a key interlock system is incorporated as a safety measure, which allows technicians to close the waveguide switches while carrying out preventive maintenance procedures. This protects personnel in the radome from hazards due to transmitter radiation or antenna movement. The GAO found that the configuration and operation of the tracking radar interlock system was at variance with the technical order and defeated the interlock's function. The GAO also found that, in violation of several technical orders in the contract and FSI's own safety manual, FSI management has

Now on pp. 14 to 18 and
46.

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routinely issued instructions to workers to bypass the safety system interlock mechanism covering radome entrance and exit procedures. Specifically, GAO found that FSI site instructions (1) do not treat key #1 as a part of the interlock system; on the day of the accident, key #1 was left in the console while the team leader performed the preventive maintenance routine, leaving the antenna operable, which could emit radiation, and (2) state that when a technician removes key #4, after closing the second waveguide switch, the key should be delivered to the Central System Monitoring Room (CSMR); however, this omits using the pedestal lock-out safety panel, which was bypassed on the day of the accident. The GAO concluded that if key #4 had been used in accordance with the specifications, the maintenance lights would have gone out and the klaxon horn would have sounded a warning for 30 seconds before the team leader could have opened the second waveguide switch. The GAO further concluded that configuration and operation of the tracking radar interlock system, in accordance with the applicable technical orders, would have prevented any RF energy from reaching the antenna even with the waveguide switches remaining open as they were when the accident occurred. (pp. 9, 15-19, GAO Draft Report)

Now on pp. 14 and 18 to 21.

DoD POSITION: Concur.

FINDING C: Transmitter Monitoring And Control Deficiencies Also Permitted Accident To Occur. The GAO found that when the radars at Clear were constructed in 1961, monitoring equipment and controls were not installed in conformance with the design and operating specifications in the technical order, making the transmitter monitoring rooms incompatible with the layout and use of the transmitters. Specifically, the GAO found that (1) there are four transmitters (23, 27, 28, and 29), which can be switched into the tracking order, (2) design specifications designated transmitters 28 and 29 as the prime tracking radar transmitters, with 23 and 27 as the backup tracking transmitters, (3) prior to installation of transmitters 28 and 29, the Air Force decided to use numbers 23 and 27 as the prime tracking transmitters-these had already been installed as primary detection radar transmitters, (4) no corresponding changes were made in the waveguide layout, wiring and automatic switching functions, (5) therefore, the transmitter monitoring and control equipment for the prime detection radar transmitters are in the Tracking Radar Automatic Monitoring Room (TRAM), while those for the tracking radar transmitters are in the Detection Radar Automatic Monitoring Room (DRAM), and (6) normally this does not present a problem when experienced, qualified technicians are manning the control rooms. The GAO concluded that the accident would not have happened if either the contractor or the Air Force had corrected the transmitter layout design as required. The GAO further concluded that, if these changes had been made, the tracker, when energized by returning it to the "normal" mode, would have preselected a transmitter that would have been turned off at 9:30 a.m. on the day of the accident. (pp. 19-20, GAO Draft Report)

Now on pp. 22 and 23.

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DoD POSITION: Concur. See response to recommendation 2.

FINDING D: Contractor Should Have Reported That Equipment Layout Needed To Be Changed. The GAO found that it is impossible for FSI to operate in accordance with the applicable technical orders, as required by its contract, because the equipment at Clear is not installed in conformity with the design specifications on which the technical orders are based. The GAO further found that when FSI assumed responsibility for the operation and maintenance at Clear, it did not notify the Air Force that the equipment layout did not conform to the technical orders and it did not propose the necessary changes. The GAO noted that a cursory inspection would have identified substantial nonconformity between the actual layout of equipment and the technical orders applicable to the Clear installation. The GAO concluded that had the design compelled the tracker team leader to use all of the safety system interlocks according to the technical order for the operation and maintenance of the tracking radar and other contractual safety directives, he could not have performed the routine that ultimately initiated the accident. (pp. 22-24, GAO Draft Report)

Now on pp. 24 and 25.

DoD POSITION: Concur.

FINDING E: Contractor Did Not Comply With Minimum Staffing Requirements. The GAO found that on the day of the accident, (1) FSI management had reduced the CSMR staffing below the minimum essential manning required in the contract's Statement of Work, (2) maintenance technicians on duty in the CSMR and DRAM were not fully qualified to perform in their assigned positions, and (3) the TRAM room was left unattended. Specifically, the GAO found that the contractor must provide sufficient, fully trained staff on each shift to continuously monitor the information displayed on the maintenance consoles in the DRAM and TRAM, but on the day of the accident, (1) the System Controller assigned to the CSMR reported for work, but FSI management gave him the day off, (2) two Equipment Controllers were left on duty; one fully qualified and the other not, (3) neither employee was qualified as a System Controller, (4) one maintenance technician had been assigned to monitor the information displayed in the DRAM; however, he had not completed any of the training packages necessary to qualify as a maintenance technician on detection radar equipment, (5) FSI management had not assigned anyone in the TRAM, and (6) a few minutes prior to the accident, the qualified Equipment Controller left the CSMR--during this period both the DRAM and the CSMR were manned by untrained staff. The GAO concluded that fully qualified technicians occupying the required positions would have immediately identified the equipment problems and taken corrective action to stop, or at least minimize, the exposure of the personnel working on the tracking antenna to RF radiation. (pp. 24-26, 43, GAO Draft Report)

Now on pp. 25 to 26 and 46.

DoD POSITION: Concur.

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FINDING F: On-Site Quality Assurance Evaluators At Clear Air Force Station Are Not Adequately Trained. The GAO found that the Quality Assurance Evaluation (QAE) surveillance program at Clear had not identified contractor noncompliance with contract specifications because the QAEs were untrained and inexperienced in the operation and maintenance of radars and contract administration procedures. The GAO reported that, according to Air Force officials, trained and experienced contract administrators are not assigned at Clear because such positions are not authorized for a 1-year tour of duty at remote locations and the personnel assigned are selected from a 1-year assignment pool, regardless of prior training, and then given only a 2-day orientation at Space Command before assuming their positions. Also, QAEs with backgrounds in radar operations and maintenance are rarely assigned to Clear. The GAO concluded that the accident may have been prevented, or the duration of exposure could have been reduced, if the Air Force had assigned staff to monitor contractor performance who were trained in the technical operation and maintenance of radars, and experienced in contract administration. (pp. 28-29, 43, GAO Draft Report)

Now on pp. 32 and 33, and
46 and 47.

DoD POSITION: Concur. Space Command is now revising its QAE training program to improve the QAEs knowledge and understanding of both contractual and technical operations. There is no Air Force Specialty Code (AFSC) for Quality Assurance Evaluators (QAEs). To offset this problem, in April, 1984, HQ AFMPC approved an exception to normal assignment policy to permit selection of only top caliber personnel to fill QAE positions. Quality control selection criteria include a requirement that the selectee must have received the highest rating on his last three performance reports; must not have an Unfavorable Information File; must possess a Space Systems Equipment (radar, satellite) Maintenance Technician Air Force Specialty Code (AFSC) proficiency level consistent with his current rank, must receive his commander's certification that he has at least 18 months experience in his specialty, is technically qualified in all aspects of his specialty, and possesses the maturity and ability to work with little or no supervision.

FINDING G: Quality Assurance Evaluator Checklist To Evaluate Contractor Performance Is Incomplete. The GAO noted that Space Command policy requires that QAEs be knowledgeable of all contract requirements, the Statement of Work, the technical proposal, directive publications, and approved contract procedures. The GAO found the contract management staff at Space Command have developed a checklist to help QAEs evaluate contractor performance. The GAO further found that the checklist is ineffective in assuring contractor compliance with the technical order because it does not include enough questions, and the questions it does include are not specific enough to accurately evaluate the contractor's performance. The GAO concluded that had additional questions been asked concerning the safety interlock mechanisms, the QAEs should have detected that

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Now on pp. 34 and 35, and
46 and 47.

(1) Clear's procedures for using the safety interlock system did not comply with technical order requirements, (2) all specified interlock systems were not installed, and (3) site instructions to employees entering the radome bypassed, or did not use, all safety interlocks. (pp. 29-31, 43, GAO Draft Report)

DoD POSITION: Concur. Revised checklists for communication/electronics maintenance were distributed to the field on 15 March 1985.

FINDING H: Other Air Force Monitoring Has Not Identified Contract Noncompliance. The GAO found that other Air Force teams or individuals, i.e., the Contract Performance Evaluation Team (Team) and the Air Force bioenvironmental engineers, who were responsible for monitoring contractor compliance with contract safety specifications relating to RF radiation, had not recognized noncompliance with safety specifications. The GAO specifically found that (1) the results of a 5-day review in July 1983, were designated as marginal; however, most of the observations reported by the Team were not related to FSI's noncompliance with the major issues raised in the GAO report, (2) in August 1984, another on-site review was conducted and the Team concluded that FSI's performance was "satisfactory with deficiencies," and recommended that FSI correct the safety system interlock technical order to conform to Clear's site instruction, (3) this recommendation was in conflict with the State of Alaska citations that told FSI to use the Air Force technical order procedures, (4) the Team members who wrote up the observation were not knowledgeable of all safety interlock systems and their use, and (5) none of the Air Force bioenvironmental engineers' RF radiation surveys performed since 1979, cited FSI's noncompliance with technical order requirements. The GAO concluded that the Air Force teams or individuals responsible for monitoring contractor compliance with contract specifications have neither recognized noncompliance nor enforced compliance with contract specifications. (pp. 31-33, 43-44, GAO Draft Report)

Now on pp. 35 and 36, and
46 and 47.

DoD POSITION: Partially concur. Air Force bioenvironmental engineers (BEE) are not responsible for monitoring contractor compliance with contract specifications. The BEE is required to perform the following during workplace visits to RF emitter sites (AFOOSH Standard 161-9, paragraph C.4.e.): (1) measurement and identification of actual radiation levels in work places and other accessible locations, either for an initial hazard evaluation or for comparison with previous surveys or other published data, (2) evaluation of adequacy of RF safety Operational Instructions and control measures, and (3) Observation of adherence to procedural requirements and posting of warning signs. The contract compliance monitoring responsibility is appropriately the responsibility of the Contract Performance Evaluation Team and discrepancies should have been identified.

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Now on p. 37.

FINDING I: Improvements To The Interlock System Are Still Under Consideration. The GAO found that about 3 months after the accident, the State of Alaska Department of Labor cited FSI for two serious violations of an Alaska statute regarding safety in the workplace and assessed FSI a penalty of \$420 for each violation. GAO noted that after protests and negotiations had taken place, a proposed amended Settlement Agreement was distributed for comment on May 20, 1985. In June 1985, it still was under consideration. GAO concluded that the State of Alaska Department of Labor identified the primary cause of the accident and made appropriate recommendations to help prevent a similar accident in the future. (pp. 33-34, GAO Draft Report)

DoD POSITION: Concur.

Now on pp. 37 and 38.

FINDING J: Technical Orders And Not Being Verified And Validated. The GAO reported that according to Air Force policy guidance, technical orders should not be delivered to the users until the accuracy of their contents and the compatibility with the equipment they support have been verified and validated. The GAO found that the Air Force contract with FSI included technical orders that did not conform to the equipment design and the tracking radar technical order accuracy had not been verified or validated. The GAO further found that until recently, no efforts have been made to correct deficiencies in the technical order system. The GAO concluded that before the FSI contract was awarded, the Air Force should have identified and corrected many of the conditions which permitted the accident to occur. (pp.34, GAO Draft Report)

DoD POSITION: Concur.

Now on pp. 40 and 41.

FINDING K: Employees Are Entitled To Medical Services. The GAO reported that FSI is responsible for operating a government-furnished medical aid station at Clear to provide services for military, government civilian and contractor employees who are permanently/temporarily assigned to the site. Also, in addition to the medical care, the employees are entitled to claim costs related to an accident under state or federal statutes. The GAO found, however, that due to the exclusive remedy provisions of both the Alaska Workers' Compensation Act and the Federal Employees Compensation Act, employees who claim under these statutes may be unable to claim against the Air Force under the Federal Tort Claims Act, 28 U.S.C. p. 2671 et. seq. (1982). The GAO concluded that it is ultimately the prerogative of the courts to determine if any of the victims has been, or will be adequately compensated for relevant medical evaluations, treatment or followup under state or federal statutes. (pp. 35-36, GAO Draft Report)

DoD POSITION: Concur.

FINDING L: Medical Attention To Employees Was Delayed Immediately After The Accident. The GAO reported that current

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Now on pp. 41 and 42.

Air Force health standards emphasize the need to take exposed individuals "without delay to the emergency room of the medical facility, which provides the unit emergency medical care." The GAO further reported that the eight individuals, who were in the vicinity of the radome when the accident happened, left the antenna immediately when they suspected they were being exposed, reported the incident to FSI management and requested medical attention. However, GAO found that a management official directed the employees to reassemble the radar antenna, clean up the work area and pick up their tools, and that three of the eight employees followed these orders. The GAO further found that the eight employees were first examined at times varying from 1 1/2 to 4 hours after the accident by a registered nurse at the FSI aid station, and approximately 24 hours after the accident, they were transported to the Fairbanks Memorial Hospital Emergency Room. The GAO concluded that medical attention was delayed immediately after the accident and, because much controversy exists over the effects of radiation, there should have been prompt emergency room treatment. (pp. 37-39, GAO Draft Report)

DoD POSITION: Concur. As a point of clarification, it should be emphasized that medical care was delayed 1 1/2 to 4 hours due to a contractor management decision. When the site nurse conducted an initial examination at the medical aid station, she determined there was no urgent need to send the employees to the hospital. Action is underway to require contractor management to develop formal procedures to insure patients are promptly taken to the aid station for evaluation following an accident or injury. A proposed revised medical Statement of Work (SOW) was forwarded to the contractor on 29 April 1985. HQ Space Command is presently clarifying the requirements and negotiating the finalized medical SOW change. It is estimated that this action will be complete by January 1986.

FINDING M: Exposed Employees Were Examined At The U.S. Air Force School Of Aerospace Medicine (USAFSAM). The GAO found that approximately 10 days after the accident, all eight exposed employees were offered the opportunity to visit the USAFSAM for a complete medical examination, but only six accepted and received medical evaluations. The GAO reported that Air Force officials recognized there was little expertise in the public sector concerning the bioeffects of radiation; therefore, it was believed appropriate to offer to evaluate the employees as part of their ongoing research in this area. The GAO further found that the specialists at USAFSAM assumed that an overexposure had occurred and clinically evaluated, in a time period of 7 to 9 days, everything which could possibly be attributed to RF exposures. The GAO also found that the Air Force findings and recommendations included all significant diagnoses, whether related or unrelated to the exposure incident and recommended followup examinations for all six employees. The GAO noted that the Air Force intends for the contractor to assume responsibility for managing any necessary followup actions for its employees,

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Now on pp. 43 and 44 and
47.

while the Air Force will conduct necessary followup actions for its employees. The GAO concluded that, although there was some delay in providing medical evaluations, the victims have received extensive medical evaluations since the accident. (pp. 39-41, 44, GAO Draft Report)

DoD POSITION: Concur.

RECOMMENDATIONS

Now on p. 48.

RECOMMENDATION 1: The GAO recommended that the Secretary of the Air Force direct the Commander of the Space Command to conform the safety system interlocks to specifications and to follow all technical order procedures for entering and exiting the radome. (p. 45, GAO Draft Report)

DoD POSITION: Concur. An Ad Hoc Air Force team was sent to Clear AFS in April 1985, to resolve all safety system interlock deficiencies with OSHA, FSI, and FSI employees, conform the safety system interlocks to specifications and ensure all technical order procedures for ingress and egress to the radome are being followed. The Air Force identified all major deficiencies and submitted a plan for remedial action to the State of Alaska. The State of Alaska denied the proposed modification to the OSHA settlement agreement and reinstated the terms and conditions of the original agreement. An extension to 15 November 1985 was granted for FELEC Services' compliance. HQ Space Command has reviewed the original agreement and is in the process of implementing it. It is estimated that this action will be completed by 15 November 1985.

Now on p. 48.

RECOMMENDATION 2: The GAO recommended that the Secretary of the Air Force direct the Commander of the Space Command to change the waveguide layout, wiring and automatic switching functions to properly align prime tracking and detection transmitters with corresponding monitoring and control equipment located in the TRAM and DRAM. (p. 45, GAO Draft Report)

DoD POSITION: Concur. The equipment waveguide layout and monitoring/control circuitry should be compatible. Although the GAO recommendation focuses on changing the waveguide layout, changing the monitoring/control circuitry would achieve the same result. On 6 May 1985, the Air Force tasked the contractor to provide a study discussing the cost/operational impact of the two alternatives by 14 November 1985. Once the study has been evaluated, action will be taken through Air Force Logistics Command to correct the system so that the waveguide and monitoring/control circuitry are compatible. It is expected that this action will be completed by December 1986.

RECOMMENDATION 3: The GAO recommended that the Secretary of the Air Force direct the Commander of the Space Command to require the contractor to comply with minimum staffing requirements in

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and Personnel)

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monitoring and control rooms, in accordance with the Statement of Work. (p. 45, GAO Draft Report)

DoD POSITION: Concur. The Commander of Space Command is requiring the contractor to comply with minimum manning requirements in the monitoring and control rooms. This is implemented by special provision 26 of the contract which incorporates the contractor's technical proposal which has been in effect since 1 October 1982. The statement of work was revised on 20 April 1984 to further emphasize manning requirements and a corresponding QAE checklist revision was published on 15 August 1984. This area is being closely monitored by the on-site QAE on a daily basis to ensure contractor compliance.

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RECOMMENDATION 4: The GAO recommended that the Secretary of the Air Force direct the Commander of the Space Command to review the contractor's technician assignment practices to ensure that technicians are fully trained and qualified in the monitoring and control rooms they are assigned to. (p. 45, GAO Draft Report)

DoD POSITION: Concur. Space Command is monitoring qualifications by reviewing personnel resumes to ensure compliance. This review is conducted under authority of the statement of work by the HQ Space Command Office of Collateral Responsibility. If the technician does not meet the employment standards required by the Government, the technician is rejected. On-site QAES ensure that training documentation is being accomplished through periodic review of training records.

Now on p. 48.

RECOMMENDATION 5: The GAO recommended that the Secretary of the Air Force direct the Commander of the Space Command to assure that only trained contract administrators fully qualified in evaluating contractor compliance with technical specifications are assigned, especially in highly technical areas such as the operation and maintenance of communication and electronic equipment. (p. 45, GAO Draft Report)

DoD POSITION: Concur. Space Command is revising its QAE (on-site contract administrators) training program to improve the QAE's knowledge and understanding of both contractual and technical operations. This revision is expected to be completed by March 1986. The Air Force military assignment system now assigns top quality individuals who meet the rank, Air Force Specialty Code, and quality control criteria established for assignment to QAE positions. The revised training program and the new assignment policy will insure that QAES assigned are better qualified in evaluating contractor compliance with technical specifications, especially in highly technical areas such as the operation and maintenance of communication and electronic equipment.

RECOMMENDATION 6: The GAO recommended that the Secretary of the Air Force conduct a survey of technical order compliance and

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and Personnel)**

Now on p. 48.

safety procedures at other radar installations to determine if similar problems may exist. If noncompliance with technical orders or other problems are identified, corrective actions should be taken. (p. 45, GAO Draft Report)

DoD POSITION: Concur. The initial implementation of this recommendation by the Air Force will be accomplished within Space Command, which operates other radar installations similar to the one at Clear AFS. Space Command will comply by doing evaluations at the two primary types of radar sites, pulsed and non-pulsed, both of which have a possibility of radiation incidents. Specifically, Space Command will address the following installations:

Pulsed Radar:

MacDill AFB, FL
Pirinlik Inst, Turkey
San Miguel, Republic of the Philippines
Clear AFS, AK
Thule SB, Greenland

Phased Array Radar:

Beale AFB, CA
Eglin AFB, FL
Cavalier AFS, ND
Otis AFB, MA
Shemya, AK

The three new phased array radars (Thule, Robins AFB, GA, and Goodfellow AFB, TX) will be checked following initial operational capability and initial radiation hazard survey.

The Space Command approach will be time phased along the following schedule:

- a. Within one month: Space Command will review Statements of Work for contractor maintained radar sites, both pulsed and phased array. This review will ensure that there is a binding, contractual vehicle forcing the contractor to adhere to AFOSH standards.
- b. Within 6 months: Tasked through Space Command, each site commander will verify that current procedures are in accordance with present Technical Orders (TO) and Maintenance Operating Instructions (MOI). If discrepancies or deficiencies are discovered, appropriate corrective actions will be taken.
- c. Within 24 months: During their normally scheduled Management Effectiveness Inspection (MEI), the Space Command Inspector General (IG), as a Special Interest Item (SII), will ensure that the sites are complying with current TO procedures, site operating instructions, or MOIs, as appropriate.

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Compliance with Air Force safety requirements is monitored by the Space Command IG during routine MEIs which were recently broadened in scope to include the activities of Air Force contractors. Inspections are conducted on a no-notice basis at approximately 18 to 24 month intervals. The inspection team is composed of highly qualified individuals in each of the specialties represented in site operations and maintenance. SIIs receive added attention for a specific length of time. A SII covering this subject will be made effective until all concerned sites have been evaluated.

Several actions having Air Force wide impact are being implemented by the Air Force Surgeon General. The review of technical order compliance and safety procedures will be addressed in a forthcoming All Major Command (ALMAJCOM) Letter containing specific instructions for the base level Bioenvironmental Engineers (BEEs) to place emphasis on the requirements of AFOSH Standard 161-9 for reviewing TO health and safety aspects and interlock/access/egress procedures. Major Command BEEs will be asked to specifically review these programs during their periodic Staff Assistance Visits to individual bases. In addition, the USAF Occupational and Environmental Health Laboratory will be tasked to assist base BEEs during its periodic Radiation Assistance Program visits to Air Force installations, in establishing these review procedures. These actions should significantly enhance the effectiveness of the BEE surveillance function toward improving RF safety.

Establishing a plan for reviewing other radar systems on an Air Force wide basis will require coordination with a number of organizations having diverse functional responsibilities. For instance, Air Force Systems Command has specific oversight of new system acquisitions; several others are primarily service oriented and conduct periodic surveys of existing installations in the areas of operations safety (antenna patterns, field strength, fuels/explosives hazards, electromagnetic interference, etc.), or health hazards (personnel exposure levels, interlock procedures, overexposure investigations). The "user" Major Commands will be tasked to develop a plan for reviewing technical order compliance, safety and contract compliance for the radar installations they operate. It will be suggested that for in-house efforts, a joint review process should include safety, operations, maintenance, medical, contracting (where applicable) and/or other areas. Air Force organizations which provide special services should be utilized as deemed appropriate by the user MAJCOM. The Air Force has initiated efforts to develop a tasking for the MAJCOMs and expects to have this completed by February 1986. After review of these results, an action plan will be prepared for implementation.

Comments From the Director, Administration, ITT/Federal Electric Corporation

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



Federal Electric Corporation

*A Worldwide Service Associate of ITT
621 Industrial Avenue
Paramus, New Jersey 07652
Telephone: (201) 967-0123 Telex: 134458
September 13, 1985*

Mr. Frank C. Conahan
Director,
United States General Accounting Office
NSIAD/AF - Room 5832
441 G Street, N. W.
Washington, D. C. 20548

Dear Mr. Conahan:

Consistent with your letter of August 5, 1985, please find below our comments on the Draft GAO Report concerning the radio-frequency radiation incident at Clear Air Force Station, Alaska (Code 392058).

We strongly feel that the draft report misrepresents the true facts of the case and the circumstances surrounding the September 14, 1983 incident. We believe further that the record should be viewed and judged in its entirety before any final report is issued by the United States General Accounting Office.

To this end, it is requested that your office give full consideration to the facts presented herein and incorporate them into the final body of the report, correcting all mis-statements, inaccuracies and errors accordingly. We also request that our response and recommendations be made an official part of the final GAO Report.

Summary

1. The 14 September 1983 incident is the first and only radiation safety mishap in 23 years of BMEWS contractor Operation and Maintenance.
2. The radiation incident occurred as a result of human error, not because of equipment configuration deficiencies or contractor minimum staffing inadequacies.
3. FSI complied with the contract's Minimum Essential manning complement for a non-operable Central System Monitoring Room (CSMR).

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4. The FSI System Controller assigned to the CSMR was fully qualified with more than 19 years of BMEWS O&M experience, the last 7 years with CSMR competence.
5. The FSI Technician assigned to the DRAM was fully qualified with more than 10 years of experience at the Clear BMEWS Site.
6. The medical attention given to the exposed employees was prompt and efficient.

Our specific comments on the draft GAO Report are as follows:

The BMEWS Site II at Clear, Alaska was accepted by the AF Systems Command from the RCA Missile & Surface Radar Division in the early 1960's. The Detection and Tracking radar transmitters were not initially installed and aligned in accordance with the test site configuration described in the original Technical Orders, which were developed by RCA at Moorestown, New Jersey. However, the system was accepted by the USAF Operating Command and turned over to the RCA Service Company for O&M in the, so called, deviate configuration. FSI understands from personnel who were present at Clear during the time of Tracker installation in the 1960's that the deviation from design of the installed transmitters was an expedient which occurred as a result of an Air Force requirement to bring the tracker on-line at the earliest possible moment to meet an emergency need for space surveillance in a national crisis situation. BMEWS O&M services since 1962 have been provided by RCA Service Company (7 years), ITT Arctic Services Company (3 years), RCA OMS Company (3 years) and ITT/ FELEC Services Incorporated (10 years) under a series of contracts procured and administered by Air Defense Command, Strategic Air Command and currently the U.S. Air Force Space Command. Over the past 23 years of BMEWS O&M in the above referenced configuration there is no record of a Tracking Radar radiation safety incident until 14 September 1983.

On various occasions over the years, the O&M contractors (RCA & ITT) attempted through established AF channels, to modify BMEWS Technical Orders to meet local operating practices and requirements. These recommended changes were disapproved by the responsible Air Logistics Center due in most part to economic considerations. Therefore, during this 23 year period of BMEWS operations, it was the accepted practice to utilize contractor prepared local documentation at each of the three forward BMEWS sites to stipulate site peculiar procedures caused by, among other things, the Technical Orders not containing accurate descriptions of the installed equipments. In essence, each of the three forward BMEWS Sites developed and implemented a uniquely distinct equipment configuration to meet individual site operating requirements, which differed from that originally designed by RCA at the test site in Moorestown, New Jersey. By necessity, field application differed from development application for very practical operating and costly economic reasons. The distinctly unique configurations and site operating systems for each of the three locations have been approved by the U. S. Air Force Command responsible for overseeing BMEWS U. S. Defense requirements and have satisfied these requirements in an outstanding fashion since 1962.

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As the record indicates, the Air Force-approved system of individual, locally prepared Site Instructions has worked very effectively. In view of the fact that BMEWS is a one of a kind system, installed in different configurations at only three locations throughout the world, the use of site instructions in lieu of maintaining high cost Technical Orders was a wise decision. The GAO condemnation of the Air Force and the O&M contractor(s) for continuing this Site Instruction practice ignores the economic impracticality of following the complex and expensive process for changing and publishing Technical Orders for unique "one-of-a-kind" installations. Similarly, each of the GAO conclusions concerning O&M Contractor and Air Force performance are in error because they are based on only part of the facts. There is a rational explanation for each of the practices which were in effect at Clear. The following paragraphs address each of the GAO cited instances of contractor non-compliance with contract terms per Chapter 3 of the report.

Now on p. 24.

Page 22: CONTRACTOR SHOULD HAVE REPORTED THAT EQUIPMENT LAYOUT
NEEDED TO BE CHANGED

The O&M contractors, since 1962, on numerous occasions submitted through AF channels recommended changes to BMEWS Technical Orders. Unfortunately, records of the submittals, which may or may not have addressed the Tracker Waveguide Configuration, are not now available to the contractor. However, depositions supporting the fact that the submittals were made may be solicited from contractor personnel who prepared the AFTO 22 forms and from those who approved and submitted them to the Air Force. Further, retired Air Force personnel who processed the recommended changes have indicated that, upon request, they would be available to provide such depositions. It would be in the GAO's best interest to secure such depositions from contractor and retired military personnel before issuing a final report. As the current O&M Contractor for the BMEWS Site I and II Operations, FSI would be more than willing to assist the Government in this task.

The GAO allegation that the contractor(s) did not propose the necessary changes to Technical Orders is not supported by fact.

At the time of FSI acceptance of O&M contractual responsibilities, the published Clear site instructions provided to FSI by the Government contained the procedures to leave Key #1 in the TRMC in order to activate antenna movement which is required under "Hot" or "Cold" PM routines. Therefore, Key #1 was separated from Key #2. (In acknowledgement of this requirement the Air Force continues to approve at Site I a spare TRMC key to be retained in the TRAM Room).

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Similarly, at the time of FSI acceptance of O&M responsibilities, the standard practice recognized that the root element in preventing RF radiation within the radome was the correct positioning of the RF Wave Guide Switches. The site instruction required that after Wave Guide Switch closure the key was to be secured by CSMR unless specifically authorized for release by the responsible Tracking Radar Team Leader. (In the 14 September 1983 incident the key was released by CSMR to the proper authority who then failed to follow established safety procedures - underscoring the fact that the incident was caused by human error.)

The operating procedures in effect at the time of the September 14, 1983 incident, relative to access to the radome area were more than adequate to meet all safety requirements and were in conformance with Clear Site instructions and the MOI in effect at the time. The fact that human error was the underlying cause of the incident should not be readily dismissed by the GAO. It is noteworthy to indicate that FSI further improved upon local safety requirements at Clear after the incident by developing the Pedestal Lock-Out Safety Panel Protection System which now provides additional safeguards including activation of a klaxon and the maintenance lighting signals in the radome area in the event of potential problems. The GAO's citing of deficiencies in this area is inappropriate since the Clear Site instructions and MOI, as provided to FSI by the U. S. Air Force, did not require the use of the Pedestal Lock-Out Safety Panel and klaxon and lighting systems prior to the September 14, 1983 incident. To cite FSI for failure to provide a system which was not required at the time is unwarranted. To raise the issue retrospectively after the contractor undertook action to upgrade an already safe system is unfair and penalizes unsolicited contractor safety initiative.

Now on p. 25.

Page 24: CONTRACTOR DID NOT COMPLY WITH MINIMUM STAFFING REQUIREMENTS

The Statement of Work stipulates a normal MINIMUM MANNING complement and a MINIMUM ESSENTIAL manning complement by each critical functional area. When all systems are operable the normal MINIMUM MANNING requirements in the functional areas are as described in the GAO report. On 14 September 1983 all systems were not operable.

CSMR - On the day of the incident, FSI management had allowed the System Controller scheduled for duty in the CSMR to take the day off because the Tracking Radar would not be operational, resulting in a reduced CSMR workload. Contrary to the GAO report, a fully qualified alternate System Controller and fully qualified Equipment Controller were scheduled to work in the CSMR for the shift in question. This manning satisfied the contract's MINIMUM ESSENTIAL manning requirements. This second qualified Systems Controller, D. Eikamp, was originally scheduled to fill an Equipment Controller position. Upon departure of the technician scheduled to perform the System Controller duties, Mr. Eikamp served in that position.

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See comment 1.

The opinion expressed by the GAO that had fully qualified technicians been occupying the positions the problem would have been immediately identified, or at least minimized, is not supported by fact. Both technicians were fully qualified. Mr. Eikamp has served in the BMEWS Operations & Maintenance (O&M) functions for over 19 years. During this period and especially since 1978 he has been qualified to perform the CSMR functions, first as an Equipment Controller and then as an Alternate Systems Controller. The Equipment Controller on duty in the CSMR the day of the incident, Mr. Telling, has over 15 years experience in O&M of BMEWS electronics systems. Since 1967 he has been qualified in a variety of BMEWS technical tasks, primarily in the CSMR and MIP functional areas. (Please refer to attached resumes of D. Eikamp and H. Telling). Further, if both were physically in their assigned positions at their respective consoles neither would have been able to identify that a live transmitter had been switched into the Tracking Radar antenna. The configuration of the CSMR System Monitoring Panel, coupled with the location of the individual consoles in relation thereto and the positions of the individuals in front of the consoles prevents the System Controller and Equipment Controllers from viewing the status of the affected transmitters. Subsequent tests have confirmed also that there are no audible or light indications which would alert the CSMR technicians that Transmitter #28 had switched into the Tracking Radar. It was only by the happenstance that the System Controller was out of position from behind the console that he was able to spot that Transmitter #28 was not assigned to the DR but was displayed as "Green" off-line.

DRAM - Although the Training Records do not reflect it, R. Gould, the technician on duty monitoring the DRMC in the DRAM room at the time of the incident was, contrary to the GAO report, fully qualified to perform the duties of that position. Mr. Gould has 10 years experience at Clear, Alaska as a Radar Technician qualified in both the TRAM and DRAM functional areas. (Please refer to the attached resume of R. Gould). Therefore, the speculation expressed in the GAO report that the situation would have been ameliorated with the assignment of a qualified technician to this position is not supported. The fact is that there was no indication in DRAM that XMTR #28 was active in the Tracking Radar.

TRAM - It is correct that "FSI management did not assign anyone to the TRAM on that day". During normal, routine "cold" PMS a technician at the TRMC serves no useful purpose unless he is required to reposition the antenna or perform maintenance in the TRAM. This practice of not manning the TRMC during "cold" PMS remains in effect today. The comments of the System Controller who had been given the day off as quoted by the GAO report are without foundation as explained above.

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Now on p. 41.

See comment 2.

Chapter 5, Page 35: MEDICAL ATTENTION PROVIDED VICTIMS OF THE ACCIDENT

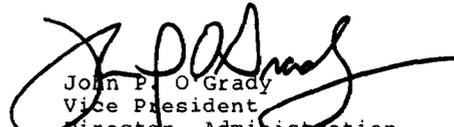
It is the contention of FSI that any more rapid response by the medical facilities would not have had any bearing on the physical condition of the affected employees. The site nurse contacted Brooks AFB prior to arrival of the affected employees at the site dispensary. Medical attention was provided in a timely manner as recommended by Brooks AFB. (Two of the personnel refused off-site examinations for several months).

In closing, it is my Company's recommendation that the draft GAO Report be modified to reflect the factual information presented above on behalf of FELEC Services, Inc., regarding its compliance with U. S. Air Force approved operating procedures at the Clear BMEWS facility.

Please feel free to contact me personally should you have any questions concerning our position on this issue. I look forward to hearing from you, on our recommendations at your earliest convenience.

Sincerely,

FEDERAL ELECTRIC CORPORATION


John P. O'Grady
Vice President
Director, Administration

Att. (4)

ITT FELEC Services, Inc.

RESUME

NAME: DARRELL M. EIKAMP

PRESENT POSITION: Equipment Controller

SUMMARY OF EXPERIENCE: Over 20 years experience in operation and maintenance of major radar and surveillance equipment in BMEWS, CMEWS, and Western Test Range.

EXPERIENCE:

May 1980 - Present: ITT/FSI, BMEWS, Clear, AK, Equipment Controller. Directs and authorizes switching of equipment when necessary to maintain BMEWS operation goals; observes Equipment Status Panel, establishes communications circuits and directs appropriate action when change in status of technical equipment occurs; directs and authorizes removal of equipment from on-line status to permit operating adjustments; directs restoration of the system capability following catastrophic failures, i.e., power failures, as authorized or directed by either the SC or SD; coordinates all maintenance and modification activities; enforces operating discipline and ensures manning of all subsystem operating consoles as required; maintains operating logs and prepares reports as required. Acts as the focal point for directing maintenance efforts. Performs as maintenance control to include plans and scheduling and job control for all maintenance on equipments which are identified in AFM 65-662. The Equipment Controller operates the Central Switching Console and takes appropriate action to maintain BMEWS operating capability when directed by the Senior Equipment Controller or Systems Controller. On the System Checkout Console, the Equipment Controller: checks the printout on the DYNAMIC Automatic Monitoring; directs the insertion of the simulated static target into the DR beam or TR for testing purposes; loads the Exercise Tapes and starts the performance system exercises required to be run on the SCO as directed by the Senior Equipment Controller; analyzes system performance exercise data from SCI printout and appropriate lights on SCO console; advises the Senior Equipment Controller of results of performance exercises; maintains operating logs as required. Prepares the Daily Site Activity Schedule for reproduction and distribution. Prepares the Monthly Maintenance Plan. Makes changes and updates to the Monthly Maintenance Plan as required. Distributes the plan and all changes to the concerned agencies. Acts as the focal point for work center scheduling problems and rescheduling actions. May be required to provide USAF operational training.

1978 - 1980: BMEWS Project Headquarters, Data Systems, CO, Maintenance Management. Projects included Honeywell Level 6 (EWALS) Computer and Univac 1810 keypunch installations at Thule, Greenland, and Clear, Alaska.

ITT FELEC Services, Inc.

RESUME

(DARRELL M. EIKAMP Continued)

1973 - 1978: Nekoma and Concrete, ND, Safeguard Project. Jobs included Power Plant Controller, Honeywell H360 computer maintenance and instrumentation maintenance.

1972 - 1973: BMEWS, Thule, GN, BMEWS Equipment Controller.

1971 - 1972: Western Test Range, Vandenberg AFB, CA, TPQ-18 Tracking Radar Maintenance. Primarily assigned to RCA 4101 computer, but due to size of site, also worked on Tracking Radar.

1970 - 1971: BMEWS, Thule, GN, BMEWS Central Technician.

1967 - 1969: BMEWS, Thule, GN, BMEWS Central Technician/Team Leader.

1964 - 1967: Trained American and German Air Force personnel on the operation and maintenance of the 412L System radar data processors used throughout West Germany. Also required to perform maintenance functions.

1960 - 1964: US Air Force. Taught AN/FST-2 and AN/FSA-12 digital radar data processing courses to military personnel at Keesler AFB, MS.

ACADEMIC BACKGROUND:

High School, Britton, SD: 1960
AN/FST-2 Digital Data Processor Maintenance and SAGE System Radar Data Processor with drum memory, Keesler AFB, MS: 1961
Technical Instructor Course, Keesler AFB, MS: 1962
AN/FSA-12 Digital Data Processor Maintenance and 412L System Radar Data Processor, Keesler AFB, MS: 1962
BMEWS Central Maintenance, Riverton, NJ: 1967
Honeywell Level 6 Maintenance, Phoenix, AZ: 1979
Univac 1810 Keypunch Maintenance, Colorado Springs, CO: 1979

SECURITY CLEARANCE: Secret

ADDITIONAL AREAS OF QUALIFICATION:

System Controller (Alternate)
MIP Technician
DTO/Central Technician

ITT FELEC Services, Inc.

RESUME

NAME: HARRY C. TELLING

PRESENT POSITION: DR Maintenance Technician

SUMMARY OF EXPERIENCE: Fifteen years experience in operation and maintenance of BMEWS heavy ground radar systems, electronic equipment, and computer systems.

EXPERIENCE:

October 1978 - 1983: ITT/FSI, Clear, AK, DR Maintenance Technician. Qualified in a variety of tasks, primarily in the CSMR and MIP functional areas in BMEWS.

April 1967 - October 1978: RCA/ITT-ASI/FSI, BMEWS System, Clear, AK, DR Technician. Responsible for performing all preventive and corrective maintenance on the Detection Radar, Transmitters, Receivers, IF Units, Synchronizer, Frequency Generation, Automatic Monitoring, Test Target Generator equipment groups and the Transmitter Cooling Systems. Performs preventive and corrective maintenance on the DR Scanner equipments. Maintains logs associated with the above equipment and completes maintenance reports, as required. Completes AFTO forms IAW USAF reporting and documentation requirements. Assists in preventive and corrective maintenance on the Tracking Radar system.

ACADEMIC BACKGROUND:

Fife High School: 1955-1958
Tacoma Voc School: 1958-1959
US Air Force: 1961-1965
Electronics School, Denver, CO: 1961-1962
Kentucky Christian College: 1977
Cyber 170/720 Hardware Course, Clear, AK: 1982

SECURITY CLEARANCE: Secret

ADDITIONAL AREAS OF QUALIFICATION:

(CSMR) Equipment Controller
MIP Technician

ITT FELEC Services, Inc.

RESUME

NAME: RICHARD N. GOULD

PRESENT POSITION: Maintenance Specialist TR

SUMMARY OF EXPERIENCE: Eight years experience as heavy radar technician and nine years as electronic technician with Bendix Company and US Army.

EXPERIENCE:

November 1978 - Present: ITT/FSI, BMEWS, Clear, AK, Maintenance Specialist TR. Highly skilled and trained technician, versatile, able to function in a number of positions within the BMEWS System.

January 1975 - November 1978: IIT/FSI, BMEWS, Clear, AK, Tracker Technician. Responsible for performing preventive and corrective maintenance on the TR electronic components, TRAM and TRMC consoles. Assists in maintenance actions on the Detection Radar System as required. Completes reports and records. Maintains logs IAW the reporting and documentation requirements.

April 1966 - January 1975: Bendix Field Engineering, Maryland, Electronic Technician. Various jobs including repair of mobile radios, QA inspection of modules for the moon shot, RFI and EMC measurements, and production work at Bendix Radio. Two years with US Army in Microwave Communications.

ACADEMIC BACKGROUND:

High School
US Army, Basic Electronics & Microwave Communications: 16 weeks

SECURITY CLEARANCE: Secret

ADDITIONAL AREAS OF QUALIFICATIONS:

DR Technician (DRAM DRMC)

Potential Depositions Concerning AFTO 22 Technical Order Change Requests

<u>Name</u>	<u>Current Position</u>
J. Mackin	Mgr, Technical Site II
C. Roat	Supvr, Data Systems, Site II
C. Pugh	Mgr, Quality Assurance, FSI PHQ
R. Boldt	Retire AF Civil Service
J. McClay	Mgr, COBRA DANE/PARCS
G. Evans	GS-13, Hq SPACECMD
W. Emmons	GS- , Hq SMALC
J. Wigley	QC Technician, Site II

Appendix IV
Comments From the Director,
Administration, ITT/Federal
Electric Corporation



Federal Electric Corporation

A Worldwide Service Associate of ITT

621 Industrial Avenue

Paramus, New Jersey 07652

Telephone: (201) 967-0123 Telex: 134458

October 21, 1985

Mr. Frank C. Conahan
Director,
United States General Accounting Office
NSIAD/AF - Room 5832
441 G Street, N. W.
Washington, D. C. 20548

Dear Mr. Conahan:

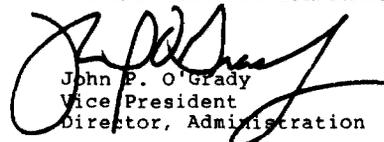
I refer to my letter of September 13, 1985 which contained our comments on the Draft GAO Report concerning the radio-frequency radiation incident at Clear Air Force Station, Alaska (Code 3920558).

On the last page of my letter I have noted an error which, for the record, should be corrected. I stated that the nurse contacted Brooks AFB prior to the arrival of the affected employees at the site dispensary. I now note that she did not contact Brooks AFB at that time, but did consult the Fairbanks Memorial Hospital, and the Environmental Department, Eielson AFB, AK prior to the arrival of the affected employees. Consultation with the Occupational Environmental Health Laboratory, Brooks AFB, TX took place at 0800 hours the following morning, September 15, 1983.

In addition to the above correction, I wish to add attachments and supporting documentation to our statements that O&M contractors at Clear AFS did, in fact, submit recommendations through proper channels to reconfigure the detection and tracking radars and associated displays; and had, in fact, assigned fully qualified personnel to the positions cited in the draft report.

Sincerely,

FEDERAL ELECTRIC CORPORATION



John P. O'Grady
Vice President
Director, Administration

Attachments

See comment 3.

The following are GAO's comments on the ITT/Federal Electric Corporation letters dated September 13, 1985, and October 21, 1985.

GAO Comments

1. By letter dated October 21, 1985, the contractor provided GAO updated on-the-job training records for three individuals who were on duty in the control rooms on the day of the accident. According to the contractor, these records support its position that fully qualified personnel were assigned to the positions cited in the draft report. As we state in the report, we used the qualifications and training records in effect at the time of the accident. Additionally, based on our discussions with two of the contractor employees in question, we were not able to verify the accuracy of the updated information.

2. By letter dated October 21, 1985, the contractor corrected its comments in its September 13, 1985, letter concerning the actions of the site nurse. According to the contractor, the site nurse did not contact Brooks Air Force Base but she did consult Fairbanks Memorial Hospital and Eielson Air Force Base, Alaska, prior to the affected employees' arrival at the site dispensary. Consultation with the Occupational Environmental Health Laboratory, Brooks Air Force Base, Texas, took place at 0800 hours the following morning, September 15, 1983.

3. Attachments not included.

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