New File C.8
Environment

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5 MEGAWATT SOLAR THERMAL TEST FACILITY

ENVIRONMENTAL ASSESSMENT

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
San Francisco Operations Office
1333 Broadway
Oakland, California 94612

Contract E(04-3)-1078

BLACK & VEATCH
HONEYWELL, INC.
GEORGIA INSTITUTE OF TECHNOLOGY

30 January 1976
Revised 9 August 1976

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SUMMARY

This document is an Environmental Assessment of the United States Energy Research and Development Administration 5 Megawatt Solar Thermal Test Facility (STTF). The document was prepared by Black & Veatch and has been authorized by the United States Energy Research and Development Administration in Contract E(04-3)-1078.

The STTF is to be located at Albuquerque, New Mexico, and will serve the testing needs of the ERDA Solar Thermal Program. The facility will have the capability for testing scale models of major subsystems comprising a solar thermal electrical power plant. The first solar thermal program power plant to be supported by the STTF will be a 10 MWe (megawatt electric) water/steam pilot plant to be operational by 1980. Provisions have been made in STTF planning to allow testing of subsystems and components being developed by private organizations. High temperature processing, materials research, and other developments which could utilize highly concentrated solar energy may also benefit from the STTF.

It is planned that the STTF will be operational at a one MWt (megawatt thermal) power level by April 1977, and will be capable of 5 MWt operation by December 1977. The STTF capabilities will include testing a solar energy collector sybsystem comprised of heliostat arrays, a receiver subsystem which consists of a boiler/superheater in which a working fluid is heated, and a thermal storage subsystem which includes tanks of high heat capacity material which stores thermal energy for subsequent use. The STTF will include a 200-foot receiver tower on which experimental receivers will be mounted. A field of working heliostats will provide concentrated solar flux for receiver testing. Foundations will be provided for mounting experimental heliostats and for

installation of thermal storage tanks. An auxiliary package boiler will be installed to supply steam for thermal storage testing and for certain modes of receiver testing. General support capabilities will include test assembly, control and instrumentation, heat dissipation, water supply and treatment, wastewater treatment, and laboratory facilities. Visitor facilities will also be provided.

The 115-acre STTF site is located southeast of Albuquerque on U. S. Government property operated by Sandia Laboratories, Albuquerque, New Mexico. The site is in a weapon system and explosive testing area called Coyote Test Field. Officially, the Coyote Test Field is closed to the public except for authorized visitors and personnel. The nearest housing is 4 miles west. No historic or archaeological resources were discovered in an archaeological survey of the site. The site is relatively undisturbed shrub-grassland on gently sloping, sandy and clayey colluvial soils which are highly susceptible to wind or water erosion, and which are impervious to runoff infiltration. The water table occurs at a depth of 500 feet and constitutes the area water supply. There are no rare, endangered, or threatened wildlife species known to occur in the area. The climate is a high-altitude, dry continental type. There is a wide diurnal temperature variation averaging 25 F. Extreme temperatures seldom exceed the 0 F to 100 F range. Average annual precipitation is 8 inches. Prevailing winds are easterly with an average annual velocity of 9 miles per hour. Occasional dust storms occur in late winter and early spring. From sunrise to sunset, clear days occur about 48 percent of the year, partly cloudy days 30 percent, and cloudy days 22 percent. Partly cloudy daytime periods usually occur in late afternoon. On a typical annual day, direct insolation exceeds 0.8 kW/m^2 during six hours, and 0.9 kW/m^2 during four hours.

Construction is expected to result in minor soil losses, siltation of runoff and fugitive dust. The small size of the site relative to similar surrounding areas indicates that loss of the site wildlife habitat due to construction will not have any significant effects on Coyote Test Field ecosystems. The planned 36-month construction will require an estimated average work force of less than 50. The total cost of construction is projected to be $22.4 million.

Minor environmental effects of operation may include those from heliostat shading and reflection, receiver operation, auxiliary boiler gaseous emissions, and heat rejection to the atmosphere via an evaporative cooling tower. Heliostat shading may modify potential vegetation and thereby alter wildlife populations, or may attract wildlife. Gravel paving of the heliostat fields to reduce water and dust erosion will modify or preclude most potential biological effects of heliostat shading. Heliostat glare is not expected to pose a hazard to personnel in aircraft flying over the area; however, quantitative analyses should be performed to determine the need for any aircraft flight controls or any other measures to ensure public safety. If birds of prey nest or perch on the receiver tower, and such uses are not controlled during periods of receiver testing, there could be bird injury by exposure to the high intensity solar flux directed toward the receiver at the top of the tower. The auxiliary boiler will be fired with No. 2 fuel oil. Due to the intermittent nature of boiler operation and low gaseous emission rates, it will not have any significant impact on ambient air quality. Similarly, cooling tower emissions of heat, water vapor, and water droplets were evaluated and will have no significant effects on local meteorology, ambient air particulate matter, or solids deposition. The STTF employment and operating expenditures will constitute only minor contributions to the local economy.

No significant environmental effects are anticipated from postulated facility accidents. The effects of any fires or explosions should be confined to the STTF and should not extend to adjacent areas. Aboveground tanks storing hazardous liquids will have catchments. The impermeable soil and lack of ground water within 500 feet of the surface should prevent ground water contamination from underground or aboveground tank leakage or spillage. Accidental releases of hazardous gases should be well-dispersed before reaching populated areas.

The only cumulative or long-term environmental effects anticipated from the facility will be the modification of site soils by gravel paving. This will prevent reestablishment of a natural vegetative community and reduce the long-term wildlife carrying capacity of the site.

There are no known or anticipated potential conflicts of the facility with State, regional, or local plans and programs. A land use permit has been requested of the Kirtland Air Force Base site property administration.

CONCLUSION

No significant adverse environmental impact is expected from STTF construction and operation.

INTRODUCTION

This document is an Environmental Assessment of the United States Energy Research and Development Administration 5 Megawatt Solar Thermal Test Facility (STTF). The document was prepared by Black & Veatch and has been authorized by the United States Energy Research and Development Administration in Contract E(04-3)-1078. This document was prepared pursuant to the requirements of the National Environmental Policy Act of 1969 and Executive Orders 11514 and 11752. It is also in accordance with 10 CFR Part 711 (formerly 10 CFR 11).

The Environmental Assessment describes the proposed STTF, its anticipated benefits, and the environment affected. It also evaluates the potential environmental impacts associated with STTF construction and operation.

1. STTF GENERAL OBJECTIVES AND BENEFITS.

A key aspect of the ERDA Solar Thermal Program is to design, build, and operate a 10 MWe (megawatt electric) water/steam pilot plant by 1980. To support this program as well as more advanced future systems, it is essential to have a facility wherein various prototypes or scale models of the important subsystems can be tested prior to final design. Such a test program is accepted practice in the development of complex systems. The testing program allows parallel development and comparison of alternate concepts and assures a high probability for successful operation of pilot plants. An integrated facility in which such a testing program can be carried out does not exist in the United States today.

To meet the testing needs of the Solar Thermal Program, ERDA has decided to design and build a 5 MWt Solar Test Facility to be located at Albuquerque, New Mexico. This facility will have the capability for testing scale models of major subsystems of a solar thermal electrical power plant. Also, the facility is planned to be flexible enough to meet both the current and long range needs of ERDA as well as needs of private organizations and universities engaged in major solar development activities.

1.1 IMMEDIATE OBJECTIVES AND BENEFITS. It is planned that the facility will be operational at a one MWt power level by April 1977. The primary objective of the facility is to test experimental receiver designs which could be scaled up for use in the 10 MWe Pilot Plant. Most of these tests will require operation of the facility at the full 5 MWt power level, scheduled for operation by December 1977. Secondary objectives include the testing of heliostat and thermal storage modules. The first subsystems to be tested will be the Subsystem Research Experiments (SRE) hardware scheduled for delivery to ERDA in late 1977 by ERDA contractors. These will consist of three different receivers, three thermal storage concepts, and four different heliostat designs.

The facility may also be used to perform verification tests of some of the components and subsystems designed for the 10 MWe Pilot Plant itself.

In addition, the facility will have the capability of testing subsystems and components that are now developed by private organizations. These components and subsystems will require testing in the near future.

1.2 OTHER OBJECTIVES AND BENEFITS.

The other objectives of the facility are to meet the needs of developing solar technology in solar thermal conversion and in related developments utilizing highly concentrated solar energy. The facility will be designed to provide flexibility for future expansion and for addition of specialized equipment so that these objectives can be met.

1.2.1 Advanced System Concepts. Receivers which utilize heat transfer fluids other than water/steam will form the basis of advanced solar thermal conversion systems. Examples of alternate heat transfer fluids are air, helium, liquid metals, molten salts, and organic liquids. Design of these receivers may be complex and will require performance verification tests in the facility. Provisions to accommodate such tests will be incorporated in the initial design of the facility to the extent practicable.

1.2.2 High Temperature Processing. The existence of the STTF will substantially extend the United States' capabilities for testing certain high-temperature chemical and metallurgical reactions.

1.2.3 Materials Research. The capability for experimentation at high temperatures offered by the STTF may provide a new tool for high-temperature materials research.

1.2.4 Environmental Assessment. The STTF may provide data on system performance characteristics for environmental assessments of larger solar thermal conversion facilities such as the 10 MWe Pilot Plant.

2. STTF DESCRIPTION.

2.1 GENERAL DESCRIPTION.

The STTF will be constructed on United States Government property at Kirtland Air Force Base in the Coyote Test Area operated by Sandia Laboratories, Albuquerque, New Mexico. The STTF location is shown on Figure 1.

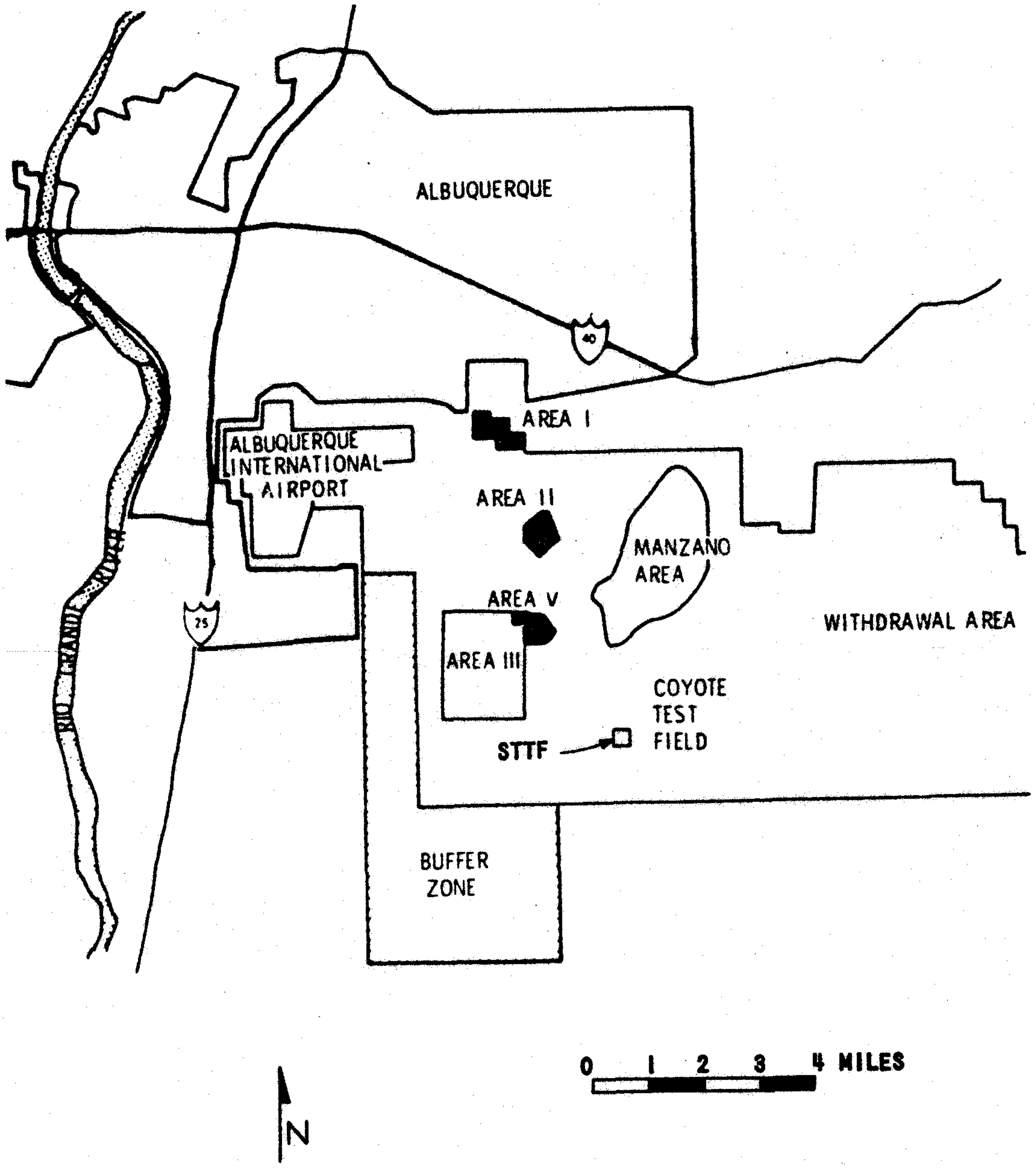
The STTF will have capabilities for testing scale models of major subsystems of a solar thermal electrical power plant. Major subsystems to be tested are:

- The collector subsystem composed of a number of heliostats and their control and drive mechanisms.
- The receiver subsystem consisting of the boiler/superheater in which the working fluid (water) is heated to produce superheated steam.
- The thermal storage subsystem which stores thermal energy for subsequent production of steam during periods of low or no insolation.

There are presently no plans for testing an electric power generation subsystem.

Support facilities for these tests will include a Receiver Tower, on which experimental receivers will be mounted, and a field of working heliostats to provide concentrated solar flux for receiver testing. Pedestals will be provided for mounting experimental heliostats, and targets will be mounted on the tower for measuring optical performance of heliostats. An auxiliary package boiler will be installed for supplying steam to charge experimental thermal storage modules. General support capabilities will include test assembly, central control, instrumentation, heat dissipation, water supply and treatment, wastewater treatment, and laboratory facilities. Visitors facilities will also be provided.

In future phases of STTF development, additional capabilities may be provided for advanced systems testing, high temperature processing, and materials research. These will be implemented as demand and funding permit.



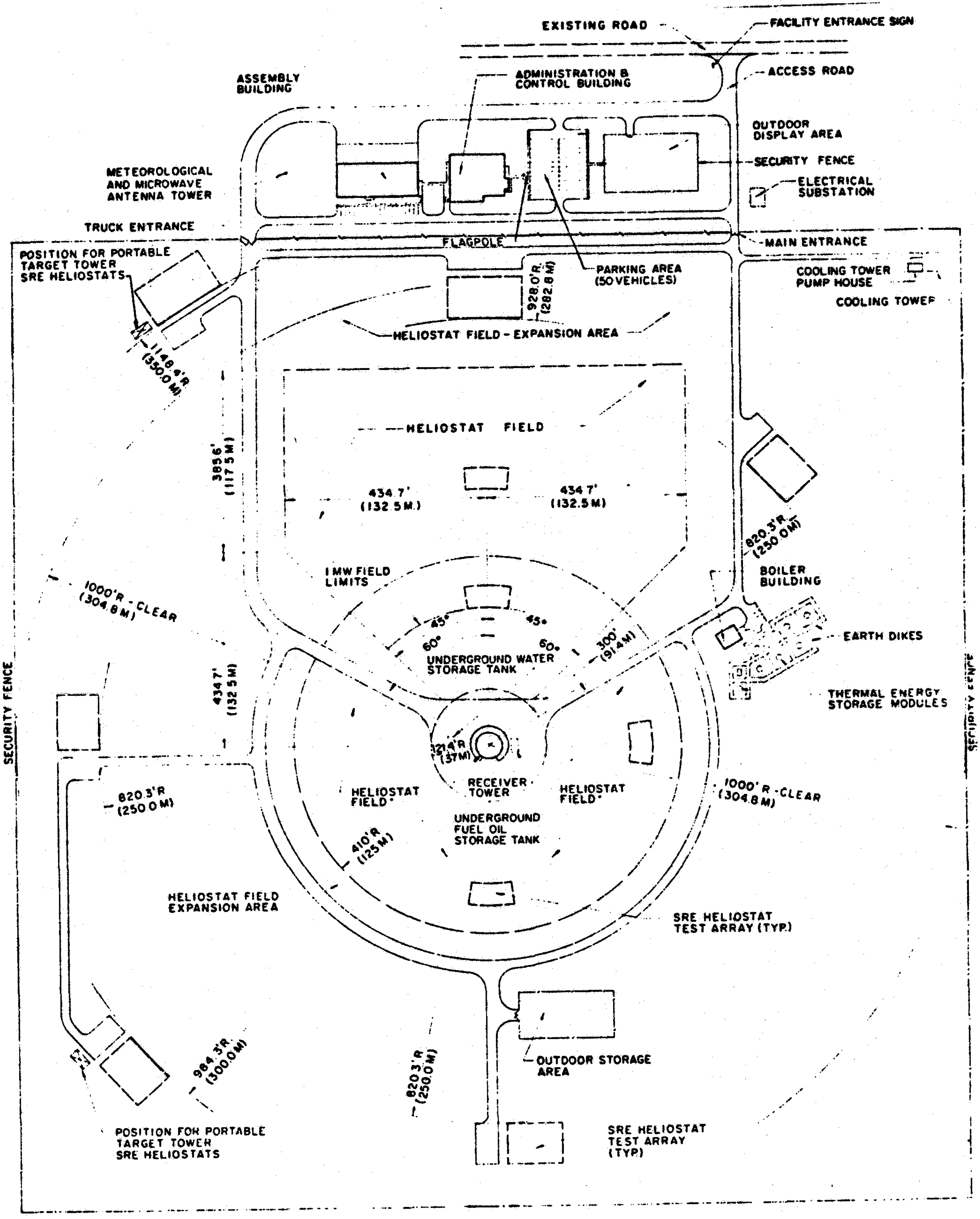
SOLAR THERMAL TEST FACILITY
LOCATION MAP

FIGURE 1

The general construction of the STTF will require approximately one year, beginning in early 1976 and ending in late 1978. The facility is scheduled to be operational for testing solar receivers at the one MWt level by April 1977 and at the 5 MWt level by December 1977.

The site layout of the STTF is shown on Figure 2. The major structures are the Administration and Control Building, Assembly Building, Receiver Tower, and Boiler Building. Several site areas will be dedicated to various functions. The major functional areas are Outdoor Display, Outdoor Storage, Thermal Storage Test, and Heliostat Fields with additional areas utilized for roads, parking, drainage, and utilities. An area with a 305-meter (1000-foot) radius from the receiver tower for 360 degrees will be restricted and enclosed by security fencing with access by vehicular gates. The tower will be surrounded by sectors of heliostat fields. The north 90-degree heliostat field will require a larger radius than sectors in other directions. Expansion space of at least 30 percent of the area for future heliostats will be provided between the outer limit of the heliostat fields and heliostat service roads. Spaces both within and outside the working heliostat fields will be provided for testing heliostats. Space within the restricted area and near the Boiler Building will be allocated for thermal storage module testing. The Administration and Control Building and the Assembly Building will be located outside the restricted area and on the north side of the tower. An 8-foot chain-link fence will be provided for site perimeter security and will have three strands of barbed wire on extension arms to a height of 9 feet.

2.2 EXTERNAL APPEARANCE. Since the STTF will be on relatively flat and open terrain, it will be visible from a distance of a few miles. The most prominent structure at a distance will be the Receiver Tower illustrated



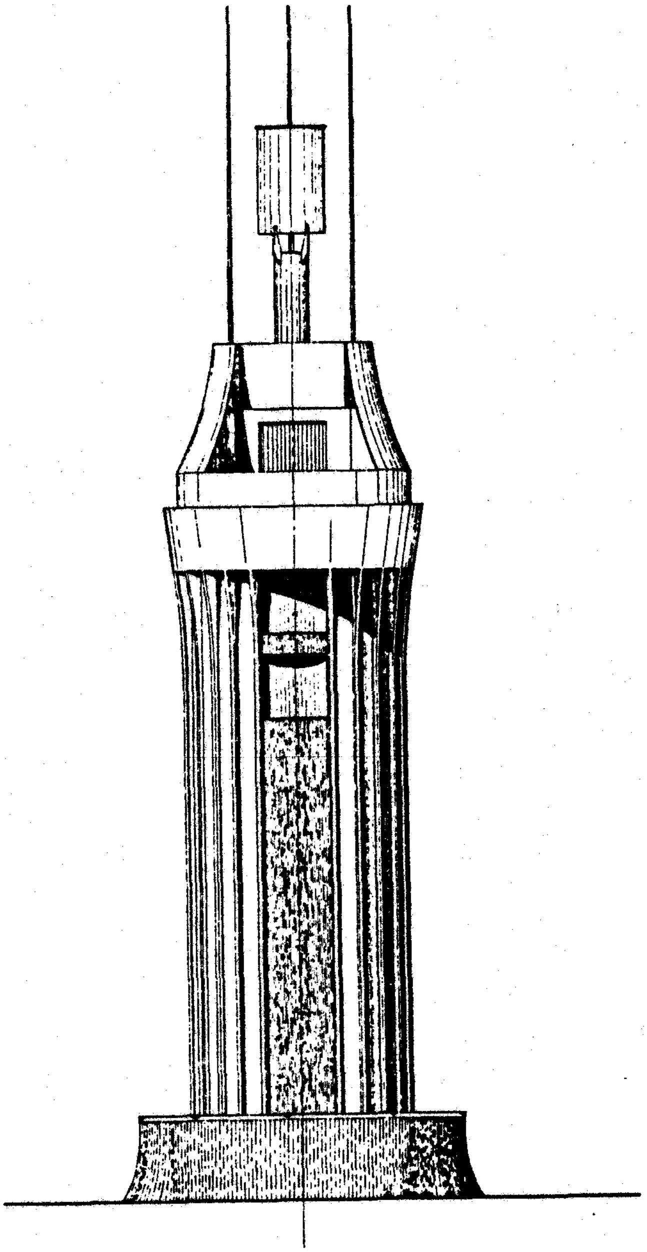
SOLAR THERMAL TEST FACILITY
SITE LAYOUT

FIGURE 2

on Figure 3. The tower will be concrete with a surface design that should create visual interest. The other major structures will be the Administration and Control Building and the Assembly Building. The exterior materials and general exterior design of these buildings will match closely and will be visually pleasing. The exterior materials will be concrete with a reeded bushhammered finish and a prefinished metal panel. Solar collector panels for heating and cooling these buildings will add visual interest. Typical Southwestern landscaping with a patterned cover of rock and gravel with native vegetation will be employed near these buildings. The overall aesthetic treatment of the STTF will reflect the importance of the facility to the public.

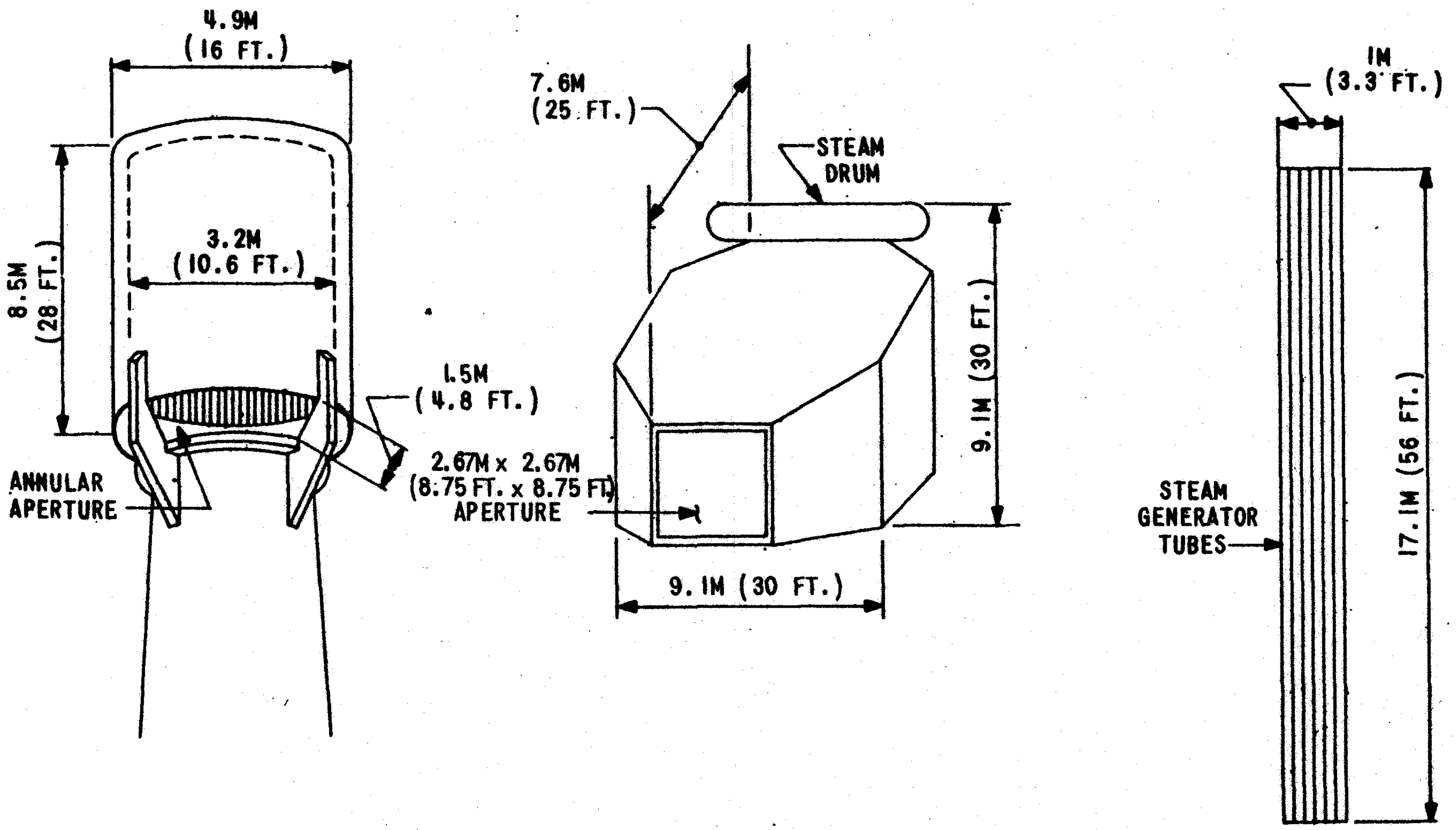
2.3 RECEIVER TOWER AND RECEIVERS. The Receiver Tower will be centrally located within the heliostat field. The tower will be approximately 55 feet in diameter and 200 feet in height with provisions for future superstructure extension to an overall height of 300 feet. There will be a working receiver used throughtout STTF operations, intended primarily for aligning, aiming, and other checkout tests of the working heliostats. This receiver will be required to absorb a maximum of 1 MWt of solar flux.

The working receiver and experimental receivers will be raised from ground level to the top of the tower by an elevating module. The elevating module shaft will have a floor 45 feet below grade. The various experimental receivers identified for testing are shown on Figure 4. The orientation of these receivers with respect to the working heliostats is shown on Figure 5. The primary tests to be performed on the experimental receivers are listed in Table 1. Working fluids for the receivers will be water and steam. The 5 MWt receivers are designed for absorbing solar flux intensities in the range 0.3 to 0.47 MW/m^2 and will produce outlet steam conditions of up to



RECEIVER TOWER
NORTH ELEVATION

FIGURE 3



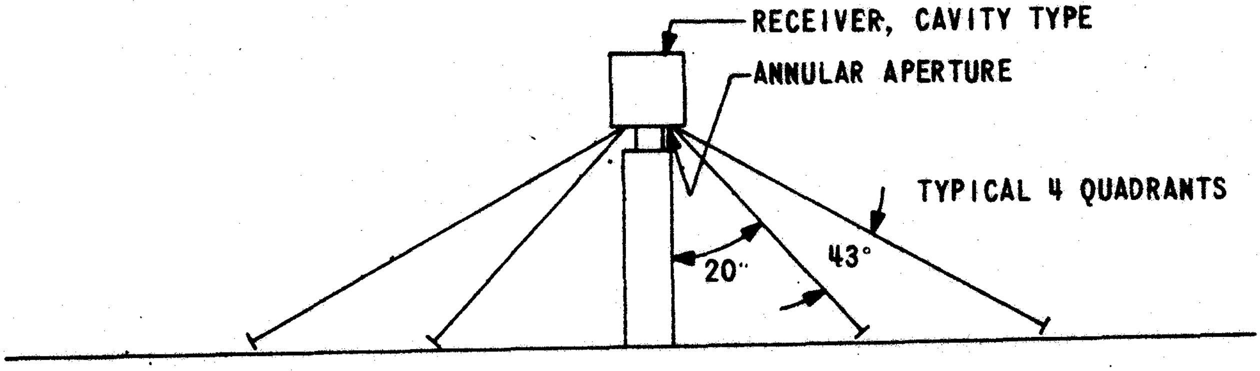
CAVITY TYPE
HONEYWELL

CAVITY TYPE
MARTIN MARIETTA

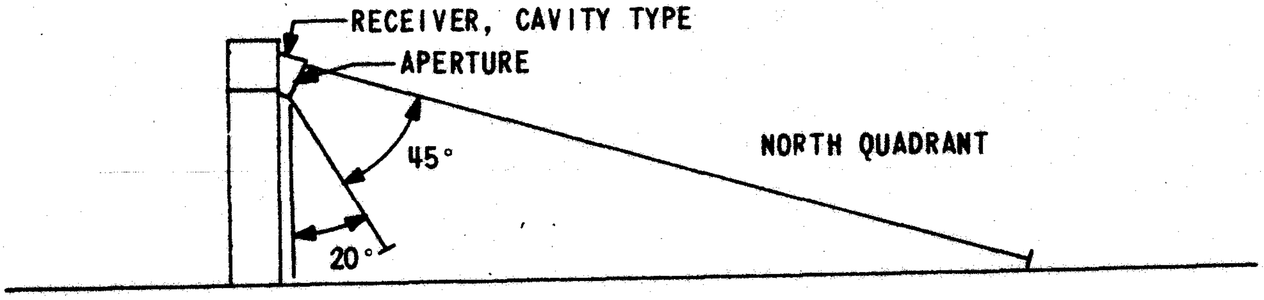
EXPOSED SURFACE
TYPE
MCDONNELL DOUGLAS

RESEARCH EXPERIMENT RECEIVERS

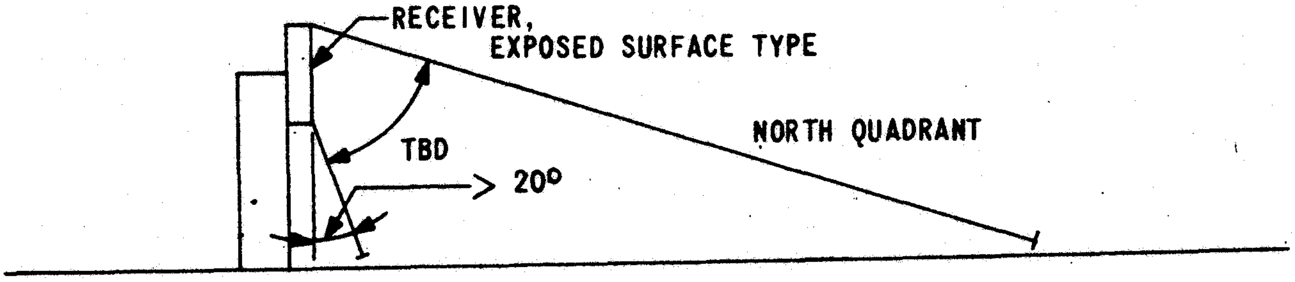
FIGURE 4



HONEYWELL - 360° HELIOSTAT FIELD



MARTIN MARIETTA - 90° HELIOSTAT FIELD



MCDONNELL DOUGLAS - 90° HELIOSTAT FIELD

ORIENTATION OF RECEIVERS TO
WORKING HELIOSTAT FIELD

FIGURE 5

TABLE 1

PRIMARY TESTS TO BE PERFORMED ON RECEIVERS

- PRE-OPERATIONAL TESTS
  - Hydrostatic Pressure Test
  - Instrumentation
  - Test Loop Check
- CONTROL SYSTEM VERIFICATION
  - Start-Up/Shutdown
  - Insolation Changes, Including Transients
  - Emergency Shutdown
- PERFORMANCE TESTS
  - Production of Steam at Design Pressures and Temperatures as a Function of:
    - Insolation Level, Including Transients
    - Air Temperatures
    - Wind Speed and Direction
    - Flux Levels Above Design Limits
  - Emergency Operation and Safety Checks
- POST-OPERATIONAL TESTS AND FIELD DESIGN MODIFICATIONS
  - Pressure Test
  - Visual Inspection
  - Modifications

1,500 psig and 955 F. The steam flow rates are 15,000 to 20,000 lb/h. The steam is condensed and waste heat extracted by the heat rejection system. For some modes of receiver testing, high pressure steam may be supplied to the receiver by the auxiliary boiler which is to be fired using No. 2 fuel oil.

Provisions have been made for minimizing potential safety hazards to personnel engaged in Receiver Tower construction and operation. OSHA requirements will be applied to minimize hazards from normal operation of equipment. Movable safety platforms will be used for installation, maintenance, and removal of receivers at the tower roof. Safety nets and rails will also be utilized to reduce fall and falling object hazards inside and outside the tower. A lightning protection system will be installed and will conform to UL Standard 96A, Master Label Requirements. The fire protection system will conform to NFPA Standards and will include a sprinkler system, fire hose cabinets, and CO_2 extinguishers. Fire alarms will include rate-of-rise and fixed temperature detectors, manual fire alarms, and vibrating bells located throughout the tower. Stairways and exits will be provided in accordance with the Uniform Building Code and OSHA requirements and will have 2-hour fire ratings.

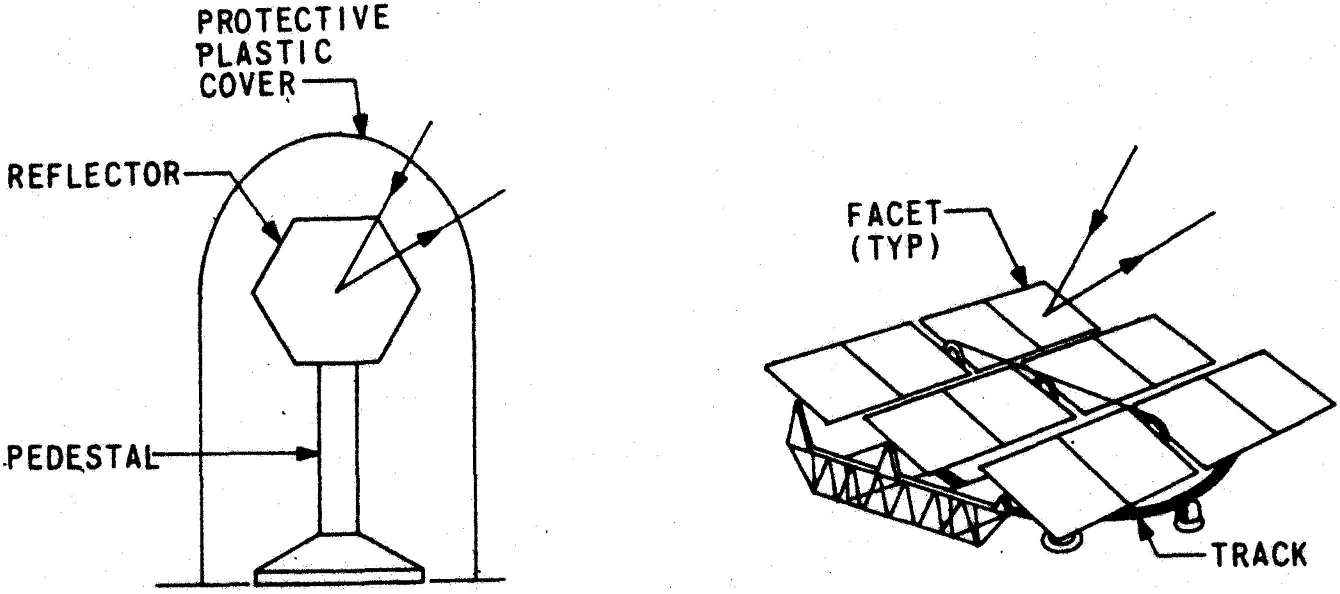
The most severe and unconventional safety hazard of tower operation will be the high intensity solar flux directed toward the receiver at the top of the tower. If personnel are exposed to this flux they could be blinded and burned. An indirect hazard would be damage to the structure or equipment from overheating or from exposure to stray flux. To prevent personnel exposure, a test warning and alarm system will notify personnel to evacuate the area. Safety interlocks will prevent personnel from entering the tower space above 40 feet anytime one or more heliostats is directed toward the receiver, and an interlock in the heliostat power supply will prevent heliostat operation while personnel are present in the tower above 40 feet. The structure and support equipment in the receiver area will be protected by a network of high-pressure fog nozzles actuated by a grid of temperature sensitive detectors. Protection will also be provided by air-cooled stainless steel louvers mounted on concrete surfaces in certain areas at the top of the tower. Heat transfer fluid flow, temperature and pressure sensors, remote-controlled television cameras, and other instrumentation will be utilized to ensure safe tower operation.

2.4 HELIOSTATS. There will be working heliostats and experimental heliostats deployed in circular strips around the Receiver Tower as shown on Figure 2. The largest heliostat field will be installed in a 90-degree north sector within inner and outer radii limits of 120 feet and 825 feet. There will also be a 360 degree, three-sector field between 120 and 410 feet radii limits. Space will be reserved in all the fields for a future expansion of at least 30 percent. The heliostat field will have paved access roads between heliostat strips for maintenance truck and mobile crane access. Ground surfaces will be gravel paved to protect soils and to minimize dust blowing onto heliostats. Power, control, and instrumentation cables will be installed in covered concrete trenches.

The working heliostat design has not been selected but is assumed to have a nominal reflection surface area of about 400 square feet. Approximately 300 of these heliostats would be required to achieve the 5 MWt solar flux power level for receiver testing. This flux level could be provided from the 90-degree north field or from the 360-degree field. Heliostats will be capable of being moved from one field position to another or of being refocused at one position. Remote computer controls will be programmable to provide any required flux distribution at the receiver within the constraints of field geometry. The designs of experimental heliostats that have been identified for testing are shown on Figure 6. Foundations for experimental heliostats will be provided in isolated locations and in arrays throughout the working heliostat fields and elsewhere. The heliostat pedestal foundations will be concrete. Approximately 600 heliostat foundations will be required.

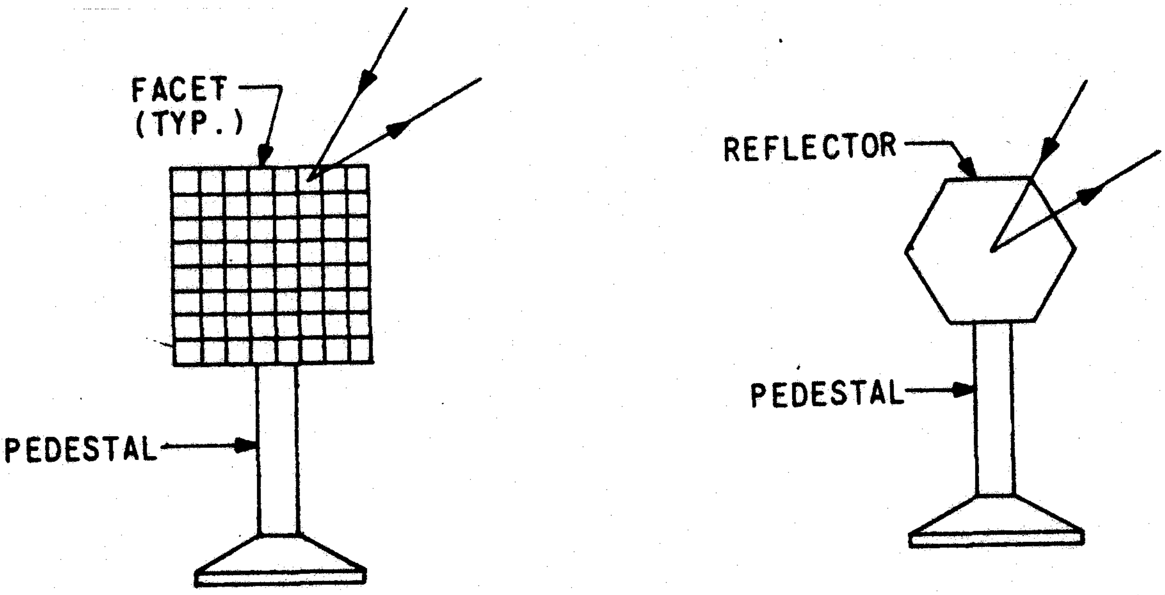
Working heliostats will be operated primarily for experimental receiver testing. With future additions of water-cooled shields, flux redirectors and other devices at the Receiver Tower, high-temperature processing or materials research and testing could be performed utilizing the working heliostats. A flux intensity of 1.5 MW/m^2 average and a total 5.5 MWt total flux (5-hour average) can be obtained within the planned working heliostat capability. Theoretical calculations indicate the maximum potential temperature which might be achieved to be about 5,275 F. Practically, the upper temperature limit is about 3,140 F. The primary tests to be performed on experimental heliostats are listed in Table 2. Heliostat reflector surfaces will require periodic cleaning with demineralized water.

There may be potential safety hazards associated with heliostat operation. Of primary concern are momentary coincidences of beams reflected from heliostats during slewing operations. That is, beams may intersect when sweeping into or out of focus on the receiver or target area. Protection for such momentary concentrations of solar flux will be provided for personnel in nearby buildings and in other areas potentially subject to such hazards. Windows in the Assembly Building and Administration and Control Building facing heliostat fields will be equipped with glare reducing glass and with interior vertical blinds to protect occupants during tests.



BOEING

HONEYWELL



MARTIN MARIETTA

MCDONNELL DOUGLAS

PILOT PLANT
HELIOSTAT CONCEPTS

FIGURE 6

TABLE 2

PRIMARY TESTS TO BE PERFORMED ON HELIOSTATS

INDIVIDUAL HELIOSTATS

- TRACKING TESTS

  Azimuth and Elevation vs. Time
  Sensitivity to Wind, Temperature Changes
  Restart After Power Loss
  Restart After Emergency Shutdown
  Restart After Stow Mode
  Update Aimpoint After Error Detection

- OPTICAL TESTS

  Image Shape and Size vs. Distance
  Image Brightness vs. Distance
  Sensitivity to Heliostat Position
  Sensitivity to Rain, Dust, Age

- EXTENDED OPERATION TESTS

  Blowing Sand
  Rain, Ice, Snow
  Wind
  Temperature Extremes

HELIOSTAT ARRAYS

- OPTICAL TESTS

  Combined Image Size, Shape, Brightness vs. Distance
  Sensitivity to Wind and Temperature Changes
  Shadowing/Blocking

- OPERATIONAL CONTROL

  Different Control Mechanisms - Open Loop Computer, Closed Loop
  Response to Wind Gusts, Cloud Passage, Temperature Changes
  Aim Strategies

Exclusion zones may be established, if required, to avoid eye hazards to aircraft crews and passengers. As described in paragraph 2.3, there will be a dual interlock system which will prevent personnel entry into the Receiver Tower above 40 feet when one or more heliostats are directed toward the receiver, and which will prevent heliostat operation when personnel are present in the Receiver Tower above 40 feet.

2.5 THERMAL STORAGE TANKS. The STTF will have the capability of testing a wide range of thermal storage mechanisms. Essential provisions include a supply of auxiliary steam (18,000 lb/h @ 1,300 psia, 955 F) for charging storage; and a heat rejection system to cool the working fluid and to provide low pressure feedwater (12,800 lb/h @ 650 psia, 350 F) to the thermal storage modules for discharge of stored heat.

Reinforced concrete foundations for thermal storage tanks and insulation between tanks and foundations will be provided according to the specific requirements of each type module tested.

The experimental thermal storage mechanisms identified for testing utilize fusible or molten salts, hydrocarbon oil, or petroleum-based fluid as storage media, charged or discharged via steam. Sulfur trioxide fluid storage medium with helium as a working fluid is another mechanism which has been identified for testing. Table 3 lists the primary tests anticipated for these thermal storage subsystems. Working heliostats may be employed to perform integrated heliostat/receiver/storage subsystem tests.

Since hazardous materials will be utilized as thermal storage media, several safeguards will be employed. Earthen berms and/or retaining walls will be placed around thermal storage tanks. Permanently installed automatic actuating high expansion foam systems will be installed at the thermal storage tanks. Additional fire protection equipment will be installed as required for each type of storage. Personnel safety equipment and procedures will be

TABLE 3

PRIMARY TESTS TO BE PERFORMED ON THERMAL STORAGE UNITS

PERFORMANCE TESTS

- Charge/Discharge Cycle - Flow Rates, Pressures, Temperatures
- Variable Charging Conditions

OPERATIONAL TESTS

- Life Cycling/Failure Modes
- Emergency/Safety

TABLE 4

TYPICAL COOLING TOWER DRIFT ANALYSIS

Ions	Concentration (mg/1)
Calcium	250
Magnesium	45
Sodium	100
Potassium	15
Bicarbonate	925
Sulfate	250
Chloride	55
Fluoride	5
NO_2+NO_3(as N)	5
PO_4	5
Silica	150
Total Dissolved Solids	1805

2.8 WATER SUPPLY AND TREATMENT. The STTF will be connected to existing nearby water lines. These lines are part of the Sandia Laboratories water system which is supplied by wells. There will be a primary supply from two existing 100,000-gallon water towers about 3,600 feet southeast, and a backup tie with an existing 700,000-gallon storage tank about 4,800 feet northwest of the site.

The water system will provide water for fire protection, steam, cooling, and general service. The design demand flow will be based on the largest flow required for fire protection of any building or structure, or other flows, whichever is greater, but not less than 1,250 gpm. Since the water supply is potable, the only water treatment will be demineralization to provide water for steam and for cleaning of heliostat reflector surfaces. The demineralizer will be a mixed-bed ion exchange type. A 5,000-gallon demineralized water storage tank will be installed 3 feet below grade.

2.9 WASTEWATER TREATMENT. All wastewater from the STTF will be treated in accordance with applicable standards. Primary wastes will include sanitary wastes, boiler blowdown, demineralizer regeneration wastes, cooling tower blowdown, and miscellaneous laboratory wastes. A sewerage system, common to major buildings, will convey sanitary and nontoxic wastes to a septic tank with a tile lateral field designed in conformance with USPHS Publication No. 526, Manual of Septic Tank Practice. Toxic and other hazardous wastes will be treated onsite or transported off-site for disposal.

2.10 MISCELLANEOUS FACILITIES.

2.10.1 Roads, Parking, and Storage Areas. All major functional areas of the STTF will be connected by a service road network as shown on Figure 2. Pavement type and load bearing capacity will vary according to the anticipated duty. To reduce air-borne dust, temporary roads, parking, and storage areas will be gravel paved with a bituminous binder covered with chat.

There will be 50, 20, 5 and 6 parking spaces for the Administration and Control Building, Assembly Building, Boiler Building and Receiver Tower, respectively.

2.10.2 Drainage. A site drainage system consisting of storm drains, gutters, culverts, and catchment basins will be provided to facilitate drainage and to control runoff. Areas subject to disturbance will be graveled to maintain existing sheet drainage and to minimize soil erosion. The overall design objective will be to maintain existing area drainage patterns, where possible, so as to minimize disturbance of off-site areas.

2.10.3 Normal and Emergency Power Supply. Electrical service to the site will be provided by a new 44-5-kV substation. This service will utilize existing and new 44-kV overhead lines and an underground 5-kV system onsite. A new 44-kV overhead line will be provided from the existing distribution system. Approximately 6,000 feet of overhead line will be installed with a 44-kV disconnect switch at the existing line and at the new substation. The new substation will be located approximately 500 feet east of the Administration and Control Building.

An uninterruptible, regulated, or backup power system or systems will be provided to serve the computer and control of the heliostats. This system will be to provide continuous operation of the computer, heliostats, and associated systems to safely curtail plant operation during normal power failure. The system will provide 75 kW of 120/208-volt power.

2.10.4 Meteorological Monitoring Instrumentation. Weather and insolation instruments mounted on the roof of or on the ground adjacent to the Administration and Control Building will include:

- Temperature sensor
- Relative humidity sensor
- Barometer

- Pyranometer
- Pyrheliometer and equatorial mount
- Steady wind vane
- Steady wind anemometer
- Heated precipitation gage
- Net radiometer
- All-sky camera
- Nephelometer
- Rawinsonde

In addition, a 200-foot meterological instrument tower will be required to support a microwave relay antenna near its top. The following instruments will be required at the top of the tower.

- Temperature sensor
- Steady wind vane
- Steady wind anemometer
- Gust wind vane
- Gust wind anemometer

Weather data will form inputs to the computer control system for testing operations.

2.10.5 Visitor Facilities. An outdoor area will be provided for displaying large outmoded test equipment and other exhibits for the public. This area will be located outside the testing area perimeter security fence to facilitate access and to ensure public safety.

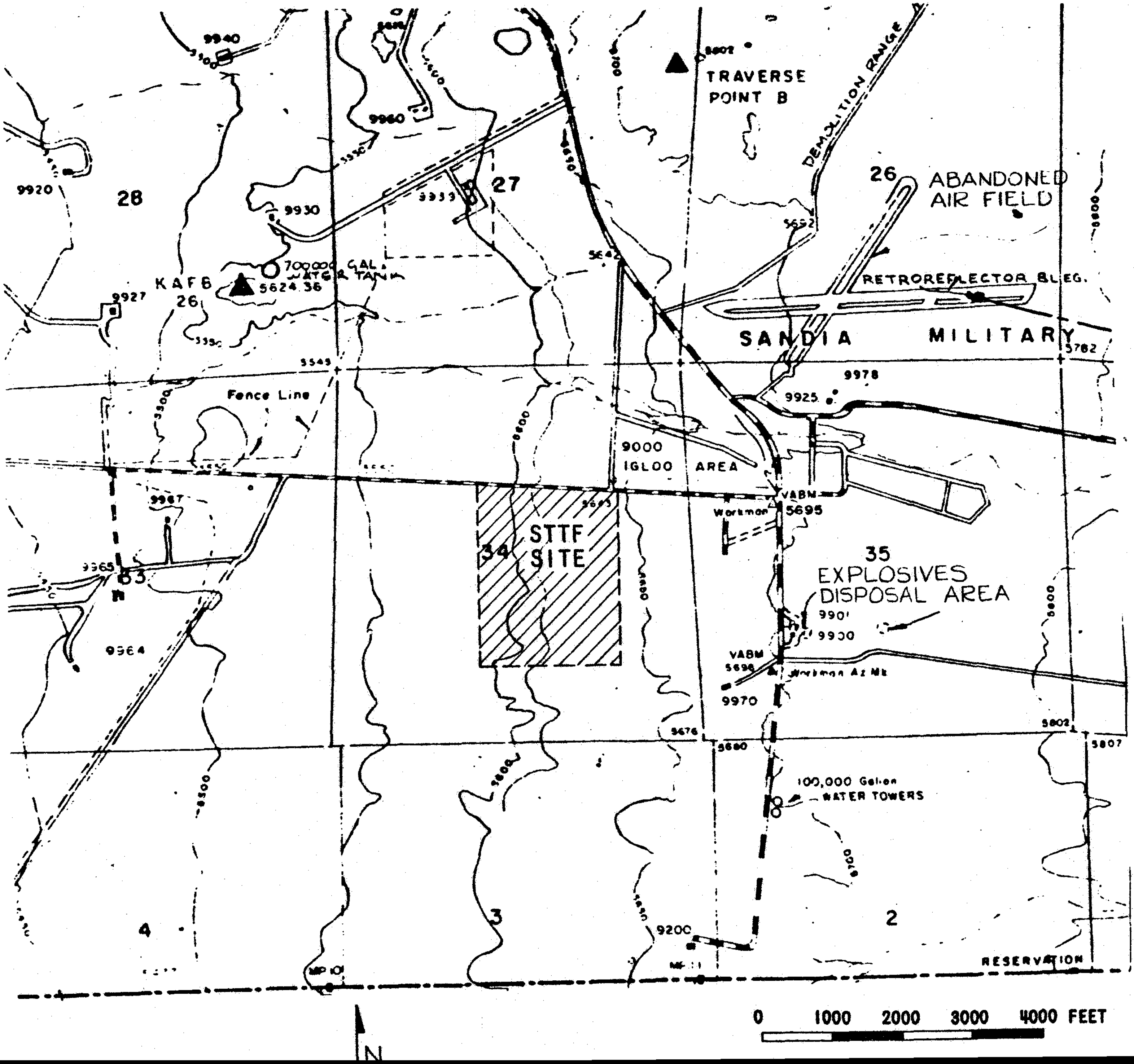
The Administration and Control Building will have a Reception Room, an adjacent Display Area, and Program Presentation and Conference Rooms. The Reception Room will have space for a receptionist and seating for about 8 visitors. The Program Presentation Room for public and contractor solar test-related audio-visual programs will have seating for 56 people, and will include a projection room and program preparation room. Public programs will provide educational information on the solar thermal test facility. Contractor programs will provide for the introduction and explanation of the facility and test briefings. Provision for large contractor coordination meetings will be included. The Program Preparation Room will provide space for preparation of technical program presentations and storage of prepared programs. A conference room will be provided for small adminstrative and technical conferences for contractor and facility personnel. The Project Room will provide space for rear screen projectors, audio system, and a control desk. An open-air Observation Deck will also be provided. A library for test reports, reference materials, and solar power-related periodicals will also be available.

3. STTF SITE ENVIRONMENT DESCRIPTION.

The description of the STTF site and environs is based primarily on a site reconnaissance which occurred in October 1975, and on an unrelated environmental assessment entitled Omnibus Environmental Assessment, Sandia Laboratories, Albuquerque, New Mexico, June 1975. The reconnaissance was performed to determine site ecological characteristics. The 115-acre STTF site is located in a remote southern area of the Kirtland Air Force Base on land which has been relatively undisturbed for at least 30 years, with the nearest Base boundry approximately 6,000 feet south of the site. The general area is known as Coyote Test Field. The Base is on an arid plateau gently sloping westward from the base of the Manzano Mountains to the Rio Grande River. Locally this area is referred to as the East Mesa.

3.1 DEMOGRAPHY AND LAND USE. The STTF site is 7 miles south of the nearest Base housing area, and the nearest off-Base housing is about 4 miles west. The nearest off-Base area is the Isleta Pueblo Indian Reservation, 6,000 feet to the south. Isleta Pueblo is located 7 miles southwest of the Base on the Rio Grande River. The Reservation lands south of the Base are used solely for grazing. The City of Albuquerque abuts the Base on the west and north. The 1970 Census population was 243,751 within the city limits and 315,774 in the metropolitan area. Officially, the Coyote Test Field is closed to the public except for authorized visitors and Base personnel; however, there are unauthorized recreational uses of the area.

Coyote Test Field road network and testing facilities near the site are shown on Figure 7. A medium duty east-west asphalt road provides



COYOTE TEST FIELD NEAR STTF SITE

FIGURE 7

direct access to the site. The area north of the site has been used for small explosive testing. Explosive storage igloos are one-half mile northeast; Lovelace Foundation Laboratory is one mile south-southeast; a radar antenna field adjacent to the south; the Explosive Assembly Building one mile west; and Shock Tube Facilities between one and two miles west. As suggested by these facility names, many entail fielding hazardous experiments usually involving detonation of large quantities of chemical explosives.

The site is located two miles south of the center line of a Low Altitude Federal Airway (V-12S-68N) with a floor 1,200 feet above the surface. Air traffic associated with Albuquerque International Airport utilizes this 8-mile wide controlled airway to pass through the Manzano Mountains. There are existing agreements with the Federal Aviation Administration for control and coordination of air traffic with Base testing activities that are potentially hazardous to aircraft.

3.2 HISTORIC AND ARCHAEOLOGICAL SITES. An archaeological survey of the STTF site was conducted by the Eastern New Mexico University, Agency of Conservation Archaeology under U. S. Antiquities Act Permit No. 76-NM-052. No historic or archaeological resources were discovered.

3.3 GEOLOGY AND SEISMOLOGY. The site is located in the eastern portion of the Albuquerque-Belen Basin, bounded by the Sandia and Manzano Mountains on the east, the Lucero uplift and Puerco plateau on the west, Nacimiento uplift on the north, and the Socorro Channel on the south. The Basin is filled with poorly consolidated Cenozoic sediments, which are complex sequences of sand, silt, clay and caliche. These sediments are on the order of 5,000 feet thick in the eastern margin of the Basin. There are no commercial near-surface mineral deposits known to exist in the Coyote Test Field, nor any known oil or gas deposits.

The Albuquerque area is classified as a Uniform Building Code, Seismic Risk Zone 2. This is a moderate damage risk corresponding to a Modified Mercalli Intensity VII, producing a ground acceleration of about 0.1 g. For the period of record beginning in 1852, there have been ten earthquakes with estimated intensities of VII in New Mexico. Most of these major earthquakes have occurred near Socorro, 70 miles south of Sandia Base. The most severe earthquake recorded in the Albuquerque area occurred in 1971 and was Intensity VII.

The site soils are derived from weathering of poorly consolidated colluvium. The sand fraction predominates with the remainder primarily silt- and clay-size particles. In small, shallow drainageways, clay covers the surface. This clay layer shrinks and cracks when it dries. Soils on drainage slopes form a thin crust which breaks under slight pressure. The soil under this crust is loose and fine-grained and is highly susceptible to wind or water erosion. Some areas have a thin pebble surface layer. Borings in nearby areas have revealed indurated caliche layers within a few feet of the surfaces. Generally, the soils have a low permeability, and infiltration of runoff is not significant.

3.4 HYDROLOGY. Drainage on the site consists of sheet flow into small, shallow swales, which drain into arroyos. The average surface gradient across the site is about 150 feet per mile in the west-southwesterly direction. The area drainage flows into large arroyos on the Isleta Pueblo Reservation, then into the Rio Grande River about 10 miles west. There are no natural lakes in the area and all drainage flows are intermittent, occurring only during periods of precipitation.

The impervious nature of subsoils results in practically no recharge of ground water. The water table occurs at a depth on the order of 500 feet. Its gradient is about 10 feet per mile west where it intercepts the Rio Grande River. Recharge occurs primarily from the Rio Grande, and to much lesser extent from alluvial fans at the base of the Sandia and Manzano Mountains. Ground water serves as the principal source of water supply for the Albuquerque Area. U.S. Geological Survey projections made in 1967 estimated that the water table on the East Mesa will have lowered from 30 to 50 feet by the year 2000.

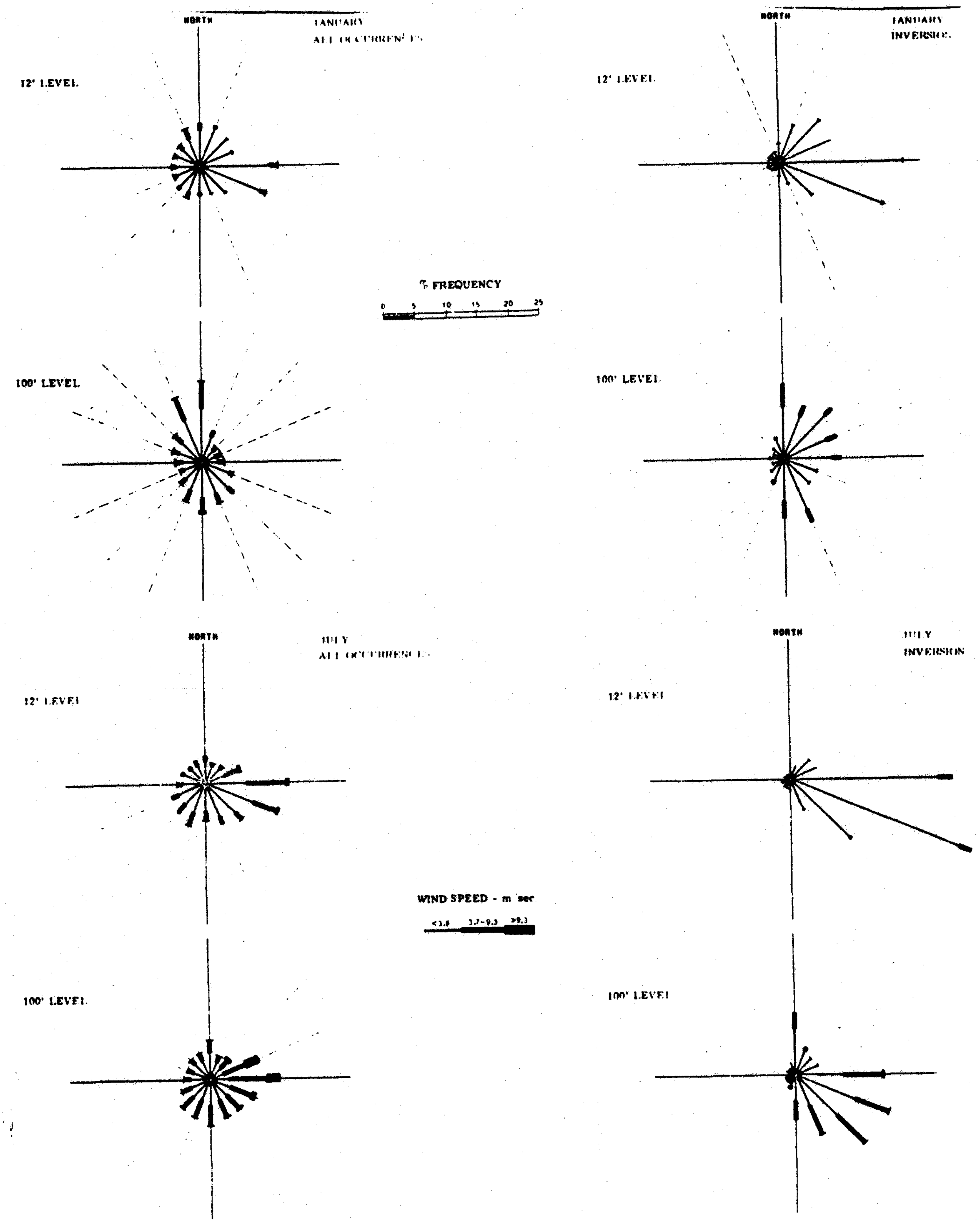
3.5 METEOROLOGY. Albuquerque has a high-altitude, dry continental type climate. There is a wide diurnal temperature variation of about 25 F. Extreme temperatures seldom exceed the 0 to 100 F range. Winter daytime temperatures average 50 F, and summer daytime mean maxima are less than 90 F except in July, when it is 92 F. There is frequent rapid radiational cooling of the ground after sunset, resulting in strong temperature inversions. Inversions persist until heating of the inversion layer occurs the following morning.

The average annual precipitation is about 8 inches. It usually occurs in late afternoon and evening as brief, and often intense, scattered thundershowers. Thirty-five percent of annual precipitation occurs in July and August; and 20 percent during September and October. Annual average snowfall is about 10 inches occurring primarily in the months December through March. Average annual relative humidity is 46 percent.

The prevailing winds are easterly, except during winter when they are northerly at an elevation of 100 feet. The annual average wind velocity is about 9 miles per hour. During late winter and early spring months, the average velocity is higher and occasional dust storms occur. On an average of 46 days during the year the maximum velocity attains 32 miles per hour. There are significant orographic effects on the wind regime of the Base. Drainage winds from the Sandia and Manzano Mountains flow down canyons into arroyos dissecting the East Mesa. When inversion conditions occur, these winds entrain air movements across the Mesa within the inversion layer until the inversion dissipates. The effects of these drainage winds can be observed on Figure 8, which displays wind roses for January and July for all occurrences and for inversion occurrences at 12-foot and 100-foot elevations. These measurements were obtained for a ten-year period at a meteorological tower approximately 3 miles northwest of the STTF site.

From sunrise to sunset clear days occur about 48 percent of the year, partly cloudy days 30 percent, and cloudy days 22 percent of the year. Partly cloudy periods usually occur in late afternoon. Due to the 5600-foot elevation, sunlight is intense. The direct component of insolation attains maximum values of about 1.05 kW/m^2. On the typical annual day, direct insolation exceeds 0.8 kW/m^2 during six hours, and exceeds 0.9 kW/m^2 during four hours. Normal annual heating-degree days are 4,292 (base 65 F).

Meteorological extremes include temperatures of 104 F and -17 F; and a record 24-hour precipitation of 1.92 inches. A 90 mile per hour wind gust lasting at least 1 to 5 seconds is expected to occur once in 60 years.



WIND ROSES DURING JANUARY AND JULY,
10-YEAR AVERAGES OF ALL OCCURRENCES
AND INVERSION CONDITIONS NEAR STTF

FIGURE 8

Every two years a one-minute duration 60 mile per hour gust is expected. Only two tornadoes have been recorded in the Albuquerque area during the last 20 years.

3.6 ECOLOGY.

3.6.1 Flora.

The 115-acre STTF site offers a very limited variety of habitats for vegetation. Consequently, the diversity of vegetation is similarly limited relative to the entire Albuquerque area.

The only vegetative association on the area is a shrub-grassland association. Within this association the dominant shrub species are winterfat (Eurotia lanata), broom snakeweed (Guterierrezia sarothrae), and oldman wormwood (Artemisia drancunculoides). The dominant grasses are black grama (Bouteloua eriopoda), burro grass (Scleropogon brevifolius), ring muhly (Muhlenbergia torreyi), sand dropseed (Sporobolus cryptandrus), and spike dropseed (S. contractus). Any of these can and do dominate locally, and occur from place to place on the site in almost pure stands.

Table 5 lists all species of plants observed during the site reconnaissance in late October 1975. Further sampling at other seasons of the year would undoubtedly reveal additional species. These species, however, would be predominantly ephemeral spring forbs and would not dominate the community or interact substantively with other species on the site.

The site has not been grazed for at least 30 years and is undisturbed except for a recent water line right-of-way and a road on the north perimeter. Fewer species of plants occur on the disturbed areas. The dominant plants on disturbed areas are Russian thistle (Salsola kali),

TABLE 5 (Continued)

SCIENTIFIC NAME	COMMON NAME
Cruciferae	Mustard family
Lesquerella fendleri (Gray) Wats.	Bladderpod
Descurainia sp.	Tansy mustard
Leguminosae	Pea family
Dalea nana Torr. in A. Gray	Dwarf indigo bush
Astragalus sp.	Milkvetch
Maluaceae	Mallow family
Sphaeralcea incana Torr. in Gray	Globe mallow
Loasacae	Loasa family
Mentzelia pumila (Nutt.) T.& G.	Stickleaf
Cactaceae	Cactus family
Opuntia arborescens Engelm	Cholla
Opuntia fragilis (Nutt.) Haw.	Prickly pear
Opuntia polyacantha Haw.	Prickly pear
Onagraceae	Evening primrose family
Oenothora albicaulis Pursh.	Evening primrose
Asclepiadaceae	Milkweed family
Asclepias latifolia (Torr.) Raf.	Broad-leaf milkweed
Polemoniaceae	Phlox family
Gilia attenuata (Gray) A. Nels.	Scarlet gilia
Boraginaceae	Borage family
Lappula redowskii (Hornem.) Greene	Stickseed
Verbenaceae	Vervain family
Verbena bracteata Lag. & Rodr.	Prostrate vervain
Solanaceae	Potato family
Physalis hederaefolia A. Grey	Ground cherry
Solanum claeagnifolium Cav.	Horse nettle

TABLE 5 (Continued)

SCIENTIFIC NAME	COMMON NAME
Scrophulariaceae	Figwort family
Mimulus glabratus H.B.K.	Monkey flower
Plantaginaceae	Plantain family
Plantago patagonica	Wooly Indian wheat
Curcubitaceae	Gourd family
Curcubita foetidissima H.B.K.	Buffalo gourd
Compositae	Thistle family
Grindelia aphanactis Rydb.	Gumweed
Gutierrezia sarothrae (Pursh.) Britt & Rusby	Broom snakeweed
Haplopappus gracilis (Nutt.) A. Gray	Goldenweed
Erigeron divergens T. & G.	Spreading fleabane
Aster spp.	Aster
Artemisia dracunculus L.	Oldman wormwood
Thelesperma megapotamicum (Spreng.) Kuntze	Hopi tea
Helianthus annuus L.	Annual sunflower
Tetradymia canescens DC.	Horsebrush
Cirsium neomexicanum A. Gray	New Mexico thistle
Lactuca sp.	Wild lettuce
Agoseris sp.	Mountain dandelion

oldman wormwood, and broom snakeweed. Of the grasses that do occur on disturbed areas, burro grass, ring muhly, and galleta grass (*Hilaria jamesii*) are most frequent.

Despite the absence of grazing for many years, evidences of past overgrazing are still apparent (e.g., the presence of burro grass and ring muhly). Total recovery of such areas in the arid Southwest may require several lifetimes (Potter & Krenetsky, 1967). Present lack of grazing pressure is slowly resulting in the decrease of these undesirable forage species as they are gradually replaced with plants less tolerant of grazing pressure. The complete lack of grazing pressure allows the species currently on the site to develop to their full height, and this results in the accumulation of material which could pose a fire hazard at certain seasons of the year.

Several subassociations were observed on the site. The bottoms of the shallow swales support a higher density of oldman wormwood than high areas between swales, reflecting increased moisture availability. The sides of the swales support an increased density of broom snakeweed. It is not known whether this higher density represents increased disturbance (caused by increased erosion) or a difference in water availability.

3.6.2 Fauna.

3.6.2.1 Reptiles and Amphibians. Because the site has no permanent water and rain pools evaporate rapidly, amphibians are not expected to occur as residents on the site. The possibility of transient amphibians, however, cannot be discounted.

A number of reptiles (Table 6) may occur on the site. These are primarily insectivorous forms of small size, but the larger snakes (including rattlesnakes) may occur. No reptiles or reptile signs were observed; however, it was late October during a period of reptile inactivity.

3.6.2.2 Birds. The simple site ecosystem represented precludes the occurrence of many species of birds. The lack of complex vegetation is the major limiting factor, and only those birds that breed in grasses and low shrubs will find conditions on the site suitable for habitation. Table 7 lists species which may use the site for breeding and nesting.

Other birds may be transients that pass through the site or use the site for foraging. An example of the latter use would be hunting by any of the raptorial birds present in the surrounding area. The only bird seen on the site proper was the burrowing owl (*Speotyto cunicularia*). Of the species listed in Table 7 and which probably reside on the site during spring and summer, most are insectivorous or seed eaters.

3.6.2.3 Mammals. Table 8 lists mammals which may reside on the site. While no mammals were actually observed, identifiable signs were observed indicating use of the site by the desert cottontail (*Sylvilagus auduboni*), the coyote (*Canis laternas*), the striped skunk (*Mephitis mephitis*), and several species of small rodents, including pocket gophers and mice.

Coyotes probably do not den on the site, but prominent coyote "highways" were observed on the bottoms of some swales, indicating that the site is used extensively for travel between areas to the east and west. A kill found on the site also indicates that coyotes feed on the extensive small rodent population. Numerous burrows and dusting areas suggest substantial rodent populations.

TABLE 6

REPTILES WHICH MAY OCCUR ON THE STTF SITE*

SCIENTIFIC NAME	COMMON NAME
Chelydridae	Snapping, Musk, and Mud Turtles
Terrapene ornata	Western box turtle
Iguanidae	
Holbrookia maculata	Lesser earless lizard
Sceloporus undulatus	Eastern fence lizard
Phrynosoma cornutum	Texas horned lizard
Phrynosoma douglassi	Short-horned lizard
Scincidae	Skinks
Eumeces obsoletus	Great plains skink
Eumeces multivirgatus	Many-lined skink
Teiidae	Whiptails
Cnemidophorus inornatus	Little striped whiptail
Cnemidophorus exsanguis	Chihuahua whiptail
Colubridae	
Masticophis flagellum	Coachwhip
Pituophis melanoleucus	Bullsnake
Rhinocheilus leucontei	Long-nosed snake
Viperidae	Vipers
Crotalus atrox	Western diamondback rattlesnake
Crotalus viridis	Prairie rattlesnake

*From Stebbins (1966).

TABLE 7

BIRDS WHICH MAY OCCUR ON THE STTF SITE*

SCIENTIFIC NAME	COMMON NAME
Phasianidae	
Callipepla squamata	Scaled quail
Columbidae	
Zenaida marcroura	Mourning dove
Cuculidae	
Geococcyx californianus	Roadrunner
Strigidae	
Glaucidium gnoma	Pygmy owl
Speotyto cunicularia	Burrowing owl
Caprimulgidae	
Chordeiles minor	Common nighthawk
Tyrannidae	
Tyrannus verticalis	Western kingbird
Alaudidae	
Emerophila alpestris	Horned lark
Corvidae	
Corvus brachyrhynchos	Common crow
Mimidae	
Mimus polyglottos	Mockingbird
Sturnidae	
Sturnus vulgaris	Starling
Ploceidae	
Passer domesticus	House sparrow

*From American Ornithologists' Union (1957, 1973).

TABLE 7 (Continued)

SCIENTIFIC NAME	COMMON NAME
Icteridae	
Sturnella neglecta	Western meadowlark
Fringillidae	
Passerina cyanea	Indigo bunting
Carpodacus mexicana	House finch
Calamospiza melanocorys	Lark bunting
Passerculus sandwichensis	Savannah sparrow
Pooecetes gramineus	Vesper sparrow
Amphispiza bilineata	Black-throated sparrow
Amphispiza bellii	Sage sparrow
Spizella breweri	Brewer's sparrow
Zonotrichia leucophrys	White-crowned sparrow
Calcarius ornatus	Chestnut-collared longspur

TABLE 8

MAMMALS WHICH MAY OCCUR ON THE STTF SITE*

SCIENTIFIC NAME	COMMON NAME
Leporidae	Hare family
Sylvilagus audobonii	Desert cottontail
Lepus californicus	Black-tailed jackrabbit
Sciuridae	Squirrel family
Ammospermophilus leucurus	White-tailed antelope squirrel
Spermophilus spilosoma	Spotted ground squirrel
Geomyidae	Pocket gopher family
Thomomys umbrinus	Southern pocket gopher
Cratogeomys castanops	Yellow-faced pocket gopher
Heteromyidae	
Perognathus flavus	Silky pocket mouse
Perognathus hispidus	Hispid pocket mouse
Dipodomys ordii	Ord's kangaroo rat
Dipodomys spectabilis	Banner-tailed kangaroo rat
Cricetidae	
Reithrodontomys megalotis	Western harvest mouse
Peromyscus maniculatus	Deer mouse
Onychomys leucogaster	Northern grasshopper mouse
Neotoma albigula	White-throated wood rat
Canidae	Wolves, Coyote, Dogs, Foxes
Canis laterans	Coyote
Vulpes macrotis	Kit fox
Mustela frenata	Long-tailed weasel
Taxidea taxus	Badger
Mephitis mephitis	Striped skunk
Conepatus mesoleucus	Hog-nosed skunk

*From Hall and Kelson (1959).

Most of the rodents feed primarily on vegetation and seeds. These foods are plentiful because of the lack of plant utilization by large grazing animals. Thus, the rodent population is relatively high under the current regime.

3.6.3 Ecological Relationships. Vegetation is predominately grasses with scattered shrubs. The lack of recent grazing is allowing species composition to gradually change toward species less tolerant of repeated short cropping. The lack of grazing by large herbivores also increases the availability of seed and vegetation utilized by animal species for food and shelter. This allows larger populations of small mammals and some birds to develop than could be supported by the site if it were grazed. Non-use and increased vegetative growth probably also allow increased terrestrial invertebrate populations which provide additional food for insectivorous birds and mammals. The greater small mammal and bird populations attract predaceous birds and mammals.

Because the site lacks permanent surface water and such water supplies are not located close to the site, animals dependent on surface water other than dew probably do not reside on the site. These species primarily include the larger carnivorous mammals such as coyotes and foxes.

While relatively few species can be expected to reside on the site, many more can be expected to utilize the site at certain times. Such uses may be frequent, for example, hunting by raptorial birds or other predators. More infrequent uses may include, for example, resting by some bird species during migration.

No rare, endangered or threatened species are known to occur in the area.

4. ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND FACILITY CONSTRUCTION.

4.1 PHYSICAL EFFECTS. The primary physical effects on air, land and water will derive from excavation and grading. Removal of vegetation cover and movements of vehicles will expose the highly erodible soil to wind and water erosion losses. As described in Section 2.10.2, a site drainage system will include catchment basins and drainage controls, and graveling to minimize siltation of runoff. Dust palliatives such as sprinkling may also be employed to minimize airborne dust. Site drainage control will be designed to maintain off-site drainage patterns.

4.2 ECOLOGICAL EFFECTS. Existing ecological elements and relationships on the site will be radically altered by construction of the STTF. The small size of the site relative to similar surrounding open areas indicates insignificant indirect effects on ecological relationships of the Coyote Test Field area.

Most of the large, timid animals (e.g., coyotes, foxes, and several bird species) will be displaced from the area. If the planned chain-link fence is properly installed, such animals as coyotes, foxes, skunks, and rabbits will be excluded from the area. The removal of a large proportion of the available cover and the leveling of the swales will probably make the site uninhabitable to many of the smaller animals that presently occur on the site. In addition, the increased human activity will cause most species to move from the site.

As long as existing vegetation remains undisturbed and revegetation provides food and cover, such small species as mice and gophers will probably remain in unutilized area of the facility. The exclusion of their major predators by fencing may allow an increased density of these species in the areas in which they remain, but the overall effect will probably be a reduction in total numbers on the site. Raptors which are not resident on the site but which now utilize it for hunting may still hunt on the site; however, the decreased prey populations and increased human activity will significantly reduce their presence.

Because the site will be fenced, such species as coyotes which currently use the site as a travel route will be forced to detour around it. This is probably of no ecological significance. There is ample similar territory surrounding the site which can absorb such changes in habits. The major ecological effect would appear to be the loss of approximately 100 acres of habitat to many of those species which reside there. Increased populations in surrounding areas will rapidly readjust to levels supportable by the carrying capacities of these ecosystems after an influx of animals from the site.

4.3 SOCIOECONOMIC EFFECTS. There are no existing human uses of the site, and construction is not expected to interfere with nearby testing activities. Since the access to the general area is restricted, minor additional controls of construction traffic may be required. A 36-month construction period is planned, with an average work force estimated to be about 50. The total cost of construction is projected to $22.4 million. The direct employment will be a minor effect on total metropolitan employment. The local capital expenditures may constitute a significant fraction of the total Sandia Laboratories purchasing activity in New Mexico which has recently been on the order of $30 million annually.

5. ENVIRONMENTAL EFFECTS OF FACILITY OPERATION.

Since the STTF is an experimental facility, testing operations may involve unforeseen effects. An attempt has been made to describe the nature of anticipated normal effects of operation within the limits of available design and performance data. Additional data needs are suggested which might resolve such uncertainties.

5.1 HELIOSTAT EFFECTS. Potential effects of heliostats would derive from the reflection and shading of sunlight. Shading will likely decrease soil temperature, which would tend to reduce evaporation of soil moisture. Collectors will also intercept precipitation perhaps increasing soil moisture between collectors. The net effect of these soil changes and direct shading of potential vegetation under and between heliostats is not known. Invertebrate populations and small mammals could be indirectly affected by any soil and vegetation changes. Small mammals, reptiles, and invertebrates could be attracted to the shade afforded by heliostats. The gravel paving of heliostat fields in order to reduce water and dust erosion, and especially to maintain clean collector surfaces, will preclude most of such potential biological effects. Future solar thermal facilities constructed at sites with less erodible soils may provide better habitat. Establishment of experimental vegetation and soil monitoring plots at the STTF could provide data for assessment of heliostat shading biological effects at larger-scale facilities.

When heliostats are focused on a receiver, the area near the receiver will have a high intensity solar flux. Since personnel will not be permitted in the Receiver Tower above 40 feet during heliostat testing, there should not be any safety risk. Occasional bird flights through the solar flux outside the focal area are expected to have a low probability of bird injury and, consequently, no ecologically significant bird losses are articipated. Birds of prey may nest or perch on the Receiver Tower. Periodic inspections of the receiver area for nests and other evidence of bird use, as well as occasional scans with the television cameras mounted at the top of the tower, should be performed to determine their presence. If these uses occur and are otherwise uncontrollable, alarms or other measures should be considered to drive birds away from the focal area during periods of heliostat field operation, thus avoiding their injury.

Focusing and defocusing operations may result in momentary coincidental beams reflected from two or more heliostats. These slewing operations, and conceivably stationary defocused heliostats, could present glare hazards to personnel at the STTF, especially in adjacent buildings above ground level, or to crew or passengers of aircraft over the area. Planned design and administrative safety measures should adequately protect STTF personnel. The probability and magnitude of any hazard to people in aircraft has not been quantitatively analyzed. The site is located within 2 miles of the centerline of a controlled federal airway with a floor 1,200 feet above the surface, and is subject to an existing coordination agreement with the Federal Aviation Administration concerning overflights of test areas. Several types of eye injury hazards may be of concern. There have been cases of iridodialysis or eye hemorrhage caused by rapid pupillary contraction in response to sunlight reflected from window panes (Duke-Elder & MacFaul, 1972). Photoretinitis or thermal damage to the retina is caused by constant fixation of the eye on the sun, rather than by fleeting, intermittent observation. This relatively low image intensity at aircraft range and likely very brief exposure of personnel in aircraft would probably preclude any retinal damage. Photophthalmia or snow-blindness caused by several hours exposure to reflected ultraviolet sunlight, would be an extremely unlikely hazard to ground personnel. Despite the apparent improbable nature of potential glare hazards to people in aircraft over the area, quantitative analyses should be performed to determine the need for aircraft flight controls and any other measures to ensure public safety. Such analyses will require detailed heliostat and heliostat field design and performance simulation data not currently available.

5.2 RECEIVER TOWER AND RECEIVER EFFECTS. Although Receiver Tower and Receiver operations pose many potential safety hazards, implementation of the planned design and administrative safeguard described in paragraph 2.3 should minimize any risk to STTF personnel. The planned 200-foot height of the Tower, with provisions for extension to a 300-foot height, should not pose a hazard to air navigation although subject to Federal Aviation Administration notification. This assessment is based on an existing agreement with the Federal Aviation Administration that all aircraft maintain a minimum 300-foot altitude above the Base. The Tower external design illustrated on Figure 3 is expected to create visual interest and not to be considered unaesthetic. Potential effects on raptorial birds in the receiver area from heliostat operation are discussed in paragraph 5.1. Auxiliary boiler and heat dissipation system operations supporting receiver testing are discussed in paragraphs 5.4 and 5.5.

5.3 THERMAL STORAGE EFFECTS. No environmental effects are anticipated from thermal storage testing except those from supporting heat dissipation system and auxiliary boiler operations. Potential thermal storage accident effects are discussed in paragraph 6.

5.4 AUXILIARY BOILER EFFECTS. The auxiliary boiler, as described in paragraph 2.6, will have a heat input capacity of about 29 MBtu per hour, and will be fired with No. 2 fuel oil. Auxiliary boiler operation at heat input capacity is estimated to result in particulate matter, sulfur dioxide, and nitrogen oxides (as nitrogen dioxide) emissions of 1, 9 to 20, and 9 to 15 pounds per hour, respectively. The opacity of emissions is estimated to be less than 20 percent, assuming the boiler is properly maintained.

Executive Order 11752 requires federal facility compliance with applicable federal and state air pollution control regulations effective under the Clean Air Act. Federal regulations (40 CFR 60) do not limit emissions from new oil-fired boilers with heat input capacities less than 250 MBtu per hour. State of New Mexico, Environmental Improvement Board, air quality control regulations (507, 605, 606) to not limit emissions from oil-fired boilers with heat inputs less than 1,000,000 MBtu per year. The auxiliary boiler will operate intermittently; however, assuming continuous operation at capacity level, the heat input would be about 254,000 MBtu per year. New Mexico regulation (401A) limits the opacity of boiler emissions to no more than 20 percent.

Due to the intermittent nature of boiler operation and low gaseous emission rates, it will not have significant impact on ambient air quality.

5.5 HEAT REJECTION EFFECTS. The heat rejection system will be operated to support receiver and thermal storage testing. As described in Section 2.7, heat will be rejected to the atmosphere by a wet mechanical draft cooling tower. Operation of the cooling tower would not be expected to create ground fog because of the meteorology and the small tower size. Water in the form of small droplets, called drift, will be discharged from the tower. Drift contains solids and other substances present in the cooling water. Larger drift droplets will fall out by gravity or impact surfaces exposed to air. A conservatively high drift rate approximation of 0.02 percent of the cooling water flow rate through the tower would result in about 3.5 gallons per minute of drift. As given in Table 4, the total dissolved solids concentration in drift would be about 1,800 mg/l; this would translate into a drift solids discharge rate of 0.053 pounds per minute or 3.2 pounds per hour.

The effects of drift are increased ambient air particulate matter, precipitation, and solids deposition. The magnitude of these effects were estimated by use of published mathematical models (Hosler, et al, 1972; Schrecker et al, 1974). Precipitation was estimated to be negligible. The maximum 24-hour average concentration of solids was estimated to be on the order of 5 micrograms per cubic meter or a very small percentage of the 150 micrograms per cubic meter, Federal ambient air quality standard. Maximum drift solids deposition was calculated to be 0.5 pound per acre per month, to occur approximately 300 feet west of the cooling tower. Within 500 feet of the tower deposition rates between 0.1 and 0.5 lb/ac-mo would be expected, with maximum deposition expected west and west-northwest of the tower. The magnitude of these effects on ambient natural elements is insignificant.

There has been speculation that solar thermal facilities may affect local meteorology by changing the local heat balance by interception of insolation that would have heated the ground, extraction of heat from the reflected light, and by rejection of waste heat to the atmosphere. A recent paper (Hanna and Gifford, 1975) assessing possible meteorological effects of large "energy parks", concluded that electrical generation on the order of 10,000 to 50,000 MWe would be required to reject sufficient heat to the atmosphere to modify local meteorology. Weather modification by heat rejected to the atmosphere would not result from STTF operation. Small temperature perturbations caused by such features as large lakes, or open areas surrounded by forests have been observed to produce clouds and other meteorological phenomena. These effects appear to be more a function of surface area size than the temperature differential. Although the critical area size for the occurrence of such effects is not well defined, it is definitely much larger than the area shaded by the heliostat fields. It is concluded that the STTF will not have any significant effects on local meteorology.

5.6 WATER SUPPLY AND WASTEWATER EFFECTS. The capacity of the existing area water supply system is adequate to meet the peak water demand and consumption of the STTF. As described in paragraph 2.9, all wastewater will be treated in accordance with applicable standards. Nearly all wastewater will be disposed in a septic tank with a tile lateral field. Since the groundwater table is at a depth of 500 feet, and the intervening sediments are unsaturated and impermeable no effects on groundwater are anticipated.

5.7 OTHER FACILITY EFFECTS. The STTF will require a staff of about 40 permanent personnel to conduct testing operations. Most of these will probably be reassignments of present Sandia Laboratories employees. Employment and operating expenditures would not significantly affect the local economy.

The new technological knowledge resulting from testing operation is the only significant socioeconomic effect from the STTF. This is viewed as a benefit accruing to the United States. Provisions of public education at the STTF will facilitate realization of this benefit, both nationally and locally.

The only cumulative or long-term environmental effects anticipated from the facility will be the modification of site soils by gravel paving. This will prevent reestablishment of a natural vegetative community and reduce the long-term wildlife carrying capacity of the site.

There are no known or anticipated potential conflicts of the facility with State, regional, or local plans and programs. A land use permit has been requested of the Kirtland Air Force Base site property administration.

6. ENVIRONMENTAL EFFECTS OF POSTULATED ACCIDENTS.

6.1 FIRES AND EXPLOSIONS. As described in paragraph 2., there will be fire detection and control measures adequate to contain fires and to ensure safety of operating personnel. The receiver auxiliary equipment in the tower, the Boiler Building, and possibly in the thermal storage tanks are the only equipment areas where explosions are at all likely to occur. Boiler explosions are very rare events because of the long experience in safe boiler design and operation. Receiver and thermal storage performance characteristics are not well known and may exceed calculated ranges. The planned instrumentation and control system should be capable of safely conducting tests to obtain performance data over the full range of operating conditions. The planned exclusion of personnel from the Receiver Tower above 40 feet and other hazardous areas during certain tests, and an extensive test warning and alarm system should minimize personnel exposure to potential fire and explosion hazards. The effects of any such accidents should be confined to the STTF and should not extend to adjacent areas.

6.2 HAZARDOUS MATERIAL RELEASES. Fuel oil for the auxiliary boiler will be stored in an underground tank which is unlikely to leak. However, the impermeable soil and lack of groundwater would contain any leakage. Small quantities of sulfuric acid and sodium hypochlorite will be stored for cooling water treatment. Storage tanks will have catchments sufficient to contain their contents. The thermal storage tanks, described in paragraph 2.5, may contain highly toxic hazardous materials such as liquid metals, salts, or sulfur trioxide. Commensurate safeguards are planned to control any accidental releases and to treat any personnel exposed to these substances. Except for gaseous storage media, releases would not be expected to move off-site. Gaseous releases should be well-dispersed before reaching populated areas.

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